VIETNAM NATIONAL REPORT
ON COMPLIANCE TO
CONVENTION ON NUCLEAR SAFETY

August 2016

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I. INTRODUCTION

1.1. National Nuclear Programs

Vietnam acceded to the Convention on Nuclear Safety (CNS) on 14 April 2010 and became a Contracting Party to the CNS on 15 July 2010. As such, this is Vietnam's Fourth National Report, including the Report for the Second CNS Extraordinary Meeting in 2012, to the Seventh Review Meeting in 2016.

Up to now, Vietnam has no nuclear installations as defined in the CNS. The Nuclear Research Institute (NRI) is the only organization in Vietnam that operates a nuclear research reactor.

Vietnam began to consider nuclear power as an option for energy supply in the 1980s to address its increasing energy needs. In 2002 the Prime Minister established the Government Steering Committee for the Development of Nuclear Power in Vietnam. On 3 January 2006, the Government of Vietnam approved the "Strategy for peaceful uses of atomic energy up to 2020", in which the first nuclear power plant was intended to be introduced by 2020. Vietnam began to implement this "Long-term Strategy" by establishing a comprehensive Master Plan, enacting the Law on Atomic Energy in 2008, and the Resolution No. 41/2009/QH12 approved by the National Assembly on 25 November 2009 for the Investment Policy of Ninh Thuan Nuclear Power Project.

To prepare for the nuclear power program, the National Nuclear Safety Council and the State Steering Committee were established by the Prime Minister's Decision No. 446/QD-TTg on 07 April 2010 and 580/QD-TTg on 04 May 2010, respectively. The National Nuclear Safety Council serves as an advisory body to the Prime Minister for safety while the State Steering Committee is responsible for assisting the Prime Minister in implementing Ninh Thuan Nuclear Power Project, acting as a NEPIO – Nuclear Energy Programme Implementing Organization, as defined in the International Atomic Energy Agency (IAEA) document "*Milestones in Development of a National Infrastructure for Nuclear Power*".

In the Master Plan for the National Energy Development during the period from 2011-2020 with the vision to 2030 (MP No. VII), the Government of Vietnam planned to put the first 2 units (1,000MW each) into operation in 2020 and by 2030, nuclear power is projected to produce 10,700 MW, accounting for 10.1% of the total national capacity. Investigation of 2 sites for the first 2 NPPs was completed. 5 sites for the third NPP were planned for investigation. The first 2 NPPs (Ninh Thuan 1 and 2) with one unit at

each site were scheduled to be in operation by 2020-2021.

To implement this Plan, several arrangements have been made since the first report was submitted in 2010 after participation of Vietnam to CNS as follows:

- An Intergovernmental Agreement (IGA) with the Russian Federation was signed in 2010 for the construction of a Nuclear Power Plant in Ninh Thuan province (NPP No.1);

- An Intergovernmental Arrangement (IGA) with Japan was signed in 2011 for the construction of a Nuclear Power Plant in Ninh Thuan province (NPP No.2);

- The State Steering Committee for Ninh Thuan Nuclear Power Project (Vietnam NEPIO) has been established by the Prime Minister's 580/QD-TTg on 04 May 2010);

- The National Steering Committee on human resource development (HRD) in the field of atomic energy was established in 2011;

- The Master Plans to implement the "Long-term Strategy" were approved;

- The Vietnam Electricity (EVN) was designated as the owner of the Ninh Thuan NPP Projects and the EVN Nuclear Power Project Management Board (EVNNPB) was established;

- Contracts for a Feasibility Study and for development of Site and Feasibility Study dossiers for each NPP, and a significant amount of work has been undertaken.

Component projects and studies are assigned to the organizations as shown in the Table 1.

Table 1. Ninh Thuan NPP component projects and studies

Component projects and studies	Responsible Organizations
1. Ninh Thuan 1 NPP (2000MW)	EVN
2. Ninh Thuan 2 NPP (2000MW)	EVN
3. Developing infrastructure for supporting NPP Projects	EVN
4. Complex zone for operation management, expatriates, PMB offices	EVN
5. Public relation center	EVN
6. Human resource training	EVN
7. Study for Development of domestic supporting industry for NPP Projects	MOIT
8. Nuclear science and technology center	MOST (VINATOM)
9. Public information study	MOST (VAEA)
10. Resettlement for NPP Projects	Ninh Thuan Provincial People's Committee

However, strategy of the Ninh Thuan 1 and Ninh Thuan 2 NPPs was amended by decision No 428/QĐ-TTg dated on 18 March 2016 by the Prime Minister. According to the Decision, the first unit is scheduled to be in operation in 2028. Total capacity of nuclear power up to 2030 is 4,600 MW to produce 32,500 GWh accounting 3.6% of the total national capacity and 5.7% of the total national power production.

EVN's consultants from Russia and Japan have already completed site investigation and field study. The draft of final applications for Site and FS approval of Ninh Thuan 2 NPP (Japanese consultant) were submitted in July 2013. As required in Document No. 736/ATBXHN – VPHĐ dated on 09 July 2014 of National Nuclear Safety Council of Vietnam, however, Japanese consultant - Japan Atom Power Company (JAPC) has conducted an "Additional detail Investigation Plant" at the proposed site of Ninh Thuan 2 NPP. Up to now, the JAPC has completed the field works at the site of Ninh Thuan 2 NPP. The final results were submitted to EVN for reporting to National Nuclear Safety Council of Vietnam. The VARANS is preparing to organize the international Technical Meeting for reviewing the additional investigation results of the site of Ninh Thuan 2 NPP by the end of August 2016. Preliminary Safety Analysis Report for Site Approval and Safety Analysis Report for FS approval of Ninh Thuan 1 NPP were submitted to both Ministry of Science and Technology (MOST) and VARANS (as National Nuclear Regulatory Body) in February 2015.

As an emerging country, Vietnam lacks experience and has limited competence for the 1st NPPs, beside utilizing domestic experts, especially in the field of assessment of site characteristics, Vietnam needs to obtain international consultants to support the National Nuclear Regulatory Body to review SARs for both Site and FS approval phases. At present, VARANS/MOST and MONRE have established bid package "Consulting services for assisting Ministry of Science and Technology and Ministry of Natural Resources and Environment in evaluating Safety Analysis Report and Environmental Impact Assessment Report for Site and Feasibility Study approval of Ninh Thuan 1 Nuclear Power Plant". This bid is being processed.

In order to ensure a safe and sustainable NPP program, Vietnam has been made every effort on developing legislation and regulations, especially technical regulations, completing national regulatory infrastructure development, and enhancing technical capacity, including human resource development, for safety assessment and verification. These developments are considered to be the highest priority.

1.2. The theme of report

The MOST has the primary responsibility for the implementation of Vietnam's obligations under the CNS, working in consultation with other relevant agencies and organizations.

This report is a self evaluation of Vietnam's compliance with the obligations of the CNS. The reporting format is based on the structure Article by Article in the CNS and in accordance with the IAEA guidelines (INFCIRC/572/Rev.4, 16 April 2013).

II. ARTICLE BY ARTICLE ASSESSMENT

A. General Provisions

Article 6 – Existing Nuclear Installation

Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

6.1. List of Nuclear Installations

As mentioned in the Introduction, Vietnam does not have any nuclear installations as defined in the CNS. However, Vietnam has a research reactor of 500 kW located at Dalat City, Lam Dong Province.

The Dalat Nuclear research reactor (DNRR) is operated by the NRI. DNRR is a 500 kW pool-type reactor using light water as both moderator and coolant. The reactor facility is used for: (1) research and training; (2) neutron activation analysis; and (3) radioactive isotope production. DNRR was reconstructed and upgraded from the USA made 250 kW TRIGA reactor. The upgraded reactor reached its first criticality on 1 November 1983 and has been officially put into operation since March 1984 with an average operation of 1200 hrs per year.

Since the first start-up, the reactor core utilized highly enriched uranium (HEU) fuel assemblies of 36 %. The fuel assemblies were of VVR-M2 type manufactured by the former USSR. During the period of 2006-2008, three projects at NRI were implemented, including modification and replacement of the reactor control system in 2007, the reactor partial core conversion from the use of HEU to low enriched uranium (LEU) of 19.75% fuels of the VVR-M2 type on 12 September 2007, and upgrading the physical protection system for reactor area in 2008. The project for full core conversion of DNRR was approved by the Prime Minister's Document No. 2012/TTg-KGVX on 21 October 2009. Accordingly, the full core conversion project was implemented with the following milestones: (1) HEU fuel was discharged from the core on 16-22 August 2011; (2) LEU fuel loading into the core was implemented during the period from 24

November 2011 - 13 January 2012. The first criticality with full LEU configuration was reached on 30 November 2011; and (3) HEU spent fuels were repatriated to Russia in July 2013. The project was completed successfully. The reactor physics experiments showed that the new core configuration met not only safety requirements but also utilization requirement (ensuring about shutdown margin and sufficient excess reactivity for reactor operation and utilization). All activities of this project have been implemented under the strict oversight of VARANS including safety assessment for licensing.

6.2. Main Safety Issues of DNRR

Ageing is the main problem for the research reactor since it was built around 50 years ago.

In 2013, the control motor of the safety rod had was slipped out of axle-box caused wrong signal to the control room. The signals showed the safety rod was fully out of the core but it was recognized by an operator that it was already fully inserted into the core. And in 2014, the regulating on rod's driving cable was broken.

These incidents are related to mechanical aging aspect of the control rod driving system. In general words, there are no consequences of these incidents, but there are potential hazards in the future, that should be carefully considered.

As obligation of members of Incident Reporting System for Research Reactors (IRSRR), the National Coordinator of Vietnam has reported these unexpected incidents to IRSRR system.

6.3. Efforts to enhance the safety of DNRR

The MOST is charged with the responsibility for the State management of radiation and nuclear safety. In 2003, MOST established the Vietnam Agency for Radiation and Nuclear Safety and Control (and now the VARANS). VARANS is responsible for assisting the Minister of MOST in the State management of radiation and nuclear safety, including licensing, inspection and enforcement.

In 2004, NRI was requested to apply for operation license with MOST. License No. 380/GP-BKHCN for DNRR operation was issued on March 2004, valid for 5 years with attached conditions to ensure the safety of operations. In 2009, as the License No. 380/GP-BKHCN expired and the Atomic Energy Law was in force, NRI applied for renewal of the license and License No. 1846/GP-BKHCN was issued on 04 September 2009 for another 5 years. On 16 November 2012, the License No. 30/GP-BKHCN was

issued for commissioning after full core conversion and the License No. 06/GP-BKHCN dated 07 February 2013 was issued for official operation. Under the License No.19/GP-BKHCN dated 17 June 2013, 106 spent HEU were exported and sent back to Russia by the SKODA VPVR/M package. Applications for licensing were assessed (by VARANS) against Vietnam Regulations and IAEA safety standards to determine whether the facility can be operated without undue risk to the health and safety of people and the environment.

The latest Safety Analysis Report for DNRR was in 2012 (SAR-2012), which has been recently updated after completing full core conversion. DNRR was designed in the early 1960s, before nuclear safety standards were formalized. Nevertheless, the examination conducted by VARANS and operation experience of DNRR show that the reactor, taking into account upgrades, is reasonably safely operated.

In fact, ageing analysis for DNRR has been performed since 1998 with visual inspection of its tank using underwater camera. Corrosion progress is being monitored. In addition, corrosion of reactor tank is restrained with maintaining the quality of the reactor water coolant in accordance with the SAR. Furthermore, in order to improve the reliability of reactor control system, a program on I&C system upgrading had been done during 2006 - 2007. Although DNRR would not fully meet modern standards, VARANS review and the SAR show that DNRR is acceptably safe and that there is no evidence of significant ageing effects that would impair the safety of the reactor operation.

Another good practice is the documentation of operation experiences, both for normal and emergency situation. This is very important for the future decommissioning program since most of the senior operators and supervisors will retire soon.

During implementation of the HEU - LEU fuel conversion from 2005 - 2013, NRI carried out enhanced reactor calculations with the support from Argonne National Laboratory (ANL, USA) that help to compare main parameters before and after conversion, and have a better understanding of physical phenomena of the reactor. The neutron and thermo-hydraulic calculations were performed to verify the safety parameters of the reactor. MCNP, RELAP5 and ORIGEN are among the computer codes that have been used in the calculation by NRI and VARANS staff.

The sub-project to send back spent HEU to Russia which was implemented successfully helps Vietnam to gain experience (in both regulatory aspect and practice of facility) in ensuring safety of transportation of spent fuels.

B. Legislation and Regulation

Article 7 - Legislative and Regulatory Framework

1. ***Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.***
2. ***The legislative and regulatory framework shall provide for:***
   i. ***the establishment of applicable national safety requirements and regulations;***
   ii. ***a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a license:***
   iii. ***a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses;***
   iv. ***the enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation.***

7.1. Legislative for Nuclear Safety

a) National Legislative for Nuclear Safety

As Vietnam is embarking its nuclear power program, Vietnam makes every effort in developing its legal system, taking into consideration the IAEA safety standards. The following figure shows the relationship between the IAEA standard structure and Vietnam national legal system.

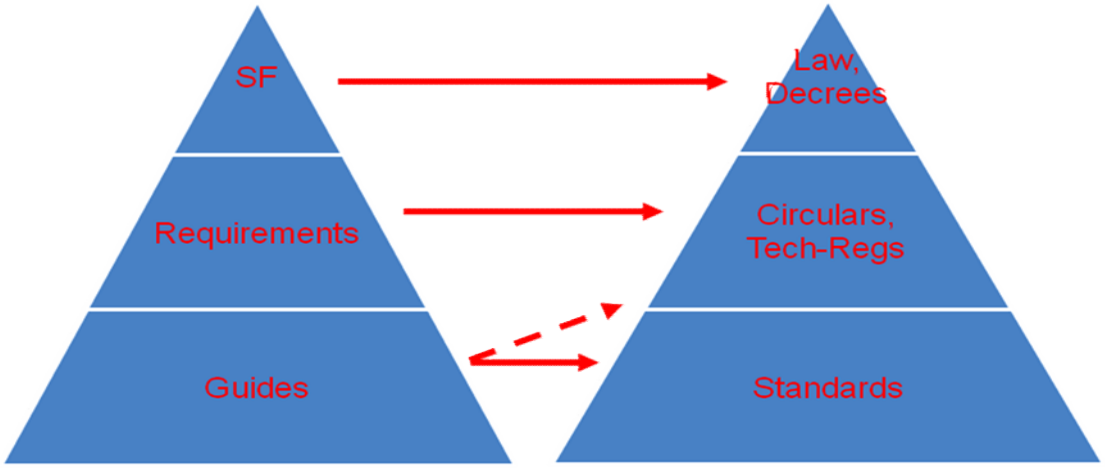

Fig 1. Relationship between IAEA standards and Vietnam legal structure

In 2008, Vietnam National Assembly passed the Atomic Energy Law, which came into effect on 01 January 2009. This is the highest legal document in the field of

nuclear energy. The Law governs all activities in the field of atomic energy including promoting activities and the assurance of safety and security for those activities. It applies to Vietnamese organizations and individuals, oversea Vietnamese individuals, foreign individuals and international organizations who conduct activities in the field of atomic energy in Vietnam.

Due to the inadequacy of the Law, especially in connection with the independence of the Regulatory Body (more details will be provided in the Article 8 – Regulatory Body of this Report), NPP licensing issues, emergency response, etc., the Government of Vietnam has decided to amend the Law. It is expected that the draft of amended Law will be submitted to the National Assembly for approval in 2018. In order to assist the revision, 2 expert missions to Hanoi were conducted by OLA, IAEA in March 2012 and May 2013 and 2 consultant missions have been carried out with the participation of high level officials from the National Assembly' Office, the Government Office, the Ministry of Justice, MOST, etc. The main issues that are being revised include: the independence of the Regulatory Body, unification in licensing process, emergency response and preparedness, liability for nuclear damage, etc.

Under the Law, a number of legislations and regulations have been developed or planning to be developed. Document No. 248/TTg-KTN, dated 19 Feb. 2013, by the Prime Minister set out a plan for the development of legal documents/regulations on NPPs up to 2020. During the implementation of the NPP programme, an updated list of legislations and regulations have been prepared for submission to the Government.

b) Participation in international conventions and legal instruments

Recognizing the importance of international cooperation, especially the contribution of international regimes, in achieving and maintaining a high level of safety, Vietnam has been a party to a number of international instruments, including:

- Treaty on Non-Proliferation of Nuclear Weapons (1982);
- Safeguards Agreement (1990);
- Convention on Early Notification of Nuclear Accident (1987);
- Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1987);
- Comprehensive Test Ban Treaty (2006);
- The Treaty South East Asia Free Zone of Nuclear Weapons (1997);
- Regional Cooperative Agreements;

- Additional Protocol to the Safeguards Agreement (signed in 2007)
- Convention on Nuclear Safety (4/2010).
- Convention on Physical Protection of Nuclear material and Its Amendment (2012);
- Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (9/2013);
- International Convention on the Suppression of Acts of Nuclear Terrorism (signed by the President on 14 July 2016).

Currently, Vietnam is actively studying to participate in the Vienna Convention on Liability for Nuclear Damage and its Protocols (2016-2017).

c) Regulatory framework for the NPP program

The Law (Article 7) designates the responsibilities for the State management in the field of nuclear energy as follows:

1. The Government shall unify the State management on activities in the field of atomic energy.

2. The MOST shall be responsible before the Government for conducting State management on activities in the field of atomic energy.

3. Ministries, ministerial-level agencies, within their functions and authorities, shall perform the State management on activities in the field of atomic energy in accordance with their responsibilities designated by the Government.

4. Provincial/city People's Committees (hereinafter referred to as provincial level), within their functions and authorities, shall perform the State management on activities in the field of atomic energy in accordance with their responsibilities designated by the Government.

In connection with NPP program, as specified in the prevailing Atomic Energy Law, the current licensing system in Vietnam is complicated: The Prime-Minister is responsible for site and feasibility study approval, MOST is responsible for construction permit, and MOIT is responsible for operation license. MOST/VARANS is responsible for safety assessment of SAR at all stages of NPP development. MONRE is responsible for assessment of EIA report, MOC is responsible for siting for disposal and storage of radioactive waste. This complication has been further recognized in the event of Fukushima Daiichi NPPs.

As mentioned before, to address this problem, the Government of Vietnam has decided to amend the Law. However, it is also recognized that amendment on unifying

regulatory activities would be feasible only if VARANS capacity as well as its TSO be sufficiently strong. In order to address this issue, the Government of Vietnam is implementing a project to enhance capacity and competence of the State Management System including VARANS – the Vietnam principal nuclear regulatory body.

The National Council for Nuclear Safety was established in pursuant to the Prime Minister's Decision No. 446/QD-TTg dated 7 April 2010. The functions of the National Nuclear Safety Council are specified in the Law, namely to advise the Prime Minister on policies and measures to assure nuclear safety in the use of atomic energy, in the course of operation of nuclear power plants as well as measures to remedy particularly serious nuclear incidents; to examine and evaluate safety reports of nuclear power plants and results of assessment by the radiation and nuclear safety agency.

7.2. Nuclear safety requirements and regulations for NPP

a) Overview of the legislation on nuclear safety

In implementing the Atomic Energy Law, the Government has issued the following:

- Decree No. No. 107/2013/ND-CP stipulates violations, procedures for handling violations, and sanctions and fines imposed on those violations.
- Decree No. 07/2010/ND-CP provides guidance for implementation of some provisions of the Atomic Energy Law, including Articles 65, 80, 82 and 90 of the Law.
- Decree No. 70/2010/ND-CP provides guidance on investment, siting, design, construction, installation, operation and decommissioning of nuclear power plants; ensuring safety and security of these activities; and conditions for nuclear power plant investors.

b) Overview of the regulations and guides for nuclear safety

For Pre-FS and Site Approval phases:

- Circular No. 13/2009/TT-BKHCN dated 20th May, 2009 by Minister of Science and Technology guiding on preliminary nuclear safety assessment for site selection for nuclear power plants in the investment decision stage (Pre-FS stage);
- Circular No. 28/2011/TT-BKHCN dated 28th November, 2011 on nuclear requirements for nuclear power plants site;
- Circular No. 29/2012/TT-BKHCN dated 28th December, 2012 on format and content of SAR for NPP site approval;

– Circular No 20/2013/TT-BKHCN dated 06th September, 2013 guiding on test procedure, inspection process and procedure in the site investigation and evaluation of nuclear power plants;

– Circular No. 21/2013/TT-BKHCN dated 13rd September, 2013 guiding on applying of technical standards and regulations on nuclear safety in the site selection, design, construction, operation and decommissioning of nuclear power units;

– Nuclear Safety Standards 9641 :2013 – External Human Induced Events in Site Evaluation for Nuclear Power Plants (based on IAEA NS-G-3.1);

– Nuclear Safety Standards 9642 :2013 - Dispersion of Radioactive Material in Air and Water and Consideration of Population Distribution in Site Evaluation Nuclear Safety (based on IAEA NS-G-3.2);

– Nuclear Safety Standards 9643 :2013 – Meteorological and Hydrological Hazards in Site Evaluation for Nuclear Power Plants Nuclear Safety (based on IAEA NS-G-3.4);

– Nuclear Safety Standards 9644 :2013 – Seismic hazards in site evaluation for nuclear installations (based on IAEA SSG -9);

– Nuclear Safety Standards 9645 :2013 – Geotechnical aspects of site evaluation and foundations for nuclear power plants (based on IAEA NS-G-3.6);

For FS Approval and Construction Permit phases:

– Circular No. 30/2012/TT-BKHCN on requirements on nuclear safety of design of NPPs (based on IAEA SSR-2/1);

– Circular No. 21/2013/TT-BKHCN dated 13rd September, 2013 guiding on applying of technical standards and regulations on nuclear safety in the site selection, design, construction, operation and decommissioning of nuclear power units;

– Circular No. 08/2014/TT-BKHCN dated 26th May, 2014 on the format and content of SAR for FS approval;

– Circular No. 12/2015/TT-BKHCN dated 20th July, 2015 on requirements for safety analysis for nuclear power plants;

– Circular No 10/2016/TT-BKHCN dated 13rd June, 2016 on the format and content of SAR for construction permit phase.

And other relevant regulations.

7.3. Nuclear Reactor Licensing

a) Licensing system for nuclear installations

Chapter V of the Atomic Energy Law deals with nuclear facilities, in which Part 2 is for research reactors and Part 3 for nuclear power plants (NPP).

The Law specifies that MOST is responsible for licensing research reactors while nuclear power plants shall be licensed in several stages and for each stage, the authorization is issued by a different competent authority as mentioned in Article 7c, namely: site approval by the Prime Minister, construction permit by MOST, and commissioning and operation license by the MOIT. This could cause complication in managing the licensing system as a whole. However, according to Article 8 of the Law, and Article 7 of Decree No. 70/2010/ND-CP, VARANS/MOST is responsible for promulgating regulations concerning safety of nuclear power plants and nuclear safety assessment for all stages of the NPP development.

