Chapter 3

Opportunities and Barriers in Securing Resilience

July 2020

This chapter should be cited as

ERIA (2020), 'Opportunities and Barriers in Securing Resilience', in Murakami, T. and V. Anbumozhi (eds.), *Securing the Resilience of Nuclear Infrastructure against Natural Disasters.* ERIA Research Project Report FY2020 no. 06, Jakarta: ERIA, pp.48-51.

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The workshop was held for sharing information on the resilience of nuclear facilities based on lessons learned from experienced natural disasters. It also aimed at developing guidelines for resilience of the nuclear facilities against natural disasters which included information sharing on natural disasters in East and Southeast Asia and their impact on energy facilities and expected policy proposals.

The following documents are the findings from the workshop.

3.1. US

The US civil nuclear energy industry consists of three pillars: the domestic fleet, advanced reactors, and international markets. The demand for baseload electricity that is domestically generated, reliable/resilient, and clean energy sources will continue in the future. Nuclear will play an important role in contributing energy security, national economy and environment. However, nuclear reactors in the US have been facing early shutdown due to low gas price.

To help revive the nuclear industry, the DOE has programs such as the following:

- Public–private partnerships.
  - Small Modular Reactor (SMR).
  - Micro-reactors.
  - Smart fuels.
  - Advanced manufacturing for securing the supply chain.
- A Versatile Test Reactor.
- Fuel supply for Advanced Nuclear.

The DOE has communicated with students and stakeholders about the importance of nuclear energy (Making Nuclear Cool Again) (DOE, 2018). As educational outreach for students in the next generation. 17 Millennial Nuclear Caucuses were established inside the US and abroad. The environment and energy security were mentioned in high school textbooks. The DOE has explained the benefits of nuclear energy for people and has implemented a series of educational meetings for policymakers as leadership education.

3.2. Japan

Following Fukushima Daiichi NPS Accident, the Nuclear Risk Research Center (NRRC) was established in December 2014 to develop risk evaluation methodology for external events. The Japan Nuclear Safety Institute (JANSI) was established as a self-regulatory organisation in November 2012 JANSI is independent from public utilities and aims to promote nuclear safety.

Japan‘s probable natural disasters are following earthquakes, tsunami, flooding, volcanic eruptions, tornadoes/typhoons, and forest fires. The government develops the design criteria and guidelines for achieving high nuclear safety against natural disasters in cooperation with academia, public utilities, and industry. Nuclear facilities are protected against the following natural disasters:

- Earthquakes.
  - ・Establish rigid design to maintain or reduce seismic response.
  - ・Build combined structures and maintain low centre of gravity.
- Tsunami.
  - ・Locate well above the maximum water level.
  - ・Build sea walls and watertight doors.
- Volcanic eruptions.
  - ・Secure the structural design, avoiding ash loading.
  - ・Prevent the loss of dynamic component function from volcanic ash.
- Tornadoes/Typhoons.
  - ・Secure the structural design from tornado/typhoon forces.
  - ・Maintain robust building and protective structures for tornado missile effects.
- Forest fires.
  - ・Build a fire break and thermal shield.

A five-layered safety design approach is defined in the IAEA Specific Safety Requirements (IAEA, 2016), which categorises the levels of defence as ‘design basis’ and ‘beyond design basis’. Levels 4 and 5 require the prevention and mitigation of radiological release, even under significant ‘beyond design basis’ conditions.

Table 6: Defence in Depth Approach

Design Dase/ Beyond Design Base	Level of Defence	Objective	Essential designs
Design Base (DB)	Level 1	Prevention of abnormal operation and failures	Conservative design and high qualityin construction of normal operation systems
	Level 2	Control of a abnormal operation and detection of failures	Limiting and protection systems and other surveillance features
	Level 3	Control design basis accidents	Engineering safetyfeatures
Beyond Design Base (BDB)	Level 4	Control of design extension conditions, including prevention of accident progression and mitigation of the consequences of severe accidents	Safety features for design extension conditions
	Level 5	Mitigation of radiological consequences of significant releases of radioactive materials	On-site and off-site emergencyresponse facilities

Source: Author, based on IAEA (2016).

3.3. ASEAN and Asian Countries

Views on nuclear power vary widely by country in ASEAN and Asia. Some countries include nuclear energy in their future energy policies or have begun to develop rules and documents on nuclear energy. Others have not yet begun considering the introduction of nuclear energy due to lack of scientific technology and human resources, although they are aware that nuclear energy might be needed in the future because of the rapid increase in demand for electricity.

Mongolia, Malaysia, Cambodia and Lao PDR presented their status on development of nuclear program as well as their energy policy trends in the workshop. The following statements are the key messages from their presentation.

Mongolia announced the Mongolian Sustainable Development Vision 2030 (STATE GREAT HURAL OF MONGOLIA, 2016) and stipulated a nuclear introduction plan in a phased manner as follows:

- Phase 1 (2016–2020): Start preparations for using nuclear energy.
- Phase 2 (2021–2025): Complete preparation for using nuclear energy.
- Phase 3 (2026–2030): Start using nuclear energy.

Mongolia conducted infrastructure studies from 2010 to 2012, but they were insufficient. To proceed with the introduction of nuclear energy, more research work related to the IAEA's Milestones in the Development of a National Infrastructure for Nuclear Power (IAEA, 2015) are expected. In terms of international cooperation, the Nuclear Energy Commission of Mongolia signed a memorandum of cooperation on the construction of the Centre of Nuclear Science and Technology in March 2018 with Rosatom (Rosatom, 2018), aiming to develop mutually beneficial cooperation in civil nuclear energy use and design a blueprint for the centre.

Malaysia has experienced sporadically earthquakes because it is located outside the Pacific Rim of Fire, but it has a high frequency of floods due to two monsoons. The disaster management structure and disaster management level are stipulated in the Malaysia Disaster Management Reference Handbook (Center for Excellence in Disaster Management and Humanitarian Assistance, 2019). The disaster management levels are defined as follows:

- Disaster management level 1 (district).
  - ・Localised incident, controllable and has no probability to spread.
  - ・Disaster managed by authorities at the district level.
- Disaster management level 2 (state).
  - ・Incident covering two or more districts but no potential to spread.
  - ・Coordinated assistance at the state level to the affected districts.
- Disaster management level 3 (central).
  - ・Complex and covering a wide area or more than two states.
  - ・Greater financial, human resources, and asset coordination.

Malaysia's Nuclear Power Policy, approved by the Cabinet in July 2010, aimed to introduce nuclear energy by 2021. However, due to political direction change, the Minister of Energy, Science, Technology, Environment, and Climate Change (MESTECC) announced in November 2019 that Malaysia would not build nuclear power plants.

Nevertheless, the Malaysian Nuclear Agency established a Nuclear and Radiological Emergency Preparedness Plan; preparedness and response to reassure the public and take the necessary actions to mitigate the consequences of accidents. The plan is revised based on the rules and regulations in Malaysia as well as recommendations from nuclear organisations such as the IAEA and the Enforcement Authorities.

Cambodia has no plan to introduce nuclear energy. Challenges for the introduction of nuclear energy in Cambodia are as follows:

- Lack of human capacity and equipment in nuclear science and technological field.
- Lack of knowledge and experience of nuclear and radiation safety.
- Limited perception of policymakers.
- Lack of training in nuclear physics, radiation protection, inspections, safeguard techniques, emergency preparedness, and response.

The Lao People's Democratic Republic (Lao PDR) has no plan to introduce nuclear energy. However, it will require more baseload power sources, including nuclear energy, in the future – especially in the dry season – because the Lao PDR largely depends on seasonal hydroelectric power. Therefore, the Lao PDR has an intention on learning experiences and lessons of nuclear resilience in the developed countries.