Genesis and Contours of Pakistan's Regulatory Regime for Safety of Nuclear Power Plants in Comparison with International Standards

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Abstract

Pakistan is the second major producer of nuclear energy in South Asian region and planning to further expand its nuclear power program to meet its growing energy needs. It is a signatory to the international Nuclear Safety Convention and is committed to ensure a high level of safety of its nuclear power plants. Pakistan has established legislative and regulatory framework and an independent regulatory body for regulating nuclear safety and radiation protection to ensure, protection of radiation workers, public, and the environment from harmful effects of ionizing radiation. The regulatory regime evolved according to the needs and expansion in nuclear power program. The purpose of this paper is to examine contours of Pakistan's nuclear safety regime, in comparison with internationally recognized benchmarks as defined under various international Conventions and IAEA Safety Standards.

Keywords

IAEA Safeguards, Nuclear Power Plants, Nuclear Safety, PNRA, safety standards, Nuclear safety regime, regulatory regime.

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Introduction

Pakistan is the second major producer of nuclear energy in South Asian region and planning to further expand its nuclear power program to meet its growing energy requirements. Currently, Pakistan has five operational Nuclear Power Plants (NPPs) that contribute 1,318 MWe in the overall energy mix, and two more advanced design reactors each having capacity of 1,100MWe are under construction and expected to start operation by 2020 and 2021 respectively.[1] Furthermore, Pakistan plans to construct more NPPs to achieve the target of 8,800 MW by 2030, as defined in the national energy security plan of the government.[2] The country's growing energy program presents a challenge to the nuclear regulatory regime.

Pakistan maintains an independent regulatory oversight regime for NPPs that is continually evolving according to the needs of expanding nuclear power programme. The regulatory authority was formally established in 2001 through the promulgation of the Pakistan Nuclear Regulatory Authority (PNRA) Ordinance (2001). Under this Ordinance, the Government of Pakistan designated PNRA as a national regulator with the responsibility for licensing and regulating NPPs in the country. PNRA was given the mandate to regulate all matters related to nuclear safety and radiation protection, including establishing regulations, issuing licenses and authorizations, conducting inspections and taking enforcement actions.[3] The purpose of this paper is to analyze Pakistan's nuclear safety regime according to internationally recognized practices as defined under international Conventions and International Atomic Energy Agency (IAEA) Safety Standards. The study also describes evolution of concept and basic principles of regulatory practices for ensuring safety of NPPs at international level and within Pakistan.

This paper is divided in four sections. First section interprets evolution of concept of nuclear safety and identifies basic elements of

national nuclear safety regime for NPPs as practiced internationally. Second section describes evolution of nuclear safety and radiation protection activities in Pakistan and measures taken by PNRA to ensure safety of nuclear power programme. Third section elaborates Pakistan's nuclear safety regulatory regime and its comparison with internationally recognized principles. Fourth section describes and analyses challenges faced by PNRA.

Evolution of Concept of National Nuclear Safety Regime

Nuclear accident is generally described as unintended conditions or events leading to radiological releases from nuclear power plants in the environment or situations of uncontrolled chain reaction in a reactor.[4] Nuclear accident could result in on site losses due to explosions, fires and radioactivity and off site damages as a result of large scale release of radioactive material to the environment and contamination of surrounding area. The concept of nuclear safety is focused on various arrangements during planning, design and operations of NPPs for the prevention of accident as a result of system failure, human error or natural calamity. The IAEA has defined nuclear safety as "achievement of proper operating conditions, prevention of accidents or mitigation of accident consequences, resulting in protection of workers, the public and the environment from undue radiation hazards."[5]

Nuclear safety has been a matter of concern for the international community ever since the beginning of use of nuclear energy for various purposes including power production. However, it remained on low priority till the end of 1970s. International Atomic Energy Agency created in 1957 for the promotion of peaceful use of nuclear energy, and was paying modest attention to safety and its focus was limited to developing recommendatory nature of safety standards and regulations to help Member States in ensuring safety of NPPs.[6] During pre-Chernobyl period, States were also reluctant to adopt binding international regime despite awareness about the consequences of

potential nuclear accident of NPPs.[7] However, independent national regimes were established by some of the advanced nuclear states to regulate safety aspects of nuclear power production. United States promulgated Atomic Energy Act of 1954 that assigned the US Atomic Energy Commission mandate for both promoting the use of nuclear power and regulating its safety.[8] Later, the US separated promotional and regulatory duties by establishing Nuclear Regulatory Commission through Energy Reorganization Act of 1974.[9]

Nuclear safety gained prominence at international level after the Three Mile Island (TMI) and Chernobyl accidents of 1979 and 1986 respectively, following which development of safety standards at international and regional levels became priority which resulted in subsequent formulation of domestic legal frameworks to regulate safety aspects of NPPs. The accidents at TMI and Chernobyl, negatively impacted growth of nuclear industry, caused serious decline in use of nuclear energy for power production, and raised public opposition to construction of new NPPs. As a result, several countries either gave up or suspended their plans to construct more NPPs. At this stage IAEA played role to rebuild confidence of international community on nuclear energy and encouraged for the negotiations to develop some legal instrument on nuclear safety.

The proposal for nuclear safety failed to achieve consensus largely because of opposition from major nuclear states.[10] However, this debate paved the way for two minor but important instruments that include Convention on Early Notification of a Nuclear Accident (October, 1986) and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency (February, 1987).[11] Later, the interest of nuclear community revived in negotiations on a Convention on Nuclear Safety (CNS) during the early 1990s. The change in global political environment as a result of disintegration of Soviet Union and fast paced expansion in nuclear energy infrastructure revived the interest of nuclear community for

negotiation on CNS that entered into force on 24 October 1996.[12] The objective of this Convention was to promote awareness about nuclear safety and implement uniform international standards for the safe operation and prevention of accidents at nuclear power plants. CNS emerged as a cornerstone of global nuclear safety regime under the auspices of IAEA and participating States committed to maintain a high level of safety by setting international benchmarks for the operation of land based nuclear power plants.[13]

IAEA Safety Standards including Safety Fundamentals,[14] Safety Codes and Requirements,[15] and Safety Guides[16] along with these Conventions constitute nuclear safety regime and provide basic principles for the establishment of effective national nuclear safety regulatory regime. The principles codified in IAEA Standards or Conventions are internationally recognized and evolved as a result of best practices stretched over more than sixty years of nuclear power production. For the purpose of this study, some integral basic principles and common practices are identified for assessment of Pakistan's nuclear safety regulatory regime. Firstly, the international practices suggest that the nuclear safety falls within national domain and State is primarily responsible to establish national legal and institutional systems to govern nuclear safety.[17] International laws and standards charges the operator with the prime responsibility of safety. In order to fulfil this responsibility, the operator has to make necessary arrangements consistent with the requirements notified by the national regulators with respect to the siting, design, construction, commissioning, operation, and deco mmissioning of nuclear installations.[18] Secondly, the Government is responsible for the establishment of an independent and technically competent regulatory body to oversee nuclear safety and radiation protection matters.[19] Thirdly, clear and consistent national nuclear laws and regulations based on international standards may be developed for licensing and regulatory oversight of nuclear power plants in the country. Fourthly, the regulatory body needs to ensure a transparent licensing and regulatory decision making process with the

participation and involvement of stakeholders including the general public. Finally, the regulator is required to maintain close coordination at regional and international level for continuous improvement in the laws and regulations, technical competence and regulatory practices in view of changing technologies, operational feedback and lesson learnt from incidents and accidents.

Genesis of Pakistan's Nuclear Safety Regulatory Regime

The concept of nuclear safety in Pakistan has been evolving since the beginning of civil nuclear activities in the country. The practical development of the safety regime commenced in 1964 with the formation of a nuclear safety committee to look after safety issues of first research reactor i.e. Pakistan Research Reactor (PARR-I). The need for establishment of Pakistan Nuclear Safety Committee (PNSC) was realized when Pakistan signed an agreement with Canadian General Electric Company (CGE) for installation of its first nuclear power plant in Karachi. The Committee was constituted by Pakistan Atomic Energy Commission (PAEC) in early 1966 with the mandate to oversee and ensure plant safety, review plant design and performance, and grant approvals of safety analysis reports submitted at various stages of the life cycle of nuclear power plant.[20]

Later, the PAEC enhanced the mandate of the committee and established Nuclear Safety and Licensing Division (NSLD) to act as secretariat of PNSC in 1970. This decision was made to foster safety in view of increase in nuclear related activities in the country such as plans for establishment of more NPPs, and to regulate growing use of radioactive material for industrial purpose and at nuclear medical centers.

PNSC was working as de-facto nuclear regulator without any legislative support as the mandate of the Commission stipulated in PAEC Ordinance of 1965 was limited to the promotion of peaceful uses of nuclear energy in the country. To fulfil this legal gap, the

Government promulgated Nuclear Safety and Radiation Protection Ordinance on January 26, 1984 that empowered the PAEC to implement nuclear safety and radiation protection regulations, issue licenses and conduct inspections of all the nuclear and radiation facilities in the country. In pursuance of requirements of this Ordinance, the PAEC established a Directorate of Nuclear Safety and Radiation Protection (DNSRP) for enforcing rules and regulations under this Ordinance.[21]

International community adopted a Convention on Nuclear Safety (CNS) in 1994 to implement uniform international standards to prevent accidents at nuclear installations. Pakistan proactively took part in the negotiation process of CNS and signed immediately after it opened for signature on 20th September 1994. As a first step towards granting autonomy to DNSRP for achieving partial compliance with CNS, the Government of Pakistan (GoP) created a quasi-independent Pakistan Nuclear Regulatory Board (PNRB) on October 30, 1994. The mandate of PNRB was to oversee and review the performance of DNSRP, approve Regulations, Guidelines and Codes prepared by DNSRP, etc. The DNSRP started reporting to the PNRB instead of PAEC and it was also empowered to issue licenses and inspect all the nuclear and radiation facilities operated in the country. However, complete autonomy was still lacking as the Chairman, PAEC was designated as Chairman of PNRB as well.

On 24th October, 1996, the CNS entered into force after it had been ratified by twenty two signatories. Article 8 of this Convention required from its parties to "establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework ... provided with adequate authority, competence, and financial and human resources ..."[22] Pakistan ratified CNS on September 30, 1997. As per requirements of this Convention, the GoP promulgated Pakistan Nuclear Regulatory Authority (PNRA) Ordinance on January 22, 2001 that created an independent regulatory body by the name of PNRA.[23]

As per mandate, PNRA began its activities with a mission to ensure safe operation of nuclear facilities and to protect workers, general public and the environment from the harmful effects of radiation by formulating and implementing effective regulations.[24] In line with legal basis provided under PNRA ordinance, PNRA implemented following measures at national level to regulate safety at nuclear installations:

- Adopted framework consisting of five core elements for licensing and regulatory oversight of NPPs that includes a) develop and issue regulations, b) issue licenses and authorizations, c) perform review and assessment, d) conduct inspections, and e) implement enforcement actions in case of non-compliance;[25]
- Established comprehensive organizational structure comprising of technical and non-technical Directorates, and Regional Offices to carry out its responsibility of ensuring safety of nuclear power plants across the country;
- Enhanced competence of Technical Directorates to issue licenses and authorizations, and formulate the regulations, guides and procedures for effective implementation of safety measures at nuclear installations;
- Established Internal Technical Support Organizations (TSOs) called Center for Nuclear Safety (CNS) and Safety Analysis Center (SAC) to conduct review and assessment of technical documents submitted by operator of NPPs in compliance with safety requirements such as Safety Analysis Report, Probabilistic Safety Analysis Report, and Program for Radiation Protection, Radioactive Waste Management, Environmental Monitoring, Physical Protection, etc.;
- Established three Regional Nuclear Safety Directorates (RNSDs) at Islamabad (RNSD-I), Chashma (RNSD-II), and Karachi (RNSD-III) to conduct planned and un-planned

inspections of NPPs to monitor and ensure compliance with its regulations, license conditions, and other commitments made by license or operator of nuclear installation;

- Established enforcement mechanism for non-compliance which includes corrective actions, suspension of activity, or cancellation of license, etc.[26]

Contours of Pakistan's Nuclear Safety Regime

Pakistan considers nuclear safety as an utmost national priority in its plans to expand nuclear energy infrastructure. For this purpose, it has established detailed national legal and institutional system to govern safety in line with the international practices. PNRA Ordinance of 2001 is the top document that defines contours of nuclear regulatory safety regime and lay down basis of institutional arrangements dedicated to ensure safety of nuclear installations. Under the Ordinance, PNRA is mandated to regulate all nuclear safety and radiation protection matters in the country, ensuring physical protection of nuclear installations and radiation facilities, ensure emergency preparedness and response arrangements, and determine the extent of civil liability for an operator in case of nuclear accident. In order to discharge these responsibilities, PNRA is empowered to establish and enforce rules, regulations, and policies; authorize production, use, disposal and storage of nuclear & radioactive materials; inspect all nuclear & radiation facilities and activities. It also has the mandate to foster cooperation with international organizations such as IAEA and other regulatory bodies for exchange of experience in order to strengthen global nuclear safety regime. Pakistan has established a three-tiered national legislative and regulatory framework comprising of a) PNRA Ordinance that describes composition, objectives, structure, powers, and functions of the regulatory body b) regulations issued by PNRA that provide mandatory safety requirements to be implemented by the licensee of nuclear power plants and radiation facilities, and c) regulatory guides

developed and issued by PNRA that recommend acceptable method for fulfilling requirements of PNRA regulations.[27]

Mandate for Ensuring Safety in Pakistan

According to the IAEA fundamental safety principles, primary responsibility for safety and to carry out actions to reduce radiation exposure is with the person or organization authorized to operate a facility or to conduct activity that may give rise to radiation risk.[28] GoP has approved National Policy on Safety based on IAEA safety fundamentals. The policy defines responsibilities of all the stakeholders and sets rules and guidelines to be implemented to ensure nuclear safety. Pakistan's nuclear safety framework clearly delegate responsibility of safety to the licensee or operator of a nuclear facility and provide layout of actions to be taken by the operator on compliance with this principle. PNRA Regulation for Licensing of Nuclear Installations in Pakistan - PAK - 909 vests the responsibility of safety to the operator, and requires compliance with the national laws and technical standards to ensure safety of its facilities and activities that would be subject to regulatory supervision.[29] Further, PAK/913 requires operator to establish effective organizational structure for safety and develop policies to ensure safety as an overriding priority.[30] PNRA ensures compliance of its requirements stipulated in its regulations through inspections, review & assessment, and enforcement mechanisms as suggested in Article 7 of the CNS. In line with these requirements, PAEC has established a dedicated Directorate of Safety for ensuring implementation of safety measures at corporate and plant level. PAEC has also established and implemented a nuclear safety policy that sets rules, procedures and requirements from operational perspective to ensure that safety measures are in place and implemented.[31]

Independent Regulatory Mechanism

The CNS and subsequent IAEA standards prescribe that the countries operating nuclear power plants must designate separate and independent regulatory body to ensure safety and safeguard public interests associated with the operation of nuclear power plants. The international practices suggest that the independence is maintained through legally protected separation of the regulator from the organizations responsible for the promotion or utilization of nuclear energy and proper empowerment of the regulator in formulation and implementation of laws and regulations. The other subsidiary indicators to measure regulatory independence include technical competence of the manpower to make independent decisions; financial autonomy to carry out unbiased regulatory decisions; and systematic and transparent processes for key appointments in the regulatory body and subsequent reporting channels.[32]

Before 2001, PAEC was performing dual role of both promotion and regulation of nuclear activities. However, PNRA Ordinance of 2001 legally separated the regulatory functions and created an independent Regulatory Authority.[33] For operational working of the organization, the ordinance also provided composition of the Authority which consists of a Chairman, two full time Members, and seven part time Members representing various stakeholders of PNRA. Federal Government appoints the Chairman as the Chief Executive of the Authority who directly reports to the Prime Minister through Secretariat of National Command Authority.[34]

PNRA gradually evolved and transformed into a technical and skilled body having experience and competent human resources to carry out regulatory functions independently. The role of competent manpower is critical for effective and independent decision making especially in the regulatory domain. PNRA has in place comprehensive and systematic professional development program to maintain and enhance competency of its technical staff. PNRA periodically conducts competence need assessment to identify areas for capacity building

and accordingly develops plans to enhance competence through in house training facilities and with the support of relevant national and international institutions.[35] Through this programme, PNRA regularly increases manpower strength and carries out necessary capacity building to meet the requirements of expanding nuclear power program.

PNRA is also financially independent from the organizations responsible for the promotion of nuclear energy as the Federal Government separately provides funds to PNRA to carry out its regulatory activities. PNRA also generates funds through fee charged on account of licensing of nuclear installations and radiation facilities.

Licensing and Regulatory Oversight Process

Regulatory oversight of NPPs involves overall licensing process and continuous monitoring of compliance with safety requirements as outlined in the national laws and regulations. PNRA ordinance empowers PNRA to develop regulations which PNRA has established based on IAEA Safety Standards and feedback experience. PNRA issues two types of regulations - administrative regulations and technical regulations. Administrative regulations describe regulatory processes for example licensing and maintaining regulatory oversight over nuclear installations and radiation facilities whereas technical regulations set requirements that the licensees have to comply in performing its activities for example site evaluation of nuclear installations, design of NPPs, quality assurance and operations of NPPs. In addition, PNRA Ordinance also mandates it to grant authorization to carry out certain activities for example construction of NPP, commissioning, fuel load, transport of fuel, and discharge or dispose off radioactive waste etc. and states that "the authority may, on application made to it accompanied by such fee, information and documents, as may be prescribed by regulations, grant an

authorization for carrying out such activities as are specified in the authorization for such period as it may specify."[36]

PNRA's licensing process for nuclear installations as stipulated in Regulations for licensing of nuclear installations and describe a number of different steps such as site registration, construction license, permission for commissioning, permission to introduce nuclear material into the installation, operating license, revalidation of operating license, licensing beyond design life, license for decommissioning of a nuclear installation, closure, and removal from regulatory control.[37] PNRA issues license and authorization based on extensive review of documents submitted by the operator of the facility as required under regulations and feedback from inspection process.[38] Regulatory inspections are conducted during construction, manufacturing, commissioning, operation and decommissioning of facilities to ensure compliance with the regulations, license conditions and directives issued from time to time by PNRA.[39]

Transparency and Stakeholders Involvement in Regulatory Processes

Stakeholders' participation in regulatory decision making is considered a compulsory element of nuclear safety regime in the IAEA standards for establishing and implementing an effective regulatory framework. This enhances confidence and trust of the masses in the use of nuclear technology and ensures transparency in regulatory decisions.[40] In Pakistan, multiple processes are in place to take national stakeholders in confidence. First, the process of developing national regulations that govern or regulate nuclear activities in the country includes input from all the stakeholders including licensees', relevant governmental organizations and general public. Input is normally obtained through circulating draft regulations among stakeholders and placing it on official web page of PNRA for review and comments. Second, it is mandatory for the licensee to obtain NOC for construction of nuclear power plant from Environmental

Protection Agency (EPA) and submit to PNRA along with application for Site Registration.[41] EPA regulates all aspects of environmental protection and conducts proper public hearing to listen and address their concerns before issuing NOC. Third, PNRA is implementing a program for enhancing public awareness on radiation risks, and has developed the process of acquiring input from stakeholders in regulatory decision making and regulatory process that are in place for public protection from radiation risks.[42] The awareness campaign is promoted through arranging lectures, seminars and workshops for the masses at schools, universities and other national institutes. PNRA also remains in contact with the public to communicate important regulatory actions through placing all important information on its web page and issuing reports. In addition to this, PNRA measures stakeholders' confidence on regulatory activities time to time through distribution of feedback questionnaire. The stakeholders' feedback is evaluated and used to identify areas for further improvement in regulatory performance.

PNRA also benefit from IAEA peer review services to enhance transparency, further strengthen national nuclear regulatory framework and enhance confidence of international community on nuclear safety regime of Pakistan. For example, PNRA invited Integrated Regulatory Review Services (IRRS) Mission in 2014 comprising renowned nuclear safety experts from all over the world for the assessment of regulatory infrastructure of nuclear and radiation safety in Pakistan and regulatory effectiveness and efficiency of PNRA.[43] The mission reviewed regulatory regime and expressed its satisfaction on PNRA's expertise and national nuclear safety practices. The mission concluded that the "PNRA has well established regulatory and legal framework that is based on IAEA safety standards and it conducts effective regulatory activities for nuclear power plants, including licensing, inspection, enforcement, lesson learned, and emergency preparedness."[44] PNRA formulated and implemented national action plan based on IRRS mission

recommendation that contributed in further improvement of PNRA regulatory framework and processes.[45]

Regional and International Cooperation

Exchange of information and knowledge at international level is essential to achieve success and goal of effective global nuclear safety regime. Mutual learning helps States in improving their regulatory regimes by updating national laws and regulations and capacity building of regulatory staff that facilitate in decision-making capabilities and build a learning organization. IAEA also strives hard to promote international cooperation considering that nuclear safety is a common responsibility and radiation risks may transcend national borders in case of a nuclear or radiological emergency. IAEA believes that the 'international cooperation promotes and enhances safety globally through exchanging experience and by improving capabilities to control hazards, prevent and mitigate any harmful consequences of nuclear accidents, and respond to emergency situations.[46]

PNRA has adopted three pronged strategy for maintaining coordination with the international community. First, PNRA maintains multilateral cooperation with the regulatory bodies of other countries under IAEA umbrella through participation and contribution in its activities related to developing and strengthening international codes and standards for safety. Second, PNRA carries out interaction and exchange of expertise with national regulators of other Member States under the auspices of IAEA especially under IAEA technical cooperation programme for capacity building of its staff. Experts from PNRA regularly visit other countries on IAEA request to participate in workshops, seminars, conferences, etc. for the capacity building in the field of nuclear safety and radiation protection and similarly experts from other countries also visit Pakistan. PNRA also contribute in IAEA activities for capacity building and regulatory infrastructure strengthening of countries embarking on nuclear power. In this

regard PNRA has signed Memorandum of Understanding (MoU) with the Nigerian Nuclear Regulatory Authority (NNRA) under auspices of IAEA technical cooperation programme for experience sharing and capacity building of regulatory staff. Third, PNRA makes efforts to establish bilateral cooperation with the regulatory bodies of other countries. For example, PNRA has established bilateral agreements with the Chinese regulatory body National Nuclear Safety Administration (NNSA) and its technical support organizations for capacity building of its staff and exchange of regulatory experience.

PNRA maintains close relationship with IAEA and operates as designated point of contact for implementation of national responsibilities arising from IAEA related international Conventions to which Pakistan is signatory. These include Convention on Nuclear Safety (CNS), Convention on Early notification of a Nuclear Accident (CENA), Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency (CANARE), and Convention on Physical Protection of Nuclear Material and Facilities (CPPNM).[47] PNRA regularly participates in CNS Review Meetings of the Contracting Parties and submits Pakistan's National Report on measures taken at national level to enhance safety of NPPs for peer review by international community. In addition, PNRA is member of several IAEA committees and forums established to promote nuclear safety across world such as IAEA Safety Standards Committees,[48] Commission on Safety Standards (CSS),[49] Regulatory Cooperation Forum (RCF),[50] Global Nuclear Safety and Security Network (GNSSN), International Reporting System for Operating Experience (IRS) etc. Participation in the activities of these forums helps regulatory bodies of IAEA Member States to learn about latest international safety standards and practices followed to ensure safety of NPPs.

Analysis of Emerging Regulatory Challenges

The comparison of Pakistan's regulatory oversight regime with international benchmarks reflects that it is quite comprehensive and

developed appropriately to regulate country's nuclear energy program effectively. However, there are some technical and socio-political challenges that need attention from regulatory perspective. Foremost issue among these is meeting the need of expanding nuclear power programme. Pakistan is considering construction of more nuclear power plants for electricity generation. The PAEC has identified a number of more sites across the country to construct additional nuclear power plants to contribute about 40,000 MWe in the national energy mix.[51] Such plans for growth in nuclear energy presents challenge in terms of nuclear safety and requires proportionate expansion in regulatory infrastructure, up-gradation of regulatory framework and increase in competence and human resource to cater emerging needs.

The next challenge is to regulate advanced design nuclear power plants. Currently, Pakistan is operating one CANDU type Pressurized Heavy Water Reactor (PHWR) having capacity of 137 MWe which is operating beyond design life and four C-series plants of Pressurized Water Reactor (PWR) design. Electricity generation capacity of C-1 is 325 MWe and electricity generation of other three power plants is around 340 MWe each. Moreover, installation of two advanced design PWR type power plants KANNUP 2 and 3 at Karachi - which are Generation-III nuclear power plants with a capacity of 1100MWe each is in progress. Furthermore, Pakistan is also planning to build capacity for small and medium sized PWR type reactors (SMR) and to indigenize capability to construct nuclear power plant similar to those already under operation in Pakistan to reduce dependence on external sources and strengthen national industrial and technological foundation.[52] These activities would bring new challenges from both operational and regulatory points of view.

From socio-political perspective, public participation in licensing of nuclear power plants is limited in Pakistan mainly because of lack of awareness among masses about NPPs and risks associated with the use of nuclear technology. Some members of civil society and local

citizens often raise concerns about nuclear activities from safety perspective which are, however, mostly viewed as motivated by either their personal interests or based on political grudges instead of genuine public concerns. They often criticize regulatory regime for lack of transparency in regulatory decisions and overlap of interests with the operator merely based on assumptions. In addition, they also criticize GoP for plans to construct more NPPs expressing fear of potential nuclear disaster. The construction of Karachi NPPs (K2 and K-3) was delayed, as members of civil society prompted by fear of Fukushima Daiichi Accident a filed petition in the court.[53] Management of nuclear accident and radiological emergencies is a critical issues from regulatory perspective. However, PNRA proactively monitors international developments in the field of NPPs Safety and accordingly carry out regulatory upgrades to prevent accidents and incidents at NPPs. Following Fukushima Accident in Japan, the PNRA immediately reviewed and updated regulatory framework and regulations governing safety of NPPs based on lessons learned from the event. Accordingly, operator of NPPs were directed to identify and submit areas for further improvements and modification to the reactors, which were implemented after approval of PNRA.[54]

PNRA's public awareness campaign is a commendable effort with reference to promoting awareness about radiological risks but is still insufficient from the point of view of involving public in regulatory decision making. There is a need to develop mechanisms for enhancing public participation in licensing and decision making processes. The regulator does not require applicant to conduct hearings as practiced in other developed countries neither any national law commits PNRA to take public into confidence while making decisions regarding licensing or regulatory oversight of NPPs. The public input is obtained through Environment Protection Agency (EPA) only which is insufficient. There is a need for the operator to establish direct liaison with the public, and develop processes to

inform public about new NPP projects, and conduct hearing to address public concerns before installation of a new NPP. In addition, the regulatory body should enhance its coordination with general public by involving them in licensing and regulatory decision making process.

Regional level coordination is important for nuclear safety as risks associated with the use of nuclear technology have potential to cause damage across borders. IAEA also encourages its Member States to make regional arrangements for exchange of information and experiences to strengthen regulatory infrastructure for safety of nuclear power plants and to develop and adopt best practices and harmonized regulatory standards and processes. Currently, several regional platforms are operating to promote nuclear safety in the world. For example, Western European Nuclear Regulators Association (WENRA). It was established in 1999 with the purpose to develop a common approach to nuclear safety and to provide an independent capability to examine nuclear safety in the region. Other such examples of regional forums, established to enhance nuclear safety cooperation, include European Nuclear Safety Regulators Group (ENSREG), Forum of Nuclear Regulatory Bodies in Africa (FNRBA), ASEAN Network of Regulatory Bodies on Atomic Energy (ASEANATOM), and Arab Network of Nuclear Regulators (ANNuR), etc.

However, in Pakistan's context, regional situation surrounding Pakistan like political instability in Afghanistan, suspicious Iranian nuclear program and tension between Pakistan and India over Jammu and Kashmir, hinders development of cooperation with the neighbouring countries in nuclear domain. In the South Asian region, Pakistan and India have ambitious nuclear energy programs, Bangladesh is also embarking on developing nuclear power. However, there are no regional arrangements or coordination between the relevant institutions to deal with nuclear emergency situations or to establish common approaches for enhancing nuclear safety within

South Asian region. There is a need to develop regional level regime of nuclear regulators to deal with the risks posed by peaceful applications of nuclear technology. Pakistan often express willingness by offering proposal to India for enhancing cooperation in the field of peaceful nuclear uses. For example, Pakistan shared proposals on Exchange of Information on Peaceful Uses of Nuclear Technology; Exchange of Information and Experience on Nuclear Safety; and Early Notification of Nuclear Related Emergencies, during expert level talks held between two countries in December 2012.[55]

Conclusion

Pakistan has developed a comprehensive nuclear regulatory regime at par with the international conventions and IAEA Safety Standards. Furthermore, it has rich experience of regulating nuclear activities and ensuring safety that is spanned over a period of more than fifty years. Over the years, PNRA has developed significant technical competence and gained considerable recognition at both national and international levels. Since its inception in 2001, PNRA has achieved several significant milestones that included development and consolidation of regulatory framework and infrastructure, and authorization of K-1 to operate beyond its design life and licensing and effective regulatory oversight of four operating units (C1-C4) and two under construction units (K2 and K-3). Internationally, now PNRA is providing technical assistance and expert support in nuclear safety and security to other countries establishing nuclear power program under IAEA umbrella. However, still there are areas which demands attention that include increasing stakeholders participation in regulatory process and enhancing coordination within the region on matters pertaining to nuclear safety.

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