THE SOCIALIST REPUBLIC OF VIETNAM

NATIONAL REPORT
ON COMPLIANCE TO
CONVENTION ON NUCLEAR SAFETY

Joint 8th and 9th Review

August 2022

THE MINISTRY OF SCIENCE AND TECHNOLOGY

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I. INTRODUCTION

1.1. National Nuclear Program

Viet Nam acceded to the Convention on Nuclear Safety (CNS) on 16 April 2010 and became a Contracting Party to the CNS on 15 July 2010. As such, this is Viet Nam's Fifth National Report, including the Report for the Second CNS Extraordinary Meeting in 2012, to the Joint Eighth and Ninth Review Meeting in 2023.

On 03 January 2006, the Government of Viet Nam approved the *"Strategy for peaceful uses of atomic energy up to 2020"*, in which the first NPP was intended to be introduced by 2020. Viet Nam began to implement this "Long-term Strategy" by establishing a comprehensive Master Plan, enacting the Law on Atomic Energy in 2008, and 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 State Steering Committee was established by the Prime Minister's Decision No. 446/QD-TTg on 07 April 2010 and 580/QD-TTg on 04 May 2010, and its 05 Sub-committees were established between 2013 and 2014. The National Nuclear Safety Council and the National Atomic Energy Council serve as advisory bodies to the Prime Minister and 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 of NG-G-3.1 *"Milestones in Development of a National Infrastructure for Nuclear Power"*.

Viet Nam requested the IAEA to follow up on recommendations from the 02 Integrated Nuclear Infrastructure Review (INIR) missions 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, such as: the National Atomic Energy Council was established in May 2013; 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; several measures were implemented to provide incentives for recruitment and retention of personnel; 05 Technical Subcommittees were established under the State Steering Committee; the project Public Information and Communication for Nuclear Power and an associated plan for its implementation were approved in 2013.

The INIR team found that Viet Nam continues to make progress on the national infrastructure for nuclear power. Viet Nam has completed implementation of 06 of the recommendations from the INIR mission in 2012, 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.

There were 03 key activities to be paid attention to approve the Master Plan for Infrastructure Development: The Plan approved by the PM, Decision No 2241/QD-TTg dated 11 December 2014, and approval of the feasibility study for the first 2 NPPs (Ninh Thuan 1&2) and enactment of the Amendment to the Atomic Energy Law (2008).

In the Master Plan for the National Energy Development during the period from 2011-2020 with the vision to 2030 (MP No. VII) approved by the Prime Minister in Decision No. 1208/QD-TTg dated 21 July 2011, Viet Nam planned to put the first 2 units (1,000 MW 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.

In the revised National Power Development Plan during the period from 2011-2020 with a vision to 2030 (amended MP No. VII) approved by the Prime Minister in Decision 428/QD-TTg on 16 March 2016, the 1st NPPs will be installed in 2028-2030.

However, on 22 November 2016, the National Assembly voted with the majority the decision to suspend the implementation of the Ninh Thuan Nuclear Power project. The NPP project suspending is due to the present country's economic situation, but not due to technology or safety reason.

On 11 February 2020, the Political Bureau issued Resolution No. 55-NQ/TW on orientations of Viet Nam's national energy development strategy to 2030, with a vision toward 2045, which stated *"Building comprehensive human resource development policies and training programs for key stages of the energy sector. Strengthening the training of technical*

workers and professional staff to meet the requirements of domestic use, towards export. Effectively using human resources trained in nuclear energy along with advanced training"; *"prioritizing allocating sufficient resources to perform the tasks stated in the Resolution; urgently implementing international commitments in the research and application of nuclear energy for peaceful purposes"*.

Up to now, Viet Nam has no nuclear installations as defined within the scope of the CNS. The DNRR operated by NRI is the only nuclear research reactor in Viet Nam. Currently, Viet Nam is planning to build the Research Center for Nuclear Energy Science and Technology (RCNEST) with a new research reactor (10-15 MWt) to replace the old one for purposes of isotopes production, silicon doping, neutron activation analysis, research and application in atomic energy field.

This project of the new research reactor was discussed during the visit of the Prime Minister of Viet Nam to Russia at the end of 2009-2010. Then the Inter-Governmental Agreement between Viet Nam and Russian Federation was signed on 21 November 2011. During 2012-2014, sites in Dong Nai province were considered for building the research reactor. The Pre-Feasibility Study Report was completed, submitted, and updated between 2015 and 2016. The Pre-FS report was reviewed by the Appraisal Council (including representatives of several related Ministries) in 2017 and approved by the Prime Minister in 2018. Currently, Viet Nam is actively developing legal documents; developing technical standards, regulations, acceptance criteria; assessing environmental impact (EIA) and planning for implementing the project.

1.2. The Theme of the Report

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

This report is a self-evaluation of Viet Nam's compliance with the obligations of the CNS. The reporting format is based on the structure of Article by Article in the CNS and in accordance with the IAEA guidelines (INFCIRC/572/Rev.6, 19 January 2018).

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, Viet Nam does not have any nuclear installations as defined within the scope of the CNS. However, Viet Nam has a research reactor with 500 kW of capacity located in Dalat city, Lam Dong province.

The Dalat nuclear research reactor (DNRR) is operated by the Nuclear Research Institute (NRI). The 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. The DNRR was upgraded from the USA made 250 kW TRIGA MARK II 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 about 1200 hrs per year.

In the first start-up, the reactor core utilized highly enriched uranium (HEU) fuel assemblies of 36 % U-235. The fuel assemblies were of the VVR-M2 type manufactured by the former USSR.

From 2006 through 2008, three projects at NRI were implemented, including the 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% of the VVR-M2 type fuel assemblies on 12 September 2007 and upgrading the physical protection system for reactor area in 2008. The project for the 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 assemblies were 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 to 13 January 2012. The first criticality with full LEU fuel was reached on 30 November 2011; and (3) HEU spent fuel assemblies were repatriated to Russia on 03 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 requirements. All activities of this project have been implemented under the strict oversight of the Viet Nam Agency for Radiation and Nuclear Safety (VARANS) including safety assessment for licensing;

In 2019, to increase radioactive isotope production, 02 beryllium rods near the neutron trap of the reactor were replaced by 02 sample cups (capsules). The report on DNRR operation results of NRI has shown that changing the core configuration increases the radioisotope yield from the reactor without affecting the safety of the DNRR, and the radiation doses received by the employees involved in the radioisotope production line were within the allowable dose limit.

In 2021, according to the operation and utilization, the NRI developed the plan to load more 06 fresh FAs into the reactor core in each pair of 02 FAs/turn, replacing the pairs of symmetrical beryllium rods. This plan was assessed and approved by VARANS according to Official Letter No. 194/ATBXHN-CP dated 31 March 2021. At this moment, the DNRR is operating with the configuration of 96 LEU FAs.

6.2. Main Safety Issues of DNRR

Although technical systems and equipment of DNRR have been checked and maintained periodically to ensure safe operation, over many years of reactor operation, aging problems of some systems and equipment have been found out clearly and need to be paid attention to.

The reactor tank which was made of aluminum is an old component of the TRIGA Mark II reactor. Up to now, the tank has been working for over 55 years. From 1963 to 1975, the tank was managed according to the operational rules of the former Dalat Atomic Center. During the period from 1975 to 1980, the tank contained only about 6 m^3 of water and the water quality was not properly tested and monitored according to the standards. Since its physical start-up in 1983 and putting the DNRR into official operation in March 1984 up to now, the water regime in the tank has been regularly well secured by an ionic and mechanical filter system. The physico-chemical parameters of reactor water are always measured and checked periodically to

ensure compliance with requirements specified in the Code of Operation of the DNRR. The NRI was equipped with an underwater video-camera system in 1998 within the framework of a ministerial research project in 1998- 1999 and then upgraded many times in the following years from the task of operating, maintaining, and upgrading technology systems of the DNRR, the problem of checking and assessing the condition of the reactor tank has more advantages. The work of checking corrosion of the reactor tank is currently carried out by the staff of the NRI and carried out periodically twice a year.

On 10 June 2016, when operating the loop I and loop II cooling pumps to filter the water of the reactor pool during the period of shut-down of the DNRR, the operator detected leaks from the cooling water pipe of loop II from a small hole in the pipe section between the confinement and glass corridor of the building No. 1. The NRI has replaced the leaked pipe section with a new one, and also conducted a survey of the pipeline section adjacent to the leaking pipe. Survey results show that the inside of the loop II pipeline is much corroded, and the leak of the loop II water pipe may continue to occur in the future. To cope with this, the NRI has prepared options to be ready to replace when damage phenomena happen on many pipelines.

On 03 March 2017, when checking the I&C system to prepare for a long term operation from 05 March 2017, the safety rod No. 1 (AT1) was lifted to the 51 mm position and then stopped (top position when the rod is raised to 0 mm). The operator has disconnected the 48V power supply for the drive mechanism but the AT1 bar does not fall into the reactor. When removing the drive mechanism of AT1 to check, a small screw from the resistor unit which is detected to the position that signal of the control rod was disjointed. This made the gear stuck and that is the reason why the control rod drive mechanism does not rotate. This motor was later repaired, inspected, and put into operation again in 130 hours in March 2017. This error has been summarized and has also been added to the Technical System Maintenance Rules of DNRR regarding the periodic inspection of the drive mechanism of control rods.

As obligation of members of Incident Reporting System for Research Reactors (IRSRR), the National Coordinator of Viet Nam has reported these unexpected incidents to IRSRR system and during the biennial Technical meeting for National Coordinators of the IRSRR.

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, the MOST established the Viet Nam 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.

a) Implementation of the HEU - LEU fuel conversion

In 2004, NRI was requested to submit an application to the MOST for an operating license. The license for DNRR operation No. 380/GP-BKHCN was issued in March 2004, valid for 05 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 05 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 for another 10 years was issued for official operation. As such, this operating license will expire on 07 February 2023. According to regulations, the NRI must apply for re-issuance of the operating license to VARANS 180 days before the date of license expiration. ie before 07 August 2022. To carry out this task, the NRI has presided over the task of *"Surveying and assessing the current state of structures, systems, and components, and proposing technical solutions for re-granting operation license for the DNRR"* within the framework of ministerial-level tasks in 2021-2022.

Under License No.19/GP-BKHCN dated 17 June 2013, 106 spent HEU fuel assemblies storaged in the SKODA VPVR/M package were exported and sent back to Russia. Applications for licensing were assessed (by VARANS) against Viet Nam 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.

During the implementation of the HEU - LEU fuel conversion from 2005 - 2013, NRI carried out enhanced reactor calculations with the support of the Argonne National Laboratory (ANL, USA) help to compare main parameters before and after conversion, and have a better understanding of physical phenomena of the reactor. The neutronic 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 fuel assemblies to Russia, which was implemented successfully helped Viet Nam to gain experience (in both regulatory aspect and practice of facility) in ensuring the safety of transportation of spent fuels.

b) The Safety Analysis Report for DNRR

The Safety Analysis Report for DNRR after full core conversion using LEU fuel assemblies was completed in 2012 (SAR-2012). The latest Safety Analysis Report was updated in 2018 (SAR-2018). DNRR was designed in the early 1960s before nuclear safety standards were formalized. Nevertheless, the examination conducted by VARANS and the operating experience of DNRR shows that the reactor, taking into account upgrades, is reasonably safely operated.

The first version of a Safety Analysis Report for the DNRR was implemented under the Research Contract of the International Atomic Energy Agency (IAEA) and completed in 1989 (SAR-1989) after 5 years of putting the DNRR into operation. The report includes a general introduction and 07 chapters, describing the characteristics of the location, construction, design, and safety analysis for the DNRR.

The second version of the SAR was updated and compiled by NRI in 1999 and completed in 2003 (SAR-2003). The SAR-2003 version consists of 20 chapters that follow the current guidelines of the IAEA, updated the information, supplemented the data compared to the SAR-1989 version, and met the recommendations of experts inside and outside the country. The SAR-2003 version was used as the primary document to apply for the first time license, meeting the licensing requirements for the nuclear facilities under the Ordinance on Radiation Safety and Control, effective from January 1997 and Decree No. 50/1998/ND-CP detailing the implementation of this Ordinance issued in July 1998. The NRI has been granted License No. 380/GP-BKHCN dated 18 March 2004, allowing it to operate and exploit for 05 years.

The third version of the SAR has been implemented by the NRI in 2007 and completed in 2009 (SAR-2009) to promptly update changes related to safety in operation, exploitation, and renewing the license, meeting the requirements of the Atomic Energy Law, which was effective from 01 January 2009. On 04 September 2009, the NRI was re-licensed under Decision No. 1846/GP-BKHCN of the MOST for 05 years.

The fourth version of the SAR has been compiled in 2010-2011 to apply for an operation license with the full LEU and on 18 November 2011 the NRI received a commissioning license No. 44/GP-BKHCN of the MOST for 01 year.

The fifth version of the SAR has also been compiled after the successful launch of physical start and energy start with LEU fuel (carried out from 24 November 2011 to 13 January 2012) and ran safety tests in long-term operations in 2012. On 07 February 2013, the NRI was granted a 10-year operating license with the LEU reactor core under Decision No. 06/GP-BKHCN of the MOST.

The sixth version of the SAR has recently been compiled and completed in 2018 (SAR-2018), after 05 years of being licensed to operate the LEU reactor to enable comprehensive evaluation in terms of radiation safety and nuclear safety of reactors as required by the license and also to promptly update changes in technical systems related to safety in operation and exploitation.

c) Aging management

Aging management is the management of technical factors, operations, maintenance methods, and other activities to control the deterioration of function due to the aging of structures, systems, and components within a specified limit. To ensure the safety of DNRR, setting up and implementing an aging management program of structures, systems and components are necessary.

The aging management program for DNRR was compiled, issued, and implemented in 2012 based on the IAEA guidelines and has been approved and implemented since 2016 (and as the result, the maintenance program was also updated). However, with the current practices, the aging management program should be further improved to better manage the aging process of the structures, systems, and components.

In fact, aging analysis for DNRR has been performed since 1998 with a visual inspection of its tank using an underwater camera. Corrosion progress is being monitored. In addition, corrosion of the reactor tank is restrained by maintaining the quality of the reactor water coolant in accordance with the SAR. Furthermore, to improve the reliability of the reactor control system, a program on I&C system upgrading had been done during 2006-2007.

d) Decontamination and dismantling for DNRR

Within the framework of the ministerial-level task in 2009-2011, the NRI has taken the lead in the task of *"Researching and evaluating radioactive characteristics in the main structures and developing a preliminary plan for decontamination and dismantling of DNRR"*. Through the implementation of the task, the preliminary plan for decontamination and dismantling for DNRR in the operation phase was built in 2011. The new preliminary plan on radioactive decontamination and dismantling for DNRR has been updated in 2021 under the framework of the ministerial-level task in 2019-2020.

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

6.4. Development of Regulations for new Nuclear Research Reactor Project

Several Regulations and Guides have been developed recently to prepare for the new nuclear research reactor project:

- Decision No. 1703/QD-BKHCN of the MOST, on acceptance criteria and methodology on site selection of Research Reactor, 07 July 2015;

- Decision No. 2403/QD-BKHCN of the MOST, on safety requirements for the site of Research Reactor, 26 August 2016;

- Circular No. 05/2020/TT-BKHCN of the MOST regulating nuclear safety for research nuclear reactor installations, 30 October 2020;

- Decision No. 1163/QD-BKHCN of the MOST on the assignment and coordination of the implementation of the RCNEST project (during the project investment preparation phase).

Several Regulations and Guides are in development (in collaboration with the Russian Regulatory Body - Rostechnadzor) such as: Decision of the MOST on the promulgation of internal regulations on site approval of the nuclear research reactor under the RCNEST project.

6.5. The Integrated Nuclear Infrastructure Review Mission for New Research Reactor Project

From 03-07 December 2018, with the request from Viet Nam to IAEA, the MOST received the Integrated Nuclear Infrastructure Review Mission for a New Research Reactor (INIR-RR). The IAEA team evaluated the status of the national infrastructure to support a new research reactor programme according to the IAEA Nuclear Energy Series Technical Report *"Specific Considerations in the Assessment of the Status of the National Nuclear Infrastructure for a New Research Reactor Programme - Reference document for the INIR-RR missions"*

The INIR-RR mission made 32 recommendations and 06 suggestions and 01 good practice in 15 of 19 infrastructure issues for nuclear research reactor mainly focused on issues as national position, funding and financing, utilization, nuclear security, as follows:

a) Recommendations

R.1.1. The Assessment, Marketing and Project Team (AMPT) for the new research reactor programme should have all responsibilities, functions and competences following IAEA guidance. Its composition should also include representatives from potential utilization stakeholders (e.g. healthcare providers, universities, industry, agriculture, etc.)

R.1.2. The Research Reactor Programme Implementing Commission (RRPIC) for the new research reactor programme should have all responsibilities, functions, and the competencies following IAEA guidance.

R.1.3. The terms of reference, including clear roles and responsibilities, of other committees related to the new research reactor project should be clarified, documented, and approved.

R.1.4. The Feasibility Study Report should be finalised in accordance with the IAEA guidance (NG-T-3.18) and submitted to the RRPIC for endorsement. A full identification of potential users and prioritization of their needs, as well as site evaluation, should be made for Phase 1.

R.2.1. The entire framework of IAEA Safety Standards for the safety of research reactors should be implemented in the development of the safety regulations for the proposed research reactor. This should include the IAEA Code of Conduct, Safety Principles SF-1, SSR-3, and supporting guidance documents for research reactors.

R.3.1. An integrated management system (IMS) for VAEA, VARANS, VINATOM, and the other relevant organizations involved with the new research reactor programme, should be developed in accordance with the IAEA standards and guidance. The IMS should include nuclear safety and security culture.

R.4.1. Human and financial resources should be allocated for the forthcoming activities related to the preparation of the new research reactor programme. These activities should include the establishment of nuclear infrastructure and a comprehensive assessment of stakeholders needs.

R.4.2. The costs related to the fuel back-end, decommissioning, long-term radioactive waste, and spent fuel management should be evaluated. The evaluation should also include the future staff costs for the utilization programme and development of the nuclear infrastructure.

R.4.3. The cost-benefit analysis should be comprehensive and systematic, including optimistic and pessimistic scenarios for the income from commercial services and products. The intangible benefits of the new research reactor programme should be further made explicit and listed.

R.4.4. The funding strategy should be developed for the new research reactor programme, involving the relevant institutions and organizations. Such a strategy should also cover risk management.

R.7.1. An effectively independent nuclear regulatory body should be established and implemented.

R.7.2. For the new research reactor programme, VARANS and other organizations involved with the regulatory framework, should be provided with additional resources, including human and financial, as well as training.

R.7.3. The relationship of MOST with other ministries, local government, and other institutions should be established and implemented formally.

R.8.1. Dose constraints, optimization, lay-out, zoning considerations, and their interfaces with safety, security and safeguards, should be considered for the new research reactor radiation protection programme.

R.9.1. A comprehensive and systematic identification and assessment of potential utilization stakeholders and quantification of their needs should be developed as part of the revised Strategic Plan and Feasibility Study Report.

R.9.2. Functional specifications of the new research reactor and its ancillary facilities should be reviewed and finalised based on quantified utilization of stakeholders' needs. This should be included in the Strategic Plan and Feasibility Study Report.

R.9.3. Formal endorsement of the Strategic Plan by the RRPIC should be obtained.

R.10.1. An analysis should be performed to identify gaps in the competencies, skills, and number of required staff for the new research reactor programme, addressing relevant organizations in MOST and outside MOST.

R.10.2. Funding and resources should be allocated for human resource development in the organizations involved in the new research reactor programme, in particular VAEA, VINATOM, VARANS, and other relevant organizations.

R.11.1. A stakeholder involvement strategy and plan for the new research reactor programme should be established and implemented. This should include an outreach and public communication programme for each involved institution and organization. The required financial and human resources with adequate competencies and skills should be made available to execute the plan.

R.12.1. The terms of reference for the site characterization and the environmental impact assessment should be established.

R.15.1. MOST should perform a self-assessment of their current nuclear security framework as compared to the Nuclear Security Series No. 19 Phases I and II, including the design basis threat (DBT) approach, to ensure all nuclear security framework considerations are addressed in a graded approach. The new research reactor programme should include an action plan resulting from the self-assessment process.

R.15.2. The new research reactor programme should include all organizations that have nuclear security roles and responsibilities and the identification of work activities that should be carried out in the subsequent project phases.

R.15.3. (2012 INIR Mission Recommendation R-15.1.1)

Viet Nam should introduce the threat assessment concept and DBT approach in the regulations and should take necessary steps to plan the DBT development.

R.15.4. (2012 INIR Mission Recommendation R-15.4.1)

Viet Nam should prepare plans to develop nuclear security culture. A national policy that recognizes the need for a strong nuclear security culture should be established.

R.16.1. Risk management should be identified and considered in the national fuel cycle strategy. The rationale for deciding the fuel type should also consider the utilization aspects.

R.16.2. The counterpart should consider long-term waste management options for the eventuality of return of generated radioactive waste from the fuel reprocessing.

R.17.1. During the feasibility study, possible approaches should be developed to address the management of radioactive waste arising from decommissioning, the capabilities and resources needed, and the options and technologies for its processing, handling, storage, and disposal.

R17.2. Options for the management of different radioactive waste categories, including funding options, should be considered, providing a clear understanding of the required needs and cost.

R.18.1. A survey of companies with the potential to participate in the new research reactor project for construction, equipment provision, or support services should be made, with a review of their ability to satisfy the requirements of a research reactor project in accordance with the IAEA guides and standards. Coordination with, or training of, potential suppliers to explain standards and qualifications required, review the feasibility of involvement, and identify required actions and funding requirements, should be done.

R.19.1. The existing procurement procedures should be reviewed, taking into account the importance of safety, and specific requirements for equipment, materials and services for nuclear installations.

R.19.2. The counterpart should develop processes for the qualification and certification of suppliers and components.

b) Suggestions

S.4.1. Research reactors are unlikely to generate sufficient revenue to cover the operational costs. Recognition that long-term Government commitment and support during the entire life cycle of the research reactor is essential.

S.4.2. Market trends and user needs, in particular for radioisotope production and Neutron Transmutation Doping, could be continuously monitored to adjust the utilization to maximise the economic benefit from the proposed research reactor.

S.9.1. The counterpart could consider to:

- Obtain statements of interest and support from potential utilization stakeholders, at the national and regional levels;

- Analyse the utilization experience and records of the existing DNRR for the potential utilization of the new research reactor.

S.15.1. MOST may obtain the support of international or bi-lateral cooperation nuclear security experts with extensive experience in the area of nuclear security framework development to assist in or review the self-assessment identified in R.15.1.

S.16.1. The design for the capacity of a storage pool could consider temporary storing of the entire fuel inventory in the core when needed in case of accident conditions.

S.16.2. The counterparts may consider increasing the spent fuel storage pool capacity to 30-40 years, removing the need for the intermediate storage facility.

c) Good Practices

G.11.1. The use of the Information Centre for Atomic Energy for public outreach of the future research reactor programme is a good practice.

As the result of the evaluation process, the IAEA team noted that Viet Nam has adopted a holistic approach resulting in the effective use of resources in developing infrastructure for the proposed multi-purpose research reactor programme. The IAEA team also concluded that Viet Nam has a clear understanding of the importance and the required steps for the development of the nuclear infrastructure for the new research reactor.

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:

- the establishment of applicable national safety requirements and regulations;

- a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a license;

- a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licenses;

- the enforcement of applicable regulations and of the terms of licenses, including suspension, modification or revocation.

7.1. Legislative and Regulatory Framework for Nuclear Safety

a) National Legislative for Nuclear Safety

Viet Nam always 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 Viet Nam national legal system.

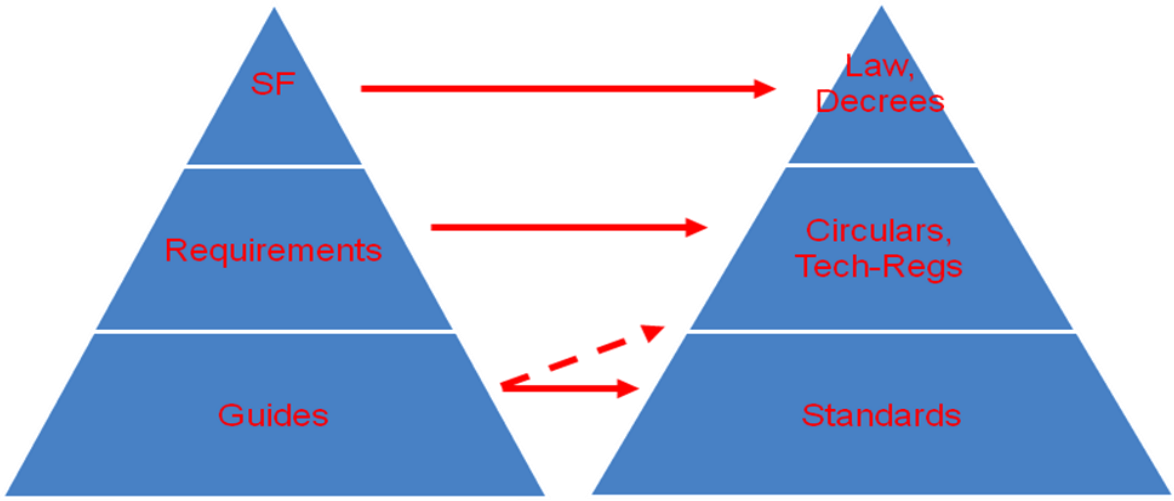

Fig 1. Relationship between IAEA standards and Viet Nam legal structure

In 2008, Viet Nam 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 Viet Nam.

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 Viet Nam has decided to amend the Law. In order to assist the revision, 02 expert missions to Hanoi were conducted by OLA, IAEA in March 2012 and May 2013 and 02 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. The plan for amendment of the Atomic Energy Law is being considered for the period of 2022-2025.

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, Viet Nam 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 (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 (July 2016).

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 Viet Nam 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. The National Nuclear Safety Council are specified in the Law 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 NPPs as well as measures to remedy particularly serious nuclear incidents; to examine and evaluate safety reports of NPPs 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 NPPs; ensuring safety and security of these activities; and conditions for NPP 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 20 May 2009 by MOST guiding on preliminary nuclear safety assessment for site selection for NPPs in the investment decision stage (Pre-FS stage);
- Circular No. 28/2011/TT-BKHCN dated 28 November 2011 on nuclear requirements for NPPs site;
- Circular No. 29/2012/TT-BKHCN dated 19 December 2012 on format and content of SAR for NPP site approval;
- Circular No 20/2013/TT-BKHCN dated 06 September 2013 guiding on test procedure, inspection process and procedure in the site investigation and evaluation of NPPs;
- Circular No. 21/2013/TT-BKHCN dated 13 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 NPPs (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 - Geotechnical aspects of site evaluation and foundations for NPPs (based on IAEA NS-G-3.6);
- Nuclear Safety Standards 9644:2013 - Seismic hazards in site evaluation for nuclear installations (based on IAEA SSG -9);
- Nuclear Safety Standards 9645:2013 - Meteorological and Hydrological Hazards in Site Evaluation for NPPs Nuclear Safety (based on IAEA NS-G-3.4);

For FS Approval and Construction Permit phases:

- Circular No. 30/2012/TT-BKHCN dated 28 December 2012 on nuclear safety requirements for the design of NPPs (based on IAEA SSR-2/1);
- Circular No. 21/2013/TT-BKHCN dated 13 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 26 May 2014 on the format and content of SAR for FS approval;
- Circular No. 12/2015/TT-BKHCN dated 20 July 2015 on requirements for safety analysis for NPPs;
- Circular No 10/2016/TT-BKHCN dated 13 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 NPP.

The Law specifies that MOST is responsible for licensing research reactors while NPPs 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 NPPs 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 NPPs. 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 NPP 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. 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.

In connection with NPP activities, MOST issued a circular No. 20/2013/TT-BKHCN, dated 06 September 2013 on the protocol for inspection during siting.

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.

The missions and tasks of the national regulatory body (VARANS) are specified in the Article 8 of the Atomic Energy Law (2008), namely:

1. Developing regulations on radiation and nuclear safety;

2. Organizing the declaration of radioactive substances, radiation equipment nuclear material, nuclear equipment, and the grant of licenses to perform radiation jobs according to its competence;

3. Assessing and organizing the assessment of radiation and nuclear safety;

4. Inspecting, examining, and handling violations of regulations on radiation and nuclear safety; ordering cessation of radiation jobs according to its competence; proposing competent state agencies to suspend the operation of nuclear research reactors or NPPs upon detecting signs of unsafety;

5. Organizing nuclear control activities under law;

6. Participating in dealing with radiation or nuclear incidents according to its competence;

7. Building and updating a national system of information on radiation and nuclear safety;

8. Organizing and coordinating with other agencies in organizing professional training, retraining or guidance on radiation and nuclear safety;

9. Organizing activities of international cooperation in radiation and nuclear safety.

The organizational structure of the regulatory body VARANS is presented in the Figure below.

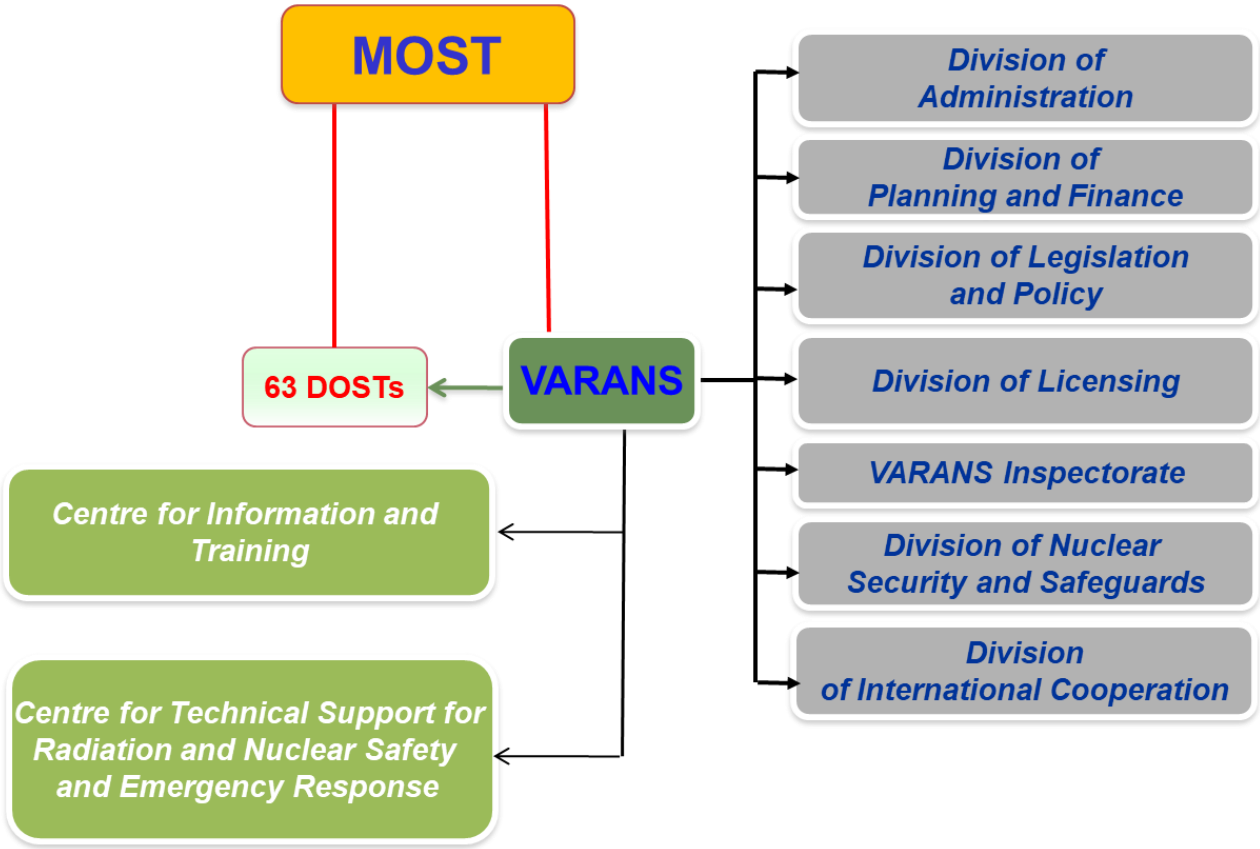

Fig 2. The organizational structure of VARANS

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 Viet Nam 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).

Regarding human resources issue, VARANS develops human resources development (HRD) plan and applies the IAEA model *"Systematic Assessment of Regulatory Competence Needs for Regulatory Bodies of Nuclear Facilities"* (SARCoN). In collaboration with IAEA, VARANS has organized workshops on SARCoN. At present, the number of VARANS' staff is

around 60 persons distributed in different divisions including Division of Administration & Personnel, Division of Licensing, VARANS Inspectorate, Division of Legislation and Policy, Division of Nuclear Security and Safeguards, Division of Planning and Finance, Division of International Cooperation, Technical Support Center for Radiation and Nuclear Safety and Emergency Response, Training and Information Center.

The 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 21 technical staffs.

Before the decision on suspending the NPP program, 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 focused 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. In the strategy at that time, besides using the mentioned in-house technical support center, VARANS also utilized the external support from other domestic organizations and international consultants in fulfilling its tasks. In phases of site and FS approval, VARANS was 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 (Viet Nam Academy of Science and Technology), Institute of Geology (Viet Nam Academy of Science and Technology), Geological Department (University of Mining and Geology), Faculty of Hydrology, Meteorology and Oceanography (University of Sciences, Viet Nam National University), Seismic Division, Institute of Geophysics (Viet Nam Academy of Science and Technology). Due to the lack of experience in nuclear activities, international consultants were also planned to be used for review of Safety Analysis Report.

Valuable knowledge and experience gained during preparation of NPP program now being utilized by VARANS' staff for the project of new research reactor.

Furthermore, in order to define competence gap and continuously improve the training program, VARANS implemented Training Need Assessment (TNA) and has conducted certain

steps of TNA based on Safety Report Series No. 79 namely Managing the Competence of the Regulatory Body as the following:

1. Defining tasks: In 2017, VARANS reviewed, assessed and reformulated all of the job description for its technical staff who performs regulatory functions.

2. Developing required competencies: In 2018, VARANS developed required competencies for its technical staff by using SARCoN questionnaires provided by IAEA.

3. Assessing existing competencies: In the end of 2018, VARANS carried out self-assessment to find out the existing competencies of all technical staff.

4. Analyzing competence gap: VARANS carried out competence gap analysis using SARCoN tools provided by IAEA.

VARANS has been issued certificate of quality management system in activities to perform the functions of advising and assisting the MOST on state management and to solve the administrative procedures on radiation protection and nuclear safety to match national standards ISO 9001:2008 in October 2013.

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 rests 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) provides the basis for VARANS' assessment of whether NRI's nuclear facilities 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.

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/QD-TTg dated 23 January 2014 on *"Finance liability and managing mechanism of finance fund for decommissioning of NPPs"* 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 State policy on atomic energy in which the leading role of the Government in human resource development is clearly prescribed. 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 NPP, for management of nuclear fuel, for storage and handling of radioactive waste and for decommissioning of the NPP.

2. Organizing training and refresh training for staff members who operate the NPP;

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/ND-CP on Professional incentive allowances for people working in the field of nuclear energy.

Before the decision on suspending the first NPP program in November 2016, 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 18 August 2010 (with the budget of 150 million USD); Project *"Personnel Training for Ninh Thuan NPP Program"* by Decision No 584/QD-TTg dated 11 April 2013; National Plan on Training Staff for State Management, Research and Development and Technical Support Organization up to 2020 for Nuclear Power Development by Decision No 1756/QD-TTg dated 15 October 2015.

From 2010, the MOET has sent more than 380 students to study in the field of nuclear energy in MEPHI and Obninsk Institute for Nuclear Power Engineering in the Russian Federation. More than 60 students of the first package have graduated. Other students are continuing their studies, with some 1st and 2nd year students moved to other fields of study in physics, nuclear power, and electrical energy. The Government of Viet Nam also assigned task to relevant ministries to review and develop plans for effective using of these students after their graduation. The MOET also sent more than 200 staffs of education institutions assigned to train human resources in the field of atomic energy to participate in 06 weeks intensive courses in Hungary, including practice at Paks NPP.

In the period of 2012-2014, the MOST has coordinated with the ministries, branches and localities to make statistics on the current status and needs of human resources in the field of atomic energy (including human resources for nuclear power development). The results of statistics on the current situation and synthesis of human resource needs have determined the structure of human resources (in terms of age, qualifications, expertise, field of work...) and forecasted human resource structure for 42 different specialties/jobs in the field of atomic energy. The results were reported to the National Steering Committee on Training of Human Resources in the field of atomic energy, in which, recommendations on the needs for a national plan on training and fostering experts, management personnel, technical staff in the field of atomic energy including human resources for research and application of atomic energy for socio-economic development and human resources for nuclear power development.

In the period of 2013-2017, MOST has used the national financial budge for short term and long term training, from basic to intensive, both domestic and abroad, for more than 500 turns of staff on safety analysis, regulatory documents development, nuclear power technology and safety, site assessment for building of NPP, Emergency Preparedness and Response (EPR), etc.

In addition, MOST has cooperated with the IAEA, the Russian Federation, Japan, the EU, etc. to organize training courses on safety analysis, regulatory documents development, nuclear technology and safety, etc. for officials of MOST and other ministries and organizations. The VAEA coordinated with the IAEA to organize expert missions (2011, 2012) to make advices on training programs for 07 domestic training organizations assigned to implement the Project. 1558 and to give advises for EVN on developing the plan for human resource training for nuclear power projects. On the basis of statistical results of the current status and needs of human resource for nuclear power development, as well as international experience and consultancy from IAEA, the MOST has developed and submitted to the Prime

Minister for approval of Decision No. 1756/QD-TTg dated 15 October 2015 on National Plan on Training Staff for State Management, Research and Development and Technical Support Organization up to 2020 for Nuclear Power Energy Development. In 2015, VAEA has also received the Simulator of the VVER-1200 reactor funded by the IAEA with a total value of nearly 200,000 Euros. The VAEA sent more than 06 staffs to the United States to study on VVER-1200 simulation systems, and also received two IAEA expert missions to Viet Nam for the VVER-1200 simulation system. Currently, VAEA is implementing the project on developing an instructions set for using VVER-1200 simulation system for research and training staff.

VAEA also actively negotiated, signed and implemented bilateral cooperation activities with USA, EU, Republic of Korea, Japan, Hungary, and France. VAEA has signed the MOU with I2EN, France on education and training in the field of atomic energy, MOU with ROSATOM, Russia on Cooperation in Information Support of joint Projects in the Area of nuclear power industry for the period of 2015-2020, MOU with KEPCO International Nuclear Graduate School on Cooperation in the field of human resources development, MOU with GE Hitachi Nuclear Energy Americas, LLC, etc. More than 10 students have been sent to KINGS, Republic of Korea for Master degree; many turns of staff have been participated in the training, research at large institutes, organizations of USA (Laboratory Argonne, Idaho, etc.), Japan (JAEA, FIHRDC, etc.), Korea (KAERI, KINS, etc.), France (AREVA, CEA, etc.), etc.

In the past period, many promising staff has been selected for intensive training in key areas such as technology and safety of NPP, developing regulatory documents, etc. This is an important human resource for the research and application of atomic energy, as well as the development of some important infrastructure areas such as environmental radiation monitoring, EPR, etc. Therefore, it is necessary to continue to review and plan for maintain these human resources to avoid losses and to develop the key expert team for the future.

Vietnam Electricity Corporation (EVN) was responsible for implementing the Project on Human Resource Training for NPP projects in Ninh Thuan province (Decision No. 584/QD-TTg in 2013 of the Prime Minister). The EVN sent more than 30 turns of people to study on the nuclear power related majors in Russian Federation and France; sent more than 25 key staff for NPPs to Japan for two years. The EVN also cooperated with the MOET to develop a plan to send more than 300 students to Russian Federation and Japan to study majors on the operation and maintenance of NPPs. In addition, since January 2013, actively using various sources of funding from international organizations such as IAEA, JEPIC, JINED, etc., EVN organized workshops for more than 400 turns of staff; sent many turns of staff to participate in

the short term training course on management and technology in Japan, Republic of Korea, Russian Federation, etc. EVN also received many expert missions through technical cooperation projects of which VAEA is the focal point.

Since 2015, there have been 20 graduate students successfully defended their doctoral dissertation and 36 PhD students are trained at the Nuclear Training Center, VINATOM. In addition, VINATOM sent 17 staff to study master's program and sent 19 staff to study doctoral and post-doctoral programs abroad.

The results of training and retraining of VINATOM staff from short-term training programs at home and abroad from 2015 up to now have 42 training courses with 811 staff members, of which 50 turns of officials took part in the advanced training overseas according to state funding. In addition, every year, about 150 staff members are nominated by VINATOM to attend national and international conferences.

In 2015, the Nuclear Power Technology and Safety Research Group of VINATOM developed criteria for technology selection for Ninh Thuan 1&2 NPPs. The criteria were approved and decided by the Ministry of Industry and Trade. In early 2015, the nuclear power safety technology research group completed the State-level project on VVER-1000 reactor technology and completed the research on designing two Ninh Thuan 1&2 NPPs to support design verification. Through research above, the young staff of the VINATOM has obtained good research results to serve nuclear power program in Viet Nam.

In addition, VINATOM has gradually mastered nuclear equipment in the design and manufacture of critical stands for human resource training for nuclear power programs, and the VINATOM's officials have studied on design calculation of critical assembly using light water as a moderator and HEU fuel from 1.6% - 5% U-235. The VINATOM has conducted burn depth calculations for the VVER-1000/V392 reactor. Using RELAP 5 software to calculate safety analysis of VVER-1200/V491 reactor, determine the total amount of rare Actinium isotopes produced during combustion and study the effects of rare Actinium containing fuel on physical and safety characteristics of the VVER-1200 reactor. Currently, the staff of the VINATOM have mastered the calculation program, can participate in the process of technology analysis and evaluation. For the work of ensuring environmental radiation safety, in the past, the VINATOM has manufactured on-line measuring equipment and successfully installed three monitoring devices on-line radioactive environment at monitoring stations in Hanoi city, Quang Ninh, Hai Phong, Lang Son and Lao Cai provinces initially serve the operation of the national environmental radiation warning monitoring network and conduct researches to come up with processes, methods and databases related to observations of environmental

radioactivity on land and at sea are currently underway to evaluate the dispersal and effects of radiation from NPPs in Fangchanggang and Chanjiang ports to Viet Nam.

In addition, for the purpose of safety assessment, the VINATOM has developed procedures for evaluating and calibrating equipment to set up a laboratory management system for analyzing standard radioactive activity. ISO/IEC 17025:2015. The study investigated the photo luminescent dosimeter (OSL) in individual dose measurement for neutron mixed radiation and photon fields to establish a personal dose measurement procedure for photon radiation fields and mixed neutron radiation fields, photon, fabrication of luminescent optical materials $LiAlO_2$ and α-$Al2O_3$: C on high-temperature vacuum furnaces and are testing the use of colored film Polyvinyl Alcohol in the measurement of photon and neutron doses. In the past time, the VINATOM has built and developed measuring techniques, neutron dose standards to provide personalized gamma-neutron dose measurement service, standard neutron dosing devices for domestic radiation and nuclear facilities. .

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.

Currently, the NRI is studying and calculating neutron, hydrothermal characteristics and safety analysis of research nuclear reactors proposed by the Russian Federation to the Center for Nuclear Science and Technology Research; studying irradiation test of single crystal silicon on DNRR, manufacturing a neutron scattering system, perfecting digitized multi-channel gamma measurement systems and ready-to-use coincides to prepare manpower for the RCNEST project and at the same time better serve the work of ensuring safe operation of DNRR. The VINATOM continues to carry out research to establish a method to assess the ability to spread radioactive materials from NPPs to marine environments in some accidents; manufacture of in-situ monitoring equipment at the site of Cs-134 and Cs-137 radioactive contamination in seawater; development of public dose assessment methods for nuclear facilities with research reactors; optimizing the geometry of environment measurement samples with Monte-Carlo simulation for low-gamma spectral method, contributing to training and forming a group of experts with sufficient capacity to assess the status, level of impact and ability to warn radioactive contamination into the marine environment.

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/TT-BKHCN on nuclear safety requirements for the 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 NPP 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.

Viet Nam has one existing research reactor with well trained staff. There were some staff who has been trained on design and safety analysis for new research reactor in USA. There are 6 universities and training center assigned for nuclear education in Viet Nam. As mentioned above, more than 300 students have been sent to Russia to study nuclear power engineering. Some of these students could be used for new research reactor project.

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 MOST 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 developing the integrated management system under the collaboration with IAEA and EC.

Namely, 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 Viet Nam Nuclear Regulatory Agency and its technical support organization"* (performed from 2012 to 2015) and the next stage of the project, VN3.01 EC/13 *"Enhancing the Capacity and Effectiveness of the Vietnam Agency for Radiation and Nuclear Safety and its Technical Support Organisation/s"* (performed from 2016 to 2019), under Task 2 which is to

develop a quality management system of the VARANS in management of nuclear facilities, the VARANS 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. After decision on the suspending the first NPP program, the draft of quality management system which is the outcome of the above-mentioned EC projects is reoriented to non-power application. The IAEA had sent an expert mission for recommendations and discussion on this draft in late July 2019.

Recognizing the possible benefits from implementing the quality assurance program (QA program), in 2014 the NRI officially issued and approved the QA Program for operation and exploitation activities.

The development and implementation of QA program for the NRI is based on the guidance documents of the IAEA, relevant legal documents of Viet Nam, standards, rules and technical guidelines issued at the NRI, and experience learned from a number of universities in the region. It can be said that the application of the QA program for the NRI recent years has made certain contributions to ensuring safe operation of the facilities, however, more efforts are needed from managers and personnel directly operating equipment to ensure quality.

Article 14 - Assessment and Verification of Safety

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

- 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;

- 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/TT-BKHCN dated 28 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 dated 26 May 2014.

As requested at the Article 4, Circular No. 30/2012/TT-BKHCN on nuclear safety requirements for the 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 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);

- Probabilistic safety assessment: RiskSpectrum PSA (funded with government budget).

The 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, Viet Nam 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 08 November 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 09 June 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 2020, Viet Nam has 1.570 radiation facilities with a total of 28.351 staffs been monitored the individual dose at eleven approved dosimetry service facilities. The individual dose results of 28.351 radiation workers in 2020 was as follows: 07 radiation workers received occupational dose exceeding dose limit of 20 mSv/year (0,02%).

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

At present the integrated and coordinated emergency, disaster response management system in Viet Nam has been established already. In general, relevant organizations and individuals shall follow requirement in Decree 30/2017/ND-CP dated 21 March 2017 regulation on organization, and operation of emergency, disaster response, search and rescue. The conventional emergency management system in Viet Nam shall be divided in 03 level, including:

- National level: Vietnam National Search and Rescue Committee (VINASARCOM) - national disaster responses, including nuclear accident, shall be carried out by the VINASARCOM;
- Ministerial level: Prevention, Response and Rescue Commander;
- Provincial level: Prevention, Response and Rescue Commanders (provincial, city; district level)

According to the Law on Atomic Energy (Art. 83), for nuclear and radiological emergency management system, there are 3 levels of emergency response plan. That are

national plan, local (provincial) plan, and facility plan. In responding to serious radiological and nuclear emergency, the system shall include:

- VINASARCOM
- Ministry of Science and Technology
- Ministry of Defense
- Ministry of Public Security
- Ministry of Foreign Affairs
- Ministry of Transport
- Ministry of Health
- Provincial People's Committees
- Ministry of Industry and Trade.

The Prime Minister had issued Decision No 884/QD-TTg dated 16 June 2017 on the approval of National Radiological and Emergency Response Plan. The organizational structure of National Radiological and Nuclear Emergency Response System are shown in Fig 3.

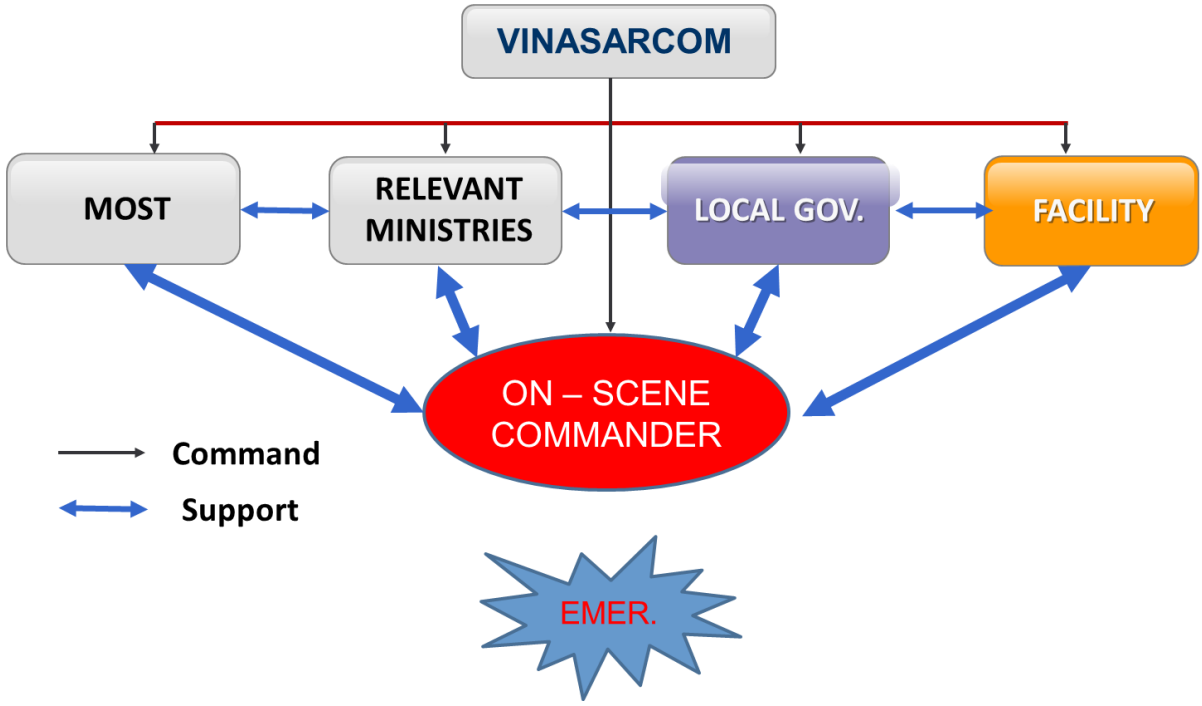

Fig 3. National Radiological and Nuclear Emergency Response System

Article 83 of the Law on Atomic Energy stipulates that radiological and nuclear emergency response plans include those at facility, provincial and national levels. Licensee and province have to develop and submit to MOST for approval the emergency response plan while MOST shall cooperate with relevant ministries and province to develop national emergency response plan and submit to Prime Minister for approval. General requirements for the content of these above plans are defined in Article 83 of the Law on Atomic Energy, that are:

- Facility plans for radiation and nuclear emergencies response shall be executed in the advent of emergencies at groups 1, 2 and 3 as prescribed in paragraph 2 Article 82 of the Law. Facility plans for radiation and nuclear emergencies response shall cover: predicted emergencies, plans for mobilizing forces and means for initial response to the emergencies: 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 emergency response.

- Provincial plans for radiation and nuclear emergencies response shall be executed in the advent of emergencies 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 emergencies response shall also cover: predicted emergencies, plans for mobilizing forces and means for initial response to the emergencies: 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 emergencies response; the MOST shall provide guidance on planning and approving the provincial plans for radiation and nuclear emergencies response. At present, with the support from VARANS, more than 50 Provincial Emergency Response Plans have been approved by MOST. In approved provincial emergency response, there are provinces located in the border area of Viet Nam and China as Quang Ninh, Lang Son, Son La, Hai Phong. Training and exercises on emergency response were conducted annually in many provinces as Hanoi, Quang Ninh, Lang Son, Ha Tinh, Da Nang, Thue Thien Hue, Quang Ngai, etc.

- National plans for radiation and nuclear emergencies response shall be executed in the advent of emergencies at group 5 as prescribed in paragraph 2 Article 82 of the Law or in case of emergency at level 4 as prescribed in paragraph 2 Article 82 of the Law that exceeding provincial capacity. National plans for radiation and nuclear emergencies response shall cover: mechanism of organization, predicted emergencies, plans for emergency response; organization of drills and exercises for emergency responses every two years. The MOST 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 emergency response to submit to the Prime Minister for approval.

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/TT-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.

Circular No. 25/2014/TT-BKHCN dated 08 October 2014 Regulation on Preparedness and Response for a Nuclear and Radiological Emergency, Development and Approval Emergency Response Plan has been issued by MOST. This Circular follows GS-R-2 and regulates in detail roles and responsibilities of relevant organizations dealing with threat categories as well as defines in detail the content of emergency response plans, intervention levels, and other guidance.

During the week of 03-07 March 2014, IAEA Expert mission was conducted to assist Viet Nam in filling the gaps in its EPR Capabilities.

Pursuant to the Prime Minister's Decision No. 1636/2010/QD-TTg of 31 August 2010, approving the *"Planning on the national environmental radiation monitoring and warning network till 2020"*, the network National environmental radiation monitoring and warning will consist of 01 National Operation Center, 04 regional stations and 16 local stations. The Institute of Nuclear Science and Technology is assigned with building and operating the National Operation Center and Northern Regional Station. This is the first online radiation monitoring and warning center of Viet Nam. At present, the monitoring points, environmental radiation monitoring and warning stations of the Institute of Nuclear Science and Technology have gradually been formed, in line with the National Environmental Radiation Monitoring and Warning Network Plan and ensuring the objectives of early warning of trans-border radioactive spread. The equipment of the current national environmental radiation monitoring and warning network is invested through projects on strengthening equipments, financed through bilateral international cooperation relations with Korea and Japan and three devices made by Viet Nam through the implementation of state-level projects. Specifically, the Institute of Nuclear Science and Technology is currently operating the equipment of the monitoring and warning network including 12 online monitoring devices located in Lang Son province, Mong Cai (02 devices), Bai Chay, Phu Lien, Bach Long Vi, Son La, Lao Cai, Cao Bang, Nghe An, Da Nang, Hanoi and 4 large gas flow sampling devices are located in Hai Phong, Mong Cai, Bai Chay,

Lao Cai and 02 automatic devices for sampling wet and dry settling in Lang Son province and Mong Cai city were installed at the end of 2019.

However, the operation of this monitoring network also has the following problems:

- Online monitoring equipment systems are using different recording, transmission and storage technologies, so the radioactive environment cannot be systematically managed.

- Online monitoring data has not been adequately processed and analyzed in order to meet timely warning requirements. The detection limit and radiation warning level have not been determined.

- The radioactive background data (concentration, specific activity of natural and artificial radioisotopes in health-related environmental objects) have not been determined at monitoring stations.

Recent events, specifically the nuclear accident at the Fukushima Daiichi NPP, have highlighted the need for, and importance of, effective radiological and nuclear EPR. 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 EPR. 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 EPR 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 EPR within ASEAN in a cost-effective and sustainable manner. Such cooperation should, however, be without prejudice to national responsibilities to ensure adequate EPR arrangements and capabilities. Experience elsewhere has shown that a key challenge in radiological and nuclear EPR 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 EPR 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 EPR, 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 EPR 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.

In November 2015, the IAEA Board of Governors approved regional technical cooperation project RAS/9/077 *"Supporting Regional Emergency Preparedness and Response in the Member States of ASEAN Region"*. The project was designed for four years of 2016-2019. The participating countries was: Brunei Darussalam, Cambodia, Indonesia, Lao P.D.R, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam. Overall objective of this project was to develop and implement emergency preparedness and response arrangements both at the national and regional levels to protect the people and the environment in case of a severe nuclear and radiological incident. The outcome of this project was to enable MSs in the region to share and exchange information in a timely manner so as to better prepare, plan and respond effectively to potential nuclear and radiological emergencies. There were number of meetings and training courses under the project which were implemented in order to archive the proposal objective. In the 8th ASEANTOM annual meeting held in July 2021, it was concluded that the objective of the RAS/9/077 project was achieved, therefore the project was completed.

At this moment, European Commission, through Instrument for Nuclear Safety Cooperation, is supporting ASEAN countries to enhance EPR capabilities in Project REG3.01/19 Establishing a regional early warning radiation monitoring network in ASEAN and enhancing national networks. The purpose of this project is to establish a regional early warning radiation monitoring network capable of providing a high level of assurance that any significant increase in the level or levels of radiation or radioactive material in ASEAN would be detected promptly. This would enable ASEAN Member States to take timely, informed and effective measures to protect their populations and the wider environment in the event of any future radiological or nuclear emergency that may affect ASEAN. This will be achieved by enhancing, or in a few cases establishing, early warning radiation monitoring networks in seven

ASEAN Member States in a cost effective manner (i.e., optimised within a wider regional/ASEAN, as opposed to a narrower national, context); and exchanging national monitoring data from all ASEAN Member States with a regional centre (ASEAN Radiation Data Exchange Platform - ASEAN-RDEP) that will be established with support from a separate but linked INSC project.

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"*. Viet Nam actively participated in this project and nominated experts to work this project as regional experts.

On 22 January 2019, the Prime Minister signed the Decision No. 104/QD-TTg to approve the national action plan on prevention, detection and response of chemical, biological, radiation and nuclear risk in the period of 2019-2022.

The EPR plan of the DNRR has been compiled by the National Committee for Atomic Energy Use of the Soviet Union and transferred to the NRI from the time of preparation for the launch of the DNRR in 1983. The next EPR Plan of the DNRR was then updated in 1996 and 2006. However, according to the requirements of Circular No. 25/2014/TT-BKHCN of the MOST on October 8, 2014 on *"Regulating the radiation and nuclear incident response and response preparation, making and approving radiation and nuclear incident response plans"*, the Emergency Preparedness and Response Plan of the DNRR has been compiled according to the above Circular and approved by the MOST in 2016. The EPR Plan of NRI was slightly updated in 2021.

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. Viet Nam will inform to neighboring states though IAEA-IEC by IECOMM or other bilateral cooperation. At this moment, MOST is the contact point for NWP, NCA (A) (D), USIE coordinator, and INES officer.

Circular No. 25/2014/TT-BKHCN requires Command Committee is responsible for establishment of a mechanism for receiving and processing information respectively and

establishes a focal point to receive and process continuously information in 24 hours one day and 7 days one week (24/7) for receiving information about the emergency, asking for assistance and recommending initial response measures. Based on an alarm level, specific conditions and monitoring data make 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 Effects 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 Viet Nam 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 and Lao Cai provinces. VINATOM is responsible for developing, running and maintaining this monitoring system.

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

Viet Nam 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 accidents in Viet Nam and from other countries.

In the 9th Joint Committee Meeting on scientific and technology in July 2016 between Viet Nam and China, China acknowledged Viet Nam 's proposal to report to the Chinese Government to assign the regulatory authorities of the Chinese nuclear power in collaboration with the MOST of Viet Nam to establish cooperation channel of information exchange related to Fangchenggang (Quangxi) and Changjiang (Hainan) NPPs in order to protect environment and respond to incidents of NPPs. In 2017, VARANS and NNSA had signed the Memorandum of Understanding for The Cooperation in the Fields of the Nuclear Safety Regulation. The scope of cooperation in this MOU includes nuclear safety acts, regulations, safety standards, radiation environmental monitoring technology, radiation accidents emergency preparedness, and so on. Viet Nam has expressed its expectation to set up an official channel between two

countries at working level for early notification and data exchange in the case of Chines NPP events.

D. Safety of Nuclear Installations

Article 17 - Siting

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

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

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

- 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;

- 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 NPPs at the stage of investment decision

Nuclear safety criteria for sites of NPPs including following contents:

1. Faults, earthquakes, volcanoes

a) There shall be no fault which is less than 08 km from a NPP 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 NPP.

c) There is no possibility of eruption of a volcano emitting lava to areas less than 15 km from a NPP.

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 NPP 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 NPP 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 NPPs

a) The distance from a NPP 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 NPP is not greater than 0.07 bar (7 kPa) if any explosion occurs.

b) The distance from a NPP 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 NPP 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 NPP. In case an individual located on the boundary of the exclusion zone more than 1 km from the fence of the NPP 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 NPP 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/TT-BKHCN on nuclear safety requirements for NPP 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/TT-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/TT-BKHCN on format and content of the PSAR that supports the application for NPP 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 seismo-tectonic 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 NPPs.

- 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 NPPs.

- TCVN 9643:2013 on Nuclear Safety - Geotechnical aspects of site evaluation and foundation for NPPs

- 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 NPPs.

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 NPPs, 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 Nuclear Installation on Individuals, Society and Environment

The Article 6 of Circular No. 28/2011/TT-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/TT-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/TT-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, civil-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 NPP.

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/TT-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/TT-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.

17.4. Consultation with other Contracting Parties likely to be Affected by the Nuclear Installation

Viet Nam 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).

As mentioned above, In 2017, VARANS and NNSA (China) had signed the Memorandum of Understanding for The Cooperation in the Fields of the Nuclear Safety Regulation. The scope of cooperation in this MOU includes nuclear safety acts, regulations, safety standards, radiation environmental monitoring technology, radiation accidents emergency preparedness, and so on.

17.5. Recently Activities relevant to Investigation of the New Research Reactor Sites

Following IAEA guidelines and based on national practices of sitting for the first NPP project as well, site survey and selection for potential areas and potential sites for the new Research Reactor of the RCNEST project was taken since 2011.

During 2011-2015, VINATOM in co-operation with State Atomic Energy Corporation of Russian Federation (ROSATOM) and local provincial authorities in Viet Nam to survey, evaluate and screen 20 potential locations in 07 provinces or cities in the country, including Hanoi City (01 site), Vinh Phuc province (01 site), Hoa Binh province (01 site), Bac Giang province (01 site), Da Lat city (04 sites), Lac Duong district of Lam Dong province (04 sites), Ninh Thuan province (02 sites), Cam My district of Dong Nai province (03 sites) and Long Khanh town of Dong Nai province (03 sites).

The MOST has developed and approved a set of criteria for site survey, evaluation, screening and selection (Decision No.1703/QD-BKHCN). The development of this Decision was based on the references of national legal documents (circulars, decisions, regulations, etc.) of Viet Nam; documents (regulations, standards, regulations, etc.) relating to the selection of sites for construction of nuclear research facilities of the Russian Federation; safety guidelines and technical documentations on site selection for nuclear facilities of the IAEA; as well as the experience of other countries and the actual situation of Viet Nam.

The set of criteria consists of 23 criteria that divided into 4 groups as follows:

- Criteria related to reactor safety;
- Criteria related to construction work;

- Criteria related to effective utilization of the reactor and possibility to attract human resources;

- Other criteria related to facilitate the construction and operation of the project such as the approval and facilitation of the local government, the ability of the land fund; current population density within a 3 km from the reactor, etc.

Using the approved criteria set, getting the evaluation of national experts, the three following candidate sites were proposed to host the new research reactor:

1. Suoi Tre Commune, Long Khanh Town, Dong Nai province;

2. Hang Gon Commune, Long Khanh Town, Dong Nai province;

3. Da Nhim Commune, Lac Duong District, Lam Dong province.

The preliminary site evaluation to review the geologic, seismic and hydrologic conditions of the proposed sites was conducted. These three candidate sites were proposed in the Pre-Feasibility Study report (Pre-FS report). The site at Hang Gon Commune, Long Khanh Town was suggested to be selected for construction of the new research reactor of the RCNEST project.

The final version of Pre-FS report was approved by the Prime Minister in 2018.

Article 18 - Design and Construction

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

- 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;

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

- 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 nuclear safety requirements for the 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 fail-safe 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 NPPs 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 NPP 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/TT-BKHCN on nuclear safety requirements for the 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

Before the decision on suspending the NPP program, Viet Nam 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 NPPs 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 20 July 2015 on requirements for safety analysis for NPPs:

- 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 NPP;

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/TT-BKHCN on nuclear safety requirements for the design of NPPs was developed basing on the IAEA SSR 2/1 2012.

18.5. Recently Activities relevant to Design of the New Research Reactor

The Pre-FS report was conducted to determine the potential of multi-purpose research reactor in enhancing the country's capability for nuclear science & technology. It described the taken steps to implement the report, justification process, key results, utilization plan and other issues related to the new research reactor project following the IAEA Nuclear Energy Series No. NG-T-3.18 *"Feasibility Study Preparation for New Research Reactor Programmes"*.

The report also provided the basis information relevant to the project to the Government for review and approval of the investment policy for building the new research reactor. It also included information of the conceptual functional design, research reactor type and power, auxiliary facilities, roughly project costs and schedule estimation.

The major design characteristics of the new research reactor consist of 10 MWt power with open pool, beryllium and graphite reflector, light water for moderator and coolant, forced convection and downward flow direction, large handling space in service pool, spent fuel storage pool; average thermal neutron flux in the core is about $2x10^{14}$ $n.cm^{-2}.s^{-1}$; average thermal neutron flux at reflector is about $1x10^{14}$ $n.cm^{-2}.s^{-1}$; UO_2 in Al matrix fuel assemblies of VVR-KN with 19.75% enrichment of U-235.

Expected main applications of the new multi-purpose research reactor included production of radioisotopes, radiopharmaceuticals and radioactive sealed sources (Moly from LEU, I-131, I-125, Y-90, Lu-177, Ho-166, Ir-192, Se-75, Co-60, etc.); neutron transmutation effects (NTD, Gemstone); neutron activation analysis (INAA, RNAA, PGNAA); fundamental research on nuclear physics; material science by scattering techniques; and neutron imaging.

Up to November 2021, the preparation work including Terms of Reference (TOR), legal documents for implementation of Feasibility Study (FS) report, Dossier for Site Approval (DSA) and EIA report has been finalized. It is expected the implementation of FS report, DSA

and EIA report will be started from 2nd Quarter of 2022 with duration of about 18 months. By this expected schedule, the new research reactor could be commissioned during 2030 - 2031.

Article 19 - Operation

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

- 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;

- 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;

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

- procedures are established for responding to anticipated operational occurrences and to accidents;

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

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

- 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;

- 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 Atomic Energy Law.

Articles 41 and 50 of the Law provide for basic requirements for commissioning and operation of nuclear research reactors and NPPs, 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 NPP 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 NPP.

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.

III. SUMMARY

Viet Nam became a Contracting party to the Convention on Nuclear Safety on 15 July 2010. This is its 5th National Report to the 8th and 9th Review Meeting.

By definition in the Convention, Viet Nam has no nuclear installation. However, Viet Nam has a research reactor of 500 kW (DNRR), located in the City of Dalat, Lam Dong province, operating since 1983. For the DNRR 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 DNRR ageing issue is adequately monitored and addressed.

Currently, Viet Nam is implementing the project of the RCNEST with a new research reactor (10-15 MWt) in order to replace the DNRR for purposes of isotopes production, silicon doping, neutron activation analysis, research activities and other applications in atomic energy field.

Great efforts, including development of legislative and regulatory framework, human resource development to ensure the safety and security of the first nuclear power program have been made before the decision on suspending this program in November 2016.

Annex. ABBREVIATIONS

CNS:	Convention on Nuclear Safety
DNRR:	Dalat Nuclear Research Reactor
DSA:	Deterministic Safety Analysis
EIA:	Environmental Impact Assessment
EPR:	Emergency Preparedness and Response
INIR:	Integrated Nuclear Infrastructure Review
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
MOST:	Ministry of Science and Technology
MOH:	Ministry of Health
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
RCNEST:	Research Center for Nuclear Energy Science and Technology
SAR:	Safety Analysis Report
VARANS:	Vietnam Agency for Radiation and Nuclear Safety
VINATOM:	Vietnam Atomic Energy Institute
VAEA:	Vietnam Atomic Energy Agency