Chapter 2

Country Review

December 2014

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CHAPTER 2
Country Review

Indonesia

1. Nuclear energy policy and development plan

1.1. Energy balances in Indonesia

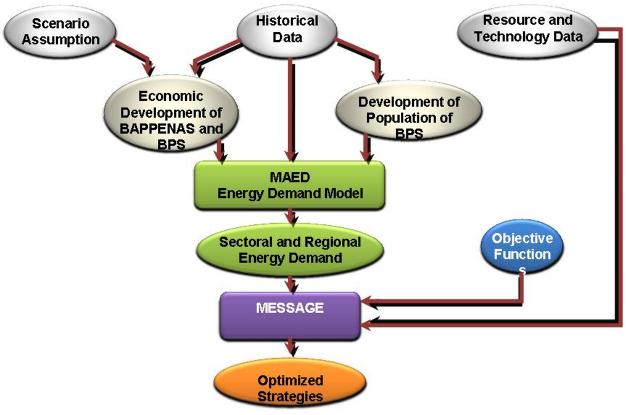
Over 95% of the total energy supply in Indonesia is currently supplied by fossil fuels, mainly oil. Indonesia's energy demand has been increasing as a result of economic development and population growth. To support this ever increasing energy demand, Indonesia had to rely heavily on oil import. As a net importer of oil since 2004, Indonesia is now facing very near-term oil resources depletion. The Government of Indonesia has decreed a policy on national energy mix to address the issue on energy supply security to reduce heavy dependence on oil, diversify energy, and promote environment-friendly development.

The medium-term and longer-term planning are expected to see a further increase in the share of coal and gas to supply Indonesia's energy demand, given its large amount of domestic resources. At the same time, this is expected to enhance the role of new and renewable energy (NRE) resources in energy supply. The use of NRE nationwide is still limited due to, among other things, high production costs and heavy subsidy on oil and liquefied petroleum gas (LPG). Nuclear energy has been included as part of the NRE to support energy security in the country and to support the national commitment to mitigate carbon emissions.

An energy planning tool, the Model for Assessment of Energy Demand (MAED), is used to calculate the projected energy demand up to 2050 given the current economic, social and energy conditions. Another tool, the Model of Energy Supply Strategy Alternatives and their General Environmental

Impacts (MESSAGE), makes use of the MAED result to evaluate energy alternatives for the same period given the constrained environmental consideration, i.e., low carbon dioxide (CO_2) scenario (Figure 2.1). This includes the role of nuclear power in the projected energy generation.

Figure 2.1: Work Flow of Demand–Supply Energy Analysis



1.2. Energy demand and energy intensity

The nationwide energy demand projections for 2010–2050 by sector are shown in Figures 2.2 and 2.3.

Figure 2.2 Projected Energy Demand by Sector (gigawatt-year)

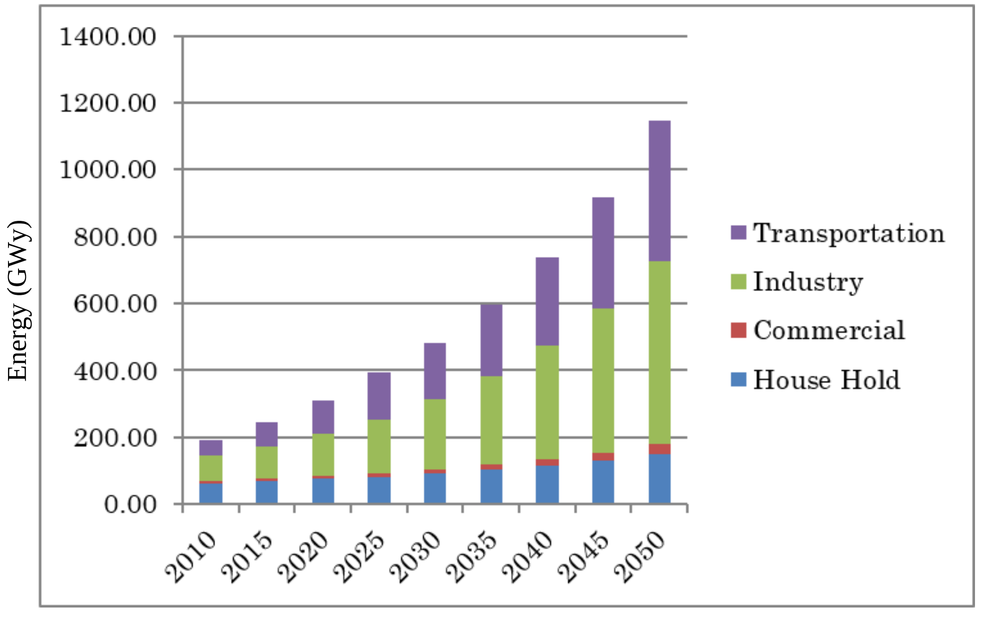
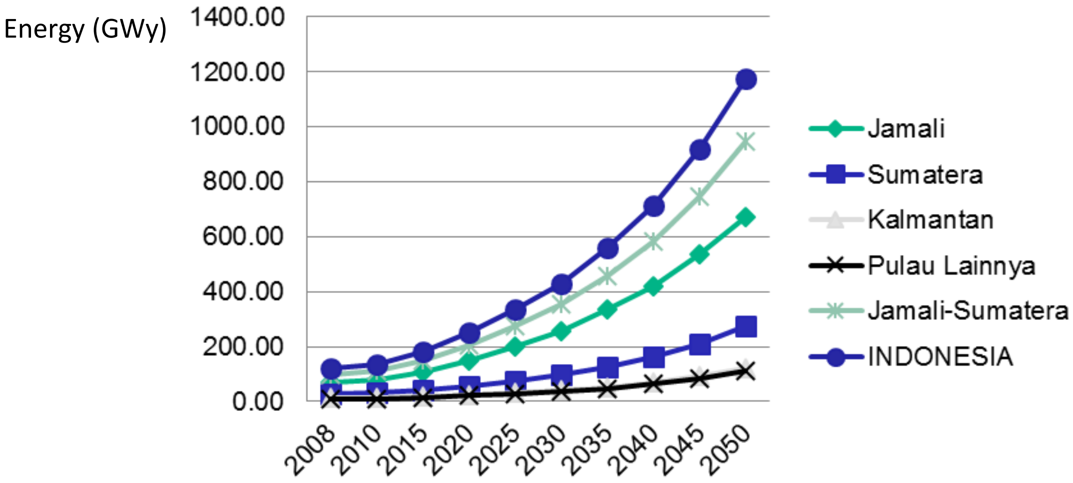


Figure 2.3 Projected Energy Demand Nationwide (gigawatt-year)



1.3. Energy supply options

Despite the potentials of energy supply, including fossil and non-fossil fuels, Indonesia at present depends heavily on fossil fuels to meet its energy supply, amounting to more than 95% of the total energy supply. The country has been a net importer of oil since late 2004 because most of its oil wells are already old and there has been no major oil discovery. In 2008, the reserve to production ratio (R/P) stood at 12 years. In 2012, the state-owned Upstream Oil and Gas Executive Agency (or BPMIGAS) reported that the country has only 4 billion barrels of reserves with a daily production of 1 million barrels. This brings the R/P ratio close to four years (2012) before Indonesia will have to import oil.

On the other hand, coal reserves are still huge at an estimated R/P ratio of 121.31 years and a production rate of 229 million tonnes (2008). With most of the coal currently being exported, the government has introduced a policy on domestic market obligation to restrict exports of energy resources so as to meet domestic demand, in accordance with the national plan to switch from oil to coal and gas. This is also considering that Indonesia is the largest gas supplier in Asia. The R/P ratio for gas is only 36 years (2008) as most of the gas is under long-term export contracts with several Asian countries.

Utilisation of NRE is still very much limited due to high production cost and subsidy on oil and LPG, except for geothermal and hydro. Indonesia is known to have the largest geothermal resources in the world but only 4% of the potential has been developed. Solar, wind, and hydro power are still at the demonstration stage and utilised mostly in remote areas. Nuclear, coal bed methane (CBM), biomass, tidal energy, and ocean thermal energy conversion are promising energy mix options for future exploitation.

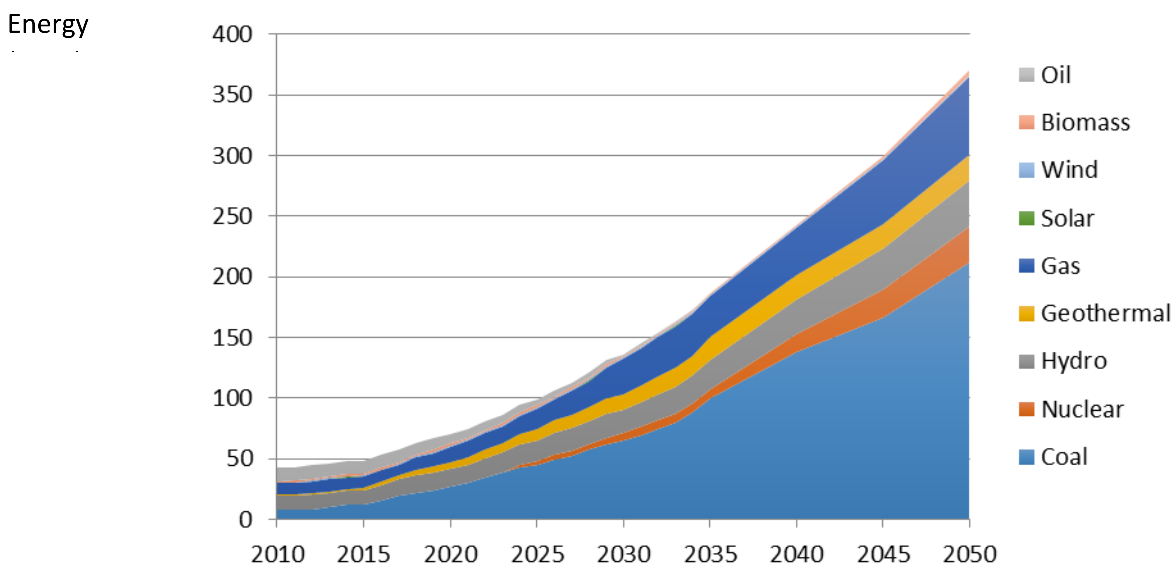
A National Energy Policy issued under Presidential Regulation No. 5/2006 underlines the importance of energy conversion in all sectors to reduce the dependence on oil, diversify energy, increase economic growth, and promote environment-friendly development to achieve security of domestic energy supply. The regulation sets a clear target of the share of each type of energy up to 2025. The primary energy mix in 2025 is expected to be mainly composed of oil at <20%, coal at >33%, gas at >30%, biofuel at >5%, geothermal at >5%, other new and renewable sources (biomass, nuclear energy, hydro, solar cell, and wind) at >5%, and liquefied coal at >2%.

1.4. Potential role of nuclear power

Nuclear power could play a role to diversify energy, enhance national energy security, and meet the national commitment on reducing carbon emissions to mitigate climate change. Deployment of nuclear power to meet a low carbon scenario is in accordance with Presidential Regulation No. 61/2011 on greenhouse gas (GHG) emissions reduction, in which the government has committed to reduce emissions by 26% or 41% with international assistance. Energy Law No. 30/2007 contains several provisions, the implementation of which will affect greenhouse gas (GHG) emissions mitigation, among others, provisions that support energy conservation and the development of NRE through incentive mechanisms. The Green Energy Policy enacted in 2004 also underlines the need to develop a “green” energy system that maximises the use of renewable energy and the efficient use of energy and of clean energy technology, such as clean coal technology, fuel cell, and nuclear energy.

The projected energy generation (GWy) for the CO_2 limitation scenario and the role of nuclear power in the energy mix as calculated by MESSAGE is given in Figure 2.4. It can be seen that with low carbon scenario, nuclear power will enter the energy scenario in 2024 with an installed capacity of 2,000 megawatt-electricity (MWe) and then it is expected to grow to 36,000 MWe by 2050.

Figure 2.4: Projected Energy Generation until 2050 based on the CO_2 Limitation Scenario



2. Nuclear safety regulatory system

2.1. Nuclear safety law

The nuclear safety law—Act No. 10 Year 1997 on Nuclear Energy—covers the following areas:

<u>Regulatory body with its functions, such as authorisation, inspection, and enforcement.</u>

Indonesia has established an adequate nuclear legal framework consisting of nuclear law and corresponding rules, regulations, and guidelines.

Pursuant to Act No. 10 of 1997 on Nuclear Energy (Jakarta, 10 April 1997; 48 Articles), the Nuclear Energy Regulatory Agency (BAPETEN) was established.

Article 14 of the Act stipulates that (1) the control on the use of any nuclear energy shall be carried out by the Regulatory Body, and (2) the control should be implemented through regulations, licensing, and inspections.

Radiation protection

General Elucidation of Act No. 10 Year 1997 para. 7, states that the use of nuclear energy for public welfare shall be implemented together with the efforts to prevent radiation hazards among workers, the public, and the environment.

Article 15 of Act No. 10 Year 1997 established the main principles of national policy in the nuclear energy area, which states that the control on the use of any nuclear energy is aimed to assure the safety and health of workers and the public, and the protection of the environment.

Environmental protection, if not covered elsewhere in the laws of the State

Article 16 of Act No. 10 Year 1997 states that any activity related to the utilisation of nuclear energy shall maintain safety, security, peace, the health of workers and the public, and environmental protection.

Safety of nuclear installations

The covered areas are emergency preparedness and response, use of sources of radiation and of radioactive material, transport of nuclear and radioactive material, management of radioactive waste and spent fuel, and mining and milling.

Safety of nuclear installation and emergency preparedness is not stated in Act No. 10 Year 1997, but according to Article 16, clause (2), it would be regulated through:

- Government Regulation No. 54 Year 2012 on Safety and Security of Nuclear Installation
- Government Regulation No. 33 Year 2007 on Safety of Ionization Radiation and Security of Radioactive Sources including Transportation

The management of radioactive waste (low-level radioactive waste and high-level radioactive waste) has been stated in Act No. 10 Year 1997, Article 22 to 27 (derived in GR 61 Year 2013).

Export and import control of nuclear materials

Export and import control of nuclear materials is not stated in Act No. 10 Year 1997, but is covered in Government Regulation No. 29 Year 2008 on the Licensing of the Utilization of Ionizing Radioactive Sources and Nuclear Materials. It is stated explicitly that an export/import activity for nuclear materials must be conducted with a partner that comes from a country that is a state party to the non-proliferation treaty (NPT) and has a safeguard agreement with the International Atomic Energy Agency (IAEA) (Article 16, Section 1).

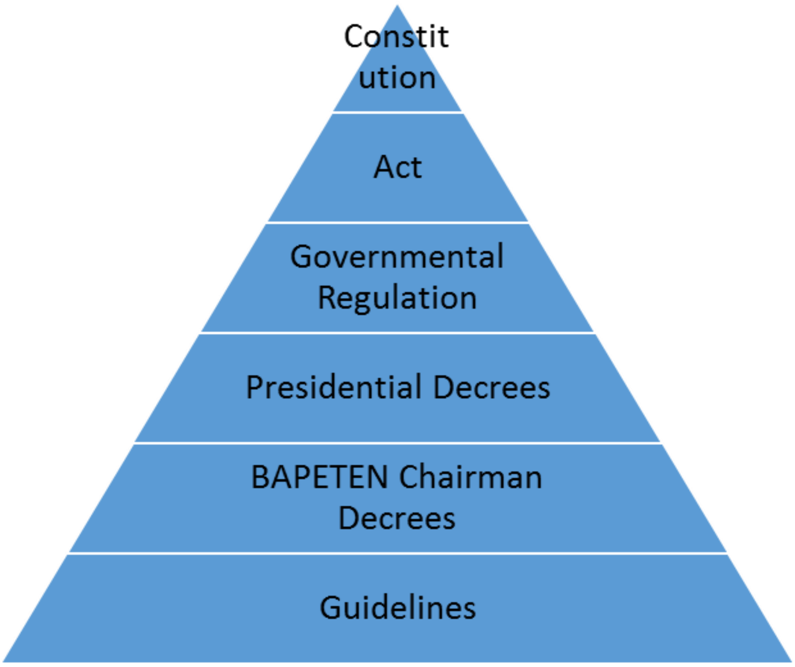
Safeguards of nuclear materials assuring non-proliferation

The safeguard of nuclear materials assuring non-proliferation is not stated in Act No. 10 Year 1997. However, they are covered in Government Regulation No. 54 Year 2012 on Safety and Security of Nuclear Installations.

2.2. Regulatory safety authority

Based on Act No. 10 Year 1997 on Nuclear Energy, the Nuclear Energy Regulatory Agency of Indonesia or BAPETEN was established. Article 14 of the Act stipulates that (1) the control in the use of any nuclear energy shall be carried out by the Regulatory Body, and (2) the control should be implemented through regulations, licensing, and inspections. Figure 2.5 shows the structure of the regulatory body in nuclear safety in Indonesia.

Figure 2.5 Regulatory hierarchy system in Indonesia



2.3. Regulations in nuclear safety

To ensure the safety of nuclear installations, BAPETEN has issued numerous regulations.

<u>On emergency preparedness and response in nuclear installations:</u>

- –BAPETEN Chairman Decree No. 1 Year 2010 on Nuclear Emergency Preparedness and Response Plan
- Government Regulation No. 54 Year 2012 on Safety and Security of Nuclear Installations
- Act No.24 Year 2007 on National Disaster Countermeasure

<u>On the use of sources of radiation and radioactive material:</u>

- Government Regulation No. 33 Year 2007 on Safety of Ionizing Radiation and Security of Radioactive Sources

- Chairman Decree No. 4 Year 2013 on Radiation Protection and Safety in Nuclear Energy Utilization
- Chairman Decree No. 3 Year 2014 on Environmental Impact Statement Arrangements in Nuclear Energy

<u>On the transportation of nuclear and radioactive material:</u>

- Government Regulation No. 26 Year 2002 on Transport Safety of Radioactive Material
- On the management of radioactive waste and spent fuel:
- Government Regulation No. 61 Year 2013 on Radioactive Waste Management

<u>On safety of mining and milling:</u>

- BAPETEN Chairman Decree No. 12/Ka-BAPETEN/VI-99 on Safety Provision on Working of Mining and Tailing of Nuclear Ores

<u>Content commitments on nuclear liability and coverage:</u>

- Act No. 10 Year 1997 on Nuclear Energy, Article 28: The nuclear installation operator shall be liable for nuclear damage suffered by the third party that results from any nuclear incident that occurs in that nuclear installation.
- Government Regulation No. 46 Year 2009 on the Limit of Nuclear Liability for Nuclear Damage
- Presidential Decree No. 74 Year 2012 on Nuclear Damage Liability

<u>Regulation of export and import controls of nuclear materials:</u>

- Government Regulation No. 29 Year 2008 on Permit Use of Nuclear Materials and Ionizing Radiation Sources
- Government Regulation No. 33 Year 2007 on Safety and Security Ionizing Radiation Radioactive Source

To confirm the implementation of the safety measures in corresponding activity, Indonesia has stated in Article 15 of Act No. 10 Year 1997 and Article 7 of Government Regulation No. 33 Year 2007 on Safety of Ionizing Radiation and Security of Radioactive Sources.

Act No.24 Year 2007 on National Disaster Countermeasure, which copes with all natural hazards, including nuclear and other technical applications, has been endorsed by the National Disaster Management Agency or BNPB.

3. International agreements on nuclear safety

Indonesia has adhered to a number of international legal instruments. To confirm the adherence to all relevant international nuclear safety legal instruments, Indonesia has signed the following legislations:

1.Convention on Nuclear Safety was signed and entered into force on 20 September 1994, stated in Presidential Decree No. 106 Year 2001 on Ratification of Nuclear Safety Convention; Jakarta, 4 October 2001.

2.Convention on Nuclear Liability was signed and entered into force

The International Convention for Nuclear Liability has been under review by BAPETEN since 2012.

3.Convention on Early Notification of a Nuclear Accident was signed and entered into force on 26 September 1986, stated in Presidential Decree No. 81 Year 1993 on Ratification of Convention on Early Notification of a Nuclear Accident; Jakarta, 1 September 1993.

4.Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency was signed and entered into force on 26 September 1986, stated in Presidential Decree No. 82 Year 1993 on Ratification of Convention on Assistance in the Case of a Nuclear Accident or Radiology Emergency; Jakarta, 1 September 1993.

5.Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management was signed and entered into force in September 1997, stated in Presidential Decree No. 84 Year 2010 on Ratification of Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management; Jakarta, 28 December 2010.

4. Human resources development plan for nuclear safety and emergency preparedness

4.1. Development and Maintenance on Human Resources in the nuclear field by the National Nuclear Energy Agency (BATAN)

To develop and maintain human resources in the nuclear field, BATAN has undertaken the following measures:

- Dispatching personnel abroad to obtain master's and doctorate degrees in nuclear energy technology and to work in notable nuclear power plant (NPP) companies, such as General Electric, Westinghouse Electric, Atomic Energy of Canada Limited, Mitsubishi, Korea Nuclear and Hydro Power, Korea Atomic Energy Research Institute (KAERI), and Korea Power Engineering Company.

- Establishing the education and training centre in Jakarta responsible for the implementation of education and training programs, especially in nuclear science and technology related to BATAN's competency. The development program is oriented to provide well-educated and well-trained personnel in the fields of research, development, and application of nuclear technology, and to promote nuclear science and technology to the public, especially to the industrial sector, through education and training programs.

- Establishing a higher education institute called Polytechnic of Nuclear Technology (STTN) in Yogyakarta, based on Presidential Decree No. 71 Year 2001. STTN is an official education institute carrying out nuclear science and technology manpower development programs through a carefully crafted four-year education system.

STTN has two majors study programs:

- Nuclear Techno-Chemistry / Chemical processes using nuclear technology; and
- Nuclear Techno-Physics relating to monitoring, measuring, and controlling physical processes related to nuclear reactions and radiation.

Establishing cooperation with Gadjah Mada University (UGM) and Bandung Institute of Technology (ITB) in various fields of study as required by a nuclear power project, including in nuclear engineering.

4.2. Education and Training System for Manpower Needed for NPPs

A human resource development (HRD) plan identifying human resources needed by organisations implementing nuclear energy programs has been addressed in the study on the HRD program and HRD blueprint carried out in 2008 and was continued until 2010. The plan was called ESDM or the Concept of Development of Human Resources for Operation and Maintenance of Electricity Generation—Nuclear Power Plant, 2010 (in Bahasa Indonesia).

It was assumed that the first NPP would be a turnkey project and that HRD for non-nuclear electricity generation is already well developed. Construction and engineering phases would be the responsibility of the contractors, hence, the report focused on manpower for operation and maintenance of the first NPP project.

Based on the study results, the education system for all three levels of training is the existing infrastructure of HRD for nuclear science and technology—covering the education system, the existing university or polytechnic with studies on nuclear science and engineering. The content and standard of courses for all communities (government, industry, and owner) are addressed in the study. Courses for all three levels, including those focused on the owner, are also explained.

Since qualified professionals and technicians are needed in planning and implementing an NPP program, it is necessary to develop highly specialised experts, and undergo trainings locally and abroad, particularly during the early implementation stages of the nuclear power program. However, this can only be useful in a very limited way and it certainly does not constitute a long-term solution.

5. International cooperation on nuclear safety and emergency preparedness

Indonesia's participation in international organisations, research programs, or conferences related to nuclear safety includes:

<u>International Atomic Energy Agency (IAEA)</u>

- EPREV mission, 1999 and 2004 (and 2015)
- Expert missions on nuclear safety and radiation protection and others
- Joint Convention on Nuclear Safety
- Asian Nuclear Safety Network (ANSN) (on Topical Group)
- Emergency Preparedness and Response
- Safety Analysis
- Operational Safety
- Safety Management of Research Reactors
- Safety Management of Research Reactors
- Others

Forum for Nuclear Cooperation in Asia (FNCA) (on Project)

- Research Reactor Network
- Nuclear Safety Culture
- Radiation Safety and Radioactive Waste Management
- Safety Management Systems for Nuclear Facilities
- Others

World Association of Nuclear Operators (WANO),

Korea Advanced Institute of Science and Technology (KAIST),

US Electric Power Research Institute (US EPRI),

US Department of Energy (US DOE), and

Nuclear Regulatory Commission (NRC)

Malaysia[1]

1. Nuclear development plan in Malaysia

The Nuclear Power Infrastructure Development Plan (NPIDP) of Malaysia is roughly divided into Project Development Study and Legal and Regulatory Study, which include initiatives and human resources development, as follows:

Project Development Study

- Nuclear Power Infrastructure Development Plan (NPIDP)

[1] 1st and 2nd NSM Working Group presentation materials of Malaysia.

- Feasibility Studies
- Site Evaluation
- Bid Document

<u>Legal and Regulatory Study</u>

- Legislation Gap Analysis
- International Legal Instruments
- Revised Atomic Law
- Nuclear Power Regulatory Infrastructure Development Plan (NPRIDP)
- Develop 22 Regulations/Guidelines

<u>Objectives of the Study</u>

- To determine and assess the current level of national capabilities and state-of-preparedness.
- To compare and benchmark the current level of national capabilities and state-of-preparedness based on best international practices.
- To identify the existing gaps and to recommend appropriate strategies and plans of action required to close the gaps.
- To recommend Malaysia's industrial infrastructure requirements and analyse national participation possibilities for localisation during construction and operation.
- To coordinate the national self-assessment of the condition to achieve milestones of 19 Key Nuclear Infrastructure areas as recommended by the IAEA.

Documents

The Standard Operating Procedures for Industrial Disasters has the following features:

- Published on 8 June 2001.
- It explains the action plan in handling fire, explosion, and toxic and radioactive emissions by various agencies.
- The Atomic Energy Licensing Board is cited as the responsible and the expert agency.
- It provides for a zoning system in which the RED ZONE is divided into "*hot zone*", "*warm zone*", and "*cool zone*".

2. Human resources development program

IAEA's Safety Assessment Education and Training Program (SAET)

SAET was established and launched in 2009 as a systematic program for the training of regulatory and operational staff in the skills needed for informed decision making and technical review of nuclear power documentation.

- SAET's program objectives include the support of member states in building and maintaining independent safety assessment competency and capacity.

- Norwegian Extra Budgetary Program funded the Safety Assessment Capacity Building Program to assist the IAEA member states to build their capacities in safety assessment.

- Malaysia and Viet Nam joined the Pilot Program in 2010 as countries introducing the NPP.

- The program aims to assist Malaysia to further develop its human capacity-building activities in general aspects of nuclear safety and in safety assessment of NPP to enhance the country's capacity to perform independent safety case reviews in support of informed decision-making competency.

The Malaysia Nuclear Agency is a certified training centre for seven sectors, as follows:

- Radiation Protection Course
- Non-Destructive Testing
- Radiation Safety and Health
- Environmental Safety and Health
- Medical X-ray
- Nuclear Instrumentation
- Research Reactor Operators

3. International cooperation on nuclear safety and emergency preparedness

Malaysia's participation in global activities

Malaysia participates in a number of global activities including IAEA, ANSN, and has bilateral relations with developed countries in Europe, such as Sweden and France.

The Malaysian government exchanged memorandums of understanding on nuclear safety with the Korea Institute of Nuclear Safety (KINS), and on nuclear defense and nuclear non-proliferation with the Japan Aeronautical Engineer's Association (JAEA).

The first meeting of the newly established ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANTOM) was held in Phuket in September 2013. The scope of network activities includes nuclear safety and information sharing in the event of an emergency and the development and training of human resources at normal times.

For international cooperation, the following actions were proposed: environment monitoring and fostering of specialists; signing the Convention on Nuclear Safety, including management, export control and ratifying additional protocols, educational training, and information exchange.

Proposals and discussions on cross-border cooperation in Southeast Asia

On nuclear safety

- Conduct environmental monitoring
- Foster the exchange or sharing of monitoring data
- Enhance technical expertise
- Implement the Nuclear Safety Convention

On nuclear security

- Prevent illicit trafficking of radioactive and nuclear material
- Foster the exchange of information
- Undertake border radiation monitor detection system

On non-proliferation

- Agree on export control
- Implement the Additional Protocol

On educational program

- Foster the exchange of fellows/experts

Information exchange

- Encourage the sharing of good practices and lessons learned

Singapore

1. Update on Singapore's Role in International Nuclear Safety and Security Cooperation

Singapore is a small island state with limited natural energy resources. Its open-market economy relies mostly on fossil fuel imports. As of 2014, for the purpose of electricity generation and for its transportation industry, Singapore imports piped natural gas from its neighbours, Indonesia and Malaysia, and liquefied natural gas (LNG) and crude oil from countries further away. Singapore does not possess nuclear energy and is unlikely to do so in the near future. Notwithstanding, the country actively participates in regional and international forums on nuclear energy cooperation, safety, and security. This report summarises Singapore's efforts in nuclear safety and security at the national and international levels.

2. Singapore's Energy Policy–National Energy Policy Report

The National Energy Policy Report (NEPR),[2] which was first released in 2007, outlines three policy objectives—economic competitiveness, energy security, and environmental sustainability.[3] These three objectives translate into five strategies: (i) enhance the infrastructure and systems, (ii) improve energy efficiency, (iii) strengthen the green economy, (iv) establish the market as the determinant of the price of energy, and (v) diversify energy sources.[4]

The strategic thinking behind Singapore's energy security policies is shaped by a combination of factors, such as the country's lack of natural energy sources; its reliance on oil imports for its refinery and petrochemical industries and its transport sector; its reliance on piped natural gas imports to generate electricity for its industries and households; and its refineries, oil trading, and the manufacturing of oil derivatives, which are keys to the country's economic growth.

Without fossil fuels, Singapore has to rely on piped natural gas (PNG) imports from Malaysia and Indonesia. Up to 2012, more than 80% of power generation in Singapore has been fuelled by PNG.[5] Figure 2.6 highlights Singapore's reliance on PNG for electricity generation. However, the country's reliance on PNG has been decreasing with the completion of the liquefied natural gas (LNG) terminal in 2013.[6] The transport sector will continue to rely on oil, at least for the next decade.

The LNG terminal will enable Singapore to import gas from countries beyond the Southeast Asian region, such as Qatar; Trinidad; and Queensland, Australia. As of 2013, the LNG terminal has been able to store up to 6 million tons per annum (Mtpa). The terminal's throughput capacity will increase to 9

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[2] http://www.mti.gov.sg/ResearchRoom/Documents/app.mti.gov.sg/data/pages/885/doc/NEPR%202007.pdf (accessed May 2, 2014).

[3] Ministry of Trade and Industry, Singapore: A Changing Energy Landscape: The Energy Trilemma. http://www.mti.gov.sg/MTIInsights/Pages/Energy-.aspx (accessed May 2, 2014).

[4] Ibid.

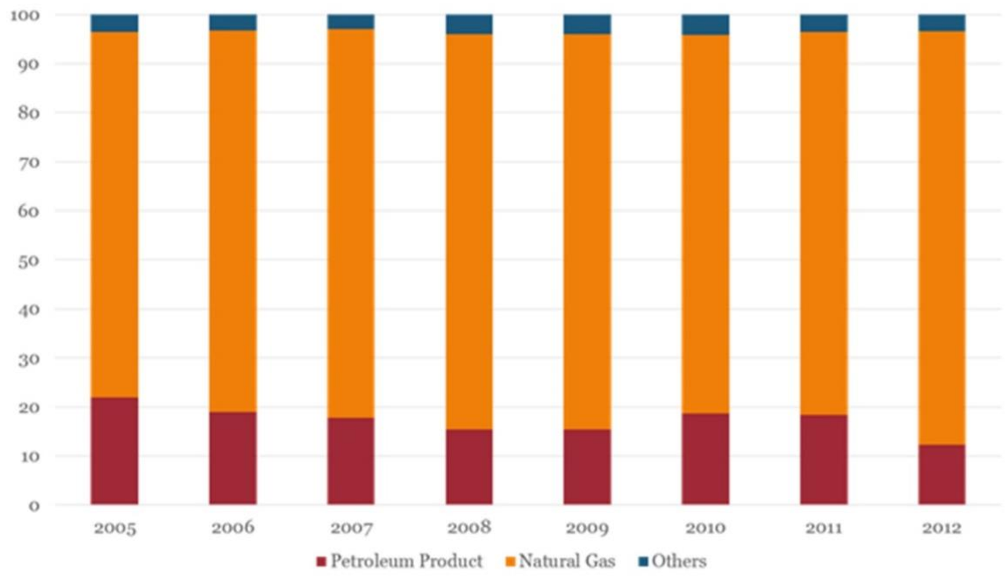
[5] Energy Market Authority: Singapore Energy Statistics 2013. p. 17. http://www.ema.gov.sg/media/files/publications/SES%202013.pdf (accessed May 5, 2014).

[6] Singapore LNG Corporation (SLNG): Singapore's LNG Terminal Starts Commercial Operations. 7 May 2013. http://www.slng.com.sg/newsroom-press-release-20130507.html (accessed May 8, 2013).

Mtpa with the addition of a fourth tank in the future.[7] The LNG terminal is one of the key security areas of supply initiatives that were outlined in the NEPR.[8]

Thus, despite Singapore's lack of natural energy sources, its LNG, PNG, and crude oil imports remain sufficient to meet the country's energy demand for the foreseeable future.

Figure 2.6 Singapore Fuel Mix for Electricity Generation (2005–2012)



Source: Energy Market Authority (2013)[9]

3. International Cooperation on Nuclear Safety and Security

In 2012, the Ministry of Trade and Industry, based on its nuclear energy pre-feasibility study, concluded that existing nuclear energy technologies are not

[7] Energy Market Authority, "Liquefied Natural Gas". http://www.ema.gov.sg/LNG/ (accessed May 9, 2013).
[8] Ministry of Trade and Industry, Singapore (2007), *Energy for Growth: National Energy Policy Report*. p. 6.
http://www.mti.gov.sg/ResearchRoom/Documents/app.mti.gov.sg/data/pages/885/doc/NEPR%202007.pdf (accessed May 2, 2014).
[9] Energy Market Authority, (2013) "Singapore Energy Statistics", p. 17.
http://www.ema.gov.sg/media/files/publications/SES%202013.pdf (accessed May 5, 2014).

suitable for Singapore given its small size and population density.[10] However, the government did not entirely rule out the use of nuclear energy technology as the Prime Minister suggested that it is possible that the country may adopt nuclear energy in the future.[11]

In 2014, despite its status as a non-nuclear power country, Singapore was invited to attend the third Nuclear Security Summit, which was held in the Netherlands. In its press statement, the Singapore government added that the agenda for the summit was to "assess the progress made over the past four years on national and international measures to enhance nuclear security, identify unmet objectives from the previous two Summits and propose how these can be achieved."[12] Singapore was invited based on its status as a global trade hub.[13]

At the summit, the Singapore announced that it will be making preparations to accede to the Convention on the Physical Protection of Nuclear Material (CPPNM) and its 2005 Amendment.[14] By acceding to the CPPNM, Singapore will undertake measures to "protect, detect and respond to threats to nuclear security…by ensuring the safe passage of nuclear materials during international transport."[15] Singapore's plan to accede to the CPPNM is a strategic necessity in strengthening the global nuclear safety and security architecture, because as a global transhipment hub, Singapore has one of the busiest maritime ports and airports in the world. Figure 2.3.2 show that the

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[10] National Research Foundation, "Establishment of Research and Education Programme in Nuclear Safety, Science and Engineering". http://www.nrf.gov.sg/docs/default-source/Press-Releases/20140423_nsrep-press-release-(final).pdf?sfvrsn=2 (accessed May 3, 2014).

[11] Singapore PM says nuclear power plant possible "during my lifetime", Platts, 1 November 2010. http://www.platts.com/latest-news/electric-power/singapore/singapore-pm-says-nuclear-power-plant-possible-8128577 (accessed May 14, 2013).

[12]Visit of Prime Minister Lee Hsien Loong to the Kingdom of the Netherlands, the Grand Duchy of Luxembourg and the United Kingdom of Great Britain and Northern Ireland, Prime Minister's Office Singapore. 22 March 2014. http://www.pmo.gov.sg/content/pmosite/mediacentre/pressreleases/2014/March/visit-of-prime-minister-lee-hsien-loong-to-the-kingdom-of-the-ne.html#.U3x4r_mSySo (accessed May 10, 2014).

[13] "PM Lee attends nuclear summit", *The Straits Times,* 23 March 2014. http://www.straitstimes.com/breaking-news/singapore/story/pm-lee-attends-nuclear-summit-20140323 (acessed May 6, 2014).

[14] "Singapore will accede to convention on protection of nuclear materials", PM LEE. ChannelNewsAsia.com, 25 March 2014. http://www.channelnewsasia.com/news/singapore/s-pore-will-accede-to/1047512.html (acessed May 8, 2014).

[15] Ibid.

volume of goods, which pass through the country's sea and air ports, are consistently high and likely to rise in the future.

Singapore's maritime ports handle the second largest volume of goods. Only the Port of Shanghai, China, surpasses Singapore's volume of container shipments.[16] In 2013, the volume of container port traffic, handled by the Singapore Port rose by 2.9% to 32.6 million twenty-foot equivalent units (TEUs) compared to 2012.[17] On a daily basis, Singapore's ports handles more than 60,000 shipping containers from more than 60 container vessels.[18] On average, there are 1,000 ships in the ports daily.[19] Singapore is also the focal point for 200 shipping lines with links to more than 600 ports in over 120 countries.[20] Singapore's port terminals are managed by two operators—PSA Singapore and Jurong Port.[21]

In addition to the maritime traffic, Singapore also has one of the busiest air traffic environments in the world. The Changi International Airport manages more than 100 airlines with destinations to over 280 cities in 60 countries and territories worldwide.[22] More than 58 million passengers pass through the airport annually. The airport also handles, on average, 1.8 million tons of freight annually since 2010.[23]

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[16] "Singapore port handles 32.6m teu of containers in 2013", Seatrade-global.com, 7 January 2014. http://www.seatrade-global.com/news/asia/singapore-port-handles-326m-teu-of-containers-in-2013.html (accessed May 10, 2014).

[17] Maritime Port Authority of Singapore, "Singapore's 2013 Maritime Performance". http://www.mpa.gov.sg/sites/global_navigation/news_center/mpa_news/mpa_news_detail.page?filename=nr140107a.xml (acessed May 9, 2014.

[18] Maritime and Port Authority of Singapore (2014), "The World's Busiest Port". p. 3.

[19] Ibid.

[20] Ibid.

[21] Ibid.

[22] Changi Airport Group: Air Traffic Statistics. (2014) http://www.changiairportgroup.com/cag/html/the-group/air_traffic_statistics.html (accessed May 12, 2014).

[23] Ibid.

Figure 2.7: Passenger and Air Freight Movements at Changi International Airport, Singapore

Source: Changi Airport Group (2014) [24]

A month after the government's decision to accede to the CPPNM, the National Research Foundation (NRF) announced a SG$63 million five-year research and education program for the Nuclear Safety Research and Educational Programme (NSREP) in the areas of nuclear safety, science, and engineering.[25] The NRF is a department that was set up within the Prime Minister's Office in 2006 and its primary role is to set the national direction for research and development (R&D). The primary objective of NSREP is to increase the nation's scientific and engineering expertise in nuclear safety and security. This program targets mainly Singaporean undergraduate and postgraduate students. The government hopes to train up to 10 people a year.[26]

The NSREP comprises two components—the Singapore Nuclear Research and Safety Initiative (SNRSI) and the Nuclear Education and Training Fund (NETF).[27] The SNRSI focuses on supporting the R&D capabilities in nuclear

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[24] Ibid.
[25] National Research Foundation, Singapore, "Establishment of Research and Education Programme in Nuclear Safety, Science, and Engineering". http://www.nrf.gov.sg/docs/default-source/Press-Releases/20140423_nsrep-press-release-(final).pdf?sfvrsn=2 (accessed May 11, 2014).
[26] Ibid.
[27] Ibid.

safety, science, and engineering, specifically in the areas of radiochemistry, radiobiology, and the safety analysis of NPPs through models and simulations. The NETF will support education and training in those areas. Both programs will be held by the National University of Singapore.[28]

4. National Framework on Radiation Protection

Singapore's accession to the CPPNM will have an impact on the national nuclear safety and security framework, although the extent remains unclear at the moment. Its national framework comprises the Radiation Protection Act and its regulator, the Radiation Protection & Nuclear Science Department (RPNSD).

The Radiation Protection Act was first implemented in 1973. Under this Act, licenses are required for the import, export, sale, manufacture, possession, and use of radioactive materials and irradiating equipment.[29] Similarly, a license is required for the transport of radioactive materials. In 2007, the Act was repealed and reenacted with further amendments with the intent of preparing the country for its ratification of the International Atomic Energy Agency's Additional Protocol.[30]

The Radiation Protection Act has evolved from when it was first enacted in 1973 to reflect the growing complexities surrounding the use of radioactive materials and equipment in Singapore and against the context of the country's relation to the international community.

The RPNSD is the national regulatory authority for radiation protection in Singapore.[31] As a regulator, it administers the country's Radiation Protection Act through licensing, notification, authorisation, inspection, and enforcement on irradiating apparatus and radioactive materials.[32] RPNSD is a department

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[28] Ibid.
[29] Ibid.
[30] Ibid.
[31] National Environment Agency (NEA), "Overview of Radiation Protection". http://app2.nea.gov.sg/anti-pollution-radiation-protection/radiation-protection/overview-of-radiation-protection. (acessed May 9, 2014).
[32] National Environment Agency (NEA), "Summary of Radiation Protection Act 2007". http://app2.nea.gov.sg/anti-pollution-radiation-protection/radiation-protection/regulatory/summary-of-radiation-protection-act-2007 (accessed May 4, 2007).

within the National Environment Agency (NEA), which is part of the Ministry of Environment and Water Resources.
At the moment, no information has been released by the government on the impact of CPPNM on the Radiation Protection Act and the scope of RPNSD's jurisdiction.

5. International Cooperation on Energy Security, Nuclear Safety,and Cooperation

Beyond R&D, and as part of the country's NEPR strategies, Singapore has been actively involved at both levels of Track-I and Track-II energy security diplomacy, specifically in the area of energy cooperation. Track-I diplomacy refers to activities that are conducted between governments. Complimenting Track-I activities is Track-II, which are activities that involve nongovernment officials and non-state actors. Track-II activities complement rather than substitute Track-I activities.

As a member of the ASEAN, Singapore has signed the Memorandum of Understanding (MOU) on the ASEAN Power Grid and Trans-ASEAN Gas Pipelines projects.[33] Additionally, Singapore is represented at several Track-II networks, such as the East Asia Summit's Energy Task Force, Asia-Pacific Economic Cooperation (APEC)'s Energy Task Force, ASEAN Nuclear Energy Cooperation Sub-Sector Network (NEC-SSN), and the Council for Security Cooperation in the Asia-Pacific (CSCAP).

Singapore's participation in CSCAP is represented through the S. Rajaratnam School of International Studies, Nanyang Technological University.[34] The Energy Market Authority (EMA), which is Singapore's electricity and natural gas industries and power system operator, is the country's representative at NEC-SSN.[35]The EMA is a statutory body under the Ministry of Trade and

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[33] Ministry of Trade and Industry, Singapore (2007), *National Energy Policy Report*. p. 25. http://www.mti.gov.sg/ResearchRoom/Documents/app.mti.gov.sg/data/pages/885/doc/NEPR%202007.pdf (accessed May 15, 2014).
[34] Council for Security Cooperation in the Asia Pacific, "Member Committees". http://www.cscap.org/index.php?page=member-committees-page (accessed May 8, 2014).
[35] ASEAN Centre for Energy, "NEC-SSN". http://aseanenergy.org/index.php/acebodies/nec-ssn (accessed May 6, 2014).

Industry. Singapore is also a party to the Southeast Asia Nuclear-Weapon-Free-Zone Treaty (SEANWFZ), also known as the Bangkok Treaty.[36]
Thus far, Singapore's involvement in Track-I and Track-II nuclear-related activities has been focused on building the cooperation, capacity, and confidence between state and non-state actors in the area of nuclear engineering. However, by acceding to the CPPNM, Singapore will have to strengthen its ties with the sea and airport operators and regulators, and the shipping and airline industries in other countries.

6. Conclusion

Although there are no plans for Singapore to deploy nuclear energy in the future, the country has been actively participating in regional and international forums on nuclear safety and security cooperation. At the national level, legal provisions have been made to ensure that the country remains safe from radioactive threats.

Beyond the national border, Singapore has actively participated in several Track-I and Track-II nuclear energy and security forums. For instance, Singapore is a member of the ASEAN Nuclear Energy Cooperation Sub-Sector Network and a party to the SEANWFZ. The government has announced its plan to accede to the Convention on the Physical Protection of Nuclear Material. Additionally, it will ramp up the country's expertise in nuclear safety and security through R&D and education.

At the national level, Singapore has enacted the Radiation Protection Act in 1973, which was amended in 2007 to reflect the growing use of radioactive material and equipment, specifically, in the health and medical industry. The Act is administered by the RPNSD at the NEA. The RPNSD is also the national nuclear regulatory authority.

Finally, by acceding to the CPPNM, Singapore's role in the global nuclear safety and security architecture has taken on an added significance, which

[36] ASEAN, speech by H.E. Le Luong Minh Secretary General of ASEAN at the "Regional Seminar on Maintaining a Southeast Asia Region Free of Nuclear Weapons". http://www.asean.org/news/item/speech-by-he-le-luong-minh-secretary-general-of-asean-at-the-regional-seminar-maintaining-a-southeast-asia-region-free-of-nuclear-weapons-2 (accessed May 5, 2014).

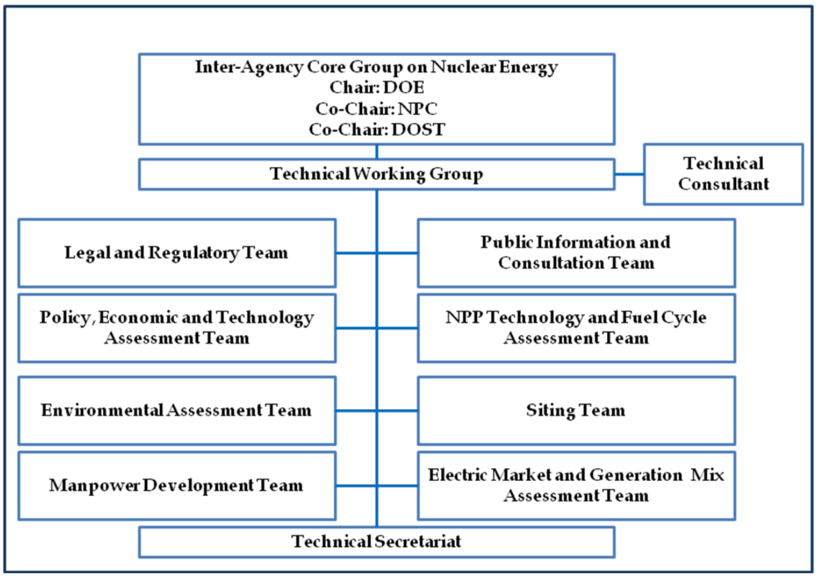
will require the country to foster closer ties and forge new areas of cooperation with the shipping and airline industries and the air and seaport regulators in other countries.

Philippines

1. Nuclear energy policy and development plan

The overall energy sector goal of the government is to have a secure, reliable, and stable supply of energy with due consideration to environment in meeting the growing energy requirements of the country. As a matter of policy, the government has been receptive to all available energy resources/technologies as potential energy sources. Nuclear energy still remains to be a long-term energy option considering its merits on supply security and the environmental advantages in terms of carbon dioxide (CO_2) emissions.

With continuous improvements in nuclear technology, safety, and safeguards, the government may embrace a clear nuclear energy policy for power generation in the future. Having robust safety standards to prevent the occurrence of nuclear accidents would somehow reduce opposition from environmentalist and cause-oriented groups and make nuclear power a socially acceptable energy source.



It may be noted that the Philippine government had again expressed interest in nuclear energy in 2007 as an outcome of a "nuclear renaissance" in the global community. To study the possibility of adopting a nuclear energy program, the Task Force on Nuclear Power Program was established by the Department of Energy. Based on the 2008 International Atomic Energy Agency (IAEA) Mission Review on the Development of Infrastructure to Support a Nuclear Power Program in the Philippines and the Feasibility of Rehabilitating the Bataan Nuclear Power Plant, an Interagency Core Group on Nuclear Energy was created. The core group, which was formed by virtue of an interdepartmental order between the Department of Energy (DOE) and Department of Science and Technology (DOST), was tasked to carry out the said IAEA mission recommendations on the 19 infrastructure requirements to launch a nuclear power program. The core group is chaired by DOE and co-chaired by DOST and the National Power Corporation (NPC). In the interim, the core group may serve as a Nuclear Energy Programme Implementing Organization.

In 2010, a public perception survey was undertaken by the core group during the series of information, education, and communication (IEC) in major cities of the country, which revealed that more than 60% of the respondents showed indications of support for a nuclear energy program. The IEC provided balanced information to the public on the applications and benefits of nuclear technology in medicine, agriculture, and industries, including existing regulations to ensure safety and security of nuclear uses.

Source: NPC

There was a feasibility study conducted by the Korea Electric Power Corporation (KEPCO) in 2008, through an MOU with NPC, for the possible rehabilitation of the 650-MWe Bataan Nuclear Power Plant (BNPP)—a pressured water reactor. The study results suggested that the BNPP is still technically feasible to rehabilitate. Another private company also proposed to rehabilitate and operate the power plant at no cost to the government. To further push for the rehabilitation of the power plant, a legislative bill at the Lower House (Congress) titled "An Act Mandating the Immediate Rehabilitation, Commissioning and Commercial Operation of the BNPP" was filed during the 14th Congress (2009).

Although the Fukushima incident in 2011 debilitated initiatives on the nuclear energy program in the country, some sectors still recommended nuclear power development in the country and sought the Congress for a resolution/law supporting the proposition. The establishment of a new nuclear power plant has also been seen to provide a long-term solution to address power supply security as espoused in a Power Summit held in the southern part of the country, which is suffering from critical power supply issues. On the other hand, as a manifestation of interest of some local government units, local resolutions were issued for the national government to look at the feasibility of hosting a nuclear power facility in their respective areas.

Despite the absence of a national policy on the nuclear energy development program, the government has not abandoned nuclear energy as a long-term supply option for the country to provide a reliable source of power in the future. Such is evident in the continuous active participation of the government in regional cooperation relating to nuclear energy development.

The country has 11 potential sites identified by the Nuclear Power Steering Committee in 1996 as possible hosts for nuclear power plants and supporting facilities once a national policy on the use of nuclear energy has been adopted.

2. Human resources development plan for nuclear safety and emergency preparedness

When the Philippines embarked on a nuclear energy program with the construction of the BNPP, the University of the Philippines offered courses on nuclear engineering to build the manpower requirement needed to operate the said nuclear power plant. However, when the government decided to mothball the BNPP in 1986, it resulted in a loss of local expertise in the various areas of nuclear science and engineering. Currently, no local university has a degree program on nuclear energy engineering. Thus, training of nuclear experts is being carried out by the Philippine Nuclear Research Institute (PNRI) through regional and international programs.

A Nuclear Training Center staff (left) gives instructions to participants from Oceanagold, Nueva Vizcaya during a practical exercise on radiation measurement
Source: 2012 PNRI Annual Report

The PNRI, being the lead agency on nuclear energy development, regularly conducts training courses on nuclear safety and emergency preparedness as part of its HRD program. Technical training programs offered by the Institute include radiation safety and physical protection and security management of radioactive sources.

The Institute has likewise put greater priority on manpower development to strengthen its workforce and, thus, efficiently deliver the tasks on nuclear R&D, promotion of nuclear energy applications, nuclear regulations, and safety and emergency preparedness. Such human resource development is extended to other government agencies involved in nuclear energy development. Technical personnel, both from the Institute and other agencies, have been sent to other countries for scholarships on nuclear energy-related fields and training to gain additional knowledge and further enhance their skills on nuclear energy development.

The Philippines maintains linkages with international organisations that provide support in HRD. From these collaborative efforts, technical cooperation projects, expert missions, and several fellowship grants and trainings have been availed. Some of the organisations where the government has established networking and collaboration are as follows:

- International Atomic Energy Agency (IAEA);
- Ministry of Science and Technology of Japan;
- Forum for Nuclear Cooperation in Asia (FNCA), Japan;
- RCA Regional Office in Korea;
- Nuclear Safety Research Association of Japan;
- Asian Nuclear Safety Network (ANSN);
- Japan Atomic Energy Agency (JAEA);
- United States Department of Energy;
- United States Department of Agriculture;
- Australian Nuclear Science and Technology Organization (ANSTO);
- Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), Vienna;
- European Commission; and
- Other organisations from Australia, Japan, Canada, the US, Republic of Korea, France, and other countries through bilateral agreements/institute agreements.

The Philippines is also hosting regional training and workshops, such as the follow-up Regional Training Course on Environmental Radioactivity Monitoring and Nuclear and Radiologic Emergency Preparedness Courses (Expert Mission) organised by the IAEA. The initial Project Coordination Meeting (regional) on "Establishing a Radioactive Waste Management Infrastructure" was also conducted in the country. Other regional cooperation activities hosted by the Philippines were as follows:

- Asian Nuclear Safety Network;
- Forum on Nuclear Cooperation Asia (FNCA) Regional Workshop; and
- IAEA Training and Workshops, among others.

Some of the fellowship grants, training, and workshops/seminars attended by the PNRI and other concerned government agencies overseas on nuclear safety and emergency preparedness were on the areas of

- Nuclear Power Plant Safety;
- Nuclear Security and Safeguards;
- Nuclear Safety for Regulators;
- Leadership and Management for Safety for Regulatory Bodies;
- Safety Management Systems;
- Emergency Preparedness and Response;
- Field of Radiation Processing Facilities and Applications;
- Site Evaluation and Safety Improvement on Post-Fukushima Nuclear Power Plant Accident Actions;
- Detailed Scientific and Engineering Review of Lessons Learned from Fukushima;
- Operational Coordination for Effective Response to Border Monitoring of Nuclear and Other Radioactive Materials for ASEAN;

- Safety Evaluation for Radioactive Waste Management and Decommissioning;
- Effective and Sustainable Regulatory Control of Radiation;
- Assessment of Radiological Risks;
- Implementation of Nuclear Security Legal Instruments; and
- Use of a Graded Approach in the Application of Safety Requirements for Research Reactors.

On the emergency preparedness and response program, the government has been constantly holding national capacity building on the following:

- Training for first responders, response initiators, communicators, basic radiation protection, radiological assessors, decontamination procedure, and safety principles;

- Emergency drills and exercises to improve response procedures and capabilities, facilities, equipment, and manpower involved in emergency response groups such as

    · Regular field drills and exercises starting with exercises with limited scope;

• Table-top exercises and drills included in training activities for response teams, facility personnel and first responders; and,

PNRI Emergency Response Lead group in ANSTO Sydney, Australia in 2010

• Maintenance and inventory program for equipment and supplies used in emergencies established by each national agency assigned to control such equipment or supply.

The PNRI has formulated an Emergency Response Plan and the Procedure Manual for Radiological Emergency Field Monitoring and Control Team (2012). Further, the Institute also developed training modules for future emergency response exercises.

3. Nuclear safety regulatory system

The Philippine Atomic Energy Commission (PAEC), now known as the Philippine Nuclear Research Institute, was created by virtue of Republic Act (RA) 2067 (Science Act of 1958) to undertake R&D in the production of atomic energy and to ensure the safety of its application. Another legislation was enacted in 1968, the RA 5207 (Atomic Energy Regulatory and Liability Act), which provided additional functions to PAEC, such as the issuance of licenses and regulations with respect to construction, possession and/or operation of any atomic energy facilities and materials. In 1986, Executive Order No. 128 was issued, reorganising PAEC into what is now the PNRI, with the following functions:

• R&D on the application of radiation and nuclear materials;

• Undertake the transfer of research results to end-users;

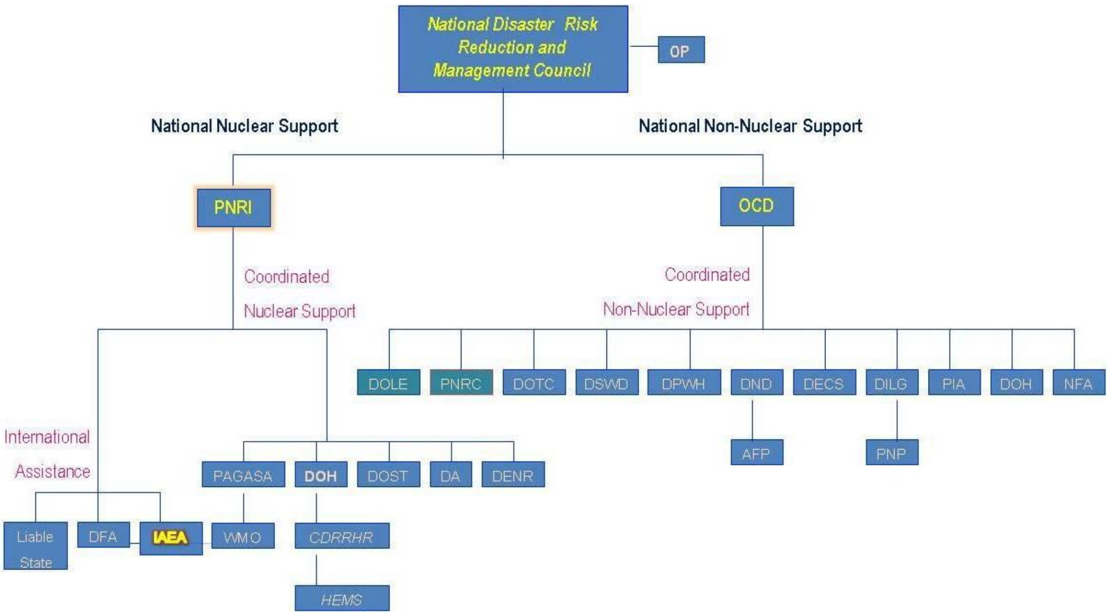
• Operate and maintain nuclear research reactors and other radiation facilities; and

• License and regulate activities relative to production, transfer, and utilisation of nuclear and radioactive substances.

PNRI inspector verifies radiation level of a nuclear industry gauge
Source: 2012 PNRI Annual Report

Currently, the PNRI is the only agency mandated to promote and regulate the safe and peaceful applications of nuclear science and technology in the Philippines. In carrying out its regulatory tasks, nuclear regulations have been formulated based on internationally accepted standards and best practices on the peaceful uses of nuclear energy. The Institute has also developed a system of regulations—the Code of PNRI Regulations (CPRs) –which established licensing and safety requirements that must be followed. The CPRs are subject to continuous review and revisions covering, among others, such as the medical use of radiopharmaceuticals, commercial providers of nuclear technical services, security of radioactive sources, nuclear power reactor criteria, and security requirements in the transport of radioactive material. An internal regulatory control program has also been implemented for the Institute's facility and laboratory compliance and adherence to nuclear regulations and standards of radiation safety and security. In the radiation protection and safety program, the Institute requires licensees and owners of radioactive materials to submit emergency plans and procedures.

In line with the national emergency preparedness program, the PNRI has continued the review and revision of the Radiological and Emergency Preparedness Plan (RADPLAN). The Institute leads the development and revision of the RADPLAN, which was approved and adopted in November 2000.The RADPLAN is set into action by the National Disaster Risk Reduction and Management Council (NDRRMC). The primary purpose of the RADPLAN is to establish an organised emergency response capability for a timely, coordinated action of the Philippine authorities in a peacetime radiological incident or emergency to protect public health and ensure safety. It outlines the capabilities, responsibilities, and authorities of participating organisations, including a concept for integrating the activities of these agencies to protect public health and safety. It assigns a responsibility to specific agencies for coordinating activities of other agencies involved in a response. An organisation may initiate a response activity either under its statutory authority, or in response to a request for assistance from another agency.



The National Response has two main components: (1) nuclear response, and (2) non-nuclear response. The PNRI is responsible for the coordination of the "National Nuclear Response", while the Office of Civil Defense is the agency responsible for the coordination of the "Non-nuclear Response". The RADPLAN assigns to these two agencies major coordination and support functions beginning with the initial notification of a radiological emergency until termination of all response activities.

The different types of radiological emergencies have been classified into the following:

- Emergencies from fixed nuclear or radiation facilities with licensed or regulated radioactive sources;

- Emergencies occurring in the transport or loss of radioactive materials – radioactive materials or wastes being transported by land, sea, or air inside Philippine territories;

- Emergencies from foreign sources having environmental or health impacts on Philippine territories, including the possible entry of contaminated food, scrap metals, and other materials that pose actual, potential, or perceived threats to any area within the territorial limits of the country;

- Emergencies from re-entries of satellites with nuclear materials as components; and,

- Emergencies from nuclear ships.

Reviewing and updating the RADPLAN has been an important task of the PNRI to make it more robust in containing the impact of nuclear accidents—core meltdowns, radioactive wastes, or even acts of terrorism.

4. International cooperation on nuclear safety and emergency preparedness

The Philippines has no official policy yet on nuclear energy program for power generation, on regional/international cooperation in nuclear energy development, including safety standards and emergency preparedness. However, it sees them as significant for a country contemplating to have a strong policy on nuclear energy as a potential source of power. Further, these regional/ international cooperation agreements are venues to gain new knowledge that would enhance measures, regulations, and safety standards that govern the domestic uses of nuclear energy to non-power-related applications (medicine, agriculture, and industry), and to improve the emergency preparedness response procedures and strategies of the country during a nuclear accident.

Thus, the Philippines welcomes the regional cooperation under the ERIA-Working Group for International Cooperation on Nuclear Safety and Management in East Asia as another opportunity to solicit technical collaboration on nuclear safety and emergency preparedness. With this, the following are proposed as possible cooperation undertakings of the said ERIA-Working Group:

- Creation of a portal/website to share developments and updates on regulations, regulatory guides, rules of procedures, standards, and criteria relative to the safety and security of radioactive materials, including emergency preparedness response, among others. A template on the information to be shared should be formulated and each member country needs to accomplish and update the said template. The information must be unique (different) from the information shared by existing regional cooperation networks to avoid duplication of efforts. The portal/website must have a window for member countries to discuss online, if necessary, certain information or to aid one member country seeking assistance for the updating of certain regulations and safety provisions of nuclear applications.

- Establishment of a Centre of Excellence (aside from a portal/website) for sharing of information on emergency preparedness and response, for the transfer of technologies and exchanges of expertise. A member country may host the centre, which may be accessed by other member countries and which may also be a venue for fellowships/training on HRD.

- Transfer of technology to improve monitoring and analysis of radiation levels and other necessary equipment relevant to radiological emergency response. Advanced member countries (Japan and the Republic of Korea) may share and/or transfer their technology to other members through exchanges of experts (or on-the-job-training schemes) for them to acquire additional skills and expertise.

- Conduct of training on emergency preparedness and response so that countries may learn of this skill and may become familiar with other response procedures that could somehow be replicated to strengthen the response procedures of other countries.

- Formulation of a Communication Plan for a public awareness campaign on nuclear safety and emergency preparedness and response that will assist the member countries raise their citizens' level of awareness on nuclear energy. This could generate social acceptability and get public support for a nuclear energy program.

Thailand

1. Nuclear energy policy and development plan

1.1. Energy policy in Thailand

Thailand's energy policy was delivered by Prime Minister Yingluck Shinawatra to the National Assembly on 23 August 2011. It touched upon the following points:

(1) Promote and drive the energy sector to generate income for the country. As a strategic industry, investment in energy infrastructure will be increased to make Thailand a regional centre for energy business, building upon the competitiveness of its strategic location.

(2) Reinforce energy security through the development of the electrical power grid and exploration of new and existing energy sources, both in Thailand and abroad. Energy sources and types will also be diversified so that Thailand will be able to meet its energy needs from a variety of sustainable energy sources.

(3) Regulate energy prices to ensure fairness as well as reflect the production costs by adjusting the role of the Oil Fund into a fund that ensures price stability. Subsidies will be available for vulnerable groups. The use of natural gas in the transport sector will also be promoted, while the use of gasohol and biodiesel will be promoted for use in the household sector.

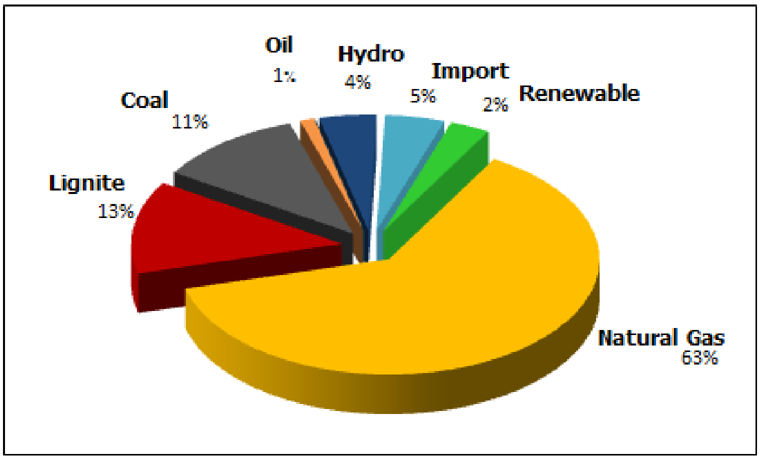
(4) Support the production, use, and R&D of renewable and alternative energy sources, with the objective of replacing 25% of the energy generated by fossil fuels within the next decade. Comprehensive development of the energy industry will also be promoted.

(5) Promote and drive energy conservation through the reduction of power usage in the production process by 25% within the next two decades. The use of energy-efficient equipment and buildings will be promoted, while Clean Development Mechanisms (CDM) will be used to reduce emissions of greenhouse gases and address the issue of global climate change. Systematically raise consumer awareness on the efficient use of energy to conserve power in the production and transport sectors, as well as in the household sector.

1.2. Energy Overview in Thailand

Thailand has been highly dependent on natural gas for electricity generation for more than 10 years. For example, in the first quarter of 2014, the share of natural gas used to generate electricity was 63% of total fuel consumption for electricity generation, followed by coal/lignite at 24%, imported electricity at 5%, hydropower at 4%, renewable energy at 2%, and fuel oil and diesel at 1%, as illustrated in Figure 2.8.

Figure 2.8 Thailand Power Generation Installed Capacity (as of Jan 2014)



Source : EPPO 2014

1.3. The Development of the Nuclear Power Program in Thailand

A) Nuclear Power Policy before the Fukushima Daiichi Nuclear Accident

The growth in electricity demand in Thailand is predicted to double in the next 12 years. This is equivalent to a growth rate of about 6% per year (Thailand Power Development Plan, 2007, Rev. 2), which means there would be an increase in electricity generation by about 1,500 megawatts (MW) each year over that time period.

In addition to the need for significantly increasing Thailand's capacity to generate electricity, it is necessary to introduce a more diversified source of fuels used to generate electricity. This is because Thailand has limited reserves of natural gas and it currently relies on this for generating over 60%of its electrical energy. It is predicted that Thailand's known reserves of natural gas will be used up in approximately 12 years, which will make Thailand dependent on imports of natural gas from Myanmar and LNG from other countries.

Given the importance of electrical energy in improving and sustaining the nation's economic viability and living standards, it is essential for Thailand to pursue alternative and more secure means of meeting its future electrical energy needs. In addition, because of global warming concerns, it is also essential that any future generating plans of Thailand should include considerations for reducing carbon emissions. As a result, 4,000 MW of nuclear power plants were incorporated in the Power Development Plan (PDP) 2007 with the first 2,000 MW achieving commercial operation in 2020, and the other 2,000 MW a year later in 2021.

In 2009, owing to the global financial crisis, the PDP 2007 was revised, and the generating capacity of nuclear power plants was decreased from 4,000 MW to 2, 000 MW. However, in 2010, the actual electricity demand of Thailand increased— significantly higher than the forecast—and tended to grow continuously so that the PDP 2010 was approved with electricity from nuclear power plants getting increased from 4,000 MW to 5,000 MW to supply electricity to the grid in 2020, 2021, 2024, 2025, and 2028.

To achieve the establishment of nuclear power plants as scheduled for 2008–2010, the Ministry of Energy and key related organisations were closely collaborating to prepare all infrastructure in accordance with the guidance of IAEA. On 13–17 December 2010, IAEA experts came to Bangkok to assess Thailand's readiness under the IAEA's Guidelines on 19 issues. The evidence showed that Thailand was ready to move to Phase II: Program Implementation. Nevertheless, in the next phase, three issues had to be taken into consideration. These were the IAEA Guidelines No. 5: Legislative Framework, No. 7: Regulatory Framework, and No. 11: Stakeholder Involvement.

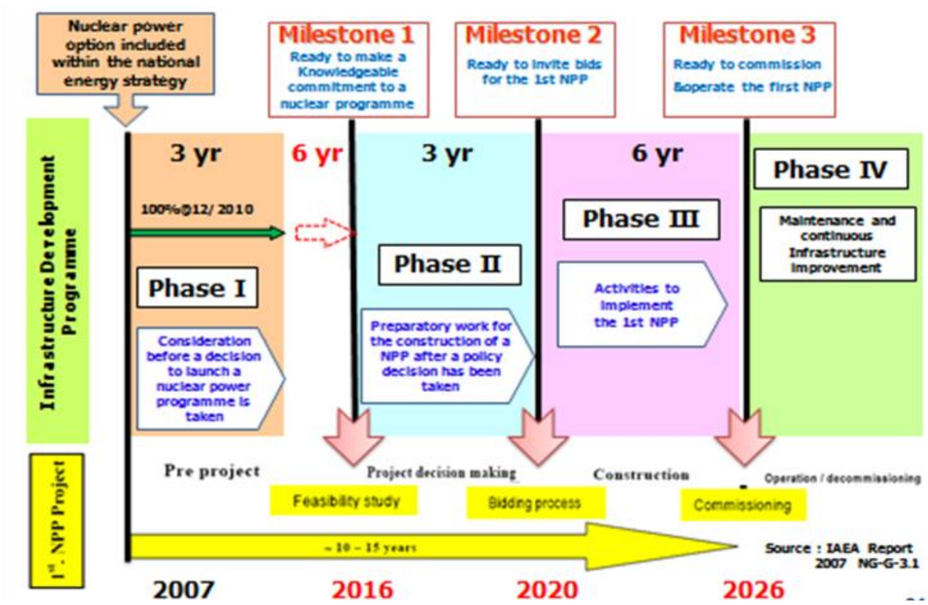
B) Nuclear Power Policy after the Fukushima Daiichi Nuclear Accident

On 11 March 2011, an earthquake occurred and a tsunami struck the east coast of Japan, resulting in severe damage to the Fukushima Daiichi Nuclear Power Plant, causing radiation leaks and contamination of the power plant. This accident dampened public acceptance and trust in Thailand's nuclear power project development. Therefore, the government decided to postpone the project for the next three years, which meant that the commercial operation of the first nuclear power plant would extend from 2020 to 2023. The main reasons for postponing the project were (i)to review the legislation framework, regulatory framework, and stakeholder involvement; and (ii) to include lessons learned from the Fukushima Daiichi nuclear power accident and additional supporting plans.

Project name	**Type**	**Capacity (MW)**	**Expected Construction Start Year**	**Expected Commercial Year**
EGAT Nuclear Power Plant # 1	LWR	1,000	2020	2026
EGAT Nuclear Power Plant # 2	LWR	1,000	2021	2027

Later in August 2011, when the Yingluck government took office, the scope of the new government policies and the variation of the economic situation induced changes and fluctuation in both power demand and power supply. As a result, PDP 2010 was reviewed in line with the changing situation. In the latest PDP 2010 , Rev. 3, power generation capacity was set at 2,000 MW, with commercial operation of the power plants set in 2026 and 2027.

C) Thailand’s Latest Nuclear Power Project Milestones



	Phase	Duration	Old Schedule	Revised Schedule On 2010	Current Schedule On 2012
Phase I	Preliminary	1 year	2007	-	
	Pre-Project Activities Government Approval to Proceed	3 years	2008 – 2010	Postpone 3 years	Postpone more 3 years
Phase II	Program Implementation	3 years	2011 – 2013	2014-2016	2016-2019
Phase III	Construction	6 years	2014 – 2019	2017-2022	2020-2025
Phase IV	Commercial Operation for 1st unit		December 2020	December 2023	December 2026

2. Human resources development plan for nuclear safety and emergency preparedness

2.1. Study of Nuclear and Radiological Emergency Plan in Thailand

The study was conducted by the Thailand Institute of Nuclear Technology

(TINT) in 2009 with the following features:

Purpose

To serve as a guide in ascertaining measures that will enable the operating organisation or operator to fulfill its essential goals of nuclear or radiological emergency preparedness and response.

Scope of the Study

(1) Study and collect data on nuclear safety, security, and safeguards for preventing nuclear accidents and events at the early stage.

(2) Study and collect relevant information on regulating the nuclear power plants (NPPs) (National Regulatory Body or NRB).

(3) Study and collect data on public disaster prevention and mitigation plans for NPP accidents by comparing three countries with nuclear power programs, namely, Sweden (in Europe), and Japan and the Republic of Korea (in Asia).

(4) Prepare guidelines/recommendations for public disaster protection and formulate mitigation plans for use in developing the nuclear power program to minimize hazards that may occur from the operation of an NPP.

(5) Training and site visit on prevention, mitigation, and preparedness for emergency situations in Japan and the Republic of Korea.

2.2. Suggestions for the structure of the National Disaster Prevention Control Center for Thailand

Recommendations from the Study

(1) The regulatory body should be independent from the organisation involved in nuclear promotion and operation.

(2) The Atomic Energy Act 2504 and other related ministerial regulations should be revised to focus on regulating research reactors and related activities only.

(3) A law or legislation should be established to regulate the physical protection and licensing requirement of nuclear facilities, including NPPs.

(4) Thailand should sign the Convention on Physical Protection of Nuclear Material (CPPNM) with the IAEA to strengthen nuclear security.

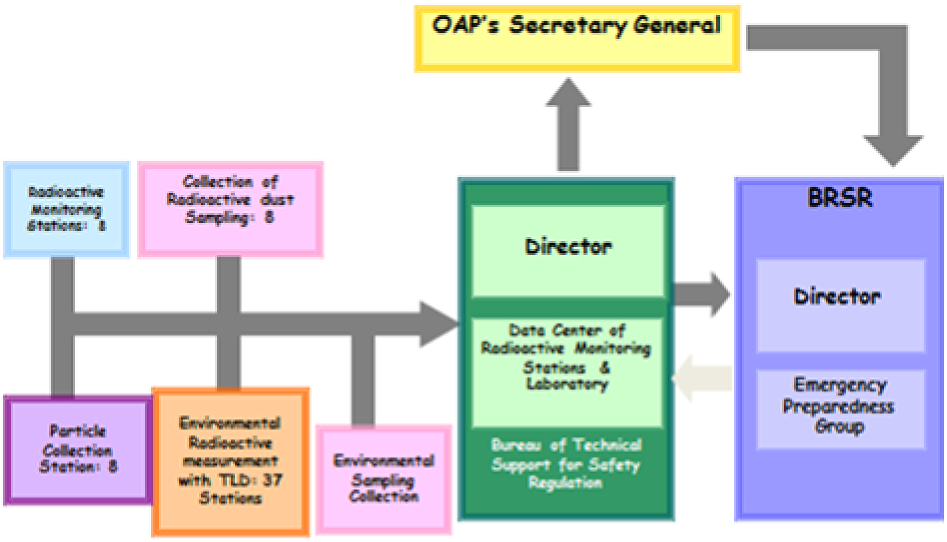
(5) Thailand should immediately prepare and implement nuclear emergency planning. The plan implementation can be made possible under two channels:

- Under Article 11 (1) of the Disaster Prevention and Mitigation Act 2007, the Department of Disaster Prevention and Mitigation, Ministry of Interior will submit the plan to the National Disaster Prevention and Mitigation Committee (NDPMC), and under Article 7 (2) of the Disaster Prevention and Mitigation Act 2007, NDPMC will approve and submit the emergency plan to the Cabinet for final approval;
- By issuing separately new and specific nuclear disaster prevention and mitigation acts.

2.3. Emergency Response and Radioactivity Monitoring in Thailand

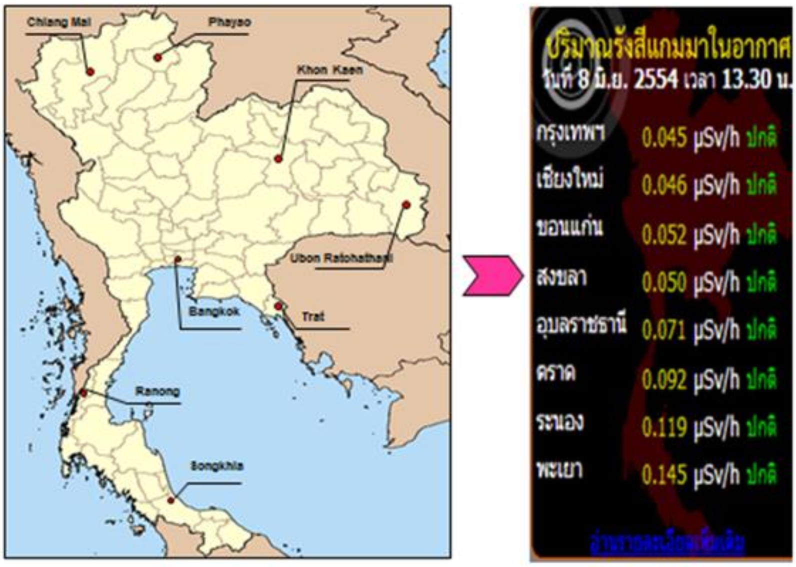
To cope with the impact of the Fukushima Daiichi nuclear power accident on Thailand, the Office of Atoms for Peace (OAP) immediately established the Center of Command and Information within the organisation in order to distribute information, provide counter measures to Thai people who are inquiring about nuclear emergencies, about Fukushima Daiichi's nuclear accident situation and its impact; and to provide information to the mass media. The mechanism of emergency response management is shown in Figure 2.9.

Figure 2.9. Thailand Process of Emergency Preparedness Response



The OAP also carried out external contamination screenings by checking the contamination levels of airline crews, cargo, and aircrafts from Japan. For internal contamination checking, the OAP provided examinations, RAM-OAP 40+ service, for people who suspect themselves of getting contaminated.

In addition, the OAP monitored the amount of gamma in the atmosphere more frequently than usual. In 2011, there were eight gamma radiation monitoring stations across the country, consisting of two stations in the north, located in Phayao, Chiang Mai; two stations in the northeast, located in Khon Kaen, Ubon Ratchathani; one station in the central area, located in Bangkok; one station in the east, in Trat; and two stations in the south, in Songkhla and Ranong.

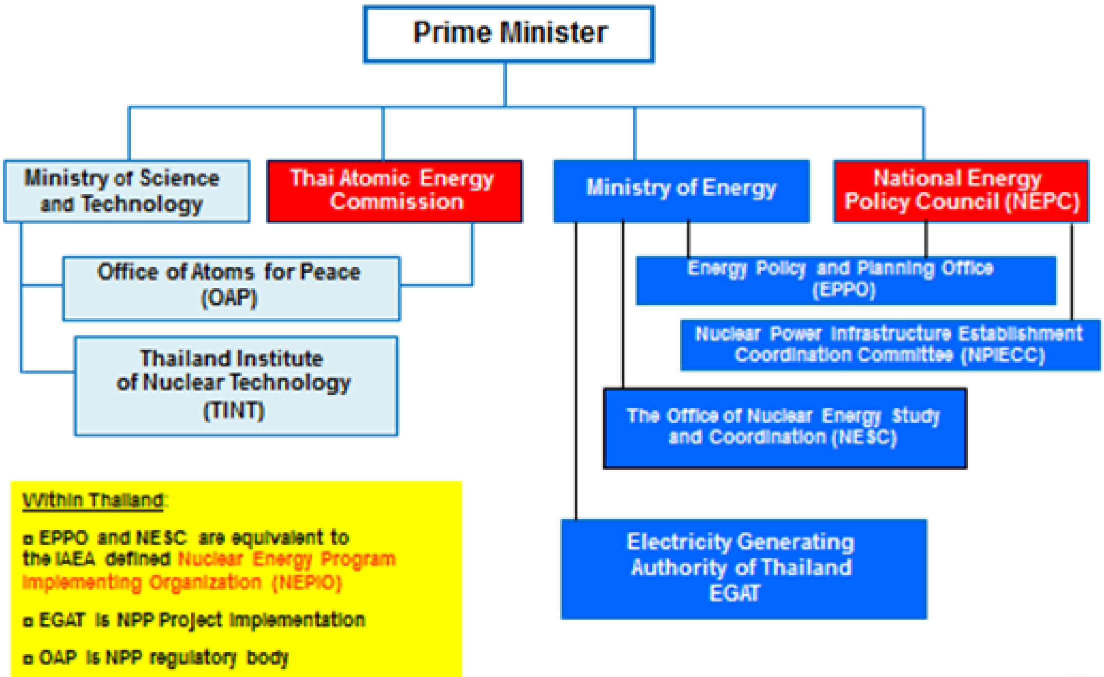


Ambient Gamma Monitoring Station

For water gamma contamination monitoring, the OAP collaborated with the Pollution Control Department, Ministry of Natural Resources and Environment, and with the Department of Fisheries, Ministry of Agriculture and Cooperatives. All information collected were provided to the public on OAP's website—www.oaep.go.th. Another area for checking was radioactivity measurement in foodstuffs imported from Japan, such as rockfish, octopus, and pickled plums, and others. The checking was in collaboration with the Food and Drug Administration, Ministry of Public Health. As a result, no radioactive contamination or radiation hazards were found in Thailand.

To enhance emergency preparedness, from 2011 to 2013, four more radiation monitoring stations were established and located in Tak, Sakon Nakhon, Kanchanaburi, and Phuket. By 2020 nine radiation monitoring stations will have been finished.

3. Nuclear safety regulatory system



(1) Ministry of Energy

The Energy Planning and Policy Office (EPPO) is a pivotal agency in formulating energy policies and in promoting them to achieve objectives. On nuclear power policy, the EPPO has been trying to accomplish energy diversification, higher energy security, and a decrease in GHG emissions. In 2013, the Ministry of Energy set up a new agency, the Office of Nuclear Energy Study and Cooperation, to promote nuclear power policy.

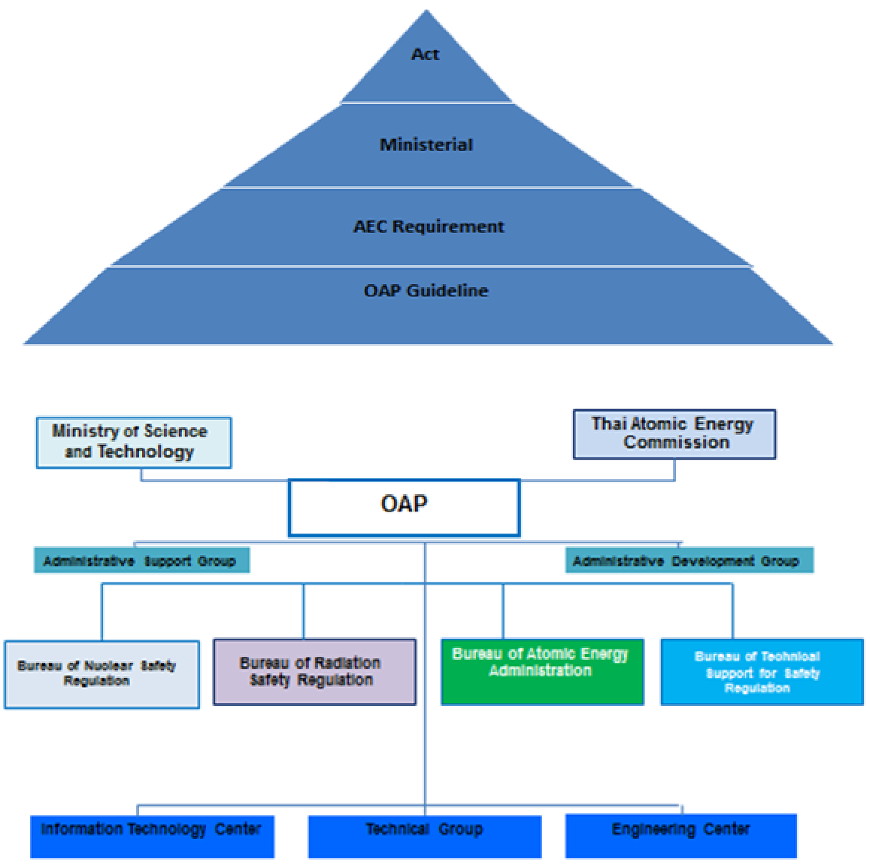
The Electricity Generating Authority of Thailand (EGAT) is in charge of a dominant electricity supply company that at present owns approximately 47% of total power plant capacity in the country. The rest is owned by private power companies in three categories: (1) independent power producers (IPPs), (2) small power producers (SPPs), and (3) very small power producers (VSPPs). In addition to electricity generation and acquisition, EGAT is also responsible for the country's transmission system and national regional control centres.

For NPPs, EGAT is mainly responsible for the preparation of their construction. Even though NPPs will be turnkey projects based on open bidding, EGAT will be the operator.

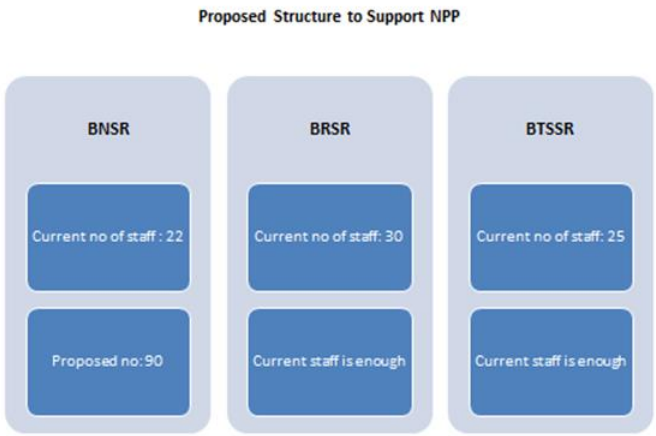
(2) Office of Atoms for Peace (OAP)

The OAP is the regulatory body. Currently, the main national laws and regulations on nuclear power consist of (1) Atomic Energy for Peace Act 1961 (Revised in 1969); (2) Ministerial Regulation Licensing 2007, which prescribes the conditions, procedures for license application, and implementation in connection with special nuclear materials, source materials by-products or atomic energy; and (3) Ordinance, Guidance and Procedures issued by OAP, and the level of laws and regulation is shown in Figure 2.10.

Figure 2.10 Thailand the level of laws and regulation



Three major bureaus are responsible for the nuclear power project. These are the (1) Bureau of Nuclear Safety Regulation (BNSR), currently with 22 people, (2) Bureau of Radiation Safety Regulation, currently with 30 people, and (3) Bureau of Technical Support for Safety Regulation, currently with 25 people—or a total personnel of 77 people.



In 2009, the BNSR conducted a training needs analysis (TNA) based on the IAEA four-quadrant competency model given in TECDOC-1254.The results of the TNA are as follows:

(1) The senior staff need the following: Improvement on legal basis, analytical techniques, specialised technologies, auditing process

(2) The junior staff need the following: Further training on basic technologies, regulatory process, licensing process, analytical safety techniques, problem-solving skills, communication skills, teamwork.

(3) Thailand Institute of Nuclear Technology(TINT)

The TINT is a public organization under the Ministry of Science and Technology. It was established in 2006 by separating from the OAP. The TINT is in charge of R&D, services, and transfer of nuclear technology applications, and it has been preparing to be the technical support organization when Thailand establishes the nuclear power project.

4. Human resources development plan for nuclear safety and emergency preparedness

The following were the training courses supported in the past by the IAEA for related NPP organisations:

(1) Strengthening nuclear science and technology education,

(2) Acquiring regulatory expertise in preparation for the first NPP and for a research reactor,

(3) Supporting the national nuclear engineering education centre,

(4) Technical support for upgrading/establishment of infrastructure for the introduction of nuclear power,

(5) Upgrading/establishing the infrastructure required for the introduction of nuclear power,

(6) Supporting web-based nuclear education and training through regional networking,

(7) Providing legislative assistance,

(8) Strengthening nuclear power infrastructure land planning,

(9) Establishing a benchmark for assessing the radiological impact of nuclear power activities on the marine environments in the Asia-Pacific region,

(10) Sustainability of regional radiation protection infrastructure,

(11) Education and training in support of radiation protection infrastructure,

(12) Strengthening national regulatory infrastructures,

(13) Strengthening capabilities for protecting the public and the environment from radiation practices,

(14) Strengthening national and regional capabilities for responding to radiological and nuclear emergencies,

(15) Strengthening nuclear regulatory authorities in the Asia and Pacific region, and

(16) Developing Human Resources in nuclear security, nuclear safety, and regulatory systems

5. International Cooperation on nuclear safety and emergency preparedness

Thailand needs support in the following areas:

(1) Enhance related organisations' personnel capability through on-the-job training and workshops on

- Radioactivity Determination in Environmental Samples
- Dose and Risk Assessment Using Predictive Models
- Radionuclide Transport Using Predictive Models
- Remediation Techniques for Radioactive Contamination in the Environment
- Quality Assurance and Uncertainty

(2) Technical advice through expert mission for establishing, conducting, and maintaining the Centre of Excellence (CoE) to the international standard.

Vietnam

1. Nuclear energy policy and development plan

1.1. Nuclear energy policy

On 3 January 2006, the Prime Minister approved the Strategy on Peaceful Use of Atomic Energy up to 2020, Decision No.01/2006/QD-TTg.

On 23 July 2007, the Prime Minister approved the Master Plan for the Implementation of the Long-Term Strategy on Peaceful Use of Atomic Energy up to 2020, covering all activities related to the development of nuclear infrastructures and capabilities for future self-reliance of NPP technology.

The Ninh Thuan Nuclear Power Project was approved by Resolution No. 41/2009/QH12 of the National Assembly on 25 November 2009.

On 18 March 2010, the Prime Minister approved the Master Plan for the Implementation of the Ninh Thuan Nuclear Power Project, Decision No. 460/TTg-KTN.

On 4 May 2010, the State Steering Committee of the Ninh Thuan Nuclear Power Project was established according to Decision No. 580/QD-TTg of the Prime Minister. The committee is chaired by the Deputy Prime Minister of Viet Nam.

On 24 July 2010, the Prime Minister, through Decision No.957/QD-TTg, approved the strategy and Master Plan. The decision identified the priorities for the future development of atomic energy applications, which include nuclear power focusing on the construction of the first and second units, starting safely by 2020 and continuing in the following years;

According to the Atomic Energy Law (Article 9) and Prime Minister Decision No. 446/QD-TTg issued in April 2010, the National Council for Nuclear Safety (NCNS) was established as a consultancy body for the Prime Minister.

1.2. Nuclear power development plan

According to the power sources development program 2011–2020, orientation to 2030 in Viet Nam–Master Plan No.7 (Decision No.1208, dated 21 July 2011), the current grid capacity of Viet Nam is about 22,000 MW, and the estimated demand will be 75,000 MW by 2020 and 146,800 MW by 2030. In 2030, nuclear power will account for 10.1% of the total power (70 billion kWh), and the total capacity of NPPs will be about 10,700 MW/146,800 MW in total.

According to Resolution No. 41/2009/QH12, the first nuclear power project in Viet Nam will be built in Ninh Thuan Province and Vietnam Electricity (EVN) has been nominated as the project investment owner. This project includes four units with a total capacity of 4,000 MW, and the two first units of 1,000 MW will be put into operation in early 2020.

On 17 June 2010, the Prime Minister approved the Orientation Planning for NPP development in Viet Nam up to 2030, through Decision No. 906/QD-TTg.

Orientation Plan to Build NPPs in Viet Nam

Nuclear Power Project	Commissioning time (Year)
Ninh Thuan 1, # 1, 1,000 MW	2020+(2 ÷ 3)
Ninh Thuan 2, # 1, 1,000 MW	2020+(2 ÷ 3)
Ninh Thuan 1, # 2, 1,000 MW	2021+(2 ÷ 3)
Ninh Thuan 2, # 2, 1,000 MW	2021+(2 ÷ 3)
NPP 3, # 1, 1,000 MW	2022
NPP 3, # 2, 1,000 MW	2023
NPP 4, # 1, 1,000 MW	2026
NPP 4, # 2, 1,000MW	2027
NPP central 1,# 1, 1,350MW	2028
NPP central 1,# 2, 1,350MW	2030

2. Nuclear safety regulation system

2.1. National Regulatory Body

Governmental Decree No. 28/2008/NĐ-CP established the Vietnam Agency for Radiation and Nuclear Safety (VARANS) as a nuclear regulatory body. VARANS is under the Ministry of Science and Technology (MOST) with the duty of assisting the Prime Minister in state management on radiation and nuclear safety.

Decision No.217/QĐ-BKHCN, dated 18 February 2014, replaced the previous regulation on organisation and operation of VARANS. Under the new regulation, the duties of VARANS are more clearly and fully defined, including the (i) state management on radiation and nuclear safety; (ii) state management on security of radioactive sources, nuclear materials, nuclear facilities; (iii) nuclear control for preventing nuclear proliferation; and (iv)other activities supporting management activities.

Following Decision No. 217/QĐ-BKHCN, dated 18 February 2014, the organisation structure of VARANS included eight divisions and three centres: the Division of Administration, Division of Planning and Finance, Division of Legislation and Policy, Division of Licensing, VARANS Inspectorate, Division of Nuclear Security and Safeguards, Division of Safety Standards, Division of International Cooperation, Center for Information and Training, Center for Technical Support for Radiation and Nuclear Safety and Emergency Response, Center for Technical Support for Radiation and Nuclear Safety and Emergency Response (TSO for nuclear power program). Currently, the Technical Support Centre (TSC) has 45 technical staff members working in different groups, such as Safety Analysis and Systems, Risk Assessment, Site Evaluation and Structural Analysis, Material and Mechanical Equipment, Radiation Safety, Nuclear and Radiological Emergency Response, or Environmental Radioactive. However, the staff members have no experience in NPPs.

In 2014, VARANS will review and approve the Safety Analysis Report for Nuclear Power Plants and the Environmental Impact Assessment report for parts related to radiation as well as future licensing activities for NPPs in Viet Nam.

VARANS has the responsibility to enhance and develop international cooperation activities on radiation and nuclear safety as assigned by the Ministry, and to participate in the execution of international treaties and other international agreements on radiation and nuclear safety.

<u>Duties of the TSC for Radiation and Nuclear Safety and Emergency Response</u>

- Evaluation and assessment of nuclear and radiation safety for radiation facilities, radiation work, and nuclear installations.

- Technical support for emergency response to nuclear and radiation incidents/accidents.

- Safety management of occupational, public, and medical exposure.
- Management of environmental radioactivity.
- Development of regulations and regulatory guidelines on nuclear and radiation safety and emergency response.
- Implementation of conventions and treaties in the fields of nuclear and radiation safety and emergency response.
- Conduct of research activities in the fields of nuclear and radiation safety and emergency response.
- Conduct of public services in the field of nuclear and radiation safety and emergency response.

2.2. Regulations for Safety Assessment for Pre-Feasibility Study and Site Approval

- Decree No. 70/2010/ND-CP, dated 11 November 2010, is on detailing and guiding a number of articles of the Law on Atomic Energy regarding NPPs.
- Circular No. 13/2009/TT-BKHCN, dated 20 May 2009, by the Minister of Science and Technology, is for guiding the preliminary nuclear safety assessment for the site selection of NPPs in the investment decision stage (Pre-FS stage).
- Circular No. 28/2011/TT-BKHCN, dated 28 November 2012, is on nuclear requirements for NPP sites.
- Circular No. 29/2012/QĐ-BKHCN, dated 28 December 2012, is on the format and content of the Safety Analysis Report (SAR) for NPP site approval.

<u>Circular on Guide on Safety Evaluation and Review of SAR for NPP Site Approval (to be issued in 2014):</u>

- Nuclear Safety Standards 6941: 2013 – External Human Induced Events in Site Evaluation for Nuclear Power Plants (based on NS-G-3.1)

- Nuclear Safety Standards 6942: 2013 – Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation Nuclear Safety (based on NS-G-3.2)

- Nuclear Safety Standards 6943: 2013 – Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Power Plant Nuclear Safety (NS-G-3.4)

- Nuclear Safety Standards 6944: 2013 – Seismic Hazards in Site Evaluations for Nuclear Installations (based on SSG -9)

- Nuclear Safety Standards 6945: 2013 – Geotechnical Aspects of Site Evaluations and Foundations for Nuclear Power Plants (based on NS-G-3.6)

For Feasibility Study (FS) Approval and Construction Permit Phases

- Decree No. 70/2010/ND-CP, on detailing and guiding a number of articles of the Law on Atomic Energy regarding NPPs.

- Circular No. 30/2012/QD-BKHCN on requirements of design for nuclear safety of NPPs (SSR 2/1).

- Circular on the format and content requirement of SAR for FS approval phases (to be issued by March 2014)

- Circular on Guide on Safety Evaluation and Review of SAR for NPP FS approval (to be issued by November 2014)

- Circular on Requirement of the format and content of SAR for Construction Permit phases (to be issued by October 2014)

- Circular on Requirement of Deterministic Safety Assessment (DSA) and Probabilistic Safety Assessment (PSA) (to be issued by October 2014)

2.3. Other legislation related to nuclear safety/security

- The Law on Atomic Energy 2008 has been approved. It requires the development and promulgation of secondary legal documents, including NPP standards (No. 18/2008-QH12)

- Circular No. 19/2010/TT-BKHCN on Guidance on Inspection of Radiation and Nuclear Safety

- Circular No.23/2010/TT-BKHCN, dated 29 December 2010, on Ensuring Security for Radioactive Sources

- Circular No.24/2010/TT-BKHCN, dated 29 December 2010, on Issuance of National Technical Regulation QCVN 6/2010-BKHCN on Radiation Protection – Categorization and Classification of Radioactive Sources

- Circular No. 02/2011/TT-BKHCN on Guidance on Control of Nuclear Materials and Source Materials

- Circular No.02/2011/TT-BKHCN,dated16 March 2011, on Safeguards Implementation

- Circular No.38/2011/TT-BKHCN, dated 30 December 2011, on Requirements on Physical Protection of Nuclear Materials and Nuclear Facilities

- Circular No. 23/2012/TT-BKHCN on Requirements for the Safe Transport of Radioactive Materials regarding Critical Safety

- Circular No.19/2012/TT-BKHCN, dated 8 November 2012, on Ensuring Radiation Protection for Occupational Exposure and Public Exposure

- Circular No.25/2012/TT-BKHCN, dated 12 Dec 2012, on export and import control of airport Annex 2 Items

- Circular No.17/2013/TT-BKHCN, dated 30 July 2013, on airport requirements

Viet Nam has acceded to the following international Instruments:

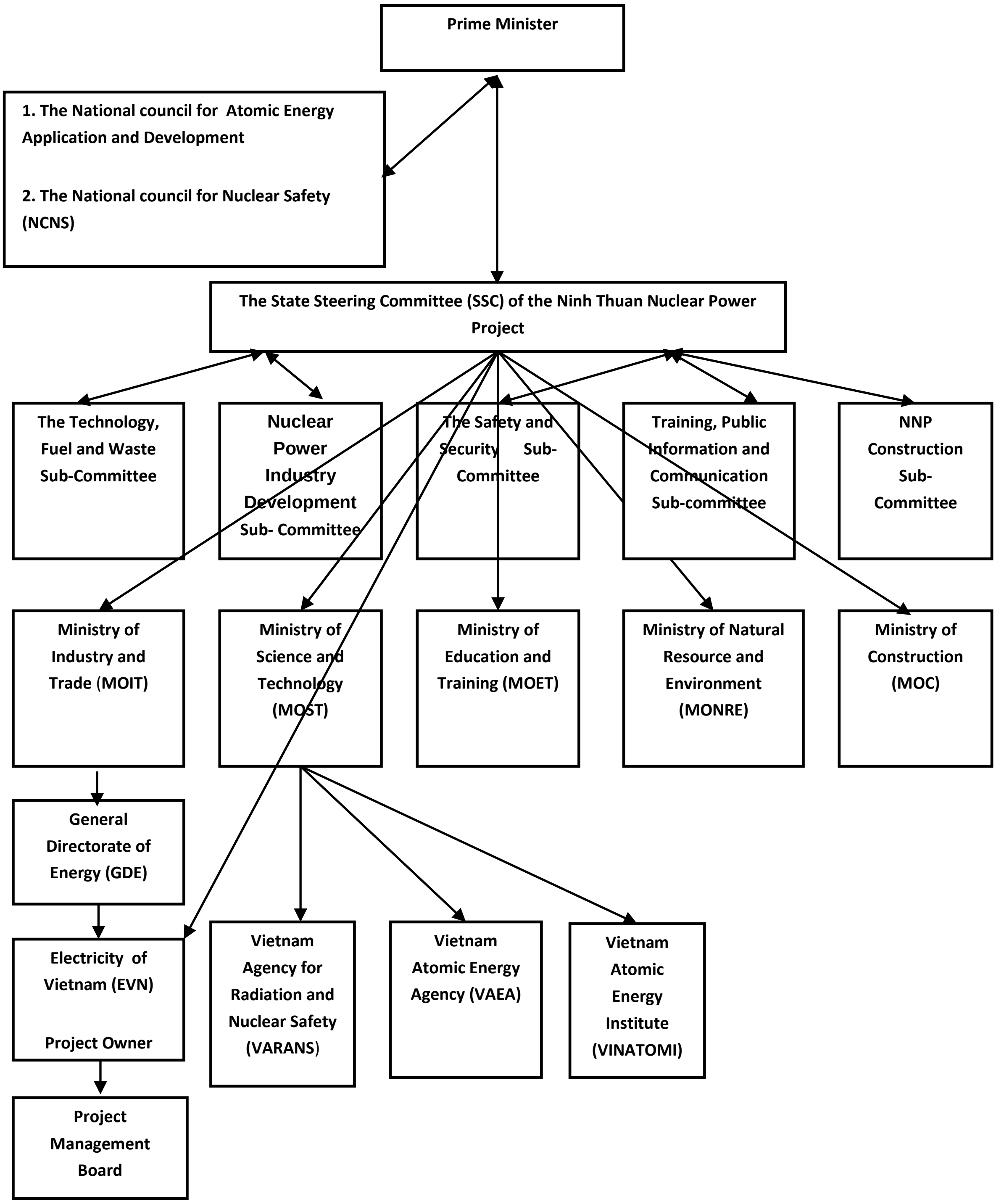
- Nuclear Non-proliferation Treaty (1982)

- Safeguards Agreement (1989)

- Convention on Early Notification of a Nuclear Accident (1987)

- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1987)
- Comprehensive Test Ban Treaty (signed 1996, ratified 2006)
- The South East Asia Treaty on the Nuclear-Weapon-Free-Zone (1997)
- Code of Conduct on the Safety and Security of Radioactive Sources and Supplementary Guidance on Import and Export of Radioactive Sources (2006)
- Additional Protocol (signed in 2007, ratified in September 2012)
- Convention on Nuclear Safety (April 2010)
- Convention on the Physical Protection of Nuclear Material (in force November 2012) and its Amendment
- Joint Conventions on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management.

2.4. Organization's responsibility of the Nuclear Power Development Program in Viet Nam



The responsibility of the State Steering Committee (SSC) is not limited only to Ninh Thuan Nuclear Project. The outcomes of the SSC are distributed to all participating organizations as government orders to take necessary actions.

The formations of the five technical subcommittees under the SSC are ongoing. The formulation of two subcommittees will be done by the first quarter of 2013, and the other three subcommittees by the end of 2013. The subcommittees are for Nuclear Safety and Security chaired by MOST, NPP Technology, Nuclear Fuel and Radioactive Waste chaired by the Ministry of Industry and Trade (MOIT), Construction chaired by MOC, Nuclear Power Industry Development chaired by MOIT, and Training, Public Information and Communication chaired by MOST.

The permanent office of the SSC was established and given six staff members under the MOIT in 2011. The main responsibilities are to provide advice and assistance for the SSC; to coordinate the work between the SSC members and the relevant ministries, agencies and local authority; and to assist the SSC in supervising and monitoring the implementation of the project.

The National Council for Nuclear Safety (NCNS) was established as a consultancy body for the Prime Minister on Nuclear Safety, and VARANS is a standing organisation of NCNS and is responsible for the working program preparation, including all conditions for the operation of NCNS. The president of NCNS is the minister of MOST, the vice-presidents of NCNS are the deputy ministers of MOST and MOIT, the committee members are the Deputy Ministers of Security, Defense, Ministry of Natural Resources and Environment, Medical, the General Director of VARANS, and some experts in the nuclear safety field.

The National Council for Atomic Energy Application and Development was established as a consultancy body for the Prime Minister on Atomic Energy Application and Development for Peaceful Purposes.

The MOIT licenses the commissioning and electricity operation based on comments of the National Council for Nuclear Safety.

The MOST licenses the permission for the construction of NPPs based on comments of the National Council for Nuclear Safety.

The Ministry of Natural Resources and Environment cooperates with the MOST in the guidance of environmental impact assessment (EIA) for nuclear power plants, and evaluates and approves the EIA of NPPs.

EVN was designated as the owner of the Ninh Thuan NPP Projects and the EVN Nuclear Power Project Management Board was established.

The 2008 Law on Atomic Energy will be revised and promulgated as soon as possible to ensure an effectively independent regulatory body; a clear delineation of responsibilities of authorities involved in the nuclear power program; adequate provisions on emergency preparedness and response, radioactive waste and spent fuel management, decommissioning, nuclear security, safeguards; and civil liability for nuclear damage. VARANS is chairing the project for amendment of the Law on Atomic Energy.

3. International/Regional Cooperation, Emergency Preparedness, Human Resources Development/Management

3.1. International Cooperation Programs

- Cooperation with the IAEA, international organizations, and other countries in RCA and participation in FNCA-related programs
- Cooperation in ASEAN: Nuclear Energy Cooperation–Sub Sector Network (Legislative Framework, PR, PA, HRD, etc.).
- Cooperation with the Russian Federation, Japan, and the United States in training programs in nuclear fields.

In Hanoi in February 2014, the VARANS, in collaboration with the IAEA, organized the Workshop on Communication in a Nuclear or Radiological Emergency

3.2. The National Nuclear and Radiological Emergency Plan (NNREP)

Viet Nam has established the framework for radiological and nuclear emergency planning (preparedness and response), which allows for the implementation of Emergency Preparedness and Response arrangements that are commensurate with the currently recognized threat. However, to implement a nuclear power program, Viet Nam needs to build a national radiological and nuclear emergency response plan with the consequences of emergencies at NPPs. For further development, the NNREP needs to be completed, taking into account IAEA Safety Standards.

<u>Legal Documents on Emergency Preparedness and Response</u>

- Law on Atomic Energy

- Decree No. 07/2010/ND-CP detailing and guiding a number of articles of the law on atomic energy

- Decree No. 70/2010/ND-CP detailing and guiding a number of articles of the law on atomic energy regarding NPPs

- Circular No. 19/2012/TT-BKHCN regulation on radiation control and safety in occupational exposure and public exposure

- Circular No.24/2012/TT-BKHCN guidance on establishment and approval of emergency response plan and approval at provincial and facility level

Legal Documents under Construction

• Circular on preparedness and response for a radiological and nuclear emergency

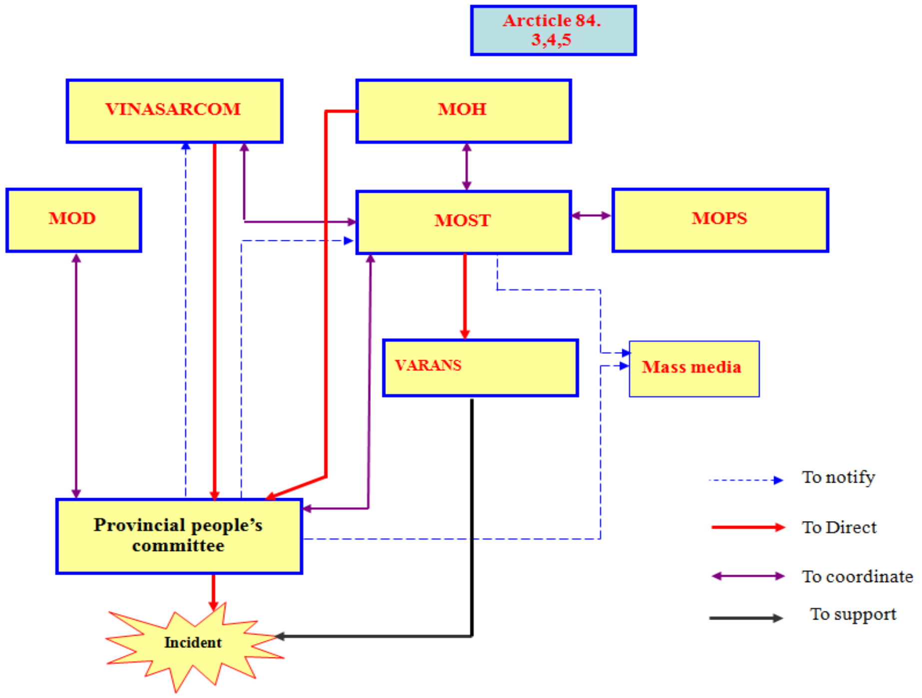
• National emergency response plan

• Manual for first responders for a radiological emergency

Organisation System of Facility-Level Emergency Response

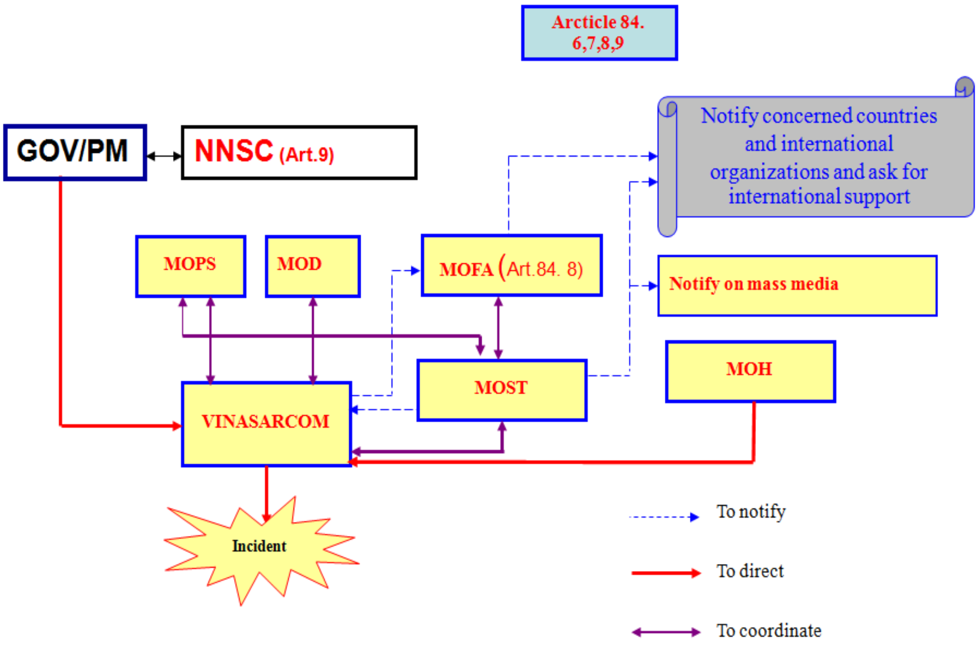
Under the provisions of the Law on Atomic Energy, all facilities conducting radiation work have to develop emergency response plans. This is one basis for granting a license to facilities conducting radiation work.

Organisation System of Provincial-Level Emergency Response



VINASARCOM: The National Committee for Search and Rescue

National-Level Emergency Response



Make it clearer in the National Emergency Response Plan

National Emergency Response Plan

• May 2012, the MOST approved the financing plan to build the national radiological and nuclear emergency response plan. The plan is expected to be completed in 2014.

• The National Committee for Search and Rescue of the Socialist Republic of Vietnam or VINASARCOM is preparing for resources for the national emergency response plan.

3.3. Human Resource Development Programs

Decision No. 1558/QD-TTg on 18 August 2010, the Prime Minister approved the project "Training and Human Resource Development (HRD) for Nuclear Energy", which indicated the national direction, objectives, funds, and implementation responsibilities in training and HRD activities for nuclear energy. This decision assigns the following responsibilities:

- MOET's overall responsibility for implementing the scheme includes the upgrading of the nuclear capability of selected universities and the VINATOM training centre;

- MOIT and EVN will implement the "Human resource training for NPP projects in Ninh Thuan" as mentioned in Document No. 460/TTg-KTN;

- MOST to prepare the training needs for all other organisations (apart from EVN) as needed to support the nuclear power program.

The National Steering Committee (NSC) on HRD in the field of atomic energy was established according to Prime Minister Decision No. 940/QD-TTG, dated 17 June 2011, and the NSC is chaired by the Deputy Prime Minister of Viet Nam in charge of education and training, science and technology, and social affairs. The Management Board, which is headed by the Minister of Education and Training, was also established to assist the NSC.

3.4. Proposals/Ideas for Regional Cooperation on Nuclear Safety, Security, or Emergency Plan

International cooperation enhancement are needed on the following:

- Technical meetings/workshop to exchange information and share experiences and knowledge for human resource development for nuclear power development programs; discuss and hold exercises based on nuclear and radiation emergency scenarios.

- Meetings/workshops on related topics, such as development of nuclear regulatory infrastructure, and the National Nuclear and Radiological Emergency Plan.

Viet Nam hopes to continuously receive support from developed countries, especially from Japan, the Russian Federation, and the US, in sharing experiences for development of the nuclear safety infrastructure and HRD of Viet Nam's NRB.

Republic of Korea

1. Nuclear energy policy and development plan

Since there has been increasing demands for a more comprehensive and consistent energy policy in proportion to the expansion of industries, the government of the Republic of Korea has maintained a consistent national policy of fostering nuclear energy for stable supply against insufficient natural resources in the county. At the time of this study, there were 23 NPP units in operation and five units under construction. Four more units were being planned for construction. The 23 operating units consist of 19 pressurized water reactor (PWR) types, and four pressurized heavy water reactor (PHWR) type, while the five units under construction are PWR types.

Nuclear energy has been playing a vital role as a credible energy resource in the Republic of Korea. However, the global situation has become less favourable for nuclear energy after the Fukushima accident. The role of nuclear safety must be further strengthened to place nuclear energy continuously to an affordable, economically efficient, and environment-friendly energy source in the future. In the use of nuclear energy, nothing can take precedence over the assurance of nuclear safety.

In February 2013, the new Park administration announced four basic directions of the national administration, 14 action strategies, and 140 strategic tasks. Among them, "Strengthening a Nuclear Safety Management System" was selected as a national agenda in the area of the action strategy "Public Safety". This task aims to achieve nuclear safety in such a way that the people may feel safe by reinforcing the management of nuclear safety through giving top priority to safety. The task contains the following five action plans:

- Conduct rigorous safety inspection for NPPs, including stress tests for old plants with long operation (Kori Unit 1 and Wolsong Unit 1).
- Enhance transparency of safety regulations to obtain public trust.
- Overhaul the nuclear power plant management system to root out widespread corruption,

- Achieve world-class expertise in nuclear safety regulation.
- Redesign the functions and organisation of the NSSC to achieve substantial strengthening of the nuclear safety system in line with the intent of government restructuring.

The 6th Basic Plan of Long-Term Electricity Supply and Demand (or BPE for short) for 2013–2027 was announced in February of 2013, reflecting the view that the Korean government had been maintaining a reserved stance on building any new NPPs. In accordance with the BPE, which used to be announced every two years, the installed capacity of NPPs in the Republic of Korea will increase from 26.4% (2012) to 27.4% (2027) on the basis of peak contribution. By the end of 2013, 23 units are in operation and 11 units are planned for construction by 2024, hence, a total of 34 units are expected to be in operation by the end of the 6th BPE period (2027).

At the same time, another decision on four additional new reactors between 2025 and 2027 was also made to be put off until the final announcement of the 2nd "Korean National Energy Master Plan" due to anti-nuclear sentiment in the wake of Japan's 2011 Fukushima accident. A government–civilian working group issued a recommendation putting the level of nuclear power reliance between 22% and 29%, calling for reductions from the Lee administration's target level of 41%.

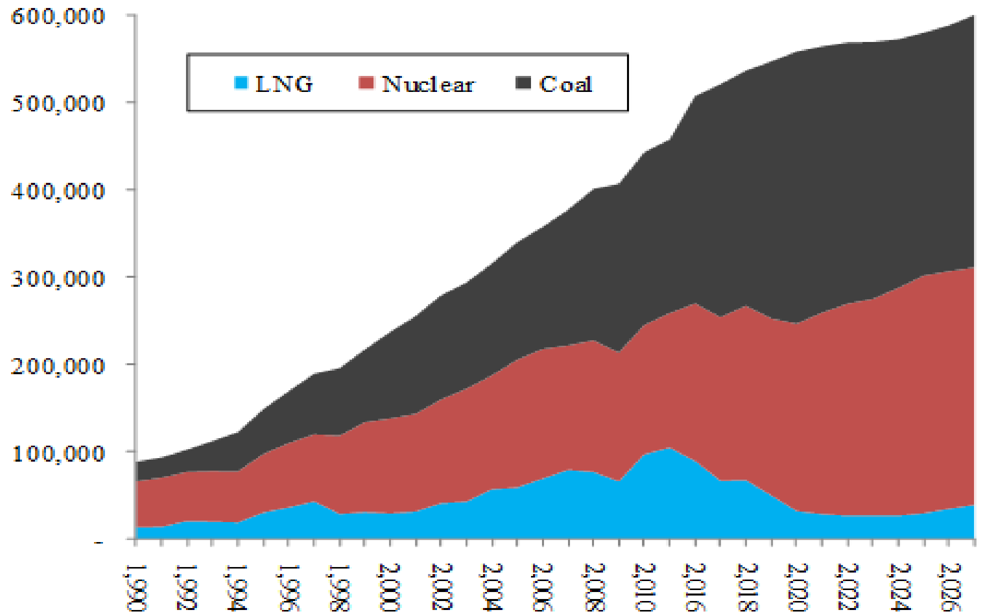
Table 1.1. Expected Installed Capacity of NPPs with the 6th BPE (as of December 2013)

Year / Item	2012	2015	2020	2027
No. of Operating NPPs	23	26	30	34
Installed Capacity on the Basis of Peak Contribution (MWe)(Ratio: %)	20,716 (26.4)	24,516 (24.5)	30,116 (23.9)	35,916 (27.4)

In January 2014, the government finalized the 2nd Korean National Energy Master Plan, calling for a target level of 29% reliance on nuclear power by 2035. Achieving this would require the building of 5–7 new plants in addition to the 23 units that are now on line and the 11 units that are currently being built or planned. Previous plans called for 41% nuclear by 2035. Currently, nuclear power accounts for 26%–29% of national electricity generation.

Figure 2.11.Projection for National Electricity Supply in the Republic of Korea

(according to the 6th BPE)



2. Nuclear safety regulatory system

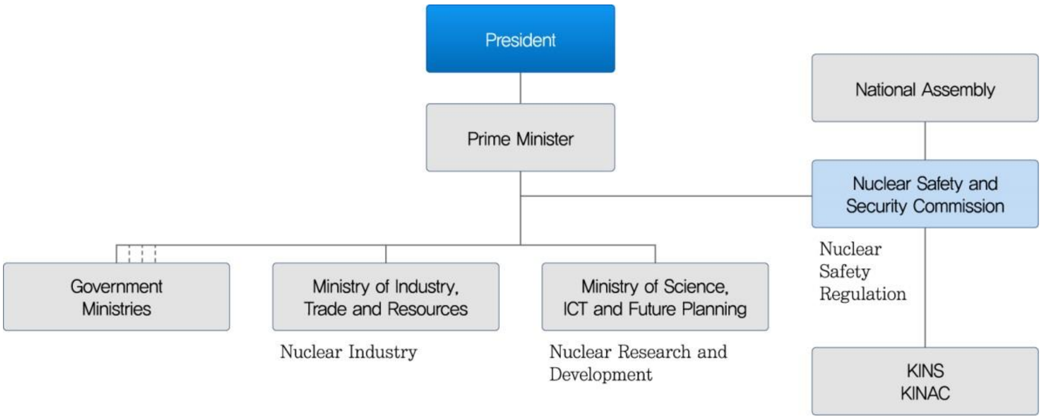
Before the Nuclear Safety and Security Commission (NSSC) was established in October 2011, the Ministry of Education, Science and Technology (MEST) had been in charge of national nuclear safety and regulatory matters, including the licensing of nuclear installations and businesses. The Fukushima accident created a momentum to set up the NSSC as a national mandate and it was formally established on 26 October 2011 as a Presidential Commission on nuclear safety and security and non-proliferation.

Following the inauguration of the new government and the subsequent restructuring of government organisations in February 2013, however, the

NSSC was placed under the Prime Minister's Office. Accordingly, relevant laws and regulations were amended to reflect the changes under the new government organisations. Today, the nuclear safety and regulatory system of the Republic of Korea is composed of the NSSC, the regulatory authority, and the Korea Institute of Nuclear Safety (KINS) and Korea Institute of Nuclear Non-proliferation and Control (KINAC), the regulatory support organisations.

The NSSC is in charge of nuclear safety regulation, including nuclear installations and licensing matters. The Ministry of Industry, Trade and Resources is responsible for the promotion of nuclear industry while the Ministry of Science, ICT and Future Planning is charged with nuclear research and development.

Figure 2.12. Government Organisations concerning Nuclear Energy



The NSSC was established in accordance with the "Act on the Establishment and Operation of the Nuclear Safety and Security Commission" and is organised in accordance with the "Enforcement Regulation on the Organization of the Nuclear Safety and Security Commission".

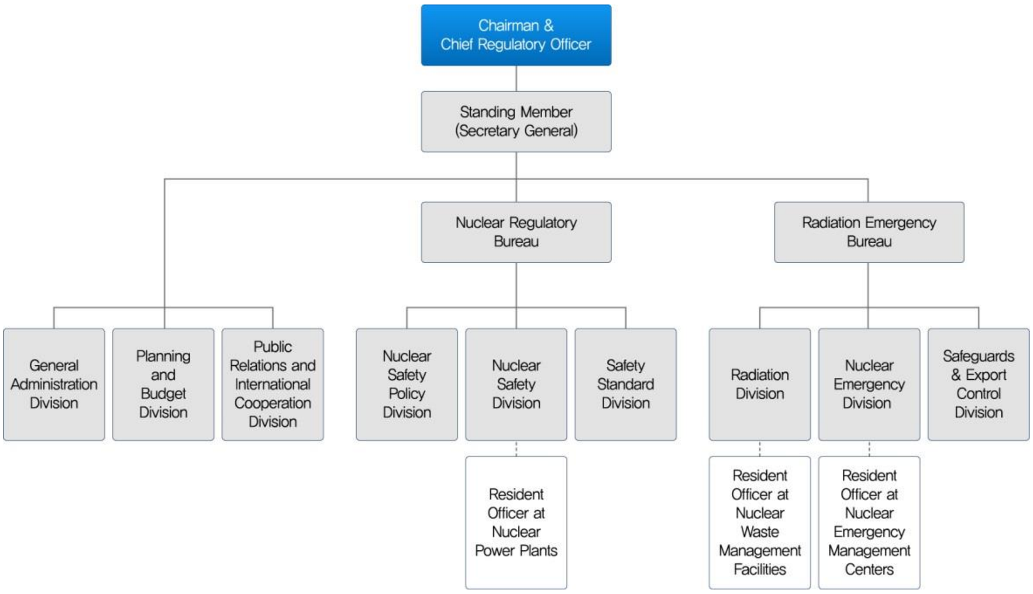
Members of the NSSC were appointed from among those who have in-depth insight and experience in nuclear safety. Members from various fields that can contribute to nuclear safety, such as nuclear energy, the environment, public health, science and technology, public security, law, and social and human sciences were appointed to the Commission.

It is prescribed that those who are working or worked as head or employee of the nuclear operator, or the nuclear operator groups within the past three years; or who are being involved or were involved in projects performed by the nuclear operator or the nuclear operator groups within the past three years, including research and development projects, entrusted by the nuclear operator or the nuclear operator groups, shall not be appointed as a member or members of the Commission. The term of office of the commission members shall be three years, and they may be reappointed once.

The chairman of the Commission is appointed by the President from among the nominees referred by the Prime Minister. Four members, including the standing members, are appointed by the President with the referral of the Chairman of the Commission, while the remaining four members are appointed by the President with the referral of the National Assembly.

Currently, the NSSC is composed of nine members including the chairman. The chairman and one member are standing members. The standing member holds an additional position of the Secretary General. The Secretariat, which deals with the general affairs of the Commission, consists of two bureaus and nine divisions with a staff of 93 as shown in Figure 2.13.

Figure 2.13 Organisation Chart for the NSSC (As of Feb. 2014)



As a regulatory support organisation entrusted by the NSSC, the Korea Institute of Nuclear Safety (KINS: http://www.kins.re.kr) has been performing various regulatory activities, such as safety review and inspections, environmental radiation monitoring and related R&D, since the first operation of a Korean NPP in 1978. KINS was established to conduct nuclear safety regulation as entrusted by the Nuclear Safety Act and the Act on Physical Protection and Radiological Emergency. It started in December 1981 as the Nuclear Safety Center within the Korea Atomic Energy Research Institute (KAERI) and became an independent, stand-alone organisation by the enactment of the "Act on the Korea Institute of Nuclear Safety" in February 1990.

The budget for fiscal year 2014 which is a little more than KRW100 billion (about USD100 million) is required for nuclear safety regulation business and relevant research projects. This regulatory spending is covered by regulatory fees by relevant nuclear users and government subsidies in accordance with the Nuclear Safety Act. As of today, the total number of KINS staff members is 443.

The Korea Institute of Nuclear Non-proliferation and Control (KINAC) was established In June 2006 to enhance the professional capabilities of the Republic of Korea's nuclear industry and to ensure compliance with international treaties and regulatory trends. KINAC analyzes the international trend of nuclear non-proliferation and establishes nuclear control policy, and is implementing safeguards over all nuclear material and facilities in the Republic of Korea. To establish a national regime of physical protection, KINAC has also been carrying out duties related to physical protection. The homepage of KINAC is http://www.kinac.re.kr**.**

KINAC performs its major mission, including matters on safeguards for nuclear materials, facilities, equipment, technology, and R&D activities related to nuclear energy, export and import control on internationally controlled goods including nuclear materials, R&D on nuclear non-proliferation and nuclear security and education and training in the area of nuclear non-proliferation and nuclear security. The budget for KINAC is around KRW25 billion (about US$2.5 million) and is required for nuclear security regulation business, construction/operation of an education centre and relevant research projects. Its spending is covered mainly by government subsidies. As of today, KINAC has about 70 staff members.

3. National Emergency Preparedness and Responses

The central government has a responsibility to control and coordinate the countermeasures against radiological disasters in the Republic of Korea. The radiological emergency response scheme is composed of the National Nuclear Emergency Management Committee (NEMC), which is chaired by the chairman of the NSSC, Off-site Emergency Management Center (OEMC), Local Emergency Management Center (LEMC), the Radiological Emergency Technical Advisory Center (RETAC) of KINS, the National Radiation Emergency Medical Service Center (REMSC) of the Korea Institute of Radiological and Medical Sciences (KIRAMS), and Emergency Operations Facility of the nuclear operator as shown in Figure 2.14.

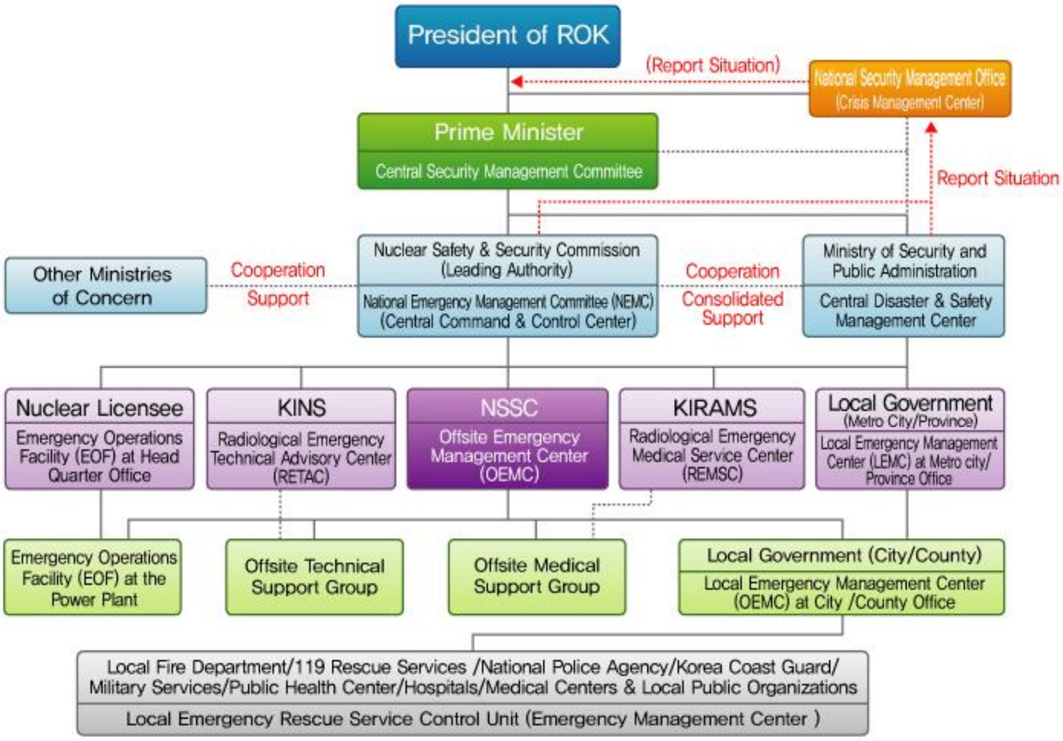
When an accident occurs, the NSSC installs and operates the NEMC and OEMC as a command and control centre on emergency responses at headquarter office and fields, respectively.

The OEMC is chaired by the standing member (Secretary General) of the NSSC. It consists of experts from the central government; local governments; local military and police; firefighting and educational institutes; nuclear safety expert organisations, radiological medical service institutes; and the nuclear operator. The OEMC performs coordination and management of radiological emergency response, such as accident analysis, radiation (radioactivity) detection, and decision making on public protective actions (sheltering, evacuation, food restriction, distribution of thyroid protection medicine, and control of carrying-out or consumption of agricultural, livestock and fishery products). The OEMC consists of seven working groups, including the Joint Disaster Countermeasures Council, which is an advisory body to the director of OEMC. The Joint Information Center is also operated as one of the working groups to provide prompt, accurate, and unified information about radiological disasters.

The LEMC, established by the local governments concerned, implements the OEMC's decision on protective measures for residents. It also takes charge of coordination and control of emergency relief activities utilising local fire stations, police stations, and military units.

When an accident occurs, the Korea Nuclear and Hydro Power, the operator of nuclear installations, is responsible for organising an Emergency Operations Facility and for taking measures to mitigate the consequences of the accident, to restore installations, and to protect the on-site personnel.

Figure 2.14 National Radiological Emergency Preparedness Scheme



•NSSC: Nuclear Safety and Security Commission; KINS: Korea Institute of Nuclear Safety
•KIRAMS: Korea Institute of Radiological and Medical Sciences;

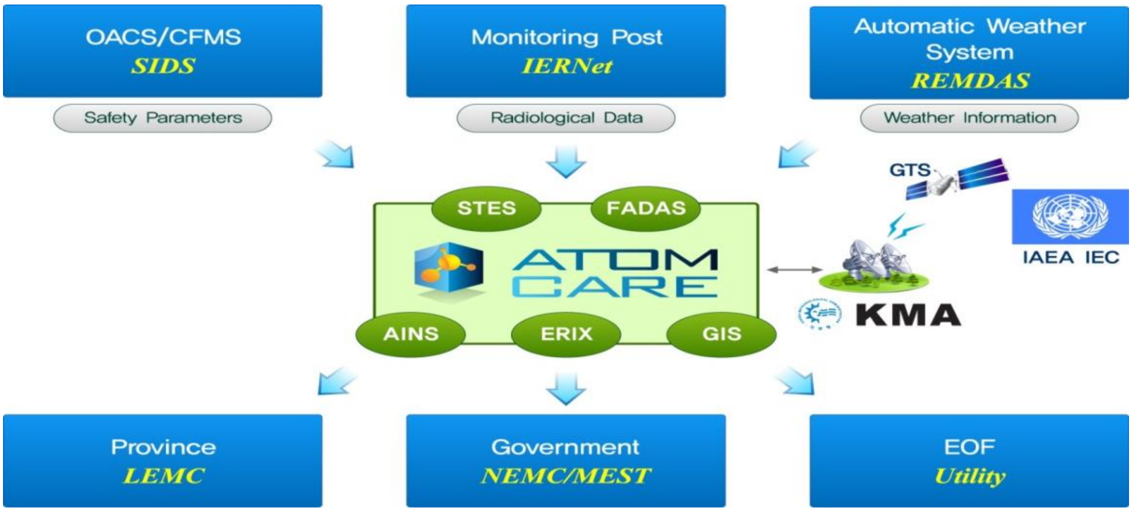
The central government also established and has operated the national radiological emergency medical treatment system for coordination and control of radiological medical services. The system consists of National Radiological Emergency Medical Service Center (REMSC) and primary and secondary radiological emergency medical hospitals designated by the region. KIRAMS established the Radiological Emergency Medical Center and administers the national radiological emergency medical system in cases of radiological emergency.

KINS organized the Radiological Emergency Technical Advisory Center (RETAC), which is in charge of providing technical advice on radiological emergency response, dispatching technical advisory teams to the affected site, initiating emergency operation of all the nationwide environmental radioactivity monitoring stations in accordance with the nationwide environmental radioactivity monitoring plan, coordination and control of off-site radiation monitoring, offering radiation monitoring cars, and monitoring the response activities of the operator.

To implement technical support activities for protection of the public and the environment in a nuclear emergency in the most efficient and effective ways, KINS has developed and operated the "Atomic Computerized Technical Advisory System for a Radiological Emergency" (AtomCARE). AtomCARE is a computer-based decision-aiding system for protecting the public and the environment in accident situations, by identifying the characteristics of an accident based on real-time operating parameters, estimating source term, assessing the impact from accident, and on-time/post-accident management.

Currently it has been operating well and effectively providing various technical supports in radiological emergencies. AtomCARE enables not only the rapid analysis and evaluation of radiological emergencies and radiation impacts but also the comprehensive management of information on several measures to protect the public.

Figure 2.15 Atomic Computerized/Technical Advisory System for the Radiological Emergency

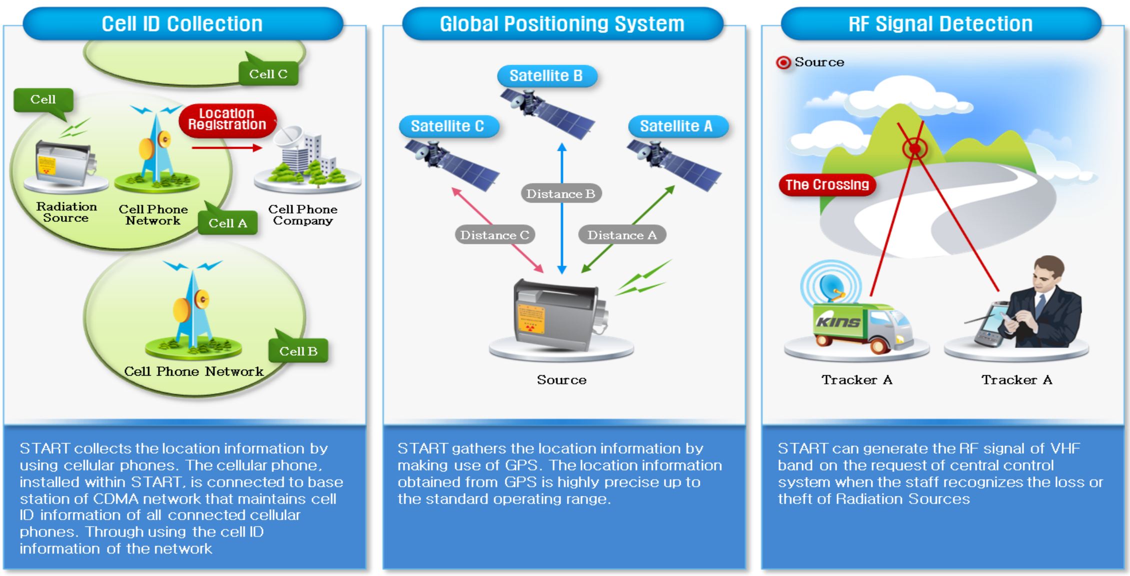


OACS: Operator Aid Computer System	**KMA: Korea Meteorological Administration**
CFMS: Critical Function Monitoring System	**GTS: Global Telecommunication System**
SIDS: Safety Information Display System	**LEMC: Local Emergency Management Committee**
IERNet: Integrated Environmental Radiation Monitoring Network	**NEMC: National Emergency Management Committee**
REMDAS: Radiological Emergency Management Data Acquisition System	**EOF: Emergency Operations Facility**
AINS: Automatic Information Notification System	**FADAS: Following Accident Dose Assessment System**
STES: Source Term Evaluation System	**GIS: Geographic Information System**
	ERIX: Emergency Response Information eXchange system

Against radiation emergency caused by hazardous radioactive sources, the NSSC and KINS have also developed and operated the Radiation Source Location Tracking System (RadLot) using the Republic of Korea's strong IT technology. The system aims to prevent and minimise public damage in the event of such radiation accidents as loss or theft, by real-time tracking of the location of radiation sources as well as monitoring the trend of radiation levels.

The RadLot system employs real-time monitoring of irradiators by showing location information and route of location, tracking mobile data terminals fixed to mobile sources using the Global Positioning System (GPS) and Code Division Multiple Access (CDMA) network in periodic or individual user demands. The RadLot system is now being used as a monitoring tool for radiation sources not only in the event of accidents but also under normal working conditions.

Figure 2.16. Location Tracking Methods for the RadLot System



At the IAEA International Regulatory Review Service (IRRS) inspection of 2012, the RadLot system was presented and was well received. Its application experiences have since been shared with overseas regulatory bodies that wanted transfer of the technology.

As an exemplary outreach program with social contribution, the NSSC and KINS have organised and operated the Ubiquitous-Regional Radiation Emergency Supporting Team (U-REST) aiming at a more rapid and effective first response to radiation accidents since 2007.

The U-REST is a voluntary service organisation consisting of radiation protection specialists with sufficient quality and capabilities. It is to be promptly dispatched to the area of concern and it supports the first response in cases of radiation accidents or terrorism. At present, the U-REST consists of around 200 experts of 40 teams in 12 regions nationwide. The members of U-REST have strengthened their cooperative first response capabilities in cases of accidents, through regular training and education, together with the first responders of the region (i.e., firefighters).

The U-REST will be dispatched to the sites of incidents/accidents, including loss of non-destructive radiography sources, and there conduct its support activities. It is expected that U-REST, as a voluntary organisation for social contribution with participation from regional radiation protection specialists, may play an important role in enhancing public confidence on nuclear/radiation safety. Once again, the U-REST has been regarded as a good example of devising a radiation emergency response framework, especially for the non-nuclear power countries in which governmental infrastructure for emergency response against radiation accidents or terrorism are not so firmly established.

For more prompt and effective protection of the public in case of radiological emergency, the revision of the radiological emergency planning zone is under consideration, to divide the existing Emergency Planning Zone (EPZ) into the Precautionary Action Zone (PAZ) and the Urgent Protective Action Planning Zone (UPZ) so as to comply with the IAEA recommendation. As of late 2013, research regarding the revision of the Emergency Zone (EZ) up to 30 km, has been completed and based on the research findings, related laws and systems will be changed, taking into consideration the opinions from concerned organisations including local governments.

As another development of post-Fukushima actions, the NSSC and KINS have reinforced a radiological/radioactive environment monitoring system across the country to ensure prompt and effective protective measures for residents. As a result, KINS has increased regional radioactive monitoring stations from 12 to 14, and Integrated Environmental Radiation Monitoring Networks (IER-Net) from 71 to 128 to cover and more extensively monitor radiation levels in the Korean territory so as to strengthen the capability for early detection of radiation (radioactivity) abnormality following nuclear accidents at home and abroad. Currently, radiological monitoring data are collected from 128 monitoring posts open to public through the web (IERNet.kins.re.kr) and mobile apps. (eRAD@now).

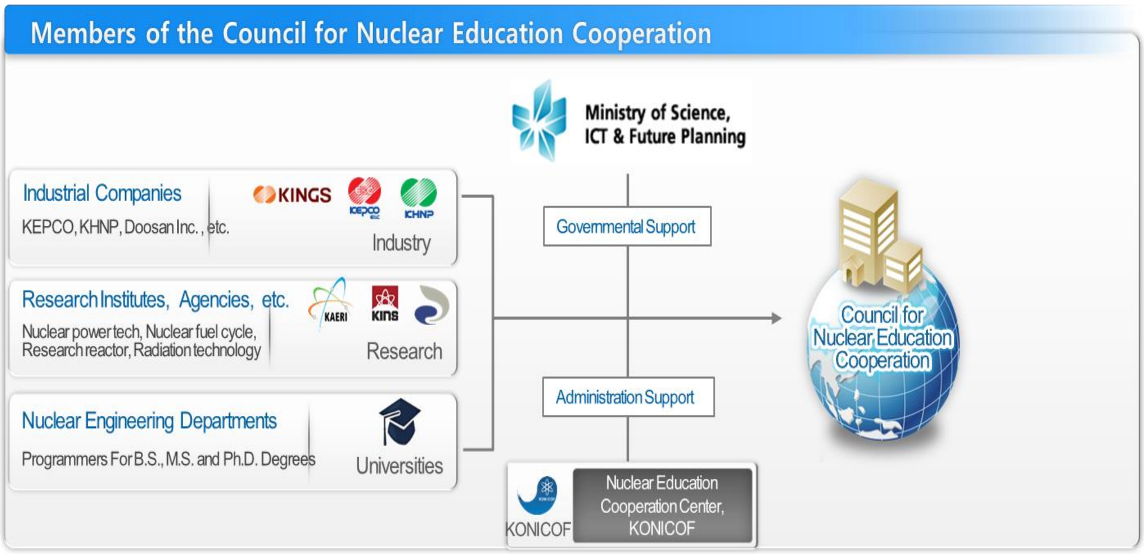
4. Human resources development plan for nuclear safety and Emergency Preparedness and Response (EP&R)

At the initial stage when nuclear power was first introduced in the early 1960s, the Republic of Korea was one of the beneficiaries of overseas technological support in nuclear power. The country has succeeded in localizing most nuclear power technologies—from design, manufacturing, construction, operation and maintenance, fuel fabrication, and building up of a safety regulatory infrastructure—in a relatively short period. While 23 nuclear plants are in operation for domestic needs, the country proves its nuclear capability through two overseas contracts—i.e., the UAE nuclear power plant and the Jordan nuclear research reactor.

It may be is noted that the localization process of nuclear power technology was derived from constant efforts to develop human resources. The first step toward nuclear self-reliance was to initiate education and training. In 1958, the first nuclear education system was initiated by a nuclear engineering department of a university. Subsequently, the Korea Atomic Energy Research Institute (KAERI), established in 1959, enlarged its role of education and training by establishing the Nuclear Training Institute in 1960. Today, more than 20 actors in industry and university levels take their specific roles[37] to produce a well-educated and highly trained workforce for the safe, successful, and competent application of nuclear power.

[37] KAERI website: http://www.kaeri.re.kr:8080/english/

Figure 2.17 Organisation Chart for Nuclear HRD in the Republic of Korea (as of February 2014)



The structure of HRD consisted of three dimensions—industry, universities, and public institutes. Numerous institutes from three sectors participate in developing nuclear human resources through education and training. Emphasizing the necessity of an HRD network on a domestic level that allows dealing with diverse HRD needs, the Nuclear Education Cooperation Council (NECC), with aid from the Korea Nuclear International Cooperation Foundation (KONICOF), was launched in early 2012. Today, it takes a significant role in coordinating any cooperation among domestic and overseas counterparts in the field of nuclear HRD.

In January 2008, KINS established the International Nuclear Safety School (INSS) as the top organisation in education and training for nuclear and radiation safety. The INSS has operated various training programs, including professional courses for in-house personnel and for nuclear experts around the world. The INSS has also offered training courses customized for regulatory experts in Asian countries to help them establish robust nuclear safety infrastructure, some of which have plans to embark on new NPPs.

Through the INSS, KINS has been offering a variety of training courses for all in-house personnel. These training courses are Leadership Development

Program, Management Issues Sharing Program, Ethics Management Course, Common Competency Program, and Functional Competency Program.

Among the training programs, the regulatory competency program is the core program that KINS has developed along with the regulatory activities conducted in the Republic of Korea. The main purpose of this program is to ensure that legally qualified personnel perform nuclear safety regulatory works and that they secure and maintain the expertise required by the relevant laws. There are three mandatory courses, as follows: Radiation Protection Training Course, Emergency Preparedness Training Course, and Nuclear Regulatory Inspectors Training Course.

For the training on radiation protection and emergency preparedness as required under the ”Atomic Energy Act” and the ”Physical Protection and Radiological Emergency Act,” respectively, specific courses are provided. A radiation protection training course is offered to help the staff who enter nuclear facilities for their duties, and to acquire and maintain essential work skills for radiation protection. A radiological emergency preparedness course is offered to help emergency responders acquire and enhance their capabilities for a systematic and effective emergency response so that in the event of a radiation disaster, a pre-planned emergency plan can be executed to protect the public and mitigate the disaster.

Nuclear regulatory inspectors training courses ensure that those who perform nuclear regulatory inspection have necessary competency and are eligible for their respective inspection fields under the provisions of the directive of the NSSC. The program comprises basic training and advanced training in inspection fields offered to in-house personnel in charge of inspections. The basic training course is a prerequisite for candidate inspectors to obtain their qualification. This course helps them acquire the basic skills, attitude, and expertise required at inspection fields. In the advanced training course, current regulatory issues are offered to candidate inspectors for them to learn about international trends, regulatory issues and challenges, among others. This course is carried out in the form of a workshop.

Further, continuous efforts to share the domestic regulatory technology and experience with the international society through the INSS have been made. In this context, an MOU was concluded between the INSS and the IAEA in January 2008 so that the INSS can play a key role as a regional hub for international education and training. Every year the INSS has trained more than 200 regulatory staff mainly from Asia, Africa, and the Middle East through a special training program called IAEA-BPTC (Basic Professional Training Course) and some on-the-job training courses on Regulatory Oversight of NPP Construction, by utilizing the existing NPP construction site.

Among the courses opened since 2009, the International Nuclear Safety Master's Degree Program is an exceptional long-term training course provided in cooperation with the Korea Advanced Institute of Science and Technology (KAIST). The program offers 1.5 years of training courses specialised in nuclear safety, with an annual quota of 10 students on full scholarship. This program aims to train younger staff from countries that are expected to introduce nuclear power in the near future to help them play a key role in their countries after receiving a master's degree in nuclear safety.

After September 11, 2001, urgent issues on nuclear security drastically changed the whole international nuclear security regime. Most of all, it made decision makers of each country to declare that they will strengthen their domestic security system through international cooperation. During the nuclear security summit, many countries stated that they will open their “centres of excellence” to raise human infrastructure on nuclear security.

Considering these developments, the KINAC launched the International Nuclear Non-proliferation and Security Academy (INSA) in February 2014 to support not only education and training but also R&D utilising test bed.

For newcomer countries in the field of nuclear power generation, establishing a nuclear security system may not be easy because there are so many factors specific to their environment. Therefore, it is important to give them chances to exchange experiences in good practice. Groups of people gathered for the training will work as a pool of experts representing each country with different experiences and environments. The INSA will provide a forum to exchange their experiences among participating expert groups.

During the preparation of the INSA program, surveys indicated that specific training was necessary for potential trainees. Survey results and experiences in operating nuclear-related systems were put together. Considering the various nuclear facilities, such as nuclear power plants (PWR and CANDU), research reactors for educational purposes a short distance away from the INSA, curricula have been provided to target audiences such as facility operators, regulators, and policy makers. The INSA will offer comprehensive education courses that cover various subjects, ranging from nuclear security, safeguards, and export control. Unlike other nuclear training centres around the world, the INSA will provide training programs on nuclear security as well as nuclear non-proliferation.

After the nuclear security issue was raised, its importance has been emphasized and thus the nuclear security system has evolved. As has been proven in the nuclear safety field, the human factor is also important to properly operate the nuclear security system. The training programs of INSA, combined with relevant R&D and opportunity for close discussions in the expert network, will help in the capacity building of the human infrastructure among the international nuclear security regime.

5. Proposals for Regional cooperation on Nuclear Safety Enhancement

It is well known that the way for regional contribution to regional and global nuclear safety could be done in several manners. These include active participation in international activities in developing the international standards, strong collaboration among regional states by sharing experience and expertise, and support for new entrants in developing their safety infrastructure. Thefollowing are some proposals for close cooperation in enhancing nuclear infrastructure in the Asian region.

Sharing Integrated Package for Developing Nuclear Infrastructure for Newcomers

Following the Fukushima accident of 2011, the global agenda in the emerging nuclear market is to provide a strict regulatory foundation for ensuring a sustainable, high-level nuclear safety. Every country planning to embark on a nuclear program should establish the nuclear safety infrastructure as a set of institutional, organisational, and technical elements and conditions. The International Regulatory Infrastructure Support Service (IRISS) developed by

KINS provides an integrated package that meets the prerequisites of the global nuclear safety regime through the establishment of a robust regulatory infrastructure.

The IRISS is an advisory package that provides guidance and consultation on the establishment of a regulatory infrastructure for countries introducing nuclear power program. It also provides guidance and consultation to build up the competency of a regulatory body based on global safety requirements and guidance. The integrated regulatory supporting tools are composed of independent sub-modules and databases developed by using state-of-the-art and IT-based technology.

The IRISS provides (1) a road map for a long-term nuclear regulatory infrastructure and specific implementation programs to be taken during the lifetime of NPPs and research reactors, (2) comprehensive and systematic education and training programs to ensure that the personnel has regulatory competence, (3) technical support for safety review and inspection of nuclear facilities, and (4) IT-based regulatory supporting tools to manage knowledge, experience, and information.

The first module supporting the establishment of a program to develop and implement the regulatory road map is organized by consolidating the action plans of nuclear power development programs set with IAEA guidance. Countries introducing an NPP can establish a long-term road map and an implementation plan for building their own infrastructure at all stages from preparation to commercial operation, by utilising safety regulatory road map and implementation plan as a part of the IRISS. KINS can provide for the establishment of nuclear regulatory infrastructure.

The second module provides education and training programs to strengthen the regulatory competence of the personnel. This module can also be independently operated to provide customized courses according to the requests of newcomers. Education and training program modules are provided in four categories, as follows: (1) Customized classroom courses according to the requests and situation of the countries, (2) On-the-job training designed for actual regulatory work, (3) Courses on computation program and devices applicable to regulatory works and in-depth courses for other technology fields, (4) Various aftercare services for review and dissemination of contents of learning (DVD, follow-up study Web Page, On/Off line Q&A staff) with compliance of all the four-quadrant competencies, as suggested by the IAEA in documents.

The third module supports technology for safety review and inspection of nuclear facilities. It supports functions and activities of the regulatory body, which deals with various licensing applications. This module provides consulting services and guidelines on safety review, pre-service inspection, and periodic inspection. It also provides various items necessary for safety evaluation, such as plant simulators for operation analysis, programs to evaluate the integrity of reactor pressure vessel and pipes, and fatigue monitoring system. Through on-the-job training on-site, the techniques for assessment and inspection and relevant experience can be obtained.

The fourth module supports the application of IT-based integrated regulatory supporting tools to manage knowledge, experience, and information, which are necessary to manage regulatory technology, knowledge, and experience obtained from regulation during the construction and operation of NPPs and research reactors.

The IRISS was developed for countries that are considering establishing a new nuclear power program but have little or no relevant experiences. Therefore, it can be used with flexibility and it contributes to building up a strong competency of the regulatory body in a meaningful and timely manner.

The IRISS can serve as a total solution for various kinds of demands. The first and consecutive services using IRISS were provided for the Federal Authority for Nuclear Regulation of UAE and have been utilised for the establishment of regulatory infrastructure in Jordan, Egypt, and Turkey. It is expected that the demands for IRISS would increase as countries considering building a new nuclear program increase.

Figure 2.18 Structures of IRISS

Establishing Joint Steering Committee of Regional Forum for Nuclear HRD

Networking through educational institutes has been widely recognised as a key strategy for capacity building and extensive use of limited educational resources in East and Southeast Asian regions. Hence, strong collaboration among nuclear education institutes in the Asian region must be one of the important elements in regional cooperation. Also, it has already been proven that the critical element in the development and wider use of nuclear technology in both power and non-power applications depends upon the availability of "soft infrastructure", i.e., qualified human resources, information, knowledge, skills, and experience from the early stage of nuclear development program. Fortunately, there are many regional networks for sharing information on nuclear HRD in the Asian region.

The first case of the regional scheme was the establishment in 2004 of the Asian Network for Education in Nuclear Technology (ANENT) as a regional partnership supported by the IAEA for cooperation in capacity building, human resource development, and knowledge management in nuclear science and technology. ANENT strives to promote, manage, and preserve nuclear knowledge to ensure the continued availability of qualified human resources in the region for the sustainability of nuclear technology and to prepare newcomers to commence nuclear power programs. ANENT members have increased to 19 as of 2013.

The second case, the Asian Nuclear Safety Network (ANSN), is one of IAEA's regional networks. The ANSN, with 14 members, was launched in 2002 to pool, analyze, and share nuclear-related information, existing and new knowledge, and practical experience among the member states. The ANSN has served as a platform for facilitating sustainable regional cooperation and for creating human networks and cyber communities among the specialists of those countries. Development of a regional capacity building system composed of knowledge networks, regional cooperation, and human networks will result in the enhancement of nuclear safety infrastructures among the participating countries, and will serve eventually to ensure and raise the safety levels of nuclear installations in the region.

The third case is the Asia-Pacific Safeguards Network (APSN), which was launched in 2009. It aims to share nuclear safeguards information, knowledge, and practical experiences among countries interested in enhancing their safeguards capabilities. The 14 participants of APSN believe that communicating, exchanging, and sharing safeguards knowledge and lessons learned are essential for establishing sustainable nuclear infrastructures and achieving a high level of safeguards implementation throughout the Asia-Pacific region.

Considering the need for sharing information and knowledge through various regional networks, the establishment of a comprehensive regional forum among nuclear-related HRD institutes involved in the regional networks should be proposed to strengthen regional networking and to help nuclear development in specific terms, such as nuclear HRD areas. The strategy for this regional forum rests upon the principles of cooperation and sharing of information and knowledge for capacity building, as part of nuclear infrastructure development and better use of available resources.

Closely linked to these regional networks is the establishment of the Joint Steering Committee (JSC) consisting of representatives from regional networks including ANENT, ANSN, APSN, RCA, FNCA, and major nuclear HRD institutes from member states. The establishment of JSC is suggested as one of the promising alternatives for the systematic operation of the regional forum in terms of education and training. It has been widely recognized that similar regional networks should be interconnected to build on positive outcomes from the regional collaboration.

Hence,, the main objectives of the JSC for regional collaboration are (i) to integrate available educational resources in synergy with existing nuclear knowledge-based networks, both within and outside the region; ii) to exchange information; and iii) to advise participating HRD institutes on how best to support the member states' systems for strengthening nuclear competence. The work plan of the JSC will be annually revised by participating members. It will be expected that JSC will share training courses, curricula, and documentation among its members and will create a compilation of websites and internet resources that are useful for the training of member states, if necessary.

Lastly, the JSC must continuously expand the collaboration/partnership between IAEA-supported regional networks in other regions such as LANENT (Latin America), AFRANET (Africa) and ENEN (Europe). The final goal of this regional collaboration through the JSC will be the establishment of joint education and training institutes such as the European Nuclear Safety Training and Tutoring Institute (ENSTTI),[38] which was founded in 2011 by four member TSOs of the European Technical Safety Organisations Network (ETSON) and each participating organisation makes its own contribution to the projects within the scope of its activities and their capacity/capability in terms of nuclear education and training.

[38]The ENSTTI is a nuclear education and training consortium among BEL, IRSN, GRS, ENEA, VUJE, SSTC-NRS, RCR, CIEMAT (European TSOs), ASN, CSN, FANC (European NRAs), and BBM Consulting to provide a team with complementary and reinforced skills and experience. The ENSTTI is designed to help governments, agencies, and organizations to identify and select the best options in the early stages of their decision-making process, whether for the choice of technologies, candidate sites, or operating procedures.

China

1. Nuclear energy policy and development plan

With the fast development of the economy in China, the transformation of the energy structure from fossil fuel-based energy to clean energy is the only solution for its long-term and sustainable development. Nuclear power has an important role in this energy transformation as China requires a reliable and large-scale energy supply source, especially in the coastal areas where the economy is developing rapidly.

Generally, nuclear plants can be built near the centres of energy demand, whereas suitable wind and hydro sites are built in remote areas in western China. The building of nuclear power infrastructure commenced in 1970 in China starting from the 300 MWe unit. The 1,000 MWe commercial-level NPPs were constructed in the middle of the 1980s and became operational in the middle of 1990s.

Daya Bay Nuclear Power Station, China's first large-scale commercial NPP, was put into commercial operation on May 6, 1994. During the last 20 years, the Daya Bay Nuclear Power Station has maintained safe and stable operation, with its safety and performance operation indicators (WANO) at the international advanced level. As of May 5, 2014, the Daya Bay Nuclear Power Station Unit 1 has kept continuous safe operation for 4,147 days without an unplanned reactor shutdown. The number of days of continuous safe operation for the Daya Bay NPP ranked No.1 in the world within similar units. Since 1999, the Daya Bay Nuclear Power Station has participated in the International Challenge Competition on Nuclear Safety and Performance of similar units, held annually in France. As of March 2014, the Daya Bay Nuclear Power Station and the Ling Ao Nuclear Power Station have been ranked in first place a total of 31 times.

As of April 30, 2014, two units of Daya Bay Nuclear Power Station have generated a total electricity output of 281 billion KWh to the grid, where the electricity exported to Hong Kong totalled 192.7 billion KWh, accounting for

70% of total output. In addition, the six units in Daya Bay Nuclear Power Base have generated total electricity output of 497 billion KWh to the grid.

Figure 2.19 Daya Bay Nuclear Power Station (front) and Ling Ao Nuclear Power Station(back)

In 2005, the nuclear industry moved into a rapid development phase due to the large demand for electricity and to nuclear power "renaissance." Technology has been introduced from France, Canada, and Russia, with local development based largely on the French element. The latest technology acquisition has been from the United States (via Westinghouse) and France (via AREVA). Through the international bidding process organized by the state government, the State Nuclear Power Technology Corporation (SNPTC) has made the Westinghouse AP1000 the main basis of technology development in the immediate future, particularly evident in the local development of CAP1000 and CAP1400.

This has led to the expectation of exporting nuclear technology, based on China's development of the CAP1400 and ACP1000 reactor, with Chinese intellectual property rights, and backed by full fuel cycle capabilities.

Before the Fukushima accident, pressurized water reactors (PWRs) were expected to level off at 200 GWe by around 2040.

Prior to 2008, the government had planned to increase nuclear generating capacity to 40 GWe by 2020, with another 18 GWe nuclear plant being constructed at that time. However, projections for nuclear power then increased to 70–80 GWe by 2020, 200 GWe by 2030, and 400–500 GWe by 2050. Following the Fukushima accident and consequent pause in approvals for new plants, the official target adopted by the State Council in October 2012 became 60 GWe by 2020 with 30 GWe under construction. National policy has moved from "moderate development" of nuclear power to "positive development" in 2004, and in 2011–2012 (after the Fukushima accident) to "steady development with safety".

In July 2013, the National Development and Reform Commission (NDRC) set a wholesale power price of CNY0.43 per kWh (~US$0.07/kWh) for all new NPPs, to promote the healthy development of nuclear power, and guide investment into the sector. The price is to be kept relatively stable but will be adjusted with technology advances and market factors. Nuclear power is already competitive, and wholesale price to grid has been less than the price of power from coal plants with flue gas desulfurization.

In October 2012, the Standing Committee of the State Council reviewed and adopted three plans, namely, (i) the Nuclear Safety and Radioactive Pollution Prevention "Twelfth Five-Year Plan", (ii) the 2020 Vision, the Nuclear Safety Plan (2011–2020), and (iii) the adjusted Nuclear Long-Term Development Plan (2011–2020). Based on these new milestones, the construction of nuclear power steadily returned to normal.

In the 12th Five-Year Plan (2011–2015), China will only approve NPP construction in coastal areas.

Tianwan phase 2 Unit 1 (i.e., Tianwan Unit 3), Fuqing Unit 4 (PWR), Yangjiang Unit 4 (PWR), and Shandong Shidaowan HTR nuclear power plant demonstration project—all these four units have started construction in 2012 and 2013. Tianwan Phase 2- Unit 1 became the first new construction nuclear power project (facility configuration documentation [FCD] on December 27, 2012) that the State Council approved after the Fukushima accident.

On February 17, 2013, the first NPP in Northeast China— the Liaoning Hongyanhe Nuclear Power Plant Unit 1— was connected to the grid and began the power generation and commissioning phase. On June 6, 2013, after the completion of the commissioning tests, the plant was officially put into commercial operation. Hongyanhe Unit 2 connected to the grid on November 23, 2013 for the first time. On April 25, 2014, Hongyanhe Unit 2 reached the 100% power platform for the first time. Since then, Hongyanhe Nuclear Power Plant Unit 2 has been conducting steady state tests on a 100% power platform, and then began final tests before commercial operation, such as the loss of power test from a 100% power platform without reactor scram, NI islanding test (house load operation from full power), generator load rejection test, reactor trip and other large transient tests, and the 168 hours of demonstration operation for commercial operation.

Hongyanhe Units 3 and 4 are under construction. As of the end of 2013, Hongyanhe Units 3 and 4 have completed 80% of the total project. Hongyanhe Phase II (Units 5 and 6) will adopt ACP1000 technology, and is pending government authorization for FCD.

Ningde NPP phase I Unit 1 was put into commercial operation on April 15, 2013. Ningde NPP Unit 2 completed a cold test, containment pressure test, hot test, the first fuel loading, etc., in 2013. On January 4, 2014, Unit 2 was connected to the grid. Ningde Unit 2 is expected to be put into commercial operation on the first half of 2014.

As of end 2013, Ningde Units 3 and 4 have completed 80% of the total project, and are expected to be put into operation by the beginning of 2015. In addition, the related work of Ningde NPP Phase II project (Units 5 and 6) is being actively pushed forward, and the National Energy Administration has agreed to conduct site protection and related evaluation for Ningde NPP Phase II. The Ningde NPP Phase II project will adopt generation 3 nuclear power technology.

By the end of 2013, the Yangjiang Nuclear Power Station Unit 6 started construction. So far, six units of Yangjiang nuclear power projects have been under construction. Yangjiang Nuclear Power Unit 1, after the demonstration operation for 168 hours, was formally put into commercial operation on March 26, 2014.

Yangjiang Nuclear Power Base Units 1 and 2 adopted China's brand of 1 GWe PWR nuclear power technology—the CPR1000. Yangjiang Units 3 and 4 adopted CPR1000+ technology to form 25 technical improvements from CPR1000 to further enhance safety and economy. Yangjiang Units 5 and 6 adopted ACPR1000 technology based on the further 31 major technological improvements from CPR1000+, mainly following the requirement of generation 3 nuclear power technology, such as severe accident prevention and mitigation measures (including in-vessel retention or IVR).

By the end of 2013, China has 17 nuclear power units in operation, with an installed capacity of 14.74 GWe. A total of 29 NPPs are under construction, with an installed capacity of 31.66 GWe. The nuclear power construction scale remains No.1 in the world.

With the commercial operation of Yangjiang Unit 1 on March 26, 2014, the number of nuclear power bases in China has increased to six. The total number of nuclear power units in China has increased from 17 to 18, and the total installed capacity of nuclear power in operation from 14.78 to 15.86 GWe. The total number of nuclear power units under construction is 28, with a total installed capacity of 30.6 GWe.

By May 5, 2014, the number of nuclear power bases in China Guangdong Nuclear Power Corporation (CGNPC) has increased to four. There are 10 operating nuclear power units in CGNPC with a total installed capacity of 10.5 GWe, accounting for 62% of the total installed capacity of nuclear power in operation in China. The number of units under construction in CGNPC total 14 units, with a total installed capacity of 16.62 GWe, accounting for 52% of total installed capacity of nuclear power units in China.

Figure 2.20. Taishan EPR

Nuclear Power Plants in China

Plant	Reactor	In operation	Construction	planning
Daya Bay大亚湾	M310	2×1GWe		
Ling Ao岭澳	CPR1000	4×1GWe		
Hongyanhe红沿河	CPR1000+	1×1.08GWe	3×1.08GWe	2^{**}
Ningde宁德	CPR1000+	1×1.08GWe	3×1.08GWe	2
Yangjiang阳江	CPR1000+;ACPR1000	1×1.08GWe	5×1.08GWe	
Taishan台山	EPR		2×1.65GWe	
Fangchenggang防城港	CPR1000+		2×1.08GWe	2
Qinshan I秦山I期	CNP300	1×0.3GWe		
Qinshan II秦II	CNP650	4×0.65GWe		
Qinshan III秦III	CANDU	2×0.7GWe		
Fangjiashan方家山	M310		2×1.08GWe	
Fuqing福清	M310		4×1.08GWe	2^{**}
Sanmen三门	AP1000		2×1.1GWe	2^{**}
Haiyang海阳	AP1000		2×1.1GWe	2^{*}
Tianwan田湾	VVER1000	2×1.1GWe	2×1.1GWe	2^{**}
Cangjiang昌江	CNP650		2×0.65GWe	
Shidaowan	HTR		(2×0.2GW)	
Xudapu徐大堡	AP1000			2^{*}
Lufeng陆丰	AP1000			2^{**}
Shidaowan石岛湾	CAP1400			2^{**}
Zhangzhou章州	AP1000			2^{**}
Total		18	29	

Note : * : The plant (AP1000) site safety review for Xudapu（徐大堡）1/2 and Haiyang 3/4 have been finished by NNSA in 2013.

**:The plant site reviews are awaiting approval by NNSA.

Figure 2.21. Distribution of NPPs in China

Hong Kong gets much of its power from mainland China. In particular, about 70% of the output from Daya Bay's 1,888 MWe net nuclear capacity is sent to Hong Kong. A 2014 agreement increases this to 80%. The Hong Kong government plans to close down its coal-fired plants, and by 2020, to get 50% of its power from mainland nuclear power (now 23%), 40% from gas locally, and 3% from renewable energy. The Hong Kong utility, China Light & Power (CLP), has 25% equity in the China General Nuclear Power Group and is negotiating a possible 17% share in Yangjiang, and may take further equity in a CGN nuclear plant. Since 1994, it gets one-third of its power from Daya Bay output, and this contract now runs to 2034.According to CLP data, nuclear power costs HK$0. 47/kWh in November 2013, compared with HK$0.27 for coal and HK$0.68 for gas, which provides the main opportunity to increase supply.

2. Nuclear safety regulatory systems

The National Nuclear Safety Administration (NNSA) under the China Atomic Energy Authority (CAEA) was set up in 1984 and is the licensing and regulatory body for all the commercial nuclear power plants and facilities, and for the international cooperation agreements regarding safety.

After the institutional reform in 1998, NNSA was incorporated into the State Environmental Protection Administration (SEPA), and the Nuclear Safety and Radiation Environmental Management Division was established to be responsible for the country's nuclear safety, radiation safety, and radiation environmental management supervision. The SEPA deputy director serves as director of NNSA. In March 2008, SEPA was upgraded to the Ministry of Environmental Protection (MEP), reserving NNSA as an independent name. The vice minister of MEP serves as director of NNSA.

NNSA is responsible for the licensing of commercial nuclear reactors and other facilities, safety inspections and reviews, operational regulations, licensing of transportation for nuclear materials, waste management, and radiation protection including radiation sources. NNSA issues licenses for the staff of nuclear manufacturers via reactor operators. NNSA is responsible for environmental impact assessment of nuclear projects. The 2003 Law on Prevention and Control of Radioactive Pollution passed by Congress is supplemented by a number of regulations issued from 1986 to 2011 with the authorization of the State Council.

NPP licenses issued by NNSA include a process beginning with a siting approval, then the issuance of a construction permit (usually 12 months before first concrete placement), fuel loading permit, operation license, and significant nuclear power plant design changes and modification implementation.

China has shown unprecedented eagerness to achieve the world's best standards in nuclear safety (also in civil aviation). It has requested and hosted 12 Operational Safety Review Team (OSART) missions from IAEA teams by October 2011. Each plant generally has one external safety review each year, either OSART, WANO peer review, or CNEA peer review with the Research Institute for Nuclear Power Operations (RINPO).

In December 2013, the NNSA, with its counterparts from Japan and the Republic of Korea, agreed to form a network to cooperate on nuclear safety and quickly exchange information in nuclear emergencies. NNSA is also part of the ASEAN+3 Forum on Nuclear Safety.

In 2013 the China Atomic Energy Authority (CAEA) signed a cooperation agreement with OECD's Nuclear Energy Agency (NEA), confirming China as a "key partner" with OECD.

Following the Fukushima accident in Japan on March 11, 2011, the government suspended its approval process pending a review of lessons that might be learned from the incident, particularly regarding the siting of reactors with plant layout, prevention, mitigation of severe accidents, and the control of radiation release. Safety checks of operating plants were undertaken immediately, and a review of those under construction was completed in October 2011. Resumption of approvals for further new plants was suspended until a new nuclear safety plan was accepted and State Council approval given in October 2012.

Following the Fukushima accident, concern regarding possible river pollution will mean delays until at least 2015 to the inland AP1000 plants, which were due to start construction in 2011.

The Ministry of Environmental Protection (MEP) has a Nuclear Safety Management Division, in charge of nuclear safety and radiation safety supervision and management, which is equivalent to NNSA. The Nuclear Safety Management Division is an internal organization in MEP, while NNSA serves external functions (as in international exchanges and cooperation). Hence, it is one body with two different names. Thus, the Nuclear Safety Management Division in MEP is greater than the size of the other departments in the MEP. NNSA consists of 12 offices including a General Branch, Nuclear Power Branch one, Nuclear Power Branch two, Nuclear Power Branch three, Nuclear Reactor Branch, Nuclear Fuel, and Transport Branch， and others.

As the need for manpower to supervise the development of nuclear power increases, the size of the nuclear and radiation safety regulatory system (including the staff in Nuclear and Radiation Safety Center of NNSA) was increased in 2012 from 300 to more than 1,000 people.

Based on the original Nuclear Safety Management Division, the NNSA in September 2012 approved the establishment of Division One, Division Two, and Division Three for nuclear and radiation safety supervision, and the staff size was increased from 38 in 2008 to 85. The original system of one division and 12 branches in the Nuclear Safety Management Division of the NNSA was changed into a three-division 15-branch system. Division One is mainly responsible for the safety of associated nuclear facilities, including public policies, regulations, emergency and monitoring, personnel qualification, etc.; Division Two is primarily responsible for supervising nuclear power reactors; Division three is mainly responsible for the front-end and back-end facilities, including branches of nuclear fuel and transport, radioactive waste management, nuclear technology utilisation, electronic radiation, and ore smelting.

The size of the Nuclear and Radiation Safety Center was increased from nearly 300 to 900 staff members. Meanwhile, the regional office size of the nuclear and radiation safety regional supervision organisation increased from 100 to 331 personnel. For purposes of routine safety oversight of NPPs, the Ministry of Environmental Protection and its six “Nuclear and Radiation Safety Supervision Regional Offices” take responsibility. The NNSA has six Supervision Regional Offices in mainland China. For example, in the Daya Bay Nuclear Power Operations and Management Company (DNMC), there are staff members from the Nuclear and Radiation Safety Supervision Regional Office of the Ministry of Environmental Protection, who are usually responsible for sampling, testing, and investigation of daily work, and for reporting significant matters directly to the NNSA.

3. National nuclear emergency preparedness and response

Civilian nuclear facilities and nuclear safety in China are mainly supervised by the NNSA. Meanwhile, in the special state during major nuclear accident, the central government, local governments, and enterprises comprise three level nuclear accident emergency response organizations.

In addition to the NNSA, there is a specialized organization to deal with off-site nuclear emergencies, namely, the National Nuclear Emergency Coordination Committee and the National Nuclear Emergency Office (NNEO), which plays important regulatory roles.

The NNEO is one of the subordinate departments of the State Administration of Science and Technology and Industry for National Defense (SASTIN), which was formerly known as the National Defense Science and Technology Commission (NDSTC). After the reform in 2008, SASTIN and the NNEO were hosted by the Ministry of Industry and Information Technology, while maintaining a certain degree of independence. The National Nuclear Emergency Coordination Committee is the highest decision-making team in NNEO.

The NNEO has a strong organisation, and its constituent units include related departments. When necessary, the State Council can lead, organize, and coordinate the national nuclear emergency management. Besides, there is an Emergency Coordination Committee Expert Advisory Group under NNEO with experts in the areas of domestic nuclear engineering, power engineering, nuclear safety, radiation protection, environmental protection, radiology, meteorology, and others.

At the local level, the provincial government, where NPPs are located, has established corresponding nuclear emergency organisation, with member units consisting of related departments (units) of provincial government and city government, military and armed police, to take charge of the provincial nuclear emergency work.

The operating units in NPPs also have strong emergency response organisations, which specifically includes emergency office, technical support centre, and related emergency professional groups under the emergency headquarters in the NPPs (or nuclear power base).

Through these three levels of emergency organizations, China has built a strong emergency response system.

3.1. National Nuclear Emergency Plan and Exercises

The State Council has revised the National Nuclear Emergency Plan on June 30, 2013, in which the three levels of nuclear emergency organisations, nuclear emergency response step-by-step actions, recovery of nuclear facilities, emergency preparedness, and logistics including training and exercises, are stipulated.

Compared to the 2005 version of the National Nuclear Emergency Plan, the revised National Nuclear Emergency Plan stipulates more clearly the three levels of emergency organisation structure of the national, provincial, and operating units, and the precise responsibilities of the three nuclear emergency organisations.

On November 10,2009, China held its first national nuclear emergency exercises (code named Shendun [Aegis] 2009) to meet the needs of China's nuclear industry development, to inspect the effectiveness of the nuclear emergency plan and program implementation, to train the team, and to maintain and improve the nuclear emergency response capabilities.

These exercises were three levels of collaborative and joint exercises by the national government, the provincial government, and the nuclear facility operating units, with military support. The members of the National Nuclear Emergency Coordination Committee and the Expert Advisory Group, the military, the Jiangsu Provincial Nuclear Emergency Response Organisations, the Tianwan Nuclear Power Plant, and a small number of the public totalling 2,000 people, participated in the exercise. The Minister of Industry and Information Technology, the National Coordinating Committee for Nuclear Emergency, Director Li Yizhong directed this exercise. The Deputy Minister of Industry and Information Technology, Director of State Administration of Science and Technology and Industry for National Defense, Director of China Atomic Energy Authority (CAEA), Chen Qiufa, vice governor of Jiangsu Province, and the Provincial Nuclear Emergency Coordination Committee, Shi Heping, acted as deputy commanders. The exercise simulated an accident scenario where the Tianwan Nuclear Power Station Unit 2 Loop 1 suffered coolant leakage eventually leading to LOCA, leading to the multi-failure of safety systems and the release of radioactive substances into the environment. This had a great impact on the public and the environment surrounding the NPP. After the accident, nuclear emergency response organizations at all levels in accordance with the nuclear emergency plans responded rapidly and launched emergency and rescue work.

To strengthen the work of the international exchange of nuclear emergencies, CAEA invited delegations from Japan and the Republic of Korea to observe the exercises according to the mutual cooperation agreement signed in December 2013.

Following the "Convention on Early Notification of a Nuclear Accident", IAEA was notified of such exercises. In addition, more than 150 representatives observed the exercise at the National Nuclear Emergency Response Center, Nuclear Emergency Command Center in Jiangsu Province, Lianyungang Command Office, and Tianwan Nuclear Power Plant. The State Emergency Management Office, Emergency Expert Group of the State Council, China Nuclear Energy Association, and a number of senior experts conducted a comprehensive assessment. The assessment experts believed that the exercise program was well-designed, well-prepared, and that the organisation and command were powerful tools with proper coordination. The participating personnel's responsibilities and job specifications were clear, and the exercises achieved the expected goals.

According to the law and the National Nuclear Emergency Plan issued by the State Council, for the newly constructed NPPs, before initial nuclear fuel loading, the NPP and the corresponding provincial nuclear emergency organisation should conduct off-site emergency exercises.

For operating NPPs, the frequency of NPP comprehensive emergency exercises is 1–2 times per year.

The frequency of national nuclear emergency exercises is once every 3–5 years. The provincial comprehensive nuclear emergency exercises frequency is once every 2–4 years.

Figure 2.22. First national nuclear emergency exercises (2009)

3.2. National Nuclear Emergency Plan and Exercises

China will set up a national nuclear accident emergency rescue team of about 300 people following the new National Nuclear Emergency Plan. In the first half of 2014, China will hold another national nuclear emergency exercise based on the new version of the National Nuclear Emergency Plan.

China is establishing the first “cross-corporation” nuclear emergency rescue team.

On May 5, 2014, during the third seminar on Nuclear Emergency Rescue Work, the vice minister of the Ministry of Environmental Protection and director of the NNSA, Li Ganjie, said China is building a nuclear accident emergency rescue “green channel” for NPPs across the nuclear power groups. The Ministry of Environmental Protection hosted on May 5, 2014 the seminar with the participation of the China National Nuclear Corporation, China Guangdong Nuclear Power Group, China Power Investment Corporation, the State Nuclear Power Technology Corporation, and China Huaneng Group, in which the “Mutual Cooperation Framework Agreement for Nuclear Accidents Emergency Rescue Among Nuclear Power Corporations” was signed. On the same day, China Guangdong Nuclear Power Group first set up a group-level Nuclear Accident Emergency Rescue Team based on strong human resources, technical reserves, and facilities of the Daya Bay Nuclear Power Plant.

The signing of the “Mutual Cooperation Framework Agreement for Nuclear Accidents Emergency Rescue among Nuclear Power Corporations” and the formation of the Nuclear Power Group emergency rescue force is another important breakthrough in China to improve nuclear safety after the Fukushima nuclear accident. The signing of the agreement will provide great convenience for the implementation of a mutual assistance program and rescue operations between NPPs and nuclear power groups, and for ensuring the timeliness and effectiveness of mutual rescue operations. This marks the establishment of a common nuclear accident emergency rescue community among China’s nuclear power corporations, and realizes the goal of sharing nuclear emergency resources and capabilities nationwide.

4. Human resources development plan on nuclear safety and radiological emergency preparedness

At the national level, NNSA is mainly in charge of safety management while technical support for the NNSA is provided by the Nuclear and Radiation Safety Center (NRSC) of the Ministry of Environmental Protection (MEP).

In September 2012, the NNSA approved the establishment of Division One, Division Two, and Division Three for nuclear and radiation safety supervision, and the staff size was increased from 38 in 2008 to 85.

As there was a need for development, in 2012, the staff size of the Safety and Radiation Center of MEP was increased from 300 to more than 1,000 people.

Regional Office of NNSA

There are six regional offices of the Nuclear and Radiation Safety in China. These are as follows:

- North Regulatory Office of Nuclear and Radiation Safety (NRO): The staff size was increased from 24 in 2008 to 111 since 2010. Bureau level since 2006. Located in Beijing.
- The East Regional Office of Nuclear and Radiation Safety (ERO) had a staff size of 75 (2010), located in Shanghai; the South Regional Office of Nuclear and Radiation Safety (SRO) had a staff size of 55 (2010), located in Shenzhen; the Southwest Regional Office of Nuclear and Radiation Safety (SWRO) had 29 staff members (2010), located in Chengdu; the Northwest Regional Office of Nuclear and Radiation Safety (NWRO) had 26 staff members (2010), located in Xi'an; the Northeast Regional Office of Nuclear and Radiation Safety (NERO) had 35 staff members (2010), located in Dalian.

In each NPP or nuclear facility, there are specific organisations for nuclear safety and radiation protection. For instance, in Daya Bay NPP, there is an independent Nuclear Safety Engineer Branch to independently supervise nuclear safety during operation and accident from the operators, which is considered a good practice in China, France, and in other countries. There is a specific Nuclear Radiation Protection Branch in charge of nuclear radiation protection. There is also a nuclear emergency organisation including nuclear emergency headquarters, technical support centre, and professional teams. A weekly on-call system with more than 100 staff on site is available for the continuous daily preparedness of nuclear safety.

Due to good organisation and practices, the NPPs in China, Daya Bay NPPS of CGN for instance, keep very good WANO international operation and performance indicators in many areas, including nuclear safety, industrial safety, radiation protection, and fuel reliability.

5. International cooperation on nuclear safety and emergency preparedness

The international cooperation on nuclear safety, nuclear emergency, and response was already mentioned in parts 2 and 3 of this report. This part only discusses the international cooperation on Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management with IAEA.

Nuclear safety is actually the safety of nuclear fuel because all radioactive materials come from irradiated nuclear fuel and spent nuclear fuel. Therefore, spent fuel safety is the key area for nuclear safety management.

On April 29, 2006, China’s National People's Congress approved the country’s joining the “Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management", which can strengthen the safety of spent fuel and radioactive waste management in China, and strengthen international cooperation and promote the healthy development of the country's nuclear industry. There were 40 member countries in 2006, and there were 69 by the end of 2013.

Another international convention on nuclear safety is the “Joint Convention on Nuclear Safety”, which China has also joined.

According to the “Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management," each member country should prepare and submit a National Report every three years, to be shared among member countries. Each member country has the right and obligation to review the national report of other member countries, and raise written review questions to related countries. Each member country will present its national report during the general assembly conference in Vienna (conducted every three years).

The National Report contents are stipulated by IAEA and include the following:

- Scope
- Safety management on spent fuel (spent fuel safety, siting, operation, and disposal)
- Safety management on nuclear waste (siting, radioactive waste safety evaluation, construction, and nuclear material inventory)
- General safety provisions (legislation and supervision structure, nuclear regulatory system, and nuclear emergency response and preparation)
- Reporting, reviewing, and meeting arrangement.

The 6th review meeting was held in Vienna from March 24 to April 4, 2014. China's 3rd national report preparation is in progress. The next general assembly of "Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management" will be held in Vienna in 2015.

5.1. Proposals for Regional Cooperation

<u>Share the lessons learned from the Fukushima accident in the area of emergency preparedness and response (EPR), including:</u>

- Fukushima site level of contamination and evolution in different zone. The land and sea data for I-131, Ce-137, Tritium, etc.
- Cleaning and decontamination status. The staff impacted from the site pollution during the decontamination and rescue.
- Sea water pollution. Sea fish and creature pollution.
- Decommissioning plan and action for Fukushima site.
- The future of NPPs in Japan, restoration of operation or continuation for shutdown.

Sharing of practice and experience on emergency preparedness and response through the following:

- Exchange of practice and experience in emergency exercises in China, Japan, the Republic of Korea, and others.
- Exchange of regulations and laws related to emergency preparedness and response.
- Exchange of information on organisation and management for nuclear safety and emergency preparedness and response.

Understanding the differences of safety levels for different NPP designs.

- Different plant designs have different requirements for emergency preparedness and response. Discussions and exchange of ideas on the design differences for Voda Voda Energo Reactor (VVER), European Pressurized Reactor, ATMEA1, ACPR1000, ACP1000, generation II+, generation III, and others for more detailed information on the plant design and safety features would be very useful. For instance, AP1000 (with passive safety design features, safety system can survive and work without power supply) can have 72-hour non-intervention (grace) period in the event of accident, while EPR (safety systems depending on power supply) can have only a 30-minute non-intervention period in the event of accident by design.
- Sharing the information on the selection of reactor types and the evaluation of its safety for East Asian countries is very crucial in order to identify and assess precisely the level of safety for the NPP and the emergency condition according to the design characteristics of each chosen reactor type.

Hold EPR seminars regularly.

- Hold a seminar once or twice a year on a regular basis.
- Participants to come from both government and corporations.

Sharing of information, which can be done through the following:

- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (China, Japan, the Republic of Korea, and others are member countries). Share the information among Southeast Asian countries regularly.
- Sharing of information and cooperation should be done both at the government (authority) and at the corporate level.

Challenges in the European Countries on Nuclear Emergency and Preparedness

European countries, especially the East and North European countries, which have experienced serious threats due to the Chernobyl accident, have strong concerns for nuclear emergency preparedness and response (or EPR hereafter). It is quite useful for East and Southeast Asian countries to learn about EPR at the national level and regional level as accumulated by the European countries during the past several decades. Such knowledge could be used to construct a practical framework for regional information exchange and cooperation in EPR.

In this chapter, the major framework of domestic EPR in the United Kingdom, France, and Sweden, and the major framework of regional EPR in the European Union and Nordic countries are described.

1. EPR in the United Kingdom (UK)

The UK Response Plan is the government's national contingency plan for dealing with the effects of overseas nuclear accidents on the country. It is a composite plan, designed to coordinate the actions of the various government departments and expert agencies that would be involved in the response to such an accident.

Radioactive Incident Monitoring Network (RIMNET) is the government's national radiation monitoring and nuclear emergency response system. RIMNET is designed to support the response to accidents within the country where there are separate and well-tested, site-specific arrangements. The use of RIMNET modeling and communications facilities in domestic emergency planning has become a regular feature of such exercises.

The Department of Energy and Climate Change (DECC) is the operator of RIMNET. The roles of DECC are to coordinate the government's response, to keep the ministers and Parliament informed of that response, and to provide information to the public and the media at the national level. The Nuclear

Emergency Planning Delivery Committee will facilitate and coordinate the EPR activities with the cooperation of the other government offices, such as the Office for Nuclear Regulation (ONR), Cabinet Office, Ministry of Defense, **Department for Environment, Food & Rural Affairs** (DEFRA), and so on. The responsibilities of DECC as a leading department are allocated based on the nature of the accident and the normal day-to-day business of individual government departments. In case of a UK nuclear accident, the primary activity is to bring the accident under control, and thus, as the sponsor department for the nuclear industry, the DECC assumes lead responsibility.

The UK is ready to receive early notification of any accidents within Western Europe through the EU and IAEA early notification arrangements, and would track and monitor any effects on the UK using RIMNET. However, it should be noted that RIMNET itself is not an early warning system; the fixed monitors record what is happening at the site at the time. Any formal warning will come via the IAEA and the European Commission, or through bilateral notification arrangements. RIMNET is an independent monitoring system that provides an alert mechanism. It also provides access to forecasts of the UK areas likely to be affected by any overseas nuclear accident based upon Met Office data and models.

To assure that the system works properly in case of emergency, RIMNET participates in regular exercises and tests of nuclear emergency response arrangements. On average, 4–5 civil and 4–5 military exercises are conducted per year, of which at least 1 is a national-level fully integrated exercise involving all bodies. International exercises tend to be held on an 18-month cycle to replicate summer and winter conditions because meteorological effects on deposition vary. To keep the staff highly qualified and well trained, the staff—five people from the government as full-time workers—are trained in overseas nuclear accident response procedures and on the use of the RIMNET system. An on-call rota ensures that staff can be contacted at any time, 24 hours a day and 365 days a year. The RIMNET staff has access to additional radiological expertise of other agencies. There are well-rehearsed procedures for calling in other DECC and agency staff as necessary to deal with the response to an overseas, or any, nuclear accident.

Not only the public body but also the private/industry parties are equipped with EPR in the UK.

When the Fukushima accident occurred, the UK nuclear industry took a quick response. The Nuclear Industry Association of the UK and the World Nuclear Association (WNA), which has its headquarters and office in London, coordinated response to over 200 media calls during the first week based on the information from IAEA and Tokyo Electric Power Company (TEPCO).

In 2011, the WNA proposed an initiation of the "Impact of Nuclear Incidents Communication Center (INI Center)", which enables regular TEPCO-WNA dialogues, international forums by communication experts, and sending messages to stakeholders. The concept of the INI Center is still under construction and discussion, and is expected to be one of the platforms or communication methods among nuclear industry players in the world.

2. EPR in France

France is the biggest nuclear generator in Europe and the Électricité de France (EDF) is the largest operator of NPPs in the world. The French government offices in charge of nuclear and renewable technologies—the Commissariat à l'énergie atomique et aux énergies alternatives (CEA), and the French nuclear safety authority, L'Autorité de sûreté nucléaire (ASN)—are responsible for EPR activities in France.

In CEA, the Crisis Management Team works at the national and local levels in cases of nuclear and radioactive emergencies in France. When an accident or radioactive hazard occurs in nuclear facilities, a CEA alert line 24/7 is sent from the staff in the facility to personnel on duty 24/7 at CEA headquarter offices. A director, an engineer, and one expert decide whether to activate CEA National Crisis Center (CCC). The CCC performs the following activities:

- Inform the guardianship ministries, the Secrétariat général de la défense et de la sécurité nationale (SGSDN), the French Government Emergency Management Operations Centre (COGIC), and the authorities (nuclear safety/security).
- Authorise emergency actions and provide reinforcements, if necessary.

- Help the site's directorate analyze the event and choose the right solution.
- Take care of coherence of the information supplied to the authorities, media, and CEA's personnel.
- Lead, supervise, and coordinate the CEA's response at the national level.

CEA also has seven response teams in each zone of the first level intervention (ZIPE). The ZIPE response teams are set up with radiation protection specialists from CEA (and AREVA), and are in charge of communicating with public authorities outside of CEA centres.

The French Inter-ministerial Committee for Nuclear or Radiological Emergencies (or CICNR) coordinates government action in radiological or nuclear emergency situations. CICNR is responsible for developing the inter-ministerial policy on national defense and security, and for monitoring its implementation.

The French nuclear safety authority, the L'Autorité de sûreté nucléaire (ASN), is in charge of the interaction with foreign organisations, such as information delivery to IAEA and to the EU. ASN is the Competent Authority under the IAEA's Emergency Notification and Assistance Convention (ENAC) since it replaced the Unified System for Information Exchange in Incidents and Emergencies (USIE). The notification and collection of information at the EU level are done based on the European Community Urgent Radiological Information Exchange (ECURIE), which aims to enable a rapid exchange of information in case of an event occurring on European soil. ASN has been keeping its expertise up to date on radioactivity, safety, and security through national exercises based on the annual circular signed by the Prime Minister, the Minister of Interior, the ASN, and the DSND, the safety authority for defense nuclear installations.

AREVA, a major France-based company, operates a large number of nuclear facilities in France and Germany, and also has its own radioactive crisis management system. The crisis management department in its headquarters is in charge of defining the AREVA group policy, supporting the plants, sites, and units, and controlling the respective rules in the field of crisis management process, relations with authorities, training, and implementation of complementary crisis management means.

The AREVA National Crisis Management Center is the core of the crisis management. It shares important decisions with the site, supports the site, and coordinates with public authorities. It also coordinates actions of the AREVA National Response Force (FINA) to ensure internal and local external communication.
FINA is an integral part of AREVA's crisis organisation at both the national and local levels. All entities with the competence and means necessary for crisis management are involved. To increase the crisis management measures and capabilities above and beyond, FINA provides trained and structured assistance as quickly as possible and within 48 hours to a devastated site during a major crisis, implements well-defined and appropriate actions to free up the local staff so that they can be used for specific tasks, and integrates engineering means for assessments that are coordinated with public authorities and other national reinforcements. It also helps AREVA group activities in post-accidental management, such as decontamination, waste and effluent management, and others.

3. EPR in Sweden

Sweden has a long history of nuclear power and has developed an emergency preparedness and response system driven by real and unexpected incidents. In 1979, when the Three Mile Island accident occurred in the US, preparedness was increased around the four nuclear installations in Sweden. When the Chernobyl accident occurred in the former USSR in 1986, Sweden was the first country to detect the radioactive materials originating from the accident, and all the country's administration boards were assigned responsibility for accident management. In September 2001, when a terroristic attack hit the US, the government and the electric utilities board built up the crisis management scheme. In 2004, when a huge tsunami hit Indonesia and the Southeast Asian region, it led to a restructuring of the safety and security authorities.

The Swedish Radiation Safety Authority (SSM) is responsible for coordinating activities related to safety and radiation protection in Sweden when an accident involving radiation occurs. SSM provides qualified advice and information to a variety of players including decision makers and the public. SSM also coordinates the national expert response organisation for

nuclear and radiological emergencies. The resources are on alert 24 hours a day. In the event of an accident, a special emergency and crisis organisation comes into operation.
Early notification of emergencies is obtained from automatic alarm monitoring stations in Sweden and abroad, and through international and bilateral agreements on early warning and information. The Integrated Regulatory Review Service (IRRS) is a tool to support emergency response for nuclear operators and related parties. It enables on-line, real-time access to NPPs operational and safety parameters, control of the inadvertent trafficking of radioactive material through the national borders, as well as the regional cooperation initiative of the Nordic countries.

There are two NPPs owners in Sweden—Vattenfall and E.On Sverige. For this study, the activities of Vattenfall were reviewed.
The two nuclear power stations, Forsmark and Ringhals, both have a Crisis Management Team (CMT) in constant readiness. Each team consists of 50 staff members. They also have facilities to lead and supervise the handling of an emergency situation. The activities are planned to be done in coordination with SSM and the Swedish legislation. The role of the CMTs is to collect information, analyse the situation, and support the site and headquarters during the crisis. Specialists on reactor safety technologies, radiology, and dispersion phenomena are in charge of the analyses. In the long term, the CMT will coordinate the supporting activities of Vattenfall in transport, generators, pumps, grid specialists, and others.

The emergency centre at the nuclear power stations will act as a part of the total crisis management activities in Vattenfall. Post-accident radiation protection activities by Forsmark Emergency Center show a good example of some identified areas for improvement. In the area of HRD (staffing of an emergency preparedness organisation) and of accessibility to equipment, these measures are undertaken—proper contracts with external suppliers, cooperation between other Swedish (and foreign) nuclear operators, equipping mobiles that are stored close to the site area, assembling a team of first responders on-site, and most of all, on-call preparedness for key functions during major holidays. More practical and theoretical ways of training and exercises, monitoring, strategies on on-site working are being discussed, developed, and implemented. In the area of post-accidental radiation protection, including dose monitoring, personal dosimetry, evacuation, off-site dose assessment and so on, the emergency centre and the crisis management team will cooperate to develop strategies and robust procedures.

4. EPR in the European Union

1) European Community Urgent Radiological Information Exchange (ECURIE)

The ECURIE system undertakes the technical implementation of the Council Decision 87/600/Euratom on Community arrangements for the early notification and exchange of information in the event of a radiological or nuclear emergency. All the 27 EU member states, as well as Switzerland and Croatia, have signed the ECURIE agreement. The Council Decision requires from ECURIE members that they promptly notify the European Commission (EC) when they intend to take counter-measures in order to protect their population against the effects of a radiological or nuclear accident. The EC will immediately forward this notification to all member states. Following this first notification, all member states are required to inform the EC at appropriate intervals about the measures they take and the radioactivity levels they have measured.

The ECURIE system consists of three major parts:

1. The data-format Convention Information Structure (CIS), which describes in detail what type of information may be sent, as well as the format in which it has to be sent;
2. Dedicated ECURIE software in order to create, send, and receive notifications in the CIS format using internet and ISDN;
3. A network of Contact Points (CPs) and Competent Authorities (CAs) officially nominated by each member state and by the EC to operate the ECURIE system.

ECURIE carries several research projects. “EURANOS,” the European approach to nuclear and radiological emergency management and rehabilitation strategies, is one the current projects. Major meetings and workshops were held from 2002 to 2006 on such workflows as:

- Collate information on the likely effectiveness and consequences of a wide range of countermeasures.
- Provide guidance to emergency management organisations and decision makers on the establishment of an appropriate response strategy.
- Further enhance advanced decision support systems through feedback from their operational use.
- Create regional initiatives leading to information exchange based on state-of-the-art information technologies.
- Develop guidance that assists member states in developing a framework for sustainable rehabilitation of the living conditions in contaminated areas.
- Maintain and enhance knowledge and competence through emergency exercises, training and education, thus, fostering best practice in emergency response.

Two generic handbooks, “Management of contaminated food production systems (Version 2)” and “Management of contaminated inhabited areas (Version 2)” are the major products of the project. The first one is to assist in the management of contaminated food production systems while the second one is to assist in the management of contaminated inhabited areas in Europe following a radiological emergency. These handbooks have been developed in conjunction with stakeholder panels from around Europe. Both handbooks provide guidance on customisation at the national/local level, and on how to develop processes for engaging stakeholders in the further development and application of the handbooks.
The handbooks were translated in Japanese by an expert group in the Atomic Society of Japan in 2011 to provide correct information to the public.

2) NERIS
The mission of NERIS, the “European Platform on preparedness for nuclear and radiological emergency response and recovery”, is to establish a forum for dialogue and methodological development between all European organisations and associations that are taking part in decision making for protective actions in nuclear and radiological emergencies and recovery in Europe. Workshops, training courses, and R&D for radioactivity protection and monitoring are held several times a year. Project PREPARE is one of the major research projects in the framework of NERIS, coordinated by the European Commission.

The project PREPARE intends to review existing operational procedures in dealing with long-lasting releases, address cross-border problems in monitoring the safety of goods. It will further develop the still missing functionalities in decision support system—ranging from improved source term estimation and dispersion modelling, to the inclusion of hydrological pathways for European water bodies. As the management of the Fukushima event in Europe was far from optimal, project PREPARE proposes to develop the means on a scientific and operational basis to improve information collection, information exchange, and the evaluation for such types of accidents. This will be achieved through the collaboration of industry, research, and government organisations in Europe, taking into account the networking activities carried out under the NERIS-TP project.

5. EPR in Nordic countries

The five Nordic countries—Denmark, Finland, Iceland, Norway, and Sweden—also have an agreement among them to be informed of any crisis in accordance with what is written in the Nordic Manual (NORMAN). The Nordic Working Group of Emergency Preparedness (NEP) has been active under NORMAN and works for information exchange, cooperation, and coordination among nuclear safety authorities in Nordic countries. The safety authorities in Nordic countries are as follows:

- Denmark: Danish Emergency Management Agency (DEMA) and National Institute of Radiation Hygiene (SIS)
- Finland: Radiation and Nuclear Safety Authority (STUK)
- Iceland: Icelandic Radiation Protection Institute (GR)
- Norway: Norwegian Radiation Protection Authority (NRPA)
- Sweden: SSM

"The Nordic Flagbook" is a Nordic guideline for protective measures in early and intermediate phases of nuclear/radioactive emergency. It was released in February 2014.

It provides a common starting point for the practical application of protective measures against radioactivity risks. The aim is to keep the residual dose below the chosen reference level (20–100 mSv). If the projected annual dose is above a certain criteria, the guideline suggests application of some protective measures.

The Nordic guidelines are based on Finnish guides for nuclear and radiological emergencies and further developed through close Nordic cooperation. They take into account both domestic emergencies and emergencies in more distant locations, and they cover accidents and intentional acts. Regular information exchange and joint training programs are ongoing.

The major feature of NEP and the Nordic Flagbook is that it is not mandatory, but voluntary. The members are expected to provide information, to participate in the workshops and training programs, and to contribute to the enhancement of utilities of the Flagbook, but they are all self-controllable.

6. Implications

Every country has its national EPR planning and action routine. The common implications to constructing EPR networks in Asia are summarized below.
Some essential points can be found from the practical application of the EPR framework in Asia. First of all, correct and rapid information sharing in case of emergency would be a precondition for starting collaborative works. Public reliance on safety authorities, operators, and nuclear experts would be the second crucial precondition. Based on these, the construction of the strategic communications plan in the initial phase, reassurance phase, and recovery phase would be required. High expertise in radioactivity, nuclear safety, and nuclear security would be necessary. Therefore, developing experts through an appropriate HRD program would be necessary.

The major lessons that could be learned from the challenges of European countries in the field of EPR are as follows:

- Strategic communications plan in the initial phase, reassurance phase, and recovery phase in the EPR is highly recommended.
- Sustainable efforts to keep on searching for better measures and to prepare for alternative plans are also highly recommended.
- The most preferable condition for a common database is its accessibility and utility enhancement so that all member states can access and utilise it.