The Decree No. 70/2010/ND-CP provides more detail guidance on process and documents necessary for NPPs licensing application at various phases: investment, siting, design, construction, installation, operation and decommissioning of nuclear power plants. The content of SAR using the IAEA approach is also defined in this Decree.

b) Involvement of the public in the licensing process

As specified in the Article 47 of the Law, the decision of site approval for NPPs shall take into account the Resolution of the provincial People's Council of the Province where the nuclear power plant is planned to be located, stating local people's opinions/views on measures to assure safety and security, policies on investment in technical infrastructure construction, development of culture, education and social welfare in order to ensure the harmonization of the interests of the State, the investors and local people's benefits.

c) Prevention of the operation of a nuclear installation without a valid license

According to Article 12 of the Law, operation of either radiation facilities, radiation activities or nuclear installations without a valid license by a competence authority is strictly prohibited.

7.4. Regulatory Inspection

Regulatory inspections for verifying the compliance with license conditions and regulatory requirements are performed by inspectors appointed by MOST and under direction of the Director General of VARANS.

In general, inspectors may inspect, examine, take measurements, or conduct test. Books, records and documents may be inspected and copies may be taken.

Special powers are also assigned for inspectors to deal with hazardous situations. In dealing with hazardous situations, the inspector may give directions for steps to be taken that the inspector considers necessary.

MOST issued a circular No. 20/2013/TT-BKHCN, dated 06/9/2013 on the protocol for inspection during siting. VARANS has a plan to develop the protocol of inspection during construction and operation. At present, VARANS has been starting to develop a construction inspection programme, including inspection areas, schedules and procedures. It will be submitted to the Minister of Science and Technology for issuance in the 2016-2018 timeframe. For this purpose, VARANS is working with the regulatory bodies of the vendor countries, and has participated in training on NPP inspections in Japan. VARANS will need to have qualified inspectors and implement processes for inspections.

7.5. Enforcement

Any violence against license conditions or regulatory requirements shall be executed with the following enforcement actions:

1. Warning note;
2. License suspension;
3. License revocation;
4. Penalties for nuclear energy utilization without a license.

Article 79 of the Law especially deals with license revocation while the Decree No. 107/2013/ND-CP stipulates violations, procedures for handling violations, and sanctions and fines imposed on those violations. The Decree also specifies actions that need to be taken should violations occur.

Article 8 – Regulatory Body

1. ***Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfill its assigned responsibilities.***
2. ***Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.***

Although licensing for different stages of NPP development is the responsibility of different Ministries, the Law and the Decree No. 70/2010/ND-CP specify that the

responsibility for assessment of safety analysis reports and ensuring the safety of each stage rests with the agency for radiation and nuclear safety (VARANS).

The fact that VARANS' mandate is specified in the law shows that the Government recognizes the importance of ensuring nuclear safety since the common practice in Vietnam is that no agency under a minister should be mandated in a law.

In addition, the Law also specifies State policy on atomic energy, in which "*the State takes due consideration to invest in infrastructure, technology and human resource so as to ensure safety and security of activities in the field of atomic energy"* (Article 5, Item 3) and "*the State shall establish a programme for human resource development, especially high level experts so as to meet the need for … and assurance of safety and security in the fields of atomic energy*" (Article 16, Item 1).

At present, the number of VARANS' staff is around 105 persons distributed in different divisions including Division of Administration & Personnel, Division of Licensing, VARANS Inspectorate, Division of Legislation and Policy, Division of Nuclear Safeguards, Division of International Cooperation, Technical Support Center for Radiation and Nuclear Safety and Emergency Response, Training and Information Center.

Technical Support Center for Radiation and Nuclear Safety and Emergency Response was established in 2015 based on merging of Nuclear Safety Division and Technical Support Center for Radiation and Emergency Response to provide technical support for management activities of VARANS such as radiation protection, emergency response and environmental radiation, nuclear safety and security including safety assessment of NPPs with 35 technical staffs. As planned, the staff number of the Center is expected to be increased to 74 by 2020 so as to have staff members with qualification on disciplines that the Center is lacking staff in some fields such as mechanic engineering, chemical engineering, seismic & earthquake (more), electrical system engineering, etc…

Recognizing the importance of enhancing technical capacity for safety assessment for NPPs, over last several years much attention has been paid to the human resource training program, which has been implemented through the multilateral and bilateral collaboration with IAEA, EC, Japan, Russia, the United States of America, etc... The training program focuses on issues of safety importance, such as site characteristics, Safety Analysis (DSA, PSA), NPP design aspects, safety review for NPPs, dose estimation, radioactive dispersion in the air and water, safety

assessment of important systems of NPPs, etc.

Besides using the mentioned in-house technical support center, VARANS also utilizes the external support from other domestic organizations and international consultants in fulfilling its tasks. In phases of site and FS approval, VARANS is being provided with expertise from the Vietnam Atomic Energy Institute (VINATOM), the Institute of Geosciences and Mineral Resources (MONRE), Center on earthquake information and tsunami warning, Institute of Geophysics (Vietnam Academy of Science and Technology), Institute of Geology (Vietnam Academy of Science and Technology), Geological Department (University of Mining and Geology), Faculty of Hydrology, Meteorology and Oceanography (University of Sciences, Vietnam National University), Seismic Division, Institute of Geophysics (Vietnam Academy of Science and Technology). Due to the lack of experience in nuclear activities, international consultants are also planned to be used for review of Safety Analysis Report. In this regard, VARANS/MOST is in collaboration with MOIT, MONRE and MOPI to progress the bidding process for selection of international consultants.

VARANS' financial resource comes from the government budget in accordance with the annual budget plan approved by the Minister of MOST and the Minister of Finance. VARANS may also use 85% of licensing fees for its activities. The rest contributes to the State revenue.

The budget for safety assessment of the two first NPPs including payment for international consultants is from separate sources which are provided directly from Government.

At this moment, VARANS belongs to MOST. It is planned that VARANS' status is to be upgraded to the higher level so that it could have adequate authority and resource to fulfill its assigned responsibilities with effective independence. The specific mechanisms for recruitment and budget are also taken into account.

Article 9 – Responsibility of the License Holder

Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant license and shall take the appropriate steps to ensure that each such license holder meets its responsibility.

The Law stipulates that the primary responsibility of the safety in the nuclear energy utilities rest with the license holder, and this responsibility shall not be delegated.

Article 26 of the Law specifies that the manager of the licensed organization and licensees conducting radiation practices shall bear the following responsibilities:

1. To be responsible for safety and security, and for compliance with provisions of this Law in the conducting radiation practices.

2. To appoint a safety officer in accordance with provisions specified by the MOST; and to designate authority and responsibility of the appointed person in writing.

3. To fully comply with provisions specified in the license.

4. To establish and organize for the implementation of guidelines, procedures on safety and security.

5. To ensure safe working conditions, and provide technical training, periodic health check and radiation dose monitoring for radiation workers.

6. To provide favorable conditions for inspectors to conduct examination and inspection work; to provide necessary information in full upon request by the regulatory body.

7. To monitor and control radioactive waste, and ensure that the radiation dose does not exceed dose limit.

8. To establish and implement emergency response plan at facility level.

VARANS regularly monitors and reviews the operation of NRI to ensure that the organization meets its responsibility for safety as specified in legislation. The license holders shall receive VARANS inspections with or without prior notification.

C. General Safety Consideration

Article 10 - Safety Priorities

Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

The Law (Articles 42, 43 and 52) provide the basis for VARANS' assessment of whether NRI's nuclear facilities (and later on, NPPs) can be licensed in accordance with safety requirements. This is to ensure that operators ensure the safety of their facilities from design through decommissioning stages.

The license issued to NRI for operation of DNRR was based on a demonstration by NRI that it has safety policy and procedures in place to achieve safety requirements.

As the license holder, the operator establishes nuclear safety policy in order to maintain the safety level of their nuclear reactors, i.e.:

a) To operate the facility in compliance with safety regulations and the requirements stated in the license conditions granted by authorities;
b) To operate and maintain the facility according to operation and maintenance procedures approved by the regulatory body;
c) To maintain high level of safety culture;
d) To implement quality assurance program in the management of the facility.

The overall safety objective for the DNRR facility is to protect the site personnel, the general public and the environment by establishing and maintaining an effective defense against radiological hazards. For this overall objective, the corresponding radiation protection objectives are to ensure that:

- the operation and utilization of the reactor are justified under radiation protection considerations;

- during the operational states, radiation exposure of the site personnel and the general public remains below limits prescribed by the national authorities, and is kept as low as reasonable achievable (ALARA); and

- to mitigate radiation exposure from accidents.

EVNNPB has established Quality Assurance System including Quality Policy with commitment to implement measures to ensure nuclear safety for NPP project. EVNNPB has also established Corporate Safety Culture Documents focusing on the nuclear safety culture and commitment of implementation of safety culture

Article 11- Financial and Human Resources

1. ***Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.***
2. ***Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.***

The Law (Article 75) sets out conditions before any radiation practice (including operation of nuclear research reactors and NPP) is issued with an operation license. These conditions include infrastructure and human resource.

11.1. Financial Resources

The Law (Article 5) states the State policy in the field of nuclear energy, in which:

- The State focuses its investment on nuclear power development and on technological infrastructure, human resource, scientific research and technological development to facilitate the development of nuclear power.

- The State takes due consideration to invest in infrastructure, technology and human resource so as to ensure safety and security of activities in the field of atomic energy.

Decree No. 70/2010/ND-CP on NPP stipulates that investor/ operator of NPPs, when applying for licenses for different stages of NPP development, shall provide financial arrangement for the construction, operation, and decommissioning, as well as for nuclear liability in the case of nuclear accident.

The research reactor operated by NRI is financially supported by the Government. The maintenance and repair during their lifetime and the decommissioning of the reactor are guaranteed by the Government. The responsibility for safety of radioactive waste management lies on NRI in accordance with Article 25 of the Atomic Energy Law.

The Prime Minister Decision No. 09/QĐ-TTg dated 23 Jan. 2014 on “Finance liability and managing mechanism of finance fund for decommissioning of nuclear

power plants" indicates that Utility annually has to extract a part of turnover of electricity sale during operating period of NPP to create a fund for dismantling and decommissioning of NPP.

11.2. Human Resources

The Law (Article 5) also specifies the leading role of the Government in human resource development. In addition, Article 56 of the Law stipulates the responsibility of NPP operator for ensuring adequate manpower, including:

1. Ensuring adequate manpower with appropriate qualifications and professional skills for safe operation of the nuclear power plant, for management of nuclear fuel, for storage and handling of radioactive waste and for decommissioning of the nuclear power plant.

2. Organizing training and refresh training for staff members who operate the nuclear power plant;

3. Designating well-qualified staff to the posts of: chief engineer, head of the operation shifts, officer handling with nuclear fuel, and safety officer.

Article 28 of the Law stipulates that individuals such as chief engineer of nuclear reactor, shift operator in chief of nuclear reactor, radiation officer, nuclear reactor's operator, etc., shall obtain certificate for radiation worker for which their professional skills and relevant knowledge on safety must be proven.

The Decree No. 07/2010/ND-CP (Article 2) also specifies measures to attract and sustain people to work for nuclear energy field, including providing favorable conditions. On 15 August 2014, the Prime Minister approved the Decision No. 45/2014/NĐ-CP on Professional incentive allowances for people working in the field of nuclear energy.

NRI organizes coaching program for junior reactor operators or supervisors from their seniors. Other related program is to employ junior personnel together with their seniors in revising operation and maintenance procedures of the reactor. This is important for transmittance of knowledge. Although recruitment is very limited, fresh graduates continue to be employed. New employees shall have to take radiation protection training and an introductory course on the activity of the reactor as well as its safety.

In order to archive the objectives of human resources development for management, research and application of atomic energy to meet the implementation requirement of "Strategy of Atomic Energy Utilization for peaceful purpose up to 2020,

especially for Nuclear Power Program, The Prime Minister has approved some documents such as Project titled “Training and Human Resources Development in Atomic Energy field” by Decision No 1558/QD-TTg dated August 18, 2010 (with the budget of 150 million USD); Project “Personnel Training for Ninh Thuan Nuclear Power Plant Program” by Decision No 584/QD-TTg dated April 11, 2013; Personnel Training and Improvement Plan in national management, research-implement and technical support up to 2020 dealt with Nuclear Power development by Decision No 1756/QD-TTg dated October 15, 2015. In 2011, the Prime Minister has created State Steering Committee on Personnel Training in Atomic Energy Application by Decision No. 940/QD-TTg.

The Government issued Decree No 24/2013/ND-CP dated October 14, 2013 stipulated preferential policies, support for training in the atomic energy field. At the same time, the MOST has completed the Joint Circular No. 208/2014/BTC-BGDDT-TTLT dated December 2014 between the Ministry of Finance (MOF) and MOET for guiding a number of articles of Decree No.124/2013/ND-CP dated 10/14/2013. MOET has also approved the Master Plan for implementation of the training and human resources development Project in the atomic energy field in the Decision No.1503/QD-BGDDT dated October 2016. The plan is built up based on Project 1558 and recommended by the MOST and the ministries, branches and localities in the number of person who need to train as undergraduate and graduate level at domestic and abroad up to 2020. Accordingly, 1,100 fresh students 220 Masters, 100 PhD will be graduated in Vietnam and abroad and fostering short-term training for 500 people on abroad.

Ministry of Education and Training (MOET) has assigned training specialty and created an Education Network between seven (07) Education and Training facilities which have been planned to participate the 1558 Project; The MOET has assigned 05 Universities which have main education programs in atomic energy application such as University of Natural Science (Hanoi National University) and University of Natural Science (Ho Chi Minh city’ s National University) is responsibility in nuclear science; Da Lat University is responsibility in nuclear technique and Hanoi University of Science and Technology is responsibility in nuclear engineering and application. In 2015, these Universities have built up the education and training programs and equipment improvement and laboratories investment project dealt with training and research in

atomic energy field; The enrollment has been started in 2015 with 30 students per promotion.

MOET has signed several MOU on personnel training in nuclear energy field with some partners in order to implement the human resources development in nuclear energy field. From 2010 to 2015, MOET has sent more than 380 students to Russia Federation to study “Equipment and Installation of Nuclear Power Plant” and ten students to study in Master course. Besides, from 2012 to present, MOET has sent 230 staffs and officers from the Organizations who have responsibility in personnel training to Hungary for on the Job training.

EVN has already developed its own “Training and HRD Project” which has been reviewed by an IAEA Expert mission and suggestions for further improvements made. In parallel, EVN will elaborate its specific training programme requirements for its staff, based on experience gained from the Russian, Japanese and other international practices:

- Pre-employment training for Ninh Thuan 1 NPP: EVN has trained 29 students in Russia Federation and 02 students in France on nuclear power. Currently, 23 students in Russian and 01 student in France have graduated. They have come back to Vietnam and assigned to work at Ninh Thuan NPP management board (EVNNPB). Up to now, there are 244 students sent by MOET to study in specialties related to nuclear power in Russian Federation have signed an agreement with EVN that after graduation they will work for Ninh Thuan NPP Project.

- Pre-employment training for Ninh Thuan 2 NPP: EVN has submitted the report and coordinated with the MOET to build up a personnel training plan to meet the manpower needs (100 people to be trained at university level related to nuclear power in Japan). Based on this plant, MOET will organize the enrollment for EVN under Decision No. 584 / QD-TTg.

- General training after recruitment for management: After improvement of the personnel training Project for NPP in Ninh Thuan approved (in April 2013), up to now, EVN has actively approached more funding international organizations such as the IAEA, JEPIC, JINED to organize 11 seminars in Hanoi and Ninh Thuan for 523 participants. EVN also sent many staffs (including 47 staffs from EVNNPB) attended the short-term training course on technical and management in Japan, Korea, USA, Russia .... From 2015, EVN has begun to send the engineers, masters graduated from abroad in the field of nuclear power to attend the practical training course on project

management and supervision of construction works at the construction site of the EVN thermal power plants. In addition, EVN also sent many officers to attend the seminar programs, training courses organized by the ministries and other international organizations and institutions at Vietnam and abroad.

- Training for operating, maintenance: Vietnam Electricity (EVN) coordinating with JINED and Tokai University – Japan organized core member training courses for Ninh Thuan 2 nuclear power project; From 2012 to 2014 Group 1 (consisting of 15 members) graduated and now is working in EVNNPB; Another 9 staff has been participating in this kind of training course from 9/2014 to 9/2016. There are 8 engineers in the Group 3 and they are studying Japanese in Vietnam and will be trained in Japan from 9/2016 to 9/2018.

VARANS is developing an internal training course and recognize the need for specific on-the-job training with experienced regulators. VARANS has actively cooperated with International partners such as Russia, Japan, USA, EU (under EC Project) and IAEA to organize the training courses in Vietnam and abroad for VARANS's employees in state management, and technical support. From 2012-2015, through the EC Project in Strengthening of Regulatory Authority Capability, VARANS has coordinated with EC to organize 51 training courses and on-the-job training for 70 VARANS's staffs. Besides, VARANS is developing an internal training course and recognize the need for specific on the job training with experienced regulators. Through Project 1558 and 1756 started in 2015, VARANS has organized 16 training courses for approximately 50 staffs in Vietnam and abroad in the state management and technical support for nuclear safety review and assessment.

The universities have engaged with representatives from VAEA/VARANS/ VINATOM to help design their upgraded graduate and post-graduate nuclear programmes and invite them to give some lectures. The selected universities and VINATOM's Training Centre have met recently and agreed to form a network to better coordinate their work (based on a recommendation from an IAEA expert mission for educational training programmes in November 2011). The High School system has been reviewed and is considered to provide graduates of sufficient quality to undertake the tertiary Engineering courses.

Article 12- Human Factors

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

The Article 23 of Circular No. 30/2012/QD-BKHCN on requirements on nuclear safety of design of NPPs (which is developed basing on IAEA SSR-2/1) indicates requirements for design for optimal operator performance in which the human performance is taken into account in the design of NPP, namely:

- Systematic consideration of human factors, including the human–machine interface, shall be included throughout the entire design process;

- The design for a nuclear power plant shall specify the minimum number of operating personnel required to perform all the simultaneous operations necessary to bring the plant into a safe state;

- Operating personnel who have gained operating experience in similar plants shall, as far as is practicable, be actively involved in the design process conducted by the design organization, in order to ensure that consideration is given as early as possible in the process to the future operation and maintenance of equipment;

- The design shall support operating personnel in the fulfillment of their responsibilities and in the performance of their tasks, and shall limit the effects of operating errors on safety;

- The human–machine interface shall be designed to provide the operators with comprehensive but easily manageable information, in accordance with the necessary decision times and action times;

- The operator shall be provided with the necessary information:

(a) To assess the general state of the plant in any condition;

(b) To operate the plant within the specified limits on parameters associated with plant systems and equipment (operational limits and conditions);

(c) To confirm that safety actions for the actuation of safety systems are automatically initiated when needed and that the relevant systems perform as intended;

(d) To determine both the need for and the time for manual initiation of the specified safety actions.

- The design shall be so as to promote the success of operator actions with due regard for the time available for action, the conditions to be expected and the psychological demands being made on the operator.

- The need for intervention by the operator on a short time scale shall be kept to a minimum, and it shall be demonstrated that the operator has sufficient time to make a decision and sufficient time to act.

- The design shall be so as to ensure that, following an event affecting the plant, environmental conditions in the control room or the supplementary control room and in locations on the access route to the supplementary control room do not compromise the protection and safety of the operating personnel.

- The design of workplaces and the working environment of the operating personnel shall be in accordance with ergonomic concepts.

- Verification and validation, including the use of simulators; features related to human factors shall be included at appropriate stages to confirm that necessary actions by the operator have been identified and can be correctly performed.

In addition, for the existing research reactor, to prevent human errors, DNRR has been operated:

- by a team consisting of at least 1 operator, 1 shift supervisor, and 1 radiation protection officer;

- with one working shift of 8 hours;

- implementing qualification and re-qualification system; and

- implementing quality assurance program and safety culture.

Article 13 – Quality Assurance

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

The Law (Article 76) specifies quality assurance program as a necessary document to be submitted for license application.

The Decree No. 70/2010/ND-CP (Article 13) specifies quality assurance program with the following:

- Quality assurance system organization;
- Quality assurance program;
- Control of design;
- Control of procurement documents;
- Procedures, instructions and drawings;
- Control of records;
- Control of procured materials, equipment and services;
- Identification and control of materials, equipment and components;
- Control of special processes;
- Quality control program;
- Testing control;
- Control of measurement and testing instruments;
- Control of receipts, storage and transportation;
- Confirmation of checking, testing and operating status;
- Control of failure equipment, components and materials;
- Corrective measures;
- Quality assurance records; and
- Internal control.

Those quality assurances apply to all stages of NPP project, taking into account special requirements for each stage.

On 09 October 2013, Directorate for Standards, Metrology and Quality issued certificate of quality management system to VARANS in activities to perform the functions of advising and assisting the Minister of Science and Technology on state management and to solve the administrative procedures on radiation protection and nuclear safety to match national standards ISO 9001:2008. Currently, VARANS is studying the integrated management system. VARANS intends to develop plans to identify the enhancements needed.

In the framework of the project VN3.01 EC/09 with cooperation of the EC on "Technical Assistance to improve the legal framework on nuclear safety and strengthening the capacity of the Nuclear Regulatory Agency of Vietnam and its

technical support organization "(performed from 2012 to 2015), under Task 2 which is to develop a quality management system of the Agency in management of nuclear facilities, the Agency was supported to develop preliminary drafts of some internal procedures including procedures of licensing, inspection, safety assessment and evaluation of safety analysis report for stage of site approval of NPPs.

At the next stage of the project, VN3.01 EC / 13, developing and completing the quality management system for the Agency in the management of nuclear facilities will be continued under the same task.

In practice, The EVNNPB obtained certification to ISO 9001:2008 on 16 November 2012. The EVNNPB is transiting to the quality management system according to ISO 9001: 2015. The management documents include general system procedures and procedures for specific activities. The project for building up integrated management system (IMS) of the project owner of the Ninh Thuan Nuclear Power project under the guidance of the IAEA has been completed by EVNNPB under the direction of EVN and sent to the IAEA for comments and recommendations. IAEA had sent an expert mission for recommendations and discussion on the project owner's IMS in late July 2016.

Article 14- Assessment and Verification of Safety

Each Contracting Party shall take the appropriate steps to ensure that:

i. ***comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;***

ii. ***verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.***

The Law requires that an operating organization to submit safety evaluation whenever applying for license or permit during the lifetime of the facility. The safety evaluation must demonstrate that the facility complies with prescribed radiation dose limits and radiation exposures are kept as low as reasonably achievable. The safety evaluation consists of design information for the facility, including the operational limits and conditions within which the facility must operate, and a safety analysis

documented in a safety analysis report (SAR). The preliminary SAR (PSAR) must be included in an application for construction of a facility. Subsequent SARs, updated versions of the PSAR must be submitted when applying for commissioning and operation.

Decree No. 70/2010/ND-CP (Article 10) provides specific requirements for the content of the SAR.

Circular No. 29/2012/QĐ-BKHCN dated 28th December, 2012 provides guidance on format and content of SAR for NPP site approval.

As strictly planned, the Circular No. 08/2014/TT-BKHCN on the format and content of SAR for FS approval and Construction Permit phases was issued by MOST May 26, 2014.

As requested at the Article 4, Circular No. 30/2012/QD-BKHCN on requirements on nuclear safety of design of NPPs, both DSA and PSA are mandatory to conduct in the design of NPPs.

To support for assessing the Chapter on Safety Analysis (equivalent to Chapter 15 of USNRC' SAR), the Circular 12/2015/TT-BKHCN on Safety Criteria for Review of the Safety Analysis Report, in which defines clearly acceptant criteria, PIEs, quality assurance of V&V of computer codes, etc.. is issued by MOST in 2015. The requirements for PSA are also considered to be included in this Circular.

In parallel, VARANS is preparing computer codes which are used for safety analysis, including recent participation to the Code Applications and Maintenance Program (CAMP) supported by USNRC to exchange information and utilize available codes on thermal-hydraulic safety. VARANS requested to MOST to become a member of Cooperative Severe Accident Research Program (CSARP) which also supported by USNRC. Up to now, the bellowing codes are utilized within VARANS' technical support units:

- Simulator PC-TRAN (provided by IAEA' TC project)
- Neutron calculation: PARCS, SCALE (CAMP), MCNP,
- Thermal Hydraulic: CATHARE2 (IRSN), RELAP5, TRACE (CAMP); ATHLET, ATLATS (GRS)
- Severe accident: ATHLET-CD, COCOSYS (GRS);
- Uncertainty: SUSA (GRS);
- Radioactive dispersion and dose estimation (free versions):
  - Radioactive dispersion in air: Hysplit 4, IXP (real time calculation),

XOQDOQ, CAP88 (in normal operation) and PAVAN (in accidental conditions);

- Radioactive dispersion in water: PCCREAM08 (in normal operation);

– PSA: RiskSpectrum (funded with government budget).

NRI has prepared the SAR when applying for operation license in 2004. Subsequently, the SAR was updated for license application for partial core conversion in 2007, for license renewal in 2009 and for full core conversion in 2012. The SAR was prepared in accordance with the requirements by the Law.

VARANS evaluates the Report through verifications and inspections. NRI has demonstrated to VARANS that it carries out a program of maintenance, periodic testing and checking activities to verify that the reactor, including its experimental channels, can be operated acceptably safely in accordance with design manuals.

Article 15 – Radiation Protection

Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

The Atomic Energy Law has adopted principles from IAEA BSS-115, i.e.: defense in depth, good engineered practices, and safety verification. It also adopts the basic concepts of justification, limitation and optimization through dose constraint and dose limits. Article 21 specifies that:

1. Radiation control includes:

a) Control of professional exposure;

b) Control of medical exposure;

c) Control of public exposure.

2. Organizations, individuals conducting radiation practices shall comply with the following principles of dose control:

a) Ensuring radiation doses to the public and radiation workers do not exceed the dose limit; and doses to patients comply with the prescription;

b) Ensuring personal dose, number of exposed people and possibility of being exposed at the lowest level reasonably;

c) Ensuring the benefit from the radiation activities can trade off the risk, damage that might pose to the people and the environment

For nuclear installations, the Law governs that:

- The licensee shall continuously, periodically and/or randomly monitor the environmental radioactivity. The level of environmental radioactivity shall not exceed the established limit of environmental radioactivity.

- Applicants shall submit the report of environmental management and environmental monitoring program.

To detail above Law's requirements, Vietnam has issued some related Circulars, as follows:

- The Circular No. 19/2012/TT-BKHCN on ensuring and control of Occupational and Public exposure was issued by MOST on November 8, 2012. This Circular establishes the dose limits for radiation worker and public in the normal operation conditions of facilities (For radiation worker: an effective dose of 20 mSv per year averaged over five consecutive; for pubic: an effective dose of 1 mSv in a year). In the case of emergency, we follow the guide of Circular No. 21/2013/TT-BKHCN providing the Application Technical Standards and Regulations on Nuclear Safety in Siting, Designing, Constructing, Operating and Decommissioning of NPP unit.

- Joint Circular No. 13/2014/TTLT-BKHCN-BYT on ensuring radiation safety in medical applications was issued by MOST and MOH on June 9, 2014, established a graded approach in the authorization of radiological medical practices based upon the inherent risks and hazards associated with the application.

Regarding to occupational dose assessment, by the end of 2015, Vietnam has 1872 radiation facilities with total staffs have been monitored the individual dose are 17 335 at six 6 approved dosimetry service facilities. The individual dose results of 7 335 radiation worker in 2015 as follows:

- 23 radiation workers received occupational dose exceeding dose limit of 20 mSv/year (0.13%).

- 100 radiation workers received occupational dose from 5 to 20 mSv/year (accounting for 0.57%).

- 14 536 radiation workers received occupational dose less than 5 mSv / year (99.3%).

Regarding to environmental monitoring, the studies of environmental radioactivity were made at National, ministerial and provincial level, in particular:

- The national level project in 2005: "Studying and assessing the radioactive contamination in Phong Tho (Lai Chau), Nong Son (Quang Nam), Ham Tan (Binh Thuan) and suggesting the prevention measures";

- The national level project No. KC09-18: "The state of the radioactive environmental contamination, the impact on health and the environment in some residential areas in Vietnam";

- The project of the Institute for Technology of Radioactive and Rare Elements in 2005: "Studying the management of natural radioactive materials in some mineral sands mining and processing facilities".

- The national level project No. KC.05.21 / 11-15 "Studying and developing the radioactivity database in food products in the border areas adjacent to the China nuclear power plants" in 2011.

In addition, the Decision No. 899/QĐ-TTg dated June 10, 2011 on approving the detailed plan on development and application of radiation in meteorology, hydrology, geology, mineralogy and environmental protection through 2020 in order to assist in planning and developing the economics and society. 33 of 63 provinces and cities of Vietnam have approved the studying projects in the natural radiation background monitoring. From that aims to build the natural radiation background map in the whole province and city.

Article 16 – Emergency Response and Preparedness

1. ***Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency.***

   For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.

2. ***Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.***

3. ***Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.***

16.1. Emergency Plans and Programmes

The Law (Article 83) stipulates that the applicant shall submit the emergency preparedness program when applying for license. In addition, the Law governs that licensees are responsible for and shall have their own capability for emergency response based on their emergency preparedness program.

According to the Law, national disaster responses, including nuclear accident, shall be carried out by the National Committee for Search and Rescue (VINASARCOM).

Decree No. 70/2010/ND-CP (Chapter VI) specifies responsibilities of all stakeholders in emergency preparation and response, including the responsibility for drilling and financing.

As required by the Circular No. 29/2012/QD-BKHCN on format and content of the PSAR, Emergency Response and Preparedness Plan, including Emergency planning, Emergency response center, Capability for the assessment of accident progression, radioactive releases and the consequences of accidents, and Emergency response exercises, is mandatory to be provided in the PSAR for site approval.

Plans for radiation and nuclear incidents response include those at facility, provincial and national levels.

- Facility plans for radiation and nuclear incidents response shall be executed in the advent of incidents at groups 1, 2 and 3 as prescribed in paragraph 2 Article 82 of the Law. Facility plans for radiation and nuclear incidents response shall cover: predicted incidents, plans for mobilizing forces and means for initial response to the incidents: first-aid for injured persons, restriction of outbreak, mitigation of consequences, isolation of dangerous areas and safety and security control; plans for annual drills and exercises for emergency responses. Organizations, individuals conducting radiation practices shall develop their plans for radiation and nuclear incident response.

- Provincial plans for radiation and nuclear incidents response shall be executed in the advent of incidents at group 4 as prescribed in paragraph 2 Article 82 of the Law or at group 1, 2 and 3 as prescribed in paragraph 2 Article 82 of the Law, in the case of exceeding facility capacity. Provincial plans for radiation and nuclear incidents response shall also cover: predicted incidents, plans for mobilizing forces and means for initial response to the incidents: first-aid for injured persons, restriction of outbreak, mitigation of consequences, isolation of dangerous areas and safety and security control; annual drills and exercises for emergency responses. Provincial People's Committee shall develop provincial plans for radiation and nuclear incidents response; the Ministry of Science and Technology shall provide guidance on planning and approving the provincial plans for radiation and nuclear incidents response.

- National plans for radiation and nuclear incidents response shall be executed in the advent of incidents at group 5 as prescribed in paragraph 2 Article 82 of the Law or in case of incident at level 4 as prescribed in paragraph 2 Article 82 of the Law that exceeding provincial capacity. National plans for radiation and nuclear incidents response shall cover: mechanism of organization, predicted incidents, plans for incident response; organization of drills and exercises for emergency responses every two years. The Ministry of Science and Technology shall collaborate with the Ministry of Industry, Ministry of Health, Ministry of Defense, Ministry of Public Security, Provincial People's Committees in which radiation facilities, nuclear facilities are operating and related organizations and individuals to develop national plans for radiation and nuclear incident response to submit to the Prime Minister for approval.

Circular No. 25/2014/TT-BKHCN dated 08 October 2014 has been recently issued by MOST to regulate emergency preparedness and response, development

and approval of facility and provincial plans for radiation and nuclear emergency response.

Currently, VARANS is preparing a draft of National Emergency Response Plan which is expected to be approved by Prime Minister and issued at the end of 2016.

At present, with the support from VARANS, 15 Provincial Emergency Response Plans have been approved. In approved provincial emergency response, there are provinces located in the border area of Vietnam and China as Quang Ninh, Lang Son, Son La, Hai Phong. Training and exercises on emergency response were conducted in some provinces as Hanoi, Quang Ninh, Lang Son, Ha Tinh, Quang Ngai etc. These could be good experiences for other provinces. When provinces have good preparedness and plan, this is favorable for the deployment of resources involved in national response to trans-boundary accidents.

The Emergency Plan of the Dalat Nuclear Research Institute (DNRI Emergency Plan), established by DNRI for the event of a nuclear, radiological and conventional emergency that might occur at the DNRR facility, shall provide reasonable assurance that the necessary actions will be taken to mitigate accident consequences in order to protect the facility personnel and the general public. The analysis of potential accidents requiring emergency response is an essential step in emergency planning since the severity of potential accidents will define the scale of the plan, the nature of the countermeasure to be considered and the intervention zones to be planned. DNRI is particularly interested in assessing the risks in the reactor during both its operation and shutdown, could result from (1) external causes originated naturally or by human (e.g. earthquake, aircraft crash, explosion and fire, sabotage); (2) malfunctions of reactor equipment important to safety; and (3) human errors in operation of the reactor. In plan, DNRI also develops contents needed for preparedness and response to DNRI incidents/accidents. MOST has approved new DNRI emergency plan in 2016.

Recent events, specifically the nuclear accident at the Fukushima Daiichi nuclear power plant, have highlighted the need for, and importance of, effective radiological and nuclear emergency preparedness and response (EP&R). There has since been a resurgence of interest in this topic, both technically and politically, and numerous actions have been taken at national, regional and international levels to further enhance EP&R. ASEAN has not been immune from this process and improvements are being sought at national and regional levels, in particular in the

context of new or emerging threats in the region. Within ASEAN, a broad consensus has emerged, following the Fukushima accident, that a regional approach to radiological and nuclear EP&R in South East Asia would be beneficial as a complement to national capacities and capabilities. The benefits identified include: enabling more rapid and informed response from the exchange, in real time, of information from national radiation monitoring networks; reduced costs from sharing expertise, methods, training, equipment and facilities at a regional level and avoiding needless duplication; and ensuring the more consistent application of protective measures in neighboring countries that would enhance trust and confidence in the populations potentially affected. Regional cooperation should, therefore, be at the core of any strategy aimed at improving EP&R within ASEAN in a cost-effective and sustainable manner. Such cooperation should, however, be without prejudice to national responsibilities to ensure adequate EP&R arrangements and capabilities. Experience elsewhere has shown that a key challenge in radiological and nuclear EP&R is sustainability, in particular to maintain a high level of expertise and capability to ensure an effective and timely response to rare events. ASEAN Member States currently have varied capabilities, and a regional approach to EP&R would have advantages in terms of sustainability and making the most efficient use of assets, capabilities and knowledge.

Against this background, all countries of ASEAN have been jointly exploring regional cooperation on radiological and nuclear EP&R, and six countries, in particular, are cooperating with the EU (under the auspices of the Instrument for Nuclear Safety Cooperation (INSC)) in a feasibility study on establishing a strategy for regional (ie, ASEAN) cooperation on EP&R and an action plan (road map) for its implementation. The strategy set out in this document has been developed on behalf of ASEAN as part of this feasibility study. It is based on an earlier discussion document, which set out options for the strategy and its implementation, and on the outcome of bi-lateral discussions held in June 2015 with the six ASEAN countries. This draft strategy will be subject to further discussion and refinement within ASEAN with a view to its being endorsed and agreed by all Member States.

During the week of 03-07 March 2014, IAEA Expert mission was conducted.to assist Vietnam in filling the gaps in its emergency Preparedness and Response (EPR) Capabilities.

From 2016, CBRN CoE (Centres of Excellence) of EC welcomes the participation of ASEAN countries to Project "Enhancement of CBRN capacities of South East Asia in addressing CBRN risk mitigation concerning CBRN first response, biosafety and biosecurity, awareness raising and legal framework". Vietnam actively participated in this project and nominated experts to work this project as regional experts.

Within the framework of the European Union (EU) Chemical, Biological, Radiological and Nuclear (CBRN) Risk Mitigation Centres of Excellence (CoE) Initiative, the 1st CBRN CoE Regional Experts Round-Table Meeting of South East Asia was hosted on 27-29 April 2016, in Manila, the Philippines, by the Government of the Philippines, the EU and the United Nations Interregional Crime and Justice Research Institute (UNICRI). The meeting was attended by experts from Brunei Darussalam, Cambodia, Lao People's Democratic Republic (PDR), Myanmar, Malaysia, the Philippines, Singapore and Viet Nam. General objective was to discuss the regional priorities and develop regional project proposals within the framework of the EU CBRN CoE. The final outcomes of the meeting and the regional project proposals, were further discussed, prioritized and approved by the National Focal Points during the 11th CBRN CoE National Focal Points Round-Table Meeting for South East Asia, 31 May - 1 June 2016, La Hulpe, Belgium.

16.2. Information of the public and neighboring states

Information on the radiation and nuclear incidents that may cause impact to the vicinity of the incident shall be provided promptly and accurately to the local population. The mass media informing on the radiation and nuclear incidents shall ensure that the information are righteous, objective and bear responsibilities in compliance with the media law.

In case of accident, information will be exchanged between IAEA and Member States on basis of Convention on Early Notification of a Nuclear Accident. Vietnam will inform to neighboring states though IAEA-IEC by IECOMM or other bilateral cooperation.

Circular No. 25/2014/TT-BKHCN requires Command Committee is responsible for establishment of a mechanism for receiving and processing information respectively and establish a focal point to receive and process information continuously operate 24/7 for receiving information about the emergency, ask for

assistance and recommends initial response measures. Based on an alarm level, specific conditions and monitoring data making timely warnings and instructions for action to protect the public and also try to limit the spread of misinformation, lack of precision.

16.3. Emergency Preparedness for potential affects from a nuclear installation in neighboring states

On 31 August 2010, the Prime Minister issued Decision No. 1636/QD-TTg on approval of the Master Plan for national environmental radiological monitoring and warning network up to 2020. The objective of this Master Plan is to establish a national network on radiological monitoring and warning in order to promptly detect abnormal radiation in the territory of Vietnam and to actively assist the response to radiological and nuclear incidents and to provide radiological data to support the state management on nuclear energy, and radiation and nuclear safety. Under this Master Plan, several Monitoring Stations will be established at the provinces in the border with China, such as Quang Ninh, Lang Son Provinces.

In addition, taking into account the development of NPP program of neighboring countries, Vietnam are continuing conduct environmental monitoring programs in Mid-Northern area and Northern coast to set up a database and ready to assessing effects of trans-boundary accident.

Vietnam Committee for Search and Rescue (VINASARCOM) are developing national means and forces plan which will concurrent with national radiological and nuclear emergency response plan to deal with NPP accident in Vietnam and from other countries.

In the 9th Joint Committee Meeting on scientific and technology in July 2016 between Vietnam and China, China acknowledged Vietnam 's proposal to report to the Chinese Government to assign the regulatory authorities of the Chinese nuclear power in collaboration with the Vietnam Ministry of Science and Technology to establish cooperation channel of information exchange related to Fangchenggang (Quangxi) and Changjiang (Hainan) nuclear power plants in order to protecting environment and responding to incidents of nuclear power plants.

D. Safety of installations

Article 17 – Siting

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

i. ***for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;***

ii. ***for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;***

iii. ***for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;***

iv. ***for consulting Contracting Parties in the vicinity of a proposed nuclear installation, in so far as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.***

17.1. Evaluation of site related factors

The Decree No. 70/2010/ND-CP (Article 20) stipulates contents of the Overview report on the site selection, taking into account site characteristics that may have impacts on the safety of the NPP. These characteristics include:

- The site's seismology, geology, topography, demography, ecology, hydrology and meteorology;

- The effects of nearby facilities and land usage;

- The availability and reliability of offsite services such as electricity, water, transportation, communication system; and

- The feasibility of emergency response.

Circular No. 13/2009/TT-BKHCN- Guiding preliminary nuclear safety evaluation of sites of nuclear power plants at the stage of investment decision

Nuclear safety criteria for sites of nuclear power plants including following contents:

1. Faults, earthquakes, volcanoes

a/ There shall be no fault which is less than 8 km from a nuclear power plant which exhibited movement at least once within the last 130.000 years.

b/ There is no evidence of an earthquake of higher than 8 MSK within a radius of less than 50 km from a nuclear power plant.

c/ There is no possibility of eruption of a volcano emitting lava to areas less than 15 km from a nuclear power plant.

d/ In case that provisions specified at Points a. b and c of this Item are not satisfied and no compensated measures can be found, the site is considered unacceptable.

2. Geo-techniques and foundations

a/ The foundation of a reactor or turbine buildings must be based on a relatively monolithic bedrock which is solid and resistant to disruption, vigorous fragmented or weathered.

b/ The foundations of other facilities of a nuclear power plant must not be based on weak, liquefiable or highly swelling soil or soil which can magnify vibratory motion.

c/ In case that provisions specified at Points a and b of this Item are not satisfied and no compensated measures can be found, the site is considered unacceptable.

3. a/ No extreme meteorological phenomenon with a wind speed of more than 300 km/h in the proposed site of a nuclear power plant occurred within the last 100 years.

b/ In case that provisions specified at Points a of this Item are not satisfied and no compensated measures can be found, the site is considered unacceptable.

4. Flooding

a/ There is no flooding within the 100 years at the proposed site of the NPP and it is forecasted that no such potential flooding would occur during the lifetime of the NPP.

b/ In case that provisions specified at Points a of this Item are not satisfied and no compensated measures can be found, the site is considered unacceptable.

5. Impacts of human activities on nuclear power plants

a/ The distance from a nuclear power plant to, military facilities, transportation routes, fuel pipeline, flammable or explosive materials storage, transport and using facilities shall be sufficient so that the overpressure at the nuclear power plant is not greater than 0.07 bar (7 kPa) if any explosion occurs.

b/ The distance from a nuclear power plant to an airport shall be at least 7 km.

c/ In case that provisions specified at Points a and b of this Item are not satisfied and no compensated measures can be found, the site is considered unacceptable.

6. Impacts of radiation on the public

a/ The proposed site of a nuclear power plant shall satisfy the following

conditions in order to mitigate impacts of radiation on the public:

- An exclusion zone shall be established with its outer boundaries at least 1 km from the fence of the nuclear power plant. In case an individual located on the boundary of the exclusion zone more than 1 km from the fence of the nuclear power plant may receive radiation in excess of 0.25 Sv (25 rem) total effective dose equivalent (TEDE) or in excess of 3 Sv (300 rem) total radiation dose to the thyroid from iodine exposure during 2 hours period following the onset of the postulated fission product release, the exclusion zone shall be expanded to that position;

- A low population zone shall be established surrounding the exclusion zone with an individual located on the outer boundary of the low population zone shall not receive radiation dose in excess of 0.25 Sv (25 rem) total effective dose equivalent or in excess of 3 Sv (300 rem) total radiation dose to the thyroid from iodine exposure during the entire passage of the radioactive cloud. Collective dose for the low population zone shall not exceed 20,000 manxSv after accidental release of radionuclides.

b/ In case that provisions specified at Points a of this Item are not satisfied and no compensated measures can be found, the site is considered unacceptable.

7. Cooling water and power supply for the operation of a plant

a/ The site of a nuclear power plant shall have sufficient cooling water supply and the power supply for the plant's operation shall be uninterrupted in any circumstance.

b/ In case that provisions specified at Points a of this Item are not satisfied and no compensated measures can be found, the site is considered unacceptable.

Circular No. 28/2011/QD-BKHCN on nuclear safety requirements for nuclear power plant sites defines: Principles for site evaluation; Site investigation; Earthquakes, surface faulting, volcanoes; Meteorological events; Flooding; Tsunami; Geotechnical hazards; External human induced events.

As required in the Circular No. 28/2011/QD-BKHCN, a site shall be considered unacceptable if existing one of the following characteristics:

- There is a capable fault in the site;

- There is potential ground motion in the site caused by earthquake with the peak ground acceleration (PGA) equal to or greater than 360 cm/s^2 and with the return period of 10,000 years;

- There is karstic formation or holes of more than 20 m in diameter formed by

carbonate karst on surface in the site.

The Appendix of Circular No. 29/2012/QD-BKHCN on format and content of the PSAR that supports the application for nuclear power plant site approval requires the contents of the Part 3 “Site evaluation” of PSAR have to specify following characteristics: (1) Information on site (location, demography, geotechnical soil properties and groundwater hydrology, the site related data and the associated ranges of uncertainty to be used in the basic design, topographical characteristics); (2) General principles of evaluation of site specific hazards; (3) Human activities in site vicinity; (4) Activities at the site area; (5) Hydrology; (6) Meteorology; (7) Geological and seismotectonic characteristics.

Several Safety Standards which have been developed based on IAEA guidelines provide in detail criteria and methodologies for site characteristics:

- TCVN 9641:2013 on Nuclear Safety – External human induced events in site evaluation for nuclear power plants.

- TCVN 9642:2013 on Nuclear Safety – Survey, assessment of radioactive material dispersion in air and water and consideration of population distribution in site evaluation for nuclear power plants.

- TCVN 9643:2013 on Nuclear Safety – Geotechnical aspects of site evaluation and foundation for nuclear power plants

- TCVN 9644:2013 on Nuclear Safety – Seismic hazards in site investigation and evaluation for nuclear installations.

- TCVN 9645:2013 on Nuclear Safety – Meteorological and hydrological survey and assessment in site evaluation for nuclear power plants.

Some criteria applied for evaluating all sites related factors affecting the safety of the nuclear installation are specified in the TCVN 9641:2013 on Nuclear Safety – External human induced events in site evaluation for nuclear power plants, namely: Screening and evaluation procedures on the basis of distance (Screening distance value SDV) or probability:

- Aircraft. The potential hazards arising from aircraft crashes are taken into account if: (1) Airways or airport approaches pass within 4 km of the site; (2) Small or medium airports are located within 10 km of the site; (3) For large airports, the distance d in kilometers to the proposed site is less than 16 km and the number of projected yearly flight operations is greater than 500 d^2; (4) For large airports, the distance d in kilometers to the proposed site is equal or greater than 16 km and the number of

projected yearly flight operations is greater than 1000 d^2. (5) Within 30 km of the proposed site, there are military installations or air space usage such as practice bombing or firing ranges, which might pose a hazard to the site.

- Sources of hazardous clouds: SDV is 10 km.

- Explosion sources: For a specific explosion sources, SDV is in meter, derived by the formula: SDV = 18 $W^{1/3}$. In that, W is TNT equivalent mass of the explosive material and W is in kilogram (kg).

- Fires: SDV is 2 km.

- If the site is outside the SDV for the initiating event under consideration, no further evaluation should be made. If the site is not outside the SDV for the initiating event under consideration, the probability of occurrence of such an event should be determined.

- If the probability of occurrence of the initiating event with radiological consequences or causing radiological exposure exceeding the limits is smaller than the 10^{-7}/year, no further analysis should be made. If such probability is equal or greater than 10^{-7}/year, such initiating event shall be considered the design basic event. However, events associated with possibly major catastrophes shall not be screened out unless their probability is shown to be significantly below the 10^{-7}/year.

In term of design, provisions used again human made external events and natural occurring external events are provided in the Circular No. 30/2012/TT-BKHCN on requirements on nuclear safety of design of NPPs (Article 9):

- The design shall be made, taking into due consideration of those natural and human induced external events that have been identified in the site evaluation process. Natural external events shall be addressed, including meteorological, hydrological, geological and seismic events. Human induced external events arising from nearby industries and transport routes shall be addressed.

- In the short term, the safety of the plant shall not be dependent on the availability of off-site services such as electricity supply and fire fighting services. The design shall take due account of site specific conditions to determine the maximum delay time by which off-site services need to be available.

- The seismic design of the plant shall provide for a sufficient safety margin to protect against seismic events and to avoid cliff edge effects.

- For multiple unit plant sites, the design shall take due account of the potential for specific hazards giving rise to simultaneous impacts on several units on the site.

17.2. Impact of the installation on individuals, society and environment

The Article 6 of Circular No. 28/2011/QD-BKHCN on nuclear safety requirements for NPP sites requires that potential effects of the NPPs on individuals, society and environment must be assessed, including: (1) Environmental characteristics that may affect dispersion of radioactive material released from the NPP, including atmospheric, surface water and groundwater dispersions; (2) The potential radiological impact on public and environment; (3) The direct and indirect pathways by which radioactive materials were released from the NPP could potentially reach and affect public and environment; and (4) The site and the NPP basic design to ensure that the radiation exposure risk to the public and the environment as low as reasonably achievable and does not exceed the limit as prescribed in legal provisions.

The Chapter IV of Circular No. 28/2011/QD-BKHCN provides in more detail requirements need to be implemented to investigate and assess potential radiological dispersion released from NPP with effects to public, including Atmospheric dispersion of radioactive material (Article 17), Dispersion of radioactive material through surface water (Article 18), Dispersion of radioactive material through groundwater (Article 19), Population distribution and ambient radioactivity (Article 20). The radiological dose limits for public during both normal operation conditions and emergency events are also specified for selected site in Article 21.

Part 5 “Environmental aspects” of the Appendix of Circular No. 29/2012/QD-BKHCN on format and content of the PSAR requests that the following factors shall take into account of PSAR: Radiological impacts; NPP impact on agriculture, silvi-culture, aquaculture and on population; NPP impact on social environment; NPP impact on transportation and on civil and industrial facilities.

TCVN 9642:2013 on Nuclear Safety – Survey, provides in detail criteria and methodologies for assessing radioactive material dispersion in air and water and consideration of population distribution in site evaluation for nuclear power plant.

As requested by the Decree No. 70/2010/ND-CP, the EIA report is mandatory for application of site approval. MONRE in collaboration/cooperation with MOST (for radiation aspects) is responsible for evaluation of this Report.

17.3. Re-evaluation of site related factors

The Article 8 of Circular No. 28/2011/QD-BKHCN on Hazard monitoring requires the site characteristics significant to the safety of the NPP, the public and the environment, shall be monitored over the lifetime of the NPP.

The Appendix of Circular No. 29/2012/QD-BKHCN on format and content of the PSAR that supports the application for NPP site approval provides the provisions to monitor site related parameters on seismology, meteorology, hydrology, demography, industrial activities and transport. Long term monitoring programs and the monitoring strategy (in terms of forecasting the effects of site related hazards and of supporting the operating organization and relevant agencies and organizations in preventing, mitigating incidents and accident management) are also specified.

Vietnam is preparing for selection of the 1st sites of NPPs, so no re-evaluating activity is implemented up to now. However, the design basic of the Ninh Thuan 2 NPP is considered to be determined based on the new Japanese regulation which is re-evaluated recently after the Fukushima accident.

17. 4. Consultation with other Contracting Parties likely to be affected by the installation

Vietnam is member of the Convention on Early Notification of Nuclear Accident (1987) and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (1987).

Up to now, no bilateral arrangement with neighboring countries is setup. As mentioned above, in the 9th Joint Committee Meeting on scientific and technology in July 2016 between Vietnam and China, China acknowledged Vietnam 's proposal to report to the Chinese Government to assign the regulatory authorities of the Chinese nuclear power in collaboration with the Vietnam Ministry of Science and Technology to establish cooperation channel of information exchange related to Fangchenggang (Quangxi) and Changjiang (Hainan) nuclear power plants in order to protecting environment and responding to incidents of nuclear power plants.

17.5 Recently activities relevant to investigation of nuclear power plant sites.

17.5.1. National Nuclear Safety Council and VARANS's activities:

VARANS has conducted Technical Meetings and site visit to Ninh Thuan proposed sites, focusing on capable fault, PGA, age of surface displacement, and Tsunami and ground foundation:

- The Workshop on Geological investigation and seismic assessment for the site of Ninh Thuan 2 Nuclear Power Plant was held by Vietnamese state-owned power utility (Vietnam Electricity, EVN) in 16/7/2013.

- The Workshop on Site Safety Assessment for the Ninh Thuan 1 and 2 NPPs,

held in Hanoi in May 2014, was organized by the VARANS, with the support of IAEA.

- The Workshop on Site Safety Review for Ninh Thuan 1 and Ninh Thuan 2 was held in the Headquarters of the Ministry of Science and Technology, in Hanoi, from October 20-22, 2014. The Workshop was organized by the VARANS, with the support of the Vietnamese state-owned power utility (Vietnam Electricity, EVN).

Up to 2015, VARANS has conducted 3 inspection activities on:

- Application of code and standard in siting survey;
- Suppervision of EVN for consultant organization, prime contractors and subcontractors in performing survey and quality assurance in detailed survey at NPP Ninh Thuan 2 site;
- Fault survey for Hon Gio East region and sampling analysis.

1.7.5.2 Overview of Siting for Nuclear Power Plants in Vietnam (up to 2016)

Main Results of Site study and investigation by Russian consultant E4-EPT-KIEP (for Ninh Thuan 1):

- Analysis of tectonic and seismic conditions on the areas with radius of 300-150 km and 30-8 km around NPP site, geophysical investigations and research on remote sensing and morphological and structural analysis have shown that the site is not disturbed by any capable faults and the site lies within the stable whole block of earth's crust.

- Results of geodynamic investigations have indicated that Ninh Thuan 1 NPP site and its vicinities have calm background geodynamic regime with low velocities of modern earth crust movements.

- Neo-tectonic investigations have confirmed that NPP site is situated in the stable block and the linear structures of NW strike a lot of tectonic genesis.

Main Results of Site study and investigation by Japan consultant JAPC (for Ninh Thuan 2):

- The effect on NPP of natural events such as earthquake, active volcano, engineering geology, abnormal weather, tsunami, flooding etc… was evaluated. It is confirmed that even if a nuclear power plant is installed at the planned site, enough safety will be securable.

- According to the result of fault survey around the site, it is confirmed that the siting standard of Vietnam (There is no potential ground motion in the site caused by earthquake with the peak ground acceleration (PGA) equal to or greater than 360 cm/s^2 and with the frequency of 10,000 years) could be satisfied.

For the afore-mentioned reasons, it is confirmed preliminary that the planned construction site for the Ninh Thuan 2 project is suitable for NPP construction.

Emerging issues of Siting for nuclear power plants in Vietnam:

- Evaluation of the PGA: the calculated results between two vendors are significantly different. The calculated PGA for Ninh Thuan 1 is about 170 cm/s^2 and for Ninh Thuan 2 is about 410 cm/s^2.

- Design basic ground motion: The Japanese consultant suggested using the PGA for seismic design of Ninh Thuan 2 NPP is 450 cm/s^2 while the Russian proposed the PGA for seismic design of Ninh Thuan 1 is only about 90 cm/s^2.

- Seismo-tectonic models have been developed by the consultants, but without having a common seismo-tectonic database and without harmonizing viewpoints and approaches.

- Seismic source characterization has been performed by the consultants for the seismogenic structures in their respective seismo-tectonic models, but uncertainties have not been accounted for.

- No criteria for GMPE selection was presented by the consultants during the workshop. Each consultant used a single GMPE, without justifying the basis for its selection.

- The consultants delivered the document on the computation procedures or both DSHA and PSHA to EVN. The quality and degree of detail of the documentation was not mentioned.

- No Peer Review for seismic hazard assessment of both sites has been carried out so far by the consultants.

JAPC has conducted an additional investigation programs in 2015, the final results of additional investigation are being prepared and submitted to VARANS by 2016.

Article 18 – Design and Construction

Each Contracting Party shall take the appropriate steps to ensure that:

i. ***the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to prevent the occurrence of accidents and to mitigating their radiological consequences should they occur;***

ii. ***the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;***

iii. ***the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.***

18.1. Implementation of Defense in Depth

The Law (Article 23) provides for principles of defense in depth, that is:

1. Defense in depth is the simultaneous application of multi-measures, multi-layers to ensure and maintain safety and security.

2. Organizations, individuals conducting radiation practices shall comply with principles of defense in depth in accordance with the hazard and threat of radioactive sources, nuclear material posed to people and the environment.

Circular No. 30/2012/TT-BKHCN on requirements on nuclear safety of design of NPPs defines:

- Article 7. Requirements for the “Defense in depth” principle;

- Article 9. Requirements for internal and external hazards;

- Article 15. Requirements for safety criteria which take into account in design: (1) the common cause failures, physical and functional separation, redundancy and diversity; (2) application of Single failure criteria; and (3) application of failsafe function principle for systems and components important to safety.

- Article 4 requires both DSA and PSA are mandatory to conduct in the design of NPPs.

- Article 11. Requirements for Design extension conditions indicate that Design extension conditions shall be defined based on engineering judgment, and deterministic and probabilistic analysis evaluation. Where the results of engineering judgment, and deterministic safety assessments and probabilistic safety assessments indicate that combinations of events could lead to anticipated operational occurrences or to accident conditions, such combinations of events shall be considered to be design basis accidents or shall be included as part of design extension conditions, depending mainly on their likelihood of occurrence. Certain events might be consequences of other events, such as a flood following an earthquake. Such consequential effects shall be considered to be part of the original postulated initiating event.

Circular No. 12/2015/TT-BKHCN on requirements on safety analysis for nuclear power plants defines:

Article 5. Requirements for safety analysis of NPP design specified that safety analysis shall demonstrate that sufficient defence in depth has been implemented in the design of the plant.

Article 6. Required outputs of probabilistic safety analysis shall include

justification, to the extent practicable, of the independence among levels of defence in depth.

Article 11 Requirement on establishment of acceptance criteria that shall ensure that an adequate level of defense in depth is maintained to ensure that no individual or the environment bears an unacceptable risk of harm.

18.2. Incorporation of proven Technologies

The NPP investment project approved by the National Assembly Resolution No. 41/2009/QH12 on 25 November 2009 specifies that the NPP shall be of advanced and proven technology.

Circular No. 30/2012/TT-BKHCN on requirements on nuclear safety of design of NPPs defines:

- Article 14. Engineering design rules require: (1) The engineering design rules for items important to safety at a NPP shall be specified and shall comply with the relevant national or international codes and standards and with proven engineering practices; (2) Methods to ensure a robust design shall be applied, and proven engineering practices shall be adhered to in the design of a nuclear power plant to ensure that the fundamental safety functions are achieved for all operational states and for all accident conditions.

- Article 16. Design of items important to safety requires application of proven design to items important to safety.

18.3. Design for reliable, stable and manageable operation

The Article 23 of the Circular No. 30/2012/QD-BKHCN on requirements on nuclear safety of design of NPPs indicates requirements for design for optimal operator performance in which the human performance is taken into account in the design of NPPs. The detailed requirements have already mentioned in the above item Article 12-Human Factors.

18.4. Implementation of The Vienna Declaration on Nuclear Safety

As an embarking country, Vietnam reviewed and developed requirements to comply with the Vienna Declaration in the implementation of the objective of the CNS to prevent accident with radiological consequences and mitigate such consequences should they occur "*New nuclear power plants are to be designed, sited, and constructed, consistent with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible*

releases of radionuclides causing long-term off-site contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions". Namely:

Circular No. 12/2015/TT-BKHCN dated 20th July, 2015 on requirements for safety analysis for nuclear power plants:

- Provision 3 of Article 12: Design extension conditions that could lead to large radioactive releases to environment shall be practically eliminated. For design extension conditions that cannot be practically eliminated the protective measures shall be available to limit radioactive dispersion in a sufficient period of time and determined area to implement protective actions for the public.

- Provision 4 of Article 12: The release of radioactive materials arising from a severe accident shall not cause the following consequences:

a) Acute harmful health effects to the public in the vicinity of nuclear power plant;

b) Any long-term restriction on the use of extensive areas of land and water;

c) Release of caesium-137 to environment exceeding 30 TBq;

d) Combined fall-out consisting of radionuclides other than cesium-isotopes shall not cause, in long-term, starting three months from the accident, a hazard greater than which would arise from a cesium release corresponding to the limit prescribed in Point c of this Item.

- Provision 2 of Article 15: For level 2 probabilistic safety analysis, a cumulative frequency that can lead to a radioactive release to environment of more than 30 TBq of Cs-137 shall be less than 10-6/reactor.year.

The Circular No. 30/2012/QD-BKHCN on requirements on nuclear safety of design of NPPs was developed basing on the IAEA SSR 2/1. VARANS has already included in the regulation development plan in 2017 to review the Circular No. 30/2012/QD-BKHCN following the recently issued IAEA SSR2/1 (revised), in which focusing on requirements on the containment.

Article 19 – Operation

Each Contracting Party shall take the appropriate steps to ensure that:

i. ***the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;***

ii. ***operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;***

iii. ***operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;***

iv. ***procedures are established for responding to anticipated operational occurrences and to accidents;***

v. ***necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;***

vi. ***incidents significant to safety are reported in a timely manner by the holder of the relevant license to the regulatory body;***

vii. ***programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;***

viii. ***the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.***

Commissioning and operation licensing process are stipulated in Articles 50-57 of the Law.

Articles 41 and 50 of the Law provide for basic requirements for commissioning and operation of nuclear research reactors and nuclear power plants, respectively.

Article 41:

- The operation testing shall be conducted at different low capacity levels while technical parameters and operation limits are examined and the capacity is to be gradually increased to the nominal level. The organization possessing a nuclear research reactor shall submit to the Agency for radiation and nuclear safety the report of the operation testing and safety analysis report of nuclear research reactor,

explaining the change of technical parameters, operation limits compared with those in the design submitted in application for construction permit.

- The Agency for radiation and nuclear safety shall conduct assessment of the report on results from operation testing and safety analysis report for nuclear research reactor, and shall make a proposal to the MOST in regard to the issuance of permit for official operation of the nuclear research reactor.

Article 50:

1. Before being fueled the nuclear power plant shall obtain permit for commissioning.

2. The commissioning shall be conducted at different low power levels in which technical parameters and operation limits are examined and the power is gradually increased to the nominal level. The organization possessing a NPP shall submit to the Agency for radiation and nuclear safety the report of the commissioning and safety analysis report of the NPP, explaining the change of technical parameters, operation limits compared with those in the design submitted in application for construction permit.

3. The Agency for radiation and nuclear safety shall conduct assessment of the report on results from commissioning and safety analysis report for NPP, and shall make a proposal to the National Nuclear Safety Council for evaluation of the assessment results in regard to the issuance of license for official operation of the nuclear power plant.

As defined in the Decree No. 70/2010/ND-CP on NPP (the Article 10), the Item “correction and testing operation program” is one of content of SAR that the utility shall submit to the Regulatory Body in the application for operation licensing.

ADDITIONAL REPORT ON INTERNATIONAL PEER REVIEW SERVICES

1. IRRS Mission

At the request of the VARANS, an IAEA convened team of international experts performed a peer review of Viet Nam's national regulatory infrastructure for radiation and nuclear safety, in accordance with the Guidelines of the IAEA Integrated Regulatory Review Service (IRRS). The IRRS mission took place from 28 September to 9 October 2009. The IRRS Team reviewed the following areas: legislative and governmental responsibilities; responsibilities and functions of the regulatory body; organization of the regulatory body; the authorization process; review and assessment; inspection and enforcement; the development of regulations and guides; and the management system of the regulatory body. In addition, at the request of the regulatory body, the mission scope included a review of regulatory oversight of the following thematic areas: Code of Conduct on the Safety and Security of Radioactive Sources; emergency preparedness and response; control of medical exposures; education and training. A review was also made of the existing safety infrastructure for a national nuclear power programme, in accordance with DS-424, the draft safety standard for establishing a safety infrastructure for a national nuclear power programme (now published as SSG-16).

At the request of the VARANS, an IAEA team of international experts performed a follow up peer review of Viet Nam's national regulatory infrastructure for radiation and nuclear safety from 29 September to 9 October 2014. The aim of the follow up mission was to review measures undertaken following the recommendations and suggestions from the 2009 mission and the status of further development of the regulatory safety infrastructure to support Viet Nam's nuclear power programme. The IRRS follow-up team determined that 22 recommendations and 8 suggestions made during the 2009 mission had been effectively addressed and could be considered closed; and that 1 recommendation could be closed on the basis of progress made and confidence in their effective completion. This leaves 44 recommendations and 28 suggestions that need to be further addressed to ensure that the IAEA safety standards are appropriately implemented.

In relation to the preparations for nuclear power that was reviewed against SSG-16, the team considered that 14 recommendations and 9 suggestions made during the 2009 mission had been effectively addressed and could be considered

closed. This leaves 9 recommendations and 2 suggestions from the 2009 mission that need to be addressed in addition to the ongoing effort required to further develop the nuclear safety infrastructure.

The IRRS Team appreciated and acknowledged VARANS' continued participation in international cooperation activities and the IRRS Team encourages continued efforts in these activities, particularly as associated with the design, construction, and operation of a nuclear power plant. The team also noted that VARANS has made significant progress in the development of the regulatory framework to support the introduction of nuclear power in Viet Nam.

2. INIR mission

Viet Nam requested the IAEA to follow up on recommendations from the Phase 2 INIR mission conducted in December 2012. An INIR follow-up mission was conducted from 10-14 November 2014 to respond to that request.

The 2012 INIR mission made 42 recommendations and 14 suggestions in 17 of the 19 infrastructure issues.

Viet Nam prepared an updated Self-Evaluation Report in September 2014 and a "Response to the Recommendations of INIR Mission 2012" in October 2014 and provided them to the IAEA in advance of the INIR follow-up mission.

The INIR team noted that the following major actions have been taken since the 2012 INIR mission:

- The National Atomic Energy Council was established;

- Viet Nam acceded to the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management;

- Some legal documents including regulations (circulars) were issued, for example in emergency preparedness, siting, and waste;

- The draft Master Plan for Nuclear Power Infrastructure was updated and awaits approval;

- 05 Technical Subcommittees were established under the State Steering Committee: (1) Development of Nuclear Power Industry, (2) Nuclear Technology, Fuel and Radioactive Wastes, (3) Nuclear Safety and Security, (4) Training, Information and Communication, and (5) Construction;

- The project Public Information and Communication for Nuclear Power and an associated plan for its implementation were approved in 2013; and

- Several measures were implemented to provide incentives for recruitment and retention of personnel.

The INIR team found that Viet Nam continues to make progress on the national infrastructure for nuclear power. Viet Nam has completed implementation of 6 of the recommendations from the 2012 INIR mission, in the areas of Electrical Grid, Stakeholder Involvement, Site and Supporting Facilities, Environmental Protection and Industrial Involvement. The other 36 recommendations require further work.

For many recommendations, Viet Nam has on-going activities. For the others where actions have not yet been initiated, the INIR team considers that Viet Nam has a good understanding of what needs to be done.

III. SUMMARY

Vietnam became a Contracting party to the Convention on Nuclear Safety on 15 July 2010. This is its third National Report to the 7th Review Meeting.

By definition in the Convention, Vietnam has no nuclear installations. However, Vietnam does have a research reactor of 500 kW (DNRR), located in the City of Dalat, Lam Dong Province, operating since 1983. For the safety and security purpose, several projects have been recently implemented, including HEU-LEU core conversion, I&C upgrade, under the supervision of VARANS through assessing SAR submitted for licensing and verifying during inspection activities. The ageing issue is adequately monitored and addressed.

Currently, Vietnam is preparing to build the first two NPPs in Ninh Thuan Province to address its increasing demand of energy. Site study and on-site investigation activities have been done at both NPP No.1 and NPP No.2. During conducting study and investigation activities, the National Nuclear Safety Council and VARANS sent experts to the sites. Recommendations and questions were raised and taken into account by the Project owner to improve the results of site investigation.

As an emerging country with poor experience and lack of competence for the 1st NPPs, besides utilizing domestic experts, especially in the field of assessment of site characteristics, Vietnam requests international consultants for supporting the Vietnam Regulatory Authorities to evaluate SAR and EIA for both Site and FS approval phases. Bidding for inviting international consultant is in progress.

Recommendation from INIR follow-up and IRRS follow-up missions on Independence of regulatory decision making (potential conflict of interest between MOST, MOIT and MONRE) is still open and these issues will be resolved in the amendment of the 2008 Law on Atomic Energy (planned to be issued in 2018).

Great efforts, including development of legislative and regulatory framework, human resource development to ensure the safety and security of the nuclear power program have been made. Learning lessons from Fukushima accident, Vietnam has pledged and will apply its the reasonably highest nuclear safety standards in the policies and activities of the Government, Regulatory Body and Operator.

Annex. ABBREVIATIONS

CNS:	Convention on Nuclear Safety
DNRR:	Dalat Nuclear Research Reactor
DSA:	Deterministic Safety Analysis
EIA report:	Environmental Impact Assessment Report
EVN:	Vietnam Electricity
EVNNPB:	Ninh Thuan Nuclear Power Projects Management Board
MOC:	Ministry of Construction
MOET:	Ministry of Education and Training
MOF:	Ministry of Finance
MoHA:	Ministry of Home Affairs
MOIT:	Ministry of Industry and Trade
MONRE:	Ministry of Natural Sources and Environment
MOPI:	Ministry of Planning and Investment
MOST:	Ministry of Science and Technology
MOH:	Ministry of Health
NA:	Vietnam National Assembly
NCSR:	National Committee for Search and Rescue
NEPIO:	Nuclear Energy Programme Implementing Organization
NPP(s):	Nuclear Power Plant(s)
NRI:	Dalat Nuclear Research Institute
PSA:	Probabilistic Safety Analysis
PSAR:	Preliminary Safety Analysis Report
SAR:	Safety Analysis Report
TSO:	Technical Support Organization
VARANS:	Vietnam Agency for Radiation and Nuclear Safety
VINATOM:	Vietnam Atomic Energy Institute