ANNUAL REPORT 2015

PAKISTAN NUCLEAR REGULATORY AUTHORITY

MEMBERS OF PNRA

PRESENT

Mr. Mohammad Anwar Habib (Chairman)
Mr. Mahboob Ali
Mr. Mohammad Iqbal
Lt. Gen. Mazhar Jamil
Dr. Muhammad Nuruddin Qazi
Mr. Hussain Ahmad Siddiqui
Syed Yusuf Raza
Prof. Dr. Mustafa Kamal
Dr. Muhammad Khurshid

FORMER

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Lt. Gen. (R) Khalid Ahmed Kidwai
Lt. Gen. Zubair Mahmood Hayat
Mr. Jawad Azim Hashimi
Syed Badshah Husain
Mr. Mohammad Shakilur Rahman
Dr. Shahid Ahmed Mallick
Dr. Inam-ur- Rahman
Prof. Dr. Mohammad Ali Maud
Dr. Younus Sheikh
Mr. Anwar Ali
Prof. Dr. Inayat Shah Roghani
Mr. Zia-ul-Hasan Siddiqui
Dr. Qazi Abdus Saboor
Mr. Asif Shuja Khan
Mr. Saeed Alam Siddiqi

MESSAGE FROM THE CHAIRMAN

It gives me a great pleasure to present our annual report for the year 2015 on the eve of the sixteenth anniversary of PNRA's inception. This year brought about many successes and challenges for PNRA in strengthening regulatory paradigm and realizing our commitments at national and international avenues. Inspired by its mission, PNRA remained engaged with the momentous task of translating its vision into reality. Accordingly, our regulatory oversight of civilian nuclear installations and radiation facilities and activities saw marked improvement during 2015.

Our foremost priority at PNRA has been the development and strengthening of a comprehensive regulatory framework in line with national and international developments. In this regard, PNRA has so far published 17 regulations.

During the year under review, PNRA issued construction licences to K-2 & K-3; authorisation for commissioning to C-3 & C-4; licence to MPF as a nuclear installation; and authorisation to NCNDT to perform NDE activities. We also processed licensing of radioactive waste management facility and design certification of Type B(U) package, which are expected to be completed early next year.

PNRA continued strong persuasions to get radiation facilities and activities into the licensing net which resulted in a considerable increase in licensed radiation facilities in the past few years.

I have always accorded the highest priority to building the capacity of my team side by side with developing the infrastructure, a substantial part of which is funded through PSDP projects. During the year, a PSDP project-Establishment of National Radiological Emergency Coordination Centre (NRECC) - was approved by the government.

In 2015, PNRA organised several forums to interact with our stakeholders including general public for imparting specific knowledge through trainings/workshops and to respond to their concerns towards the safety of nuclear power plants and radiation facilities.

I consider myself honoured as, during the year under review, we completed a Safety Culture Self-Assessment (SCSA) using IAEA methodology, becoming the first regulator worldwide to have reached this milestone. This effort of PNRA, as a role model for other nuclear regulators, has won accolades from the world's premier nuclear agency - the IAEA.

After successful implementation of its short-term strategic plan, PNRA has developed a long-term strategic plan for the period 2015-2018. We also conducted third internal technical audit of all organisational units, during this year, which highlighted recommendations and suggestions for further improvement. I believe that it will ultimately contribute to enhance our performance and inculcate a sense of teamwork in PNRA's workforce by creating commitment and devotion among PNRA's personnel.

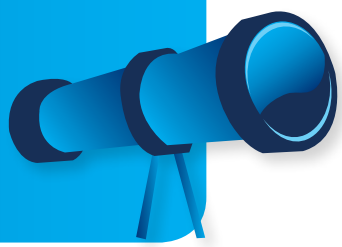
As per my commitment to enhance our contribution at international front, PNRA continued its experts' support to IAEA in strengthening infrastructure of regulatory authorities of the member states.

I realise that capacity building of our regulatory workforce requires to be further emphasised in order to cater for the international developments in the field of nuclear safety and security. I feel privileged to have a superb team with consistent approach, utmost commitment and paramount dedication. With such a team and discreet planning, I am confident that PNRA would amicably and professionally meet all current and future challenges in the regulatory business and would continue to contribute for the noble cause of protecting the workers, public and the environment from harmful effects of radiation.

(Mohammad Anwar Habib)

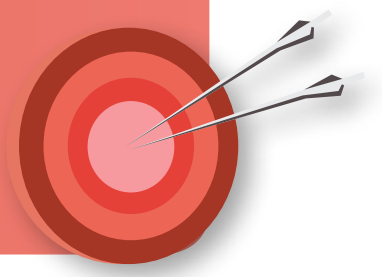
VISION

To become a world class regulatory body with highly trained, competent and dedicated personnel working in unison with a zeal to foster a positive safety culture in their licensees and to regulate nuclear safety to protect the public, the workers and the environment from the harmful effects of radiation in a manner that wins the confidence of all the stakeholders viz. the public, the government and the licensees.



MISSION

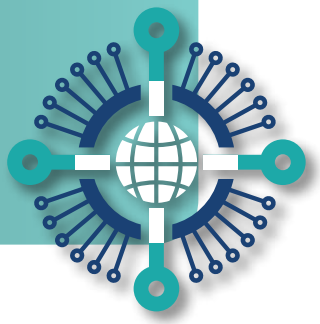
To ensure the safe operation of nuclear facilities and protect the radiation workers, general public and the environment from the harmful effects of radiation by formulating and implementing effective regulations and building a relationship of trust with the licensees and maintaining transparency in actions and decisions taken by the regulatory body.



CORE VALUES

PNRA staff members work in an atmosphere of openness and trust. They observe the following core values while continuously assessing the quality of their work and directing their efforts towards excellence in performance.

- *Integrity*
- *Transparency*
- *Independence in Decision Making*
- *Competence and Professionalism*
- *Mutual Respect*
- *Caring and Compassionate Attitude*



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1. INTRODUCTION

The importance of a framework to regulate radiation protection in the country was recognised way back in 1965 when the first research reactor PARR-1 was commissioned. At that time, a limited setup was established within Pakistan Atomic Energy Commission (PAEC) to look-after radiation protection matters according to internationally acceptable standards.

The first legislative setup to govern radiation protection in the country was established under Pakistan Nuclear Safety and Radiation Protection Ordinance-1984 as "Directorate of Nuclear Safety and Radiation Protection" (DNSRP) within the PAEC.

In 1994, Pakistan signed the International Convention on Nuclear Safety. Although from the very beginning, there was a realisation that regulatory affairs in nuclear and radiation safety should be independent from the operational aspects and this independence was initially maintained by utilising organisational means and approaches, however, signing the Convention on Nuclear Safety worked as a catalyst to this effect.

One of the main obligations of the member states under this convention is to ensure that functions of the regulatory body are institutionally separated from activities related to promotion and utilisation of nuclear energy in the country.

As a first step towards meeting this obligation, Pakistan moved from institutionally combined promoter and regulator to a quasi-independent regulatory body by establishing Pakistan Nuclear Regulatory Board (PNRB) in 1994. A complete separation of promotion and regulatory functions & responsibilities was achieved in 2001, when the Pakistan Nuclear Regulatory Authority Ordinance was promulgated.

Consequently, Pakistan Nuclear Regulatory Authority (PNRA) was created as a regulatory body, independent from the promoters, with the powers for regulating nuclear safety and radiation protection in Pakistan.

As envisaged in the Ordinance, the Authority consists of a Chairman, two full-time Members and seven part-time Members, including representatives of the Ministry of Health; Pakistan Environmental Protection Agency; Pakistan Atomic Energy Commission; Strategic Plans Division of the Joint Staff Headquarters; and eminent professionals from the science, engineering and medical sectors.

The Authority has established various organisational units for its effective operational working. The Headquarter of PNRA is situated in Islamabad whereas its regional offices are located in different cities of Pakistan. The organisational structure of PNRA is presented in Figure 1.

The Authority has been empowered by the Ordinance to control, regulate and supervise all matters related to nuclear safety and radiation protection in Pakistan. To effectively meet its regulatory obligations, PNRA has been authorised to devise, adopt, make and enforce rules, regulations, orders or codes of practice for nuclear safety and radiation protection; and to plan, develop and execute comprehensive policies and programmes for the protection of life, health and property against the risk of ionising radiation.

The Authority regulates the radiation safety aspects of nuclear installations e.g. nuclear power plants, nuclear research reactors, molybdenium production facility, etc.; and radiation facilities e.g. diagnostic radiology centers, radiotherapy centers, nuclear medical centers, irradiators, industrial and agricultural radiography facilities, etc.

The Authority also grants authorisations and issues licences to nuclear installations and radiation facilities and their operators for the use of nuclear material and radioactive sources; and inspects all such installations and facilities to verify that regulations concerning safety measures are being properly followed. PNRA also issues NOCs to importers and exporters of radioactive sources and "Radiation-Free Certificates" for exportable food items.

Transportation and disposal of radioactive materials also fall under the purview of PNRA. In addition, PNRA ensures that the licensees maintain effective preparedness and coordination for managing nuclear and radiological accidents and emergencies.

PNRA is the focal point for international conventions concerning nuclear safety; physical protection of nuclear materials; and early notification and assistance in case of nuclear or radiological emergencies. As such, it assists the Government of Pakistan in execution of its obligations under these conventions.

At the national level, PNRA has close working interaction at the national level with organisations such as Strategic Plans Division, Planning Commission, Ministry of Foreign Affairs and other national authorities, law enforcement agencies, etc.

PNRA also collaborates with national universities and research institutes for keeping abreast with latest national/international research in disciplines of nuclear and radiation safety and for human resource development activities. PNRA attaches a great emphasis on working in

a manner that ensures the confidence of the licensees, the government and the general public.

PNRA understands that while its statutory foundation is essential to meet its regulatory responsibilities, this alone cannot work in the absence of competent regulatory personnel; and that its effectiveness as a regulatory body depends directly on the competence of its workforce.

With respect to the human resources, PNRA has adopted competence and professionalism as its core values and it considers cultivation of these qualities among its workforce as a high-priority task. It is always looking to enhance and upgrade technical competence of its officials in all regulatory functions, namely, development of regulatory framework; review & assessment; licensing & authorisation; and inspection & enforcement covering all phases and stages including site evaluation, design, manufacture, construction, installation, commissioning, operation and decommissioning.

PNRA is also mindful that only technical competence is not enough; and that expertise in other disciplines – legal, regulatory and organisational basis; and Inter-personnel skills – is also indispensable for the successful discharge of its regulatory duties. Accordingly, PNRA makes a sustained effort to enhance expertise in all these areas.

PNRA believes that its real strength lies in its highly trained and motivated workforce. This is precisely why the Authority maintains linkages and arrangements with international institutions and organisations under various bilateral and multilateral initiatives to place its officials for higher studies and technical trainings abroad.

The International Atomic Energy Agency (IAEA) also provides support to PNRA under various technical cooperation programmes for capacity building of its manpower. There are also a number of bilateral agreements with various organisations under which these organisations provide specialised technical support to PNRA in performing its regulatory functions.

Striving for continuous improvement, PNRA conducted internal technical audit of its organisational units in 2015. PNRA believes that this internal technical audit is a dynamic activity which helps to achieve organisational objectives through an independent, objective and consultative evaluation aimed to add value and improve an organisation's assignments, activities and processes.

Internal audit works as a catalyst for improving organisation's management controls and effectiveness of technical/operational assignments by providing insight and recommendations. The audit focused the working of PNRA in all relevant areas of nuclear safety and radiation protection, including licensing & authorisation, review & assessment and inspection & enforcement processes by utilising a systematic, disciplined approach to evaluate/ improve the effectiveness of management control and execution of core processes of PNRA.

PNRA continues to contribute to international endeavors in promoting nuclear safety and security. Over the year under review, numerous experts and resource persons from PNRA provided technical expertise and consultancy services to IAEA in its programmes related to strengthening nuclear regulatory infrastructure worldwide. Among the activities PNRA helped with, were technical & consultancy meetings, expert missions, review missions, workshops and training courses.

PNRA is also extending support – under the auspices of the IAEA – to countries newly embarking upon use of nuclear technology, in establishing regulatory infrastructure and developing legislation and regulations.

Group Photo at Licensing Ceremony of K-2/K-3

MAJOR ACTIVITIES IN 2015

Major activities of PNRA during 2015 are summarised as follows:

1. Conducted regulatory monitoring of activities at three operational nuclear power plants (Karachi Nuclear Power Plant Unit-1, Chashma Nuclear Power Plant Units 1 & 2), two under commissioning nuclear power plants (Chashma Nuclear Power Plant Units 3 & 4) and two under construction nuclear power plants (Karachi Nuclear Power Plant Units 2 & 3). Releases to the environment from the operating NPPs and radiation doses to workers were evaluated at PNRA which remained well below the prescribed regulatory limits;
2. Awarded construction licences to Karachi Nuclear Power Plant Unit 2 and Unit 3 (K-2 & K-3) and granted authorisations for commissioning to Chashma Nuclear Power Plant Unit 3 and Unit 4 (C-3 & C-4);
3. Issued licence to Molybdenum Production Facility (MPF) as a nuclear installation;
4. Granted authorisation to National Center of Non-Destructive Testing (NCNDT) to perform Non Destructive Examination (NDE) activities;
5. Observed 10th refueling outage of Chashma Nuclear Power Plant Unit 1 and 3rd refueling outage of Chashma Nuclear Power Plant Unit 2.
6. Monitored the conduct of emergency exercises at K-1, CNPGS and PINSTECH;
7. Expanded the licensing net for diagnostic radiation facilities by about 15 percent. More than 550 new facilities were registered during the reported period;
8. Completed review and accepted the second Periodic Safety Review (PSR) Reports of the Karachi Nuclear Power Plant Unit 1 (K-1);
9. Reviewed Revision-2 of Initial Decommissioning Plan of K-1;
10. Approved amendment in the the following Regulations:
    a. Regulations on the Safety of Nuclear Power Plants Operation - (PAK/913) (Rev.1);
    b. Regulations on the Safety of Nuclear Research Reactor(s) Operation - (PAK/923); and
    c. Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority - (PAK/900) (Rev.1);
11. Completed the review of Safety Analysis Report (SAR) of PINSTECH Pre-disposal Radioactive Waste Management Facility;
12. Finalised and issued work plan for activities under PNRA Strategic Plan 2015-2018;
13. Completed Safety Culture Self Assessment (SCSA);
14. Reviewed a number of radioactive waste management programmes, radiation protection programmes, emergency response plans and physical protection programmes;
15. Conducted 23 training courses in the field of nuclear & radiation safety; and nuclear security & physical protection. More than 600 personnel from PNRA and other stakeholder organisations benefited from these training courses;
16. Organised a number of lectures/seminars as part of its campaign to improve public awareness of hazards associated with nuclear technology in Islamabad, Lahore and Peshawar; in which more than 2,300 personnel participated;
17. The eighth Steering Committee Meeting between PNRA and National Nuclear Safety Administration (NNSA) of China was held at Rongcheng City, Shandong, China to review and discuss the issues of bilateral cooperation / interests in the field of Nuclear Safety;
18. Established Physical Protection Exterior Laboratory (PPEL) with assistance of IAEA under the PNRA-IAEA Nuclear Security Cooperation Programme at Pakistan Centre of Excellence near Islamabad;
19. Continued at full pace the implementation of PSDP Project for construction of "PNRA Residential Colony at Chashma" for providing official residences for its employees posted at RNSD-II and;
20. PSDP Project "Establishment of National Radiological Emergency Coordination Centre" was approved by Planning Commission of Pakistan and execution initiated.

TARGETS FOR 2016

The targets set for 2016 are summarised as follows:

1. Development of "Regulations on Decommissioning of Facilities using Radioactive Material" (PAK/930) and revision of "Regulations for Licensing of Nuclear Safety Class Equipment and Component Manufacturers" (PAK/907);
2. Continue monitoring of licensees' activities in order to avoid any major incidents, overexposure to workers and radiation releases to the environment;
3. Award of licence to the PINSTECH Pre-disposal Radioactive Waste Management Facility (RWMF);
4. Issuance of design approval certificate to PINSTECH Type B(U) Transport Container;
5. Enhancing the licensing net for diagnostic radiation facilities by another 10 percent;
6. ISO 9001:2008 certification of NISAS;
7. Continue cooperation with national and international organisations;
8. Implementation of action plan in the light of IRRS Mission's recommendations & suggestions for further improvement in the regulatory framework and processes;
9. Implementation of PNRA Strategic Plan 2015-2018;
10. Review of equipment manufacturing industry application for grant of permission for manufacturing equipment for future projects;
11. Issuance of the Regulatory Guides on:
    a. Preparation of Radiation Emergency Plan for Radiation Facilities and Activities (RG 914.02);
    b. Radiation Safety in Industrial Radiography (RG 904.03); and
    c. Protection of Patients in Diagnostic Radiology (RG 904.05);
12. Issuance of revised PNRA Management System Manual;
13. Rationalisation of human resource with the tasks and functions assigned to PNRA directorates/projects;
14. Completion of security barracks, hostel and three blocks of family accomadation in PNRA Residential Colony at Chashma;
15. Operation of Physical Protection Exterior Laboratory (PPEL) at Pakistan Centre of Excellence;
16. Review of Initial Decommissioning Plan (IDP) of C-3; and
17. Acquisition of land, approval of building design and procurement of online radiation monitoring system for NRECC Project.

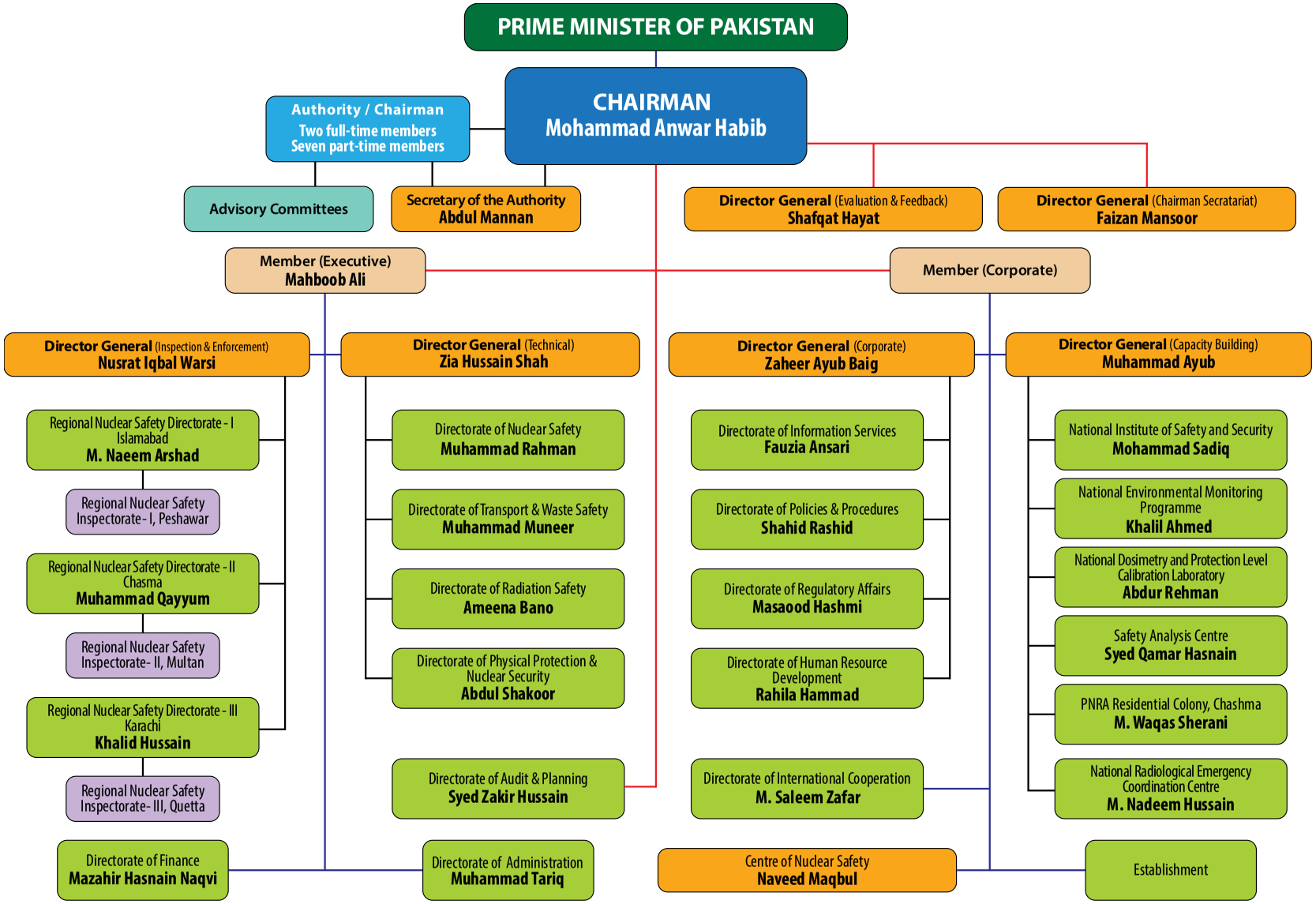


Figure 1: Organisational Structure of PNRA

2. REGULATORY FRAMEWORK

PNRA is continuously striving to develop, strengthen and improve its regulatory framework for effective regulatory control over the nuclear installations, radiation facilities and associated activities in the country.

The statutory framework for PNRA's regulatory operations comprises three tiers approach as illustrated in Figure 2. The charter statute – PNRA Ordinance, 2001 – is the first tier, followed by PNRA regulations and regulatory guides issued there-under in the subsequent tiers.

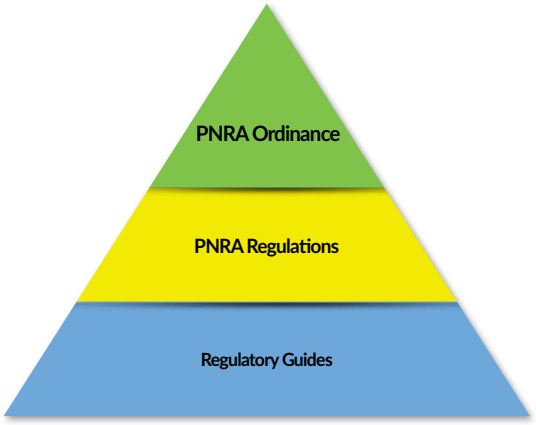


Figure 2: Statutory Framework for the PNRA's Regulatory Operations

PNRA Ordinance describes the mandate, powers, functions and responsibilities of the Authority as envisaged by the Federal Government. Under the statute, PNRA is empowered to formulate rules, regulations, policies and programmes for regulation of safety of nuclear installations and radiation facilities for protection against risks arising from ionising radiation.

The regulations issued by PNRA form the second tier of the statutory framework for the Authority's regulatory operations. These regulations set mandatory requirements for the licensees. Their compliance to the regulations is verified through:

a) Review and assessment of submissions made by an applicant/licensee as part of application for obtaining authorisation or licence from PNRA as well as other submissions made during the authorisation or licensed period; and

b) Conducting regulatory inspections of the actual work practices at the licensees' premises.

All reported instances of non-compliance are subject to appropriate enforcement action to get a constructive outcome.

The third tier of the statutory framework for PNRA's regulatory operations consists of regulatory guides, which describe acceptable methodology for implementation of requirements set forth by PNRA regulations. These regulatory guides are non-binding; a licensee may therefore choose alternate approaches as long as the intent of regulatory requirements is met. In all such cases, the licensee is required to demonstrate, to the entire satisfaction of the Authority, that the proposed approach provides at least the same level of safety as would have been achieved, had the methodology described in the regulatory guides been applied.

Review of PNRA Ordinance

In order to accommodate the administrative and technical developments at national and international level, PNRA initiated the review of its Ordinance during the reported period. All the technical directorates participated in the rigorous review process based upon our experience, which resulted in a proposal highlighting significant amendments to the Ordinance.

Regulations

The regulations developed by PNRA help translate its mission, of protecting the radiation workers, the general public and the environment from the harmful effects of ionising radiation, into reality. A comprehensive process exists for the development of regulations including rigorous internal reviews at various levels within PNRA followed by invitation of comments from the stakeholders such as the licensees, the government and the public.

Different stages of the process for development of PNRA regulations are described in Figure 3.

The regulations are reviewed, at the most, after every five years or may be reviewed earlier, if needed, taking into account the obligations under PNRA Ordinance, regulatory experience feedback, stakeholders' feedback and the latest international developments. The regulations are modified and amended through the process mentioned in Figure 3. PNRA has so far published 17 regulations

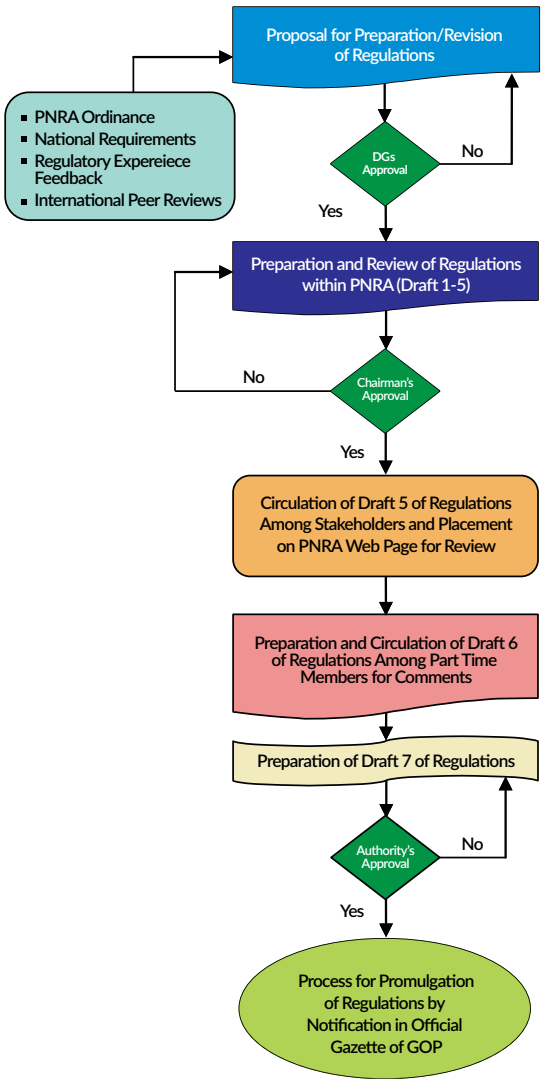


Figure 3: Process for Development of PNRA Regulations

as shown in Table 1. These regulations are available at PNRA website (www.pnra.org) for the assistance of all the stakeholders.

During the year 2015, work on the development of the following regulations remained in progress:

1. Regulations on Authorisation of Organisations for Non Destructive Examination (NDE) of Safety Class Equipment for Nuclear Installation(s) - (PAK/906);
2. Regulations on Safety of Spent Nuclear Fuel Management - (PAK/918);
3. Regulations on Physical Protection of Nuclear Material(s) and Nuclear Installation(s) - (PAK/925);
4. Regulations on Security of Sealed Radioactive Sources (SRS) - (PAK/926); and
5. Regulations on Decommissioning of Facilities using Radioactive Material - (PAK/930).

Following regulations are currently in the process of revision, triggered by their periodic review:

1. Regulations for Licensing of Nuclear Safety Class Equipment and Components Manufacturers - (PAK/907) (Rev.0);
2. Regulations for the Licensing of Radiation Facility(ies) other than Nuclear Installation(s) - (PAK/908);
3. Regulations on the Safety of Nuclear Power Plant Design - (PAK/911) (Rev.1);
4. Regulations on the Safety of Nuclear Power Plants Operation - (PAK/913) (Rev.1); and
5. Regulations on Radioactive Waste Management - (PAK/915)

In addition, the amendments in a section, clause or a part of the following regulations were approved during the year 2015:

1. Annex-III of the Regulations on the Safety of Nuclear Power Plants Operation - (PAK/913) (Rev.1); regarding "Criteria for Shift Supervisor Licence";
2. Appendix-I of the Regulations on the Safety of Nuclear Research Reactor(s) Operation - (PAK/923); regarding "Criteria for Licensing of Research Reactor Operating Personnel"; and
3. Clause 4(b) of the Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority - (PAK/900) (Rev.1) regarding validity period of licensing fee from "Calendar Year" to "Financial Year".

PNRA Ordinance empowers the Authority to fix the extent of civil liability for an operator in case of various nuclear incidents in Pakistan. The case for determination of the extent of civil liability against nuclear damage prior to award of "Construction Licence (CL)" to the new nuclear power plants at Hawke's Bay, Karachi (K-2/K-3) was under consideration during the reported period.

Based on the technical data, experience feedback and other available information, PNRA decided to adopt the "Site Specific Approach", as was adopted in the case of CNPGS Kundian site, for the determination of the extent of civil liability and approved an amount of US$300 million as civil liability against nuclear damage resulting from all the nuclear installations at Hawke's Bay site, Karachi.

Regulatory Guides

Regulatory guides issued by PNRA are developed to facilitate the licensees and stakeholders in the implementation of the requirements set forth by PNRA regulations. PNRA has so far published eight regulatory guides as shown in Table 2.

During the year 2015, development of the following regulatory guides remained in progress:

1. Radiation Safety in Industrial Radiography (PNRA-RG-904.03);
2. Protection of Patients in Diagnostic Radiology (PNRA-RG-904.05);
3. Radiation Protection and Safety in Radiotherapy (PNRA-RG-904.06);
4. Format and Contents of Radiation Protection Programme of Radiation Facilities/Activities (PNRA-RG-904.07);
5. Guidelines for Medical Professionals on Transport, Diagnosis & Management of Overexposed & Contaminated Individuals in Radiological Emergency (PNRA-RG-904.08);
6. Format and Content of Safety Analysis Reports (SARs) of NPPs (PNRA-RG-909.01);
7. Format and Contents of Physical Protection Programme of Nuclear Installation(s) (PNRA-RG-909.02); and
8. Format and Contents of Radiation Emergency Plans of Radiation Facilities and Activities (PNRA-RG-914.02).

Maintenance of Regulatory and Management System Documentation

PNRA maintains all regulatory documents and management system documents generated within PNRA.

The regulatory documents include PNRA Ordinance, Regulations and Regulatory Guides.

The management system and the associated documents include manuals, policies, internal working procedures, processes, plans, checklists, forms, guidelines, schedules, research reports, etc.

Clearly understandable and user friendly, these documents are controlled, readable, identifiable and readily available to PNRA officials. They are subject to revision based on feedback; internal and external lessons learnt; changes in organisational policies and strategies; and for reasons of effectiveness and improvement.

PNRA has a centralized system for the maintenance of regulatory documents and management system documents that are generated within PNRA, including regulations, regulatory guides, policies, PNRA management system manual and internal working procedures. For this purpose, PNRA has developed a central registry of all these documents. Figure 4 below presents the overall status of PNRA regulations, regulatory guides, policies and procedures registered in the central registry so far.

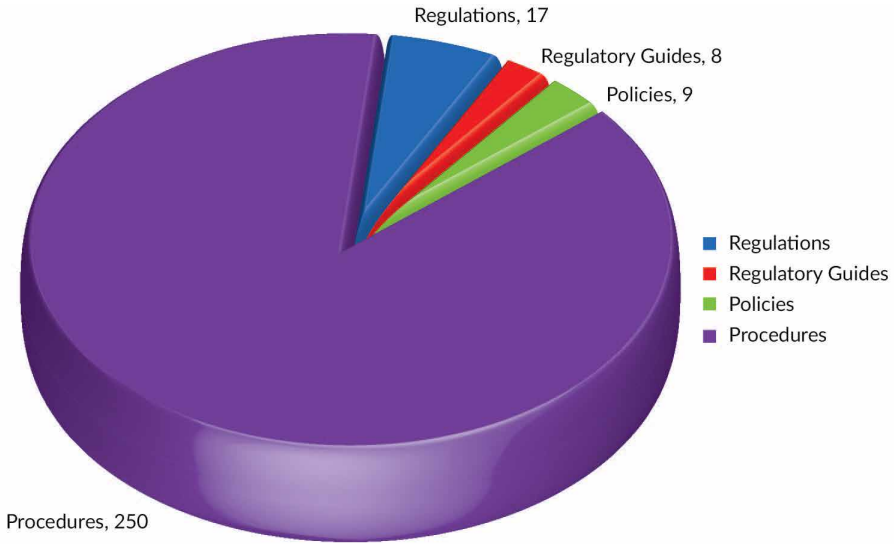


Figure 4: Status of PNRA Central Registry

Table 1: List of Gazette Notified Regulations

1 Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority - (PAK/900)	9 Regulations on Safety of Nuclear Power Plants-Quality Assurance - (PAK/912)
2 Regulations on Transaction of Business of Pakistan Nuclear Regulatory Authority - (PAK/901)	10 Regulations on Safety of Nuclear Power Plants - Operation - (PAK/913)
3 Regulations on Radiation Protection - (PAK/904)	11 Regulations on Management of a Nuclear or Radiological Emergency - (PAK/914)
4 Regulations for Licensing of Nuclear Safety Class Equipment and Components Manufacturers – (PAK/907)	12 Regulations on Radioactive Waste Management - (PAK/915)
5 Regulations for Licensing of Radiation Facilities other than Nuclear Installations - (PAK/908)	13 Regulations for the Safe Transport of Radioactive Material - (PAK/916)
6 Regulations for Licensing of Nuclear Installation(s) in Pakistan - (PAK/909)	14 Regulations on the Safety of Nuclear Research Reactor(s) Operation - (PAK/923)
7 Regulations on Safety of Nuclear Installations – Site Evaluation - (PAK/910)	15 Pakistan Nuclear Regulatory Authority Enforcement Regulation - (PAK/950)
8 Regulations on Safety of Nuclear Power Plant Design - (PAK/911)	16 Pakistan Nuclear Safety and Radiation Protection Regulations, 1990
17 Pakistan Nuclear Safety and Radiation Protection (Treatment of Food by Ionizing Radiation) Regulations, 1996	

Table 2: List of Regulatory Guides

1	Quality Assurance in Nuclear Medicine (PNRA-RG-904.01)
2	Guidance for the Users of Iodine - 131 in Nuclear Medicine Centers (PNRA-RG-904.02)
3	Probabilistic Safety Assessment of Nuclear Power Plants Level-1 (PNRA-RG-911.01)
4	Format and Contents of Application for Design Modifications in Nuclear Power Plants (PNRA-RG-913.02)
5	Format and Contents of Application for Modifications in Technical Specifications and Operating Policies and Principles of Nuclear Power Plants (PNRA-RG-913.03)
6	Dosage and Distribution of Potassium Iodide Tablets (a Thyroid Blocking Agent) in Radiation Emergencies (PNRA-RG-914.01)
7	Transportation of Radioactive Material by Road in Pakistan (PNRA-RG-916.01)
8	Registration/Licensing and Issuance of NOC to the Exporter(s) of Radiopharmaceuticals (PAK/9801)

3. OVERSIGHT OF NUCLEAR INSTALLATIONS

PNRA regulates all civilian nuclear installations and associated activities in the country through established regulatory instruments and processes like licensing; review & assessment; and inspection & enforcement. Such an installation remains under regulatory control starting with site registration until it is released from regulatory control upon successful completion of decommissioning and ensuring that no radiological hazard exists at the site.

PNRA registers sites and issues various authorisations after satisfactory review of licensees' submissions during various phases of installation's life cycle i.e. construction licence, fuel load permit, operation licence, etc.

Within PNRA's regulatory framework, these registrations and licences are accompanied by certain generic and specific conditions, which emanate from regulatory processes of review, assessment and inspection. PNRA conducts inspections to verify the compliance with the safety requirements during and after the issuance of licences or authorisations.

Currently, there are six operational civilian nuclear installations in Pakistan, which include three nuclear power plants (K-1, C-1 and C-2), two research reactors (PARR-1 and PARR-2) and one molybdenum production facility. In addition, commissioning of two nuclear power plants (C-3 and C-4) and construction of two nuclear power plants (K-2 and K-3) is in progress.

In 2015, PNRA completed the review of construction licence application of Karachi Nuclear Power Plant Unit 2 and Unit 3 (K-2 and K-3) and issued construction licences to these units. A listing, by status, of civilian nuclear

Table 3 : Civilian Nuclear Installations under PNRA's Purview, by Status

S.No.	Installation	Type	Capacity	Commercial Operation
IN OPERATION				
1.	Karachi Nuclear Power Plant Unit 1 (K-1)	Pressurised Heavy Water Reactor	137 MWe	1972
2.	Chashma Nuclear Power Plant Unit 1 (C-1)	Pressurised Light Water Reactor	325 MWe	2000
3.	Chashma Nuclear Power Plant Unit 2 (C-2)	Pressurised Light Water Reactor	340 MWe	2011
4.	Pakistan Research Reactor-1 (PARR-1)	Swimming Pool	10 MWt	1965
5.	Pakistan Research Reactor-2 (PARR-2)	Tank-in-Pool	30 KWt	1991
6.	Molybdenum Production Facility (MPF)	--	100 Ci	2013
IN COMMISSIONING PHASE				
7.	Chashma Nuclear Power Plant Unit 3 (C-3)	Pressurised Light Water Reactor	340 MWe	2016 (expected)
8.	Chashma Nuclear Power Plant Unit 4 (C-4)	Pressurised Light Water Reactor	340 MWe	2016 (expected)
UNDER CONSTRUCTION				
9.	Karachi Nuclear Power Plant Unit 2 (K-2)	Pressurised Light Water Reactor	1100 MWe	2020 (expected)
10.	Karachi Nuclear Power Plant Unit 3 (K-3)	Pressurised Light Water Reactor	1100 MWe	2021 (expected)

installations in operation, commissioning, and under construction is given in Table 3.

PNRA reviews and assesses the submissions made by the licensees or applicants in support of their applications for licensing or authorisation as required under PNRA regulations. The modifications, event reports, routine reports, plans, programmes and other documents required under various regulations, licence conditions and other regulatory requirements are reviewed by PNRA.

The objective of regulatory review and assessment is to determine whether the activities and performance of the respective applicant or licensee and the safety of the installation are in conformance with the pertinent regulatory requirements, i.e. PNRA regulations, licence conditions, applicable codes and standards, etc.

In case of non-conformance with the regulatory requirements, PNRA may reject licence application or may take an enforcement action necessary to ensure the safety of the installation, radiation workers, public, and the environment. During 2015, PNRA reviewed 14 design modifications and two event reports of K-1; and one design modification and 4 event reports of each of C-1 and C-2. PNRA also issued one directive each to K-1, C-1, C-2 and PARR-2.

Nuclear Installations in Pakistan

Nuclear Power Plants in Operation

Karachi Nuclear Power Plant Unit 1 (K-1)

Karachi Nuclear Power Plant Unit 1 (K-1) is a CANDU type pressurised heavy water reactor operating beyond its design life since 2003. During the year 2015, K-1 tripped three times mainly due to grid transients and also remained under long outage from September 13, 2015 to October 28, 2015 to carry out necessary maintenance, assessment, evaluation, testing and refurbishment jobs.

After holding a criticality meeting with KANUPP officials on 27 October 2015, PNRA granted authorisation to make the K-1 reactor critical in light of satisfactory completion of outage jobs and the resolution of safety issues identified through regulatory inspections.

K-1 completed its second Periodic Safety Review (PSR) during the year under consideration, on the course of which it submitted 100 reports covering 13 safety factors of the PSR. These reports were reviewed by PNRA and the issues identified by PNRA review team were discussed and resolved during the review meetings with K-1.

It is worth mentioning here that around 50 additional corrective actions have been undertaken by K-1, which arose as a result of PNRA's review of the PSR reports, and have since been incorporated into the K-1's PSR Corrective Action Plan. After completing the submission of PSR safety factor reports, K-1 submitted Global Assessment Report and Corrective Action Plan. The PSR was eventually accepted by PNRA based on the review of PSR safety factor reports and Global Assessment Report.

K-1 also submits different information and data about radiation safety activities and exposure of workers to PNRA in various licensing submissions. In monthly technical reports, information about the number of persons exposed; monthly collective dose; and average and maximum individual dose is provided – among other technical information.

During the year 2015, the review of monthly technical reports submitted by K-1 indicated that doses received by most of the radiation workers at K-1 during the reported period were well within the regulatory limit. However, a few workers did receive annual individual doses of more than 20 mSv. In such cases, the next step is to ensure that the total dose received by the workers in question over the five years is less than 100 mSv as required by national regulations.

Figure 5 represents the percentage of workers exposed to different dose ranges during 2015.

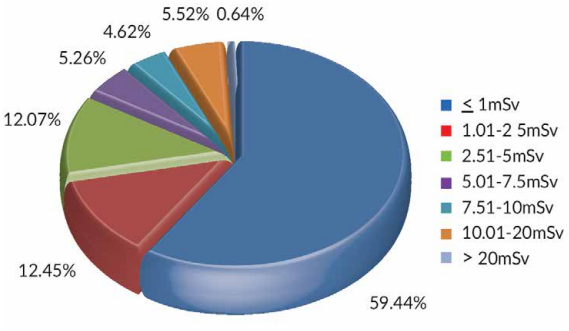


Figure 5: Annual Radiation Doses to K-1 Workers

Chashma Nuclear Power Plant Unit 1 (C-1)

Chashma Nuclear Power Plant Unit 1 (C-1) is a two-loop, pressurised, light water reactor. During the year 2015, C-1 tripped thrice mainly due to grid transients and also remained shut down from 11 September 2015 for its 10th Refueling Outage (RFO-10) until end of reporting year. During In-Service Inspection (ISI) activities of the turbine generator, indications of cracks were found on the blade roots of turbine and the duration of shutdown was increased for one and half month in order to resolve the issue. PNRA carried out an independent inspection to gather firsthand information about the issue. Objective evidences were collected to facilitate a thorough review of the issue and the subsequent regulatory decision.

C-1 submitted monthly technical reports during the year 2015, which included information and data about radiation exposure of workers at C-1. Among other data, these reports also provide information about number of people exposed; monthly collective dose; and average and maximum individual dose.

Doses received by most of the radiation workers at C-1 during the reported period were well within the regulatory limit. Figure 6 represent the graphical distribution of doses of workers of C-1.

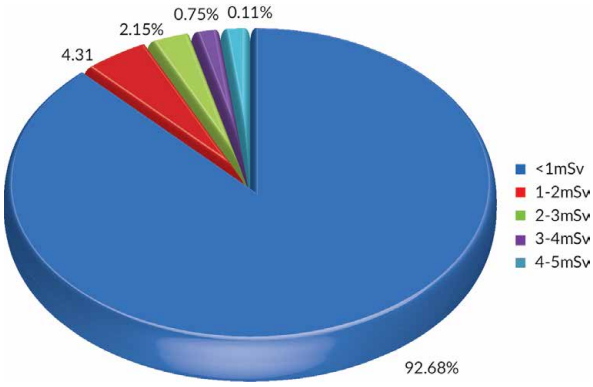


Figure 6: Annual Radiation Doses to C-1 Workers

C-1 underwent its 10th Refueling Outage (RFO) in the year 2015. During RFO-10 at C-1, the actual collective dose received by workers remained within the estimated collective dose as shown in Figure 7.

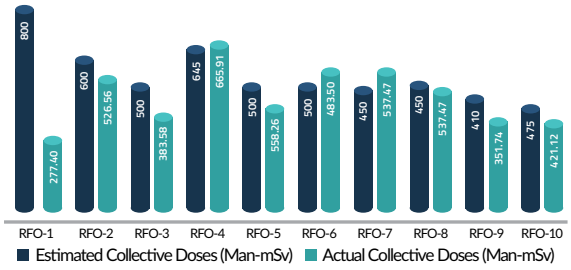


Figure 7: Estimated and Actual Collective Doses during C-1 RFOs

Chashma Nuclear Power Plant Unit 2 (C-2)

Chashma Nuclear Power Plant Unit 2 (C-2) is also a two loop pressurised light water reactor. During the year 2015, C-2 tripped twice and underwent its third Refueling Outage (RFO-3) from 7 August till 11 September 2015.

After satisfactory completion of outage jobs and resolution of safety issues identified through regulatory inspections, PNRA granted authorisation to restart C-2 after holding a criticality meeting on 5 September 2015. Thus began the fourth operating cycle of the plant.

During the reported period, review of monthly technical reports submitted by C-2 indicated that doses received by most of the radiation workers were well within the regulatory limit.

Figure 8 represent the graphical distribution of doses of workers of C-2.

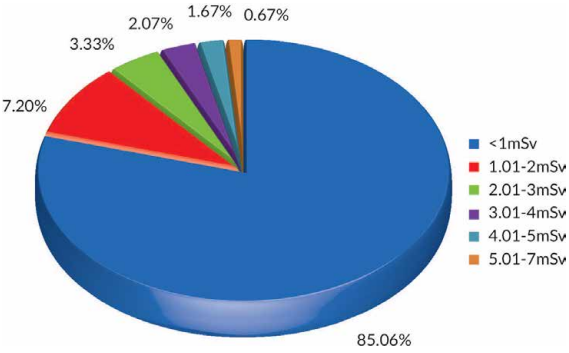


Figure 8: Annual Radiation Doses to C-2 Workers

During RFO-3 at C-2, the actual collective dose received by workers remained within estimated collective dose as shown in Figure 9.

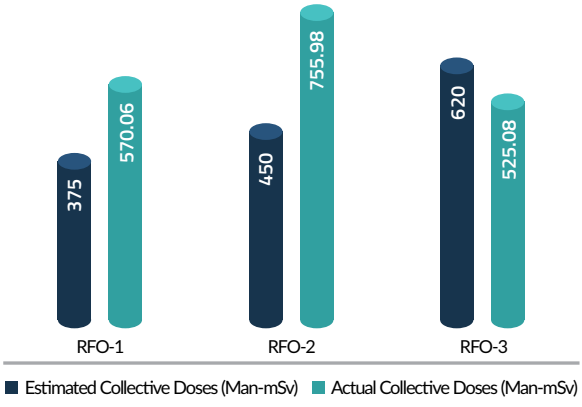


Figure 9: Estimated and Actual Collective Doses during C-2 RFOs

Nuclear Power Plants under Commissioning Phase

Commissioning is an important step during which systems and components are made operational in an integrated manner to verify that everything is functioning in accordance with the design parameters and meets the requisite performance and regulatory criteria.

During the reported period, PNRA granted authorisation for commissioning to Chashma Nuclear Power Plant Unit 3 and Unit 4 (C-3 & C-4) based on the satisfactory completion of review and assessment process. As a result, commissioning of these two units started and remained

PNRA Inspectors at Hydrostatic Test of C-3 Reactor Coolant System

in progress during the year. During the commissioning, PNRA conducted a number of regulatory inspections of the selected control points at C-3 and C-4 in order to ascertain that the safety systems are commissioned in the same way as had been presented in the safety analysis report.

During the year 2015, C-3 and C-4 also submitted applications for fuel load permit. After reviewing the preliminary content of the application, PNRA started a detailed review of the applications and raised a number of queries. Several review meetings were held with the licensee and its main contractors, including the designer, to address the issues raised by PNRA.

Nuclear Power Plants under Construction

During 2015, the review of K-2 and K-3 applications for issuance of construction licence was completed. Review meetings to discuss PNRA's queries on preliminary safety analysis report were held with K-2 and K-3 team, which was supported by their designer and main contractor in March and May 2015.

After satisfactory completion of the review, PNRA issued construction licences to K-2 and K-3. Quality assurance administrative inspection of K-2 and K-3 subcontractor was conducted in August 2015. In parallel, the manufacturing of long-lead equipment, i.e. Reactor Pressure Vessel, Steam Generators, Pressuriser, etc. for K-2 and K-3 is in progress. PNRA is participating in the regulatory inspections of selected control points during the manufacturing of these equipment.

Research Reactors

Pakistan Research Reactor-1 (PARR-1), a swimming pool type research reactor of 10 MWt output, is the country's first nuclear reactor, operating since 1965. Pakistan Research Reactor-2 (PARR-2), a tank-in-pool type research reactor of 30 kWt capacity, is operating since 1991. During 2015, PARR-2 submitted the documents that were either committed in PSR or required under licence conditions. PNRA is currently reviewing these submissions.

Based on the positive results achieved through coordination meeting with the management of the country's nuclear power plants, PNRA has started holding such meetings with PARR-1 and PARR-2 as well. During these meetings, issues and challenges pertaining to safety enhancement, future plans, challenges and performance excellence are discussed; and future strategy and line of actions are agreed/communicated.

Radiation safety aspects at PARR-1 and PARR-2 are also continuously evaluated. PARR-1 and PARR-2 submitted monthly technical reports and annual safety report describing operation history; reportable incidents; system performance and evaluation tests; personal radiation exposures; and QA activities, etc.

Review of these reports indicated that occupational exposure of the radiation workers at PARR-1 and PARR-2 during the reported period were well within the regulatory limit. Figure 10 represents the percentage of workers exposed to different dose ranges during 2015.

Chairman PNRA Awarding K-2 Construction Licence to Chairman PAEC

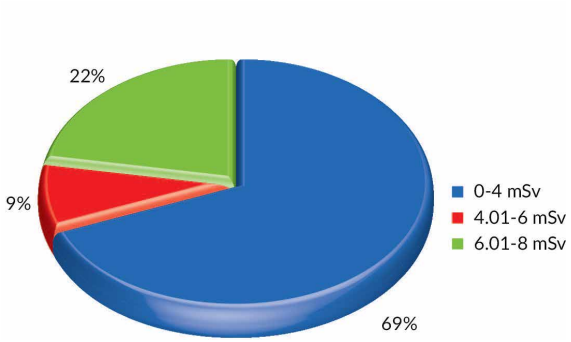


Figure 10: Annual Radiation Doses to Research Reactors Workers

Molybdenum Production Facility (MPF)

Molybdenum Production Facility (MPF) produces Molybdenum99 (Mo99) as the mother product for production of Technetium-99m (Tc99m) and is used in health sector for diagnosis of different types of cancer. Initially Molybdenum Production Facility (MPF) was licensed under PAK/908 as a radiation facility. During the reported period, the licence of MPF as a radiation facility was extended until 31 December 2015.

However, during the year 2015, PNRA made a determination, in line with IRRS recommendations, to licence MPF as a nuclear installation in order to ensure safety of MPF. Accordingly, regulatory requirements for the safe operation as a nuclear installation were identified and communicated to the licensee. The licensee has since submitted all the required documents and based on the review and subsequent acceptance of these submissions, MPF has been licensed to operate as a nuclear installation until 2022.

Licensing of Operating Personnel

Duly qualified and trained operating personnel are the cornerstone of PNRA's safety strategy. Accordingly, every effort is made to ensure that qualified and competent personnel operate the plants as required under the regulatory regime. On the request of plant management, PNRA conducts oral and practical examinations for the award of licences to plant operating personnel. Once issued, the licences are up for renewal annually in the light of the technical and professional competence. Completion of necessary retraining and medical fitness recommendation from a qualified medical practitioner is also a requirement which is verified by PNRA.

Details of new licences issued to C-1, C-2 and K-1 operating personnel are shown in Figure 11 and renewal of licences to C-1, C-2, and K-1 operating personnel is shown in Figure 12. Figure 13 provides the data of issuance and renewal of licences to operating personnel of PARR-1 and PARR-2 during the year 2015.

Regulatory Inspections of Nuclear Installations

The main purpose of regulatory inspections is to verify that the activities conducted by the licensees are in accordance with PNRA regulations, licence conditions and the directives issued by the Authority from time to time. Equally important, inspections help determine if

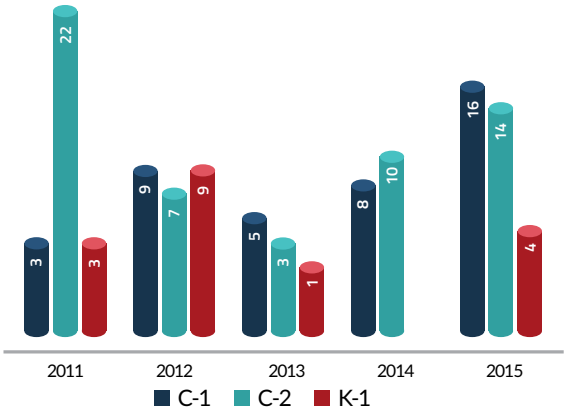


Figure 11: New Licences Issued to Operating Personnel of NPPs

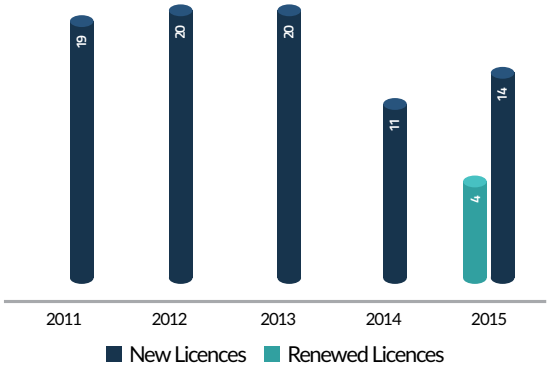


Figure 13: Issuance and Renewal of Licences to Operating Personnel of Research Rectors

the licensees are acting appropriately to promote safety culture within their organisations.

PNRA has established three Regional Nuclear Safety Directorates (RNSDs) for the conduct of regulatory inspections – one each in Islamabad, Kundian and Karachi, respectively designated as RNSD-I, RNSD-II and RNSD-III. Resident inspectors undertake regulatory inspections in their respective regions, with the directorates at PNRA headquarters providing them technical support whenever needed.

Inspections cover all phases of a nuclear installation's life cycle, i.e. construction, commissioning, operation, etc. They take place according to an approved inspection programme that incorporates annual inspection plans, procedures, and checklists; and may be planned or reactive, announced or unannounced.

The deficiencies observed during these inspections are communicated to the licensees in the form of inspection reports along with necessary requirements for corrective actions. A follow-up process is in place to ascertain satisfactory implementation of corrective actions.

Under the regional directorates' annual inspection plans, resident inspectors undertake a variety of routine and planned inspections of nuclear installations in their respective regions. General surveillance of various plant areas is conducted on a daily basis. Control point inspections of selected activities are also performed. Unplanned and reactive inspections are also carried out as and when required. Figure 14 represents number of inspections conducted at NPPs during last five years.

In addition to inspections at plant sites, control point inspections are also carried out during manufacturing of safety equipment, which are managed through PNRA headquarters. During the year 2015, a number of inspections of C-3, C-4, K-2, and K-3 were carried out by PNRA at various equipment manufacturing sites, which is summarised in Table 4.

During the year 2015, PNRA conducted regulatory inspections of PARR-1 and PARR-2 in the areas of reactor utilisation, operating policies & procedures, surveillance, safety systems, emergency preparedness, fire fighting, radiation safety, physical protection, management of

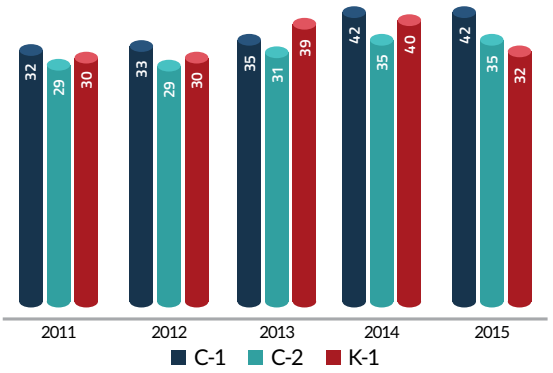


Figure 12: Renewal of Licences for Operating Personnel of NPPs

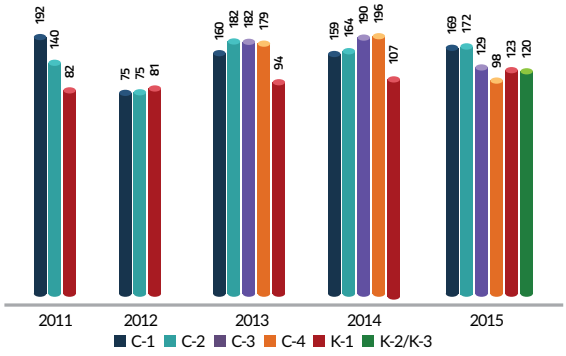


Figure 14: Regulatory Inspections of NPPs.

Table 4: Summary of Equipment Manufacturing Inspections of C-3/C-4 and K-2/K-3

Plant	Inspection Area
C-3/C-4	Witness Point Inspection of Performance Test of Reactor Coolant Pump of C-3
	Witness Point Inspection of Electrical Heater Performance Test of C-4 Pressuriser
	Witness Point Inspection of Hydrostatic Test of C-4 Pressuriser General Assembly
K-2/K-3	First QA Administrative Inspection of Contractor and Subcontractors of K-2/K-3
	Witness Point Inspection of Mechanical Property Testing of K-2 Pressuriser Forging

radioactive waste, etc. An overview of inspections conducted at PARR-1 and PARR-2 during 2011-2015 is given in Figure 15.

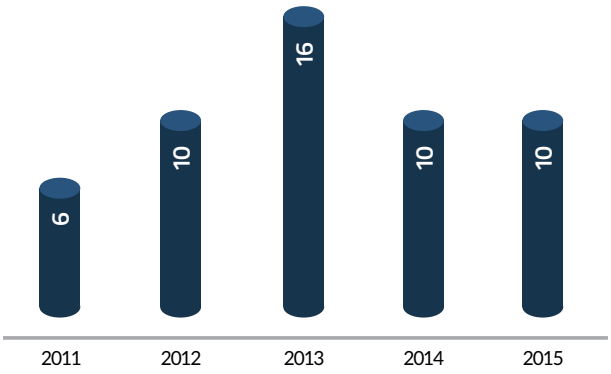


Figure 15: Regulatory Inspections of Research Reactors

Equipment Manufacturing

Under the licence issued by PNRA and subsequent PNRA's consent regarding manufacturing of equipment as per RCCM code, equipment manufacturing industry in Pakistan has started manufacturing of a number of safety class equipment for K-2 & K-3 projects.

PNRA inspectors perform inspections during the manufacturing of equipment for K-2 and K-3 projects to confirm compliance of the equipment with the regulatory requirements.

Criteria for PNRA Inspectors of Nuclear Installations

PNRA has established stringent eligibility criteria for its inspectors for conducting regulatory inspections of nuclear installations and associated activities. These include qualification, service and experience requirements for the officers to qualify as an inspector.

Any of PNRA officers meeting the eligibility criteria for a specific category may be designated as an inspector. Special identification cards are issued to the inspectors with specific validity period and are renewable upon expiry.

During the year under review, the eligibility criteria for inspectors remained under revision, based on the experience feedback.

Workshop on Ageing Management and PSR of Research Reactors

4. OVERSIGHT OF RADIATION FACILITIES

Use of radiation sources has become integral to everyday life in the world of today. In any modern society, radiation sources have a wide range of applications, helping improve the common citizen's life in diverse ways – and Pakistan is no exception. These sources are commonly used in agriculture, medicine, industry, oil well logging, security activities and research & development.

All applications of radiation sources carry the potential of exposing workers, the public, and the environment to radiation. Given the health hazards associated with exposure to high levels of radiation, every application of radiation needs to be carefully regulated from the standpoint of safety.

It is, therefore, mandatory for all radiation facilities in Pakistan to obtain licence or authorisation from PNRA, which in turn is responsible for enforcing safe operation of the sources and equipment installed/used within these facilities.

During various stages of licensing, PNRA requires submission of certain documents from the applicant such as radiation protection programme, emergency response plan, physical protection programme, ALARA plan and training programme to demonstrate the safety of the facility and activity for the protection of workers, the public and the environment.

Review and assessment of licensing submissions and inspection of radiation facilities are utilised to verify compliance with regulatory requirements, and where necessary, enforcement action is taken to rectify non-conformance.

PNRA applies a graded approach to regulate the facilities and activities with higher hazard potential attracting more stringent control measures, stricter safety requirements, and sterner enforcement action.

Radiation Safety at Radiation Facilities

Both PNRA's mandate and its posture are geared towards protecting workers, the public, and the environment from harmful effects of radiation. To meet these obligations, PNRA employs a whole range of regulatory instruments like regulations & regulatory guides; licensing & authorisation; review & assessment of the applicants' submissions; inspection; and where necessary, enforcement actions.

Review and assessment of licensees' submissions is the foremost regulatory tool used by PNRA to assess radiation safety at a prospective licensee's establishment. PNRA experts perform safety review and assessment regarding shielding design; facility layout; inventory of radiation sources; credentials and experience of radiation workers/ Radiation Protection Officer (RPO); etc.

PNRA also verifies, using a graded approach, arrangements for personal protective gears; personal and area monitoring equipment; radiation dosimetry; health surveillance; and physical protection measures during the review and assessment process.

Some of the major activities undertaken concerning safety at radiation facilities during the year included:

- Review of SAR of PET/CT & Cyclotron facility at Aga Khan University Hospital;
- Review of commissioning report of 6MV LINAC at Shifa International Hospital;
- Authorisation of drive-through X-ray scanning of suspected vehicles at airports installed by CAA;
- Investigation of a number of cases of reported overexposure of radiation workers; and
- Review and approval of a number of radiation protection programmes of various radiation facilities.

Given below is a summary of activities in the area of radiation safety at radiation facilities during the year 2015:

Licensing of Radiation Facilities

PNRA Ordinance requires all radiation facilities and activities in the country to be licensed by the Authority. Such licences, issued after thorough diligence, are usually valid for a period of one year, and require annual renewal based upon the acceptable safety and security status of the facility.

As of now, all radiotherapy centers, nuclear medical centers, irradiators, practices involving use of radiation sources in industry, industrial radiography and research are under the licensing ambit of PNRA. However, some of the medical diagnostic facilities are still outside the licensing net of PNRA.

Over the past few years, PNRA has undertaken strong advocacy to bring these remaining radiation facilities under the ambit of licensing. Our efforts have borne fruit, leading to an appreciable increase in the number of licensed X-ray facilities during this period. By the end of 2015, licensed radiation facilities and activities numbered in excess of 4,400.

Among facilities licensed so far by PNRA are 75 medical centers; 163 industrial users; 60 research institutes; 115 importers; 3,914 diagnostic X-ray facilities; and 120 other radiation facilities.

During the year under review, PNRA initiated legal action, in line with the enforcement procedure stipulated in enforcement regulations of the Authority, against those found in violation of safety provisions.

Inspections of Radiation Facilities

Regulatory inspection of radiation facilities is a key instrument in the regulatory oversight process of PNRA, as these help the Authority verify firsthand whether a licensee complies with the provisions of PNRA Ordinance, regulatory requirements, licence conditions and other directives of PNRA.

Section 29 of PNRA Ordinance 2001 empowers the Authority to inspect all facilities using ionising radiation. These powers extend over all activities related to radiation protection at such facilities and enable the Authority to accomplish its mission of protecting the workers, the public, and the environment from the harmful effects of ionising radiation.

Accordingly, PNRA conducts regulatory inspections of all radiation facilities and activities such as diagnostic & interventional radiology; nuclear medicine; radiotherapy; industrial radiography; nuclear gauges & scanners; educational institutes; research & development organisations; traders & manufacturers of consumer products and irradiators; etc.

The objective of these inspections is to ensure that radiation sources – whether radioactive materials or radiation generators – are used safely; and radiation workers possess the requisite qualifications, skills, and experience.

PNRA's inspection programme for radiation facilities and activities is a reflection of the Authority's commitment. The programme lays down in specific detail, the types and frequency of regulatory inspections applicable to different radiation facilities and activities.

An initial inspection is mandatory before licensing a radiation facility. Subsequently, PNRA routinely undertakes periodic inspections to monitor continued compliance with safety provisions. An annual inspection plan to conduct routine inspections of radiation facilities and activities is prepared each year. Special inspections may be undertaken whenever deemed necessary.

The annual inspection plan includes various types of inspections like planned and special inspections, both of which are either announced or un-announced. The frequency of inspections targeted at a facility is commensurate to the safety implications and hazards associated with it.

To ensure effective regulatory oversight through the conduct of timely inspections of radiation facilities across the country, PNRA has established three regional nuclear safety directorates, one each at Islamabad, Kundian, and Karachi; and three regional nuclear safety inspectorates, one each at Peshawar, Quetta and Multan.

During an inspection, PNRA verifies, among other matters, the availability of personal protective gears; a qualified RPO; personal and area monitoring equipment; radiation dose records; and physical protection arrangements.

In accordance with the annual inspection plan, in 2015, PNRA undertook more than 3,100 inspections of radiation facilities. Figure 16 presents a year-by-year view on inspections which PNRA undertook over the past five years.

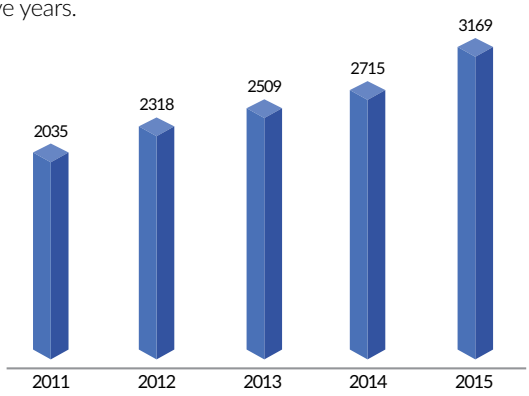


Figure 16: Year-by-Year View on Regulatory Inspections of Radiation Facilities

The findings of an inspection, including any compliance gaps and suggestions for improvement, are included in post-inspection reports, which are shared with the inspected facilities. A follow-up mechanism is in place to help ensure compliance.

Criteria for PNRA Inspectors of Radiation Facilities

PNRA has established stringent eligibility criteria for its inspectors for conducting regulatory inspections

of radiation facilities and activities. These include qualification, service and experience requirements for the officers to qualify as an inspector.

Any of PNRA officers meeting the eligibility criteria for a specific category may be designated as an inspector.

During the year under review, the eligibility criteria for inspectors remained under revision, based on the experience feedback.

Occupational Exposure at Radiation Facilities

PNRA obtains and maintains occupational exposure records of radiation workers as reported by dosimetry service providers as well as by each radiation facility across the country. A database developed at PNRA, containing such records since the year 1998, helps track trends in occupational exposures and effectiveness of each facility's radiation protection programme.

This database has two basic sources of input: dosimetry data submitted by the licensee through regional directorates and the data provided by the dosimetry service providers. Currently, the database includes dose records of around 9,000 radiation workers of various categories such as radiotherapy, nuclear medicine, industrial sector, research & education, diagnostic radiology, etc.

Distribution of radiation workers in various categories is shown in Figure 17.

According to the record available to date, annual radiation doses to 95 percent of radiation workers remain less than 5mSv while 4.23 percent of workers received doses between 5-20 mSv. A small fraction of workers – 0.77 percent of the total – received doses in excess of 20 mSv.

Although the five-year average annual doses of the latter remained within the regulatory limit of 100mSv, the licensees have been advised to investigate the cause of such relatively high doses and to take necessary corrective actions, if needed.

A representation of radiation workers in different dose ranges is given in Figure 18.

Authorisation of Import and Export of Radiation Sources

PNRA follows a cradle-to-grave approach while tracking records of all radiation sources including radiation generators imported and used in the country. PNRA Ordinance requires any person intending to acquire, design, manufacture, construct, install or operate any device that contains any radioactive material or produces ionising radiation, to be licensed by PNRA.

According to PNRA regulations, only licensed importers and exporters of radioactive sources or radiation generators are authorised through "No Objection Certificate" (NOC) to import or export radioactive sources and/or radiation generators.

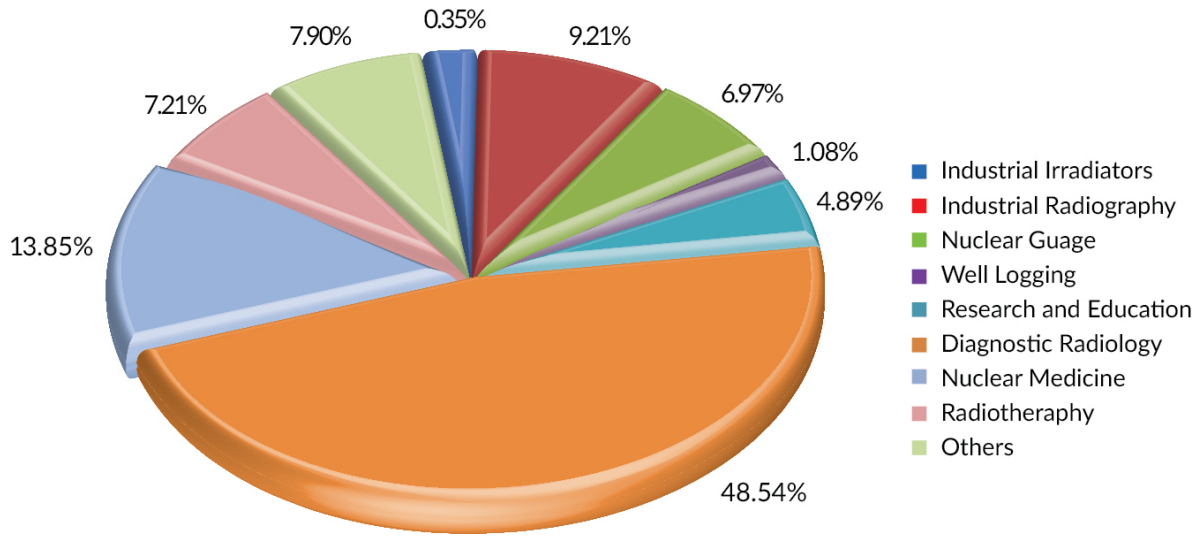


Figure 17: Radiation Workers in Different Radiation Facilities

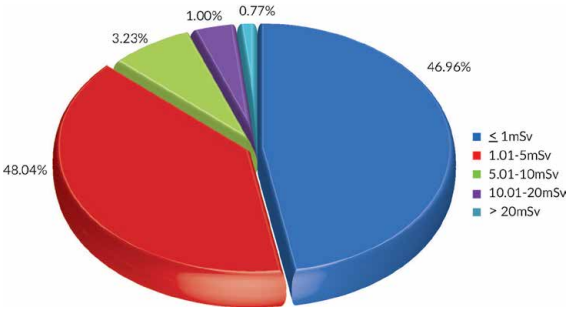


Figure 18: Radiation Workers in Different Dose Ranges

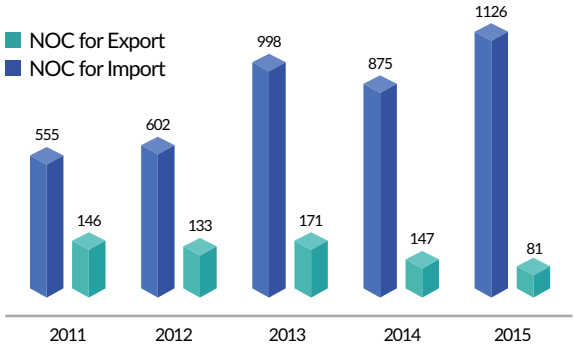


Figure 19: Issuance of NOC for Import-Export of Radiation Sources

PNRA issues an NOC only after verification of the intended end use, end user and the technical specifications of the radiation source to be imported or exported.

Another precondition that PNRA maintains for an NOC is that a licensee may purchase a high activity radioactive source only after obtaining an undertaking from the supplier or manufacturer to accept the return of the source at the end of its useful design life as a part of the purchase contract.

Some countries of origin may require a special permit prior to placement of order for procurement of radioactive sources or radiation generators. In such cases, PNRA after necessary verifications, issue the requisite permit in the name of the licensee.

During the year 2015, PNRA issued more than 1,100 NOCs for the import of new radiation sources and empty containers and 80 NOCs for the export of disused radiation sources and empty containers. Figure 19 is a graphical representation of comparison of the issuance of NOCs in 2015 with the previous years, while Figure 20 shows the usage of radioactive sources in various categories.

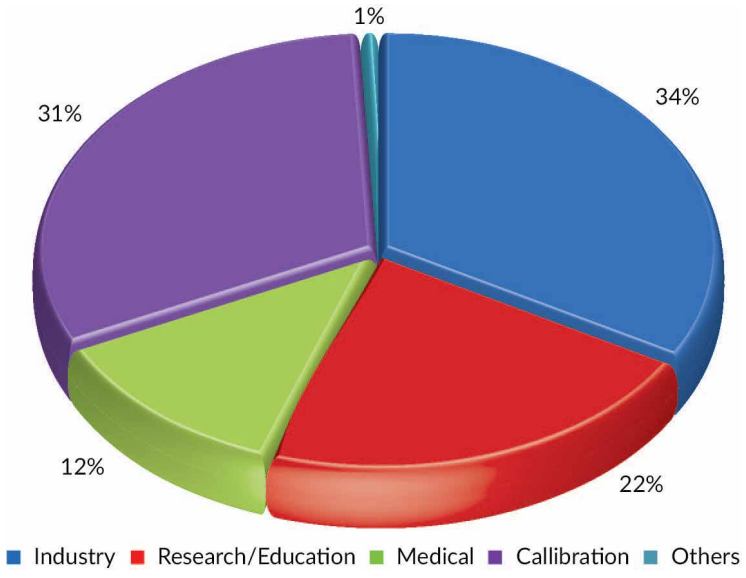


Figure 20: Sealed Radiation Sources by Usage

5. RADIOACTIVE WASTE & TRANSPORT SAFETY

PNRA regulates all radioactive waste generated during operation and decommissioning of nuclear installations, radiation facilities and associated activities in the country. Radioactive waste management is a critical area of PNRA's regulatory regime as exposure to radioactive waste may pose serious hazards to human health and safety. PNRA makes every effort to deal with it according to internationally accepted principles and best practices in the light of Pakistan's national policy on control and safe management of radioactive waste.

While PNRA strives to ensure the protection of human health and the existing environment, equally hard efforts are made to ensure that any undue burden is not imposed on future generations.

To minimise the challenges of managing radioactive waste generated during operation and decommissioning of nuclear installations and radiation facilities, PNRA pays utmost importance towards this activity and requires every user to adopt such technologies and methods that reduce the generation of radioactive waste. PNRA further requires its licensees of radioactive material to manage the radioactive waste using proven technology. These requirements are stipulated in Regulations on Radioactive Waste Management (PAK/915).

Radioactive material is regularly transported throughout its life cycle, i.e. from production until disposal and it may need to cross international borders for legitimate reasons. It is important to comprehensively regulate such transportation activity to ensure protection of workers, the public and the environment from the hazards of radiation.

PNRA is also responsible for regulating transportation of radioactive material in the country. A stringent and effective regulatory framework is, therefore, indispensable to ensure safe transportation of radioactive material. With this end in view, PNRA has promulgated Regulations on the Safe Transport of Radioactive Material (PAK/916).

To ensure compliance with the regulations, PNRA undertakes a thorough review and assessment of licensee's submissions, certification of packaging and authorisation of shipments and regulatory inspections.

Radioactive Waste Safety at Nuclear Installations

There are six nuclear installations generating radioactive waste in the country; producing low, intermediate, and high level radioactive waste. Three of these are operational nuclear power plants (K-1, C-1 and C-2), two are research reactors (PARR-1 and PARR-2) and one is a molybdenum production facility.

PNRA maintains a comprehensive inventory of radioactive waste generated at these nuclear installations and ensures that all licensees are managing radioactive waste appropriately by taking suitable measures for its classification, segregation, treatment, conditioning and storage.

Regular inspections of nuclear installations are conducted by PNRA to verify compliance with regulatory requirements concerning radioactive waste management and the implementation of radioactive waste management programmes and procedures.

During the reported period, a number of inspections were conducted. These inspections yielded some recommendations for further improvement in the implementation of radioactive waste management programmes and procedures.

Discharges from nuclear installations can also be a source of hazardous radiation. PNRA ensures that such discharges are kept to a minimum so that exposure to the public and the environment remain As Low As Reasonably Achievable (ALARA).

Nuclear Power Plants

During the year 2015, both gaseous and liquid radioactive effluents from K-1 remained lower than the Derived Release Limits (DRLs). Solid radioactive waste generated during the year has been stored in mild steel drums in the Radioactive Waste Storage Area (RAWSA) at K-1. Figure 21 shows the graphical representation of the compacted solid waste drums at K-1.

During the year under review, the levels of radioactive effluents from C-1 and C-2 to the environment also remained well below the technical specifications' limits.

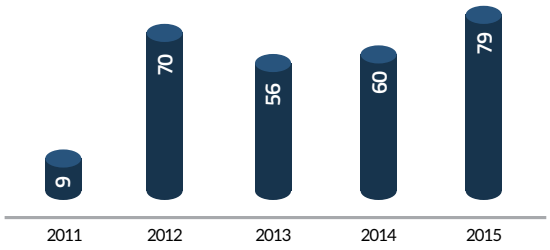


Figure 21: Year-by-Year View on Compacted Solid Waste Drums at K-1

PNRA ensures that C-1 and C-2 are managing their radioactive waste in accordance with the approved Radioactive Waste Management Programme (RWMP). Radioactive waste generated at C-1 & C-2 is processed and categorized into two types namely compacted waste and solidified waste. The waste comprising tissues, dungarees, rubber shoes, gloves etc. is compacted whereas waste comprising resins and concentrates is solidified. This compacted waste and solidified waste is stored in mild steel drums in the radioactive waste storage building at the plant site.

Currently, C-1 is in the process of expanding its storage capacity by establishing an extended waste storage facility at its site. Construction and commissioning of the facility has been completed and it is expected to start operation in 2016.

Figure 22 shows the number of compacted and solidified waste drums at C-1 and C-2.

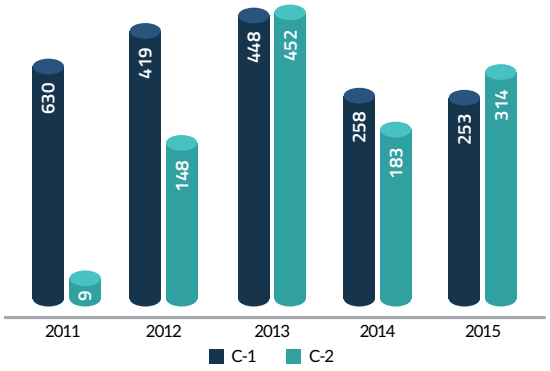


Figure 22: Year-by-Year View on Compacted and Solidified Waste Drums at C-1 & C-2

Radioactive Waste Management Facilities

Currently, radioactive waste generated in the country is being stored in the predisposal radioactive waste management facilities. The geological study is in progress to locate a suitable place for final disposal of such waste in the national repository. Existing radioactive waste management facilities include PINSTECH Predisposal Radioactive Waste Management Facility and K-1 Radioactive Waste Storage Area. These are briefly described below:

PINSTECH Predisposal Radioactive Waste Management Facility

As per national policy on control and safe management of radioactive waste, PINSTECH Predisposal Radioactive Waste Management Facility is one of the designated interim storage facilities for Disused Sealed Radioactive Sources (DSRS) and low-level waste generated from industrial, medical and research facilities located in the northern part of Pakistan. The radioactive waste is stored in Reinforced Cement Concrete (RCC) barrels at PINSTECH. The number of cementised and compacted containers of radioactive waste stored at PINSTECH during last five years is shown in Figure 23.

The facility was previously licensed under the general licence of PINSTECH, but the licensee made a submission to PNRA in 2012 for its independent licensing. The licensing process for this facility is underway under the Regulations for Licensing of Nuclear Installation(s) (PAK/909).

The review of safety analysis report and associated documents such as quality assurance programme, radiation protection programme and emergency preparedness programme has been completed and all queries raised during the review have been adequately addressed by the applicant. The facility is expected to be licensed in early 2016.

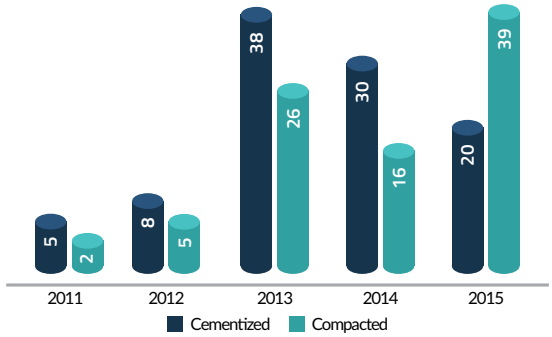


Figure 23: Year-by-Year View on Cementised and Compacted Radioactive Waste Containers at PINSTECH

Radioactive Waste Storage Area at K-1

Radioactive Waste Storage Area (RAWSA) at K-1 is another site designated for collection of radioactive waste generated from the operation of nuclear installations and radiation facilities in southern part of Pakistan as per national policy on control and safe management of

radioactive waste. This facility is covered under operating licence of K-1. However, in 2012, K-1 extended the facility to increase the available storage capacity for its solid radioactive waste.

As per regulatory requirements, K-1 submitted the Safety Assessment Report for modification and extension of RAWSA to PNRA, which was approved in 2015 upon thorough review and satisfactory resolution of review queries.

Inspections in the Area of Radioactive Waste Management

PNRA conducts inspections of nuclear installations and radiation facilities to verify compliance with regulatory requirements concerning radioactive waste management and the implementation of radioactive waste management programmes and procedures. These inspections mainly focus on radioactive waste storage facilities to assess the safety of radioactive waste collection, classification, treatment, conditioning and storage.

During the reported period, a number of inspections were conducted at K-1 and PINSTECH. These inspections yielded some recommendations for further improvement in the implementation of radioactive waste management programmes and procedures.

Decommissioning

Once a nuclear installation is declared by the licensee to be permanently shutdown, the installation is decommissioned to secure release from regulatory control. Currently, no nuclear installation is under decommissioning in Pakistan.

However, PNRA Regulations for Licensing of Nuclear Installation(s) (PAK/909) in Pakistan require an Initial Decommissioning Plan (IDP) at the time of issuance of permit to introduce nuclear material in the installation.

During the reported year, PNRA reviewed revision 2 of initial decommissioning plan submitted by K-1 and review queries were communicated to K-1 for compliance. The decommissioning strategies of C-1 and C-2 were approved by PNRA, however it was agreed in the coordination meeting between PNRA and C-1/C-2 that both installations will submit their initial decommission plan to PNRA. C-3 also submitted the Initial Decommission Plan, which is under review at PNRA. Similarly, the Initial Decommissioning Plan of Pakistan Research Reactor-2 (PARR-2) and Molybdenum Production Facility (MPF) were reviewed and comments were communicated to the respective licensees.

PNRA realises that there is a need to establish a process for addressing the transition phase between the operation and decommissioning of a nuclear installation, to ensure effective regulatory control after the permanent shutdown of a nuclear installation. The Authority is conducting a study with a view to working out a strategy to deal with this situation.

Radioactive Waste Safety at Radiation Facilities

PNRA strives hard to ensure that the radioactive waste generated at radiation facilities besides nuclear power plants and research reactors, i.e. industries and nuclear medical centers, is being managed and disposed off in a safe manner. A large part of radioactive waste generated in the industry is in the form of radioactive sources that have completed their useful life. Such sources are stored at the designated storage sites.

Radionuclides used in nuclear medical centers are short-lived. As per the regulatory requirements, nuclear medical centers are required to store their radioactive waste safely for at least ten half lives, after which they may treat it as ordinary waste.

PNRA ensures the implementation of regulatory requirements through inspections and record review. Inspections of radiation facilities are conducted to verify compliance with the regulatory requirements concerning radioactive waste management and the implementation of radioactive waste management programmes and procedures.

During the reported period, a number of inspections of nuclear medical centers were conducted. These inspections were aimed to provide recommendations for further improvement in the implementation of radioactive waste management programmes and procedures at radiation facilities.

Under the requirement of national regulations, nuclear medical centers are required to prepare their radioactive waste management programme and submit it to PNRA for review and approval. PNRA reviewed radioactive waste management programmes of ten nuclear medical centers during the year under review.

Management of Disused Sealed Radioactive Sources (DSRS)

The licensee has the responsibility for safe disposal of radioactive waste including Disused Sealed Radioactive Sources (DSRS) produced by radiation facilities in the country. The Regulations on Radioactive Waste Management (PAK/915) also describe the responsibilities of licensee for the safe and secure management of DSRS.

The importers of radioactive sources having a half life of more than one year and with initial activity greater than

100 GBq are required to return such material to the original supplier when the source is no longer useful. PNRA does not issue the NOC for procurement of radioactive sources unless this condition is included in the purchase contract.

PNRA maintains an inventory of DSRS in the country. Going by the inventory status at the end of 2015, out of the total sealed radioactive sources, 32 percent are in use by licensees, 5 percent have been returned to the supplier, and the remaining 63 percent have been safely deposited at the designated storage sites. The DSRS stored at the designated sites mainly include Cobalt-60, Cesium-137, Iridium-192, and Radium-226. Figure 24 shows the graphical representation of the status of SRS in the country.

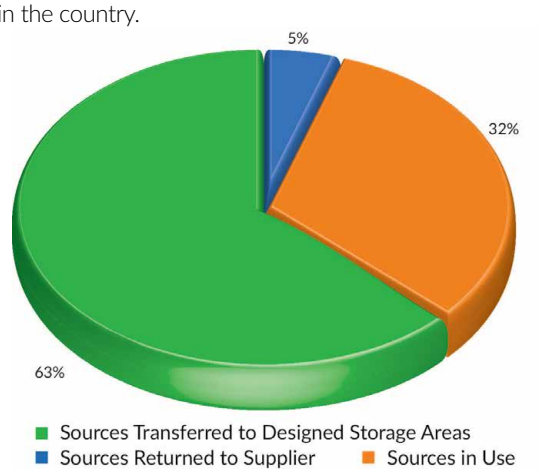


Figure 24: Status of SRS

For radioactive sources having activity below the exemption limit, the Authority issues a clearance certificate. The licensee is required to deposit such sources at a designated radioactive waste storage facility.

Irretrievable radioactive sources stuck during oil well logging operations are also managed properly through the implementation of licensees' abandonment procedures approved by PNRA.

Safe Transport of Radioactive Materials

PNRA ensures safe and secure transportation and associated activities in the country in accordance with regulatory framework. Such activities are on the upsurge with the growing application of radioactive materials in medicine, research and power production facilities.

PNRA maintains a record of movement of high activity radioactive sources and shipments involving nuclear material. During the year under review, 147 such source movements or shipments were recorded.

PNRA ensures that consignors fulfill their obligations and comply with the national requirements for safe transportation of radioactive materials and sources within the country.

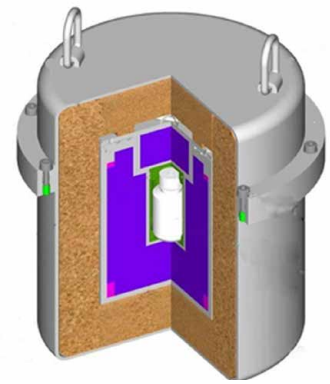
Regional directorates of PNRA conduct routine and periodic inspections, some of them unannounced, to verify compliance of regulatory requirements. All radioactive consignments imported into the country and exported under contract must be duly authorised by PNRA. The shipping documents of such consignments are evaluated and permissions granted after confirming that the shipments meet national and international safety and security requirements for the transportation of nuclear materials / radioactive sources.

Certification of Type B(U) Packaging

From the standpoint of safe transport of radioactive material, the importance of packaging designed and built to withstand accident conditions cannot be overemphasised. All such packagings produced in Pakistan must have the design approval certification from PNRA. PINSTECH applied for the certification of Type B(U) Packaging from PNRA in accordance with requirements of Regulations on the Safe Transport of Radioactive Material (PAK/916). Designed to transport radio-pharmaceuticals, the PINSTECH's Type B(U) Packaging is the first such packaging being produced in the country.

PNRA reviewed the applicant's SAR, quality assurance programme, functional test reports and witnessed functional qualification tests for normal and accident conditions. In 2015, the applicant successfully performed water immersion test and leakage test on the prototype package, both of which were witnessed firsthand by PNRA inspectors.

PNRA also conducted review meeting with the applicant on the queries raised during the review of licensing submissions. All the queries have since been satisfactorily resolved. The outcome of inspections and the review is to be incorporated in the revised SAR by the applicant; subsequent to which a certificate may be issued by PNRA in early 2016.



PINSTECH TYPE B(U) Transport Package (PRTP-001)

Authorisation for Domestic Transportation of 660 Series Gamma Projectors

Packagings produced abroad can secure PNRA's authorisation for use in Pakistan upon presenting a valid Type B(U) design certificate issued by the appropriate authority of the country of origin.

A major issue was experienced concerning the transportation of 660 series gamma projectors – originally designed by QSA Global, USA – when their design certificate expired in 2013 because the designer did not seek its revalidation from the respective US regulatory authority. The licensees were not in a position to replace the projectors at once due to various reasons not related to safety.

PNRA allowed a grace period of one year and initiated a study on the regulatory solutions to resolve the matter. Meanwhile, the Authority granted "Permission for Domestic Transportation of 660 Series Gamma Projectors by Road Only" under the special arrangements as per PNRA Regulations (PAK/916).

For the implementation of this proposal, PNRA reviewed the management system and radiation protection programmes on safe transport of radioactive material of eight NDT firms and performed their regulatory inspections during the reported period.

Depending on the actual condition of each projector borne out by review and inspection findings, some of the 660 series gamma projectors were allowed to remain in use as transport containers for a further period of six months while some were allowed extended use for one year. Some of them were deemed not fit for further use and were required to be disposed-off in the designated storage facility.

Safe Management of Spent Nuclear Fuel

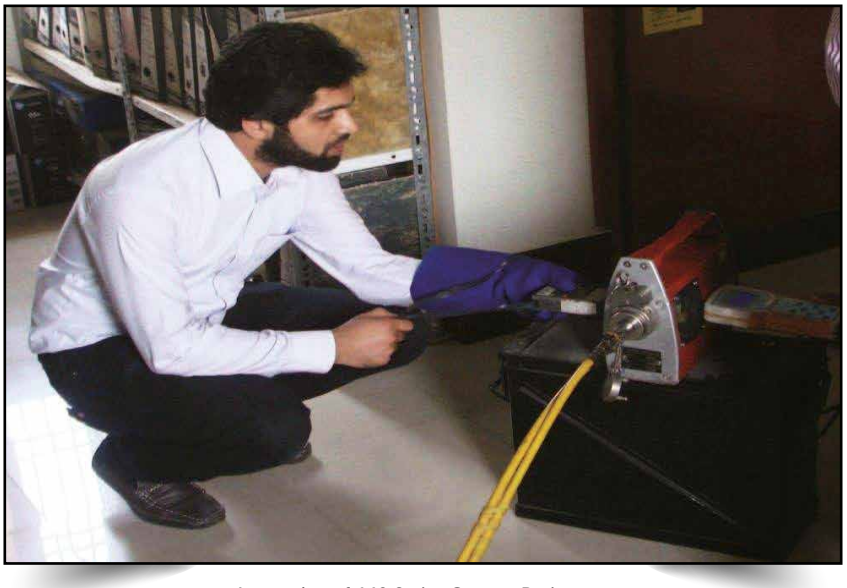
International best practice calls for nuclear fuel irradiated at nuclear reactors to be managed safely after its permanent withdrawal from the reactor. The first step for such material is that it may be stored on-site in purpose-built spent fuel pools for a certain period for cooling. The same approach is being followed by the nuclear power plants in Pakistan as per national regulatory framework.

Certification of Spent Nuclear Fuel (SNF) Dry Storage Cask

Spent nuclear fuel dry storage is an internationally established technology used at nuclear power plants worldwide to enhance the ability to meet their spent nuclear fuel storage needs. The NPPs in Pakistan are adopting this approach to enhance storage capacity for spent fuel at nuclear reactors' pools for the rest of their operational life, especially K-1.

For this purpose, the licensee has submitted its intention for the design and manufacturing of Spent Nuclear Fuel Dry Storage Cask. PNRA has worked out and agreed on the codes and standards to be followed for the licensing with the applicant.

The PSAR for the design and manufacturing of Spent Nuclear Fuel Dry Storage Cask for K-1 has also been submitted to PNRA in September 2015. The review of 1st phase (Format & Contents) of the PSAR has been completed, which will be followed by detailed review to ascertain compliance with the safety requirements.



Inspection of 660 Series Gamma Projectors

6. EMERGENCY PREPAREDNESS & RESPONSE

PNRA ensures that all nuclear installations and radiation facilities in Pakistan are designed and operated in such a manner that their designs intrinsically prevent the occurrence of any nuclear accident or radiological emergency. However, the possibility of such incidents cannot be eliminated completely through design or operational measures.

An incident at a radiation facility may lead radioactive sources to cause radiation injuries, overexposure of individuals or spread of contamination within or outside the facility. A severe accident at a nuclear installation may lead to the releases of a range of radioactive elements comprising of gases and fission products to the environment.

Such releases may cause severe deterministic health effects in the vicinity of the installation and stochastic effects at larger distances along with widespread radioactive contamination of the environment.

Although the probability of such incidents is very low, robust measures are essential for ensuring proportional preparedness and effective response to nuclear accidents and radiation emergencies at national, local and facility level. Such measures are complemented with stringent regulatory oversight to ensure the protection of lives, property and environment from harmful effects of ionising radiation.

In Pakistan, regulatory framework for the management of a nuclear or radiological emergency is an integral part of overall nuclear safety regime. The Government of Pakistan has vested in PNRA the responsibility to ensure, coordinate and enforce preparation of emergency plans for actions to be taken by the relevant onsite and offsite authorities following foreseeable nuclear incidents that might affect the public.

Under the obligations of the Ordinance, PNRA has established detailed requirements in the form of Regulations on Management of a Nuclear or Radiological Emergency (PAK/914) to ensure adequate levels of preparedness and response to a nuclear accident or radiological emergency for minimization of the consequences for people, property and the environment.

The regulations require maintaining emergency preparedness infrastructure for coordinated response both within and outside the facilities, for the sources under the control of the licensee, including actions to be taken both during and after the emergency.

Under these regulations, licensees are bound to coordinate with local authorities responsible for interventions during emergencies and with national authorities responsible for the provision of necessary support in case the consequences are expected to go beyond the control of licensee and subsequently local authorities.

On the part of licensee, preparedness is ensured through training and retraining of emergency response personnel and periodic emergency drills and exercises. The responsibilities of all the stakeholders, including decision makers involved in emergency response, are defined in emergency plans prepared by the licensee. A coordination mechanism is also established beforehand for implementing such decisions both within and outside the facility.

PNRA ensures that complete emergency preparedness and response arrangements are in place and tested before introducing nuclear fuel into the systems of a nuclear installation or, in case of radiation facility, before a radioactive material is brought into a facility with potential for significant radiation hazards requiring protective measures. The permission for commencement of the operation is not granted until these arrangements are demonstrated to the entire satisfaction of the Authority through an emergency exercise.

PNRA is also responsible, as per the Ordinance, to advise the Federal Government and other authorities concerned on the implementation of necessary safety and protection measures. This is practiced under the mechanisms established in Nuclear Emergency Management System (NEMS) and is tested during different emergency exercises.

National Radiation Emergency Coordination Centre (NRECC)

Pakistan is a state party to the IAEA's Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency.

These conventions require the designation of a

competent authority; and establishment & continuous availability of a point of contact, authorised to make & receive notifications and requests for assistance in the member states.

For the fulfillment of the obligations of these conventions, in Pakistan, Chairman PNRA is the designated competent authority for coordination with IAEA. PNRA has established National Radiation Emergency Coordination Centre (NRECC) at its Headquarters in Islamabad, which acts as a point of contact/national warning point and remains available round-the-clock for receipt and dissemination of emergency notifications; and initiation & coordination of emergency response at national and international level.

NRECC is equipped with dedicated and diverse communication facilities, radiation detection equipment, personal protective equipment, mobile radiological monitoring laboratories and a technical support team comprising experts from various directorates of PNRA.

PNRA has established a network of six mobile radiological monitoring laboratories with field response teams, composed of highly trained individuals. These mobile laboratories and field response teams are strategically located in major cities across the country - Islamabad, Chashma, Karachi, Peshawar, Multan and Quetta. The purpose of these teams is to provide technical assistance to local and national response authorities and to perform independent assessment of any emergency situation involving nuclear or radioactive material.

Being the point of contact, NRECC also receives information regarding emergency incidents and events occurring worldwide through the IAEA Unified System for Information Exchange in Incidents and Emergencies (USIE) web portal and Nuclear Events Web-based System (NEWS) website. NRECC disseminates this information within PNRA and to the relevant stakeholders in order to keep them abreast with the worldwide operating experience feedback and to learn lessons from such experiences for further improvement in our own emergency management system.

Emergency Plans and Procedures

PNRA regulations require the licensees of nuclear installations and radiation facilities to submit emergency preparedness and response plans describing their actions and responses to various types of nuclear accidents and/or radiation emergencies.

The Authority reviews and approves the onsite emergency plans and ensures that the plans are demonstrated properly through the conduct of periodic emergency drills and exercises. The offsite plans approved by the government at appropriate level are reviewed for acceptance by PNRA. In 2015, PNRA reviewed a number of such emergency response plans of nuclear installations and radiation facilities.

Among nuclear installations, PNRA reviewed initial emergency plan for K-2 and K-3, submitted as part of preliminary safety analysis report. The plan has been accepted following necessary modifications based on the recommendations made by PNRA. Emergency plans for C-3 and C-4, PARR-II, PINSTECH Predisposal Radioactive Waste Management Facility and revised onsite plan for K-1 were also reviewed by PNRA.

Among radiation facilities, the emergency plans of PET/Cyclotron facility of Aga Khan University Hospital, Karachi; PINSTECH Iodine Production facility; and several other industries and hospitals were reviewed. In total, more than 25 emergency plans for radiation facilities were reviewed in 2015.

Emergency Drills and Exercises

PNRA officials participate and evaluate different types of emergency drills and exercises conducted at following levels:

1. PNRA level - to verify the availability of communication channels and to test the capability of field response teams;
2. National level - to ensure the effectiveness and implementation of emergency plans of installations and facilities; and
3. International level - to verify the international communication channels and response capabilities during different emergency situations.

The detail of these exercises conducted during 2015 is given below:

Emergency Exercises at PNRA Level

NRECC conducts various emergency exercises to test its own preparedness and response arrangements for various emergencies. These exercises include Communication Test Exercise (COMTEX) and Mobile Radiological Monitoring Laboratory (MRML) field exercise.

The COMTEX is conducted thrice a year to check the availability and reliability of communication channels established with the licensees and other relevant national organisations; whereas, the MRML field exercise is conducted twice a year to test the procedures and operations of field response teams in emergency situations.

When such field exercises take place in cities besides

Islamabad, these are organised in coordination with the respective regional directorates of PNRA through involvement of regional field response teams.

Field Exercise of First Responders and Paramedics at PNRA Headquarters

Emergency Exercises at National Level

Exercises are an essential component of the demonstration of emergency preparedness and response infrastructure. PNRA sets forth the requirements to conduct emergency drills and exercises through regulations and tracks such activities.

PNRA reviews and evaluates the emergency drill and exercise planning, execution and documentation by the licensees. These drills and exercises are conducted by the licensees on a frequency determined in advance jointly with PNRA and offsite authorities and documented in emergency plans and procedures.

The two types of emergency exercises conducted at nuclear installations are partial emergency exercise and integrated emergency exercise. In partial emergency exercises, either onsite or offsite emergency response plans are tested; while in integrated emergency exercises, both the onsite and offsite plans are tested simultaneously.

During the year 2015, PNRA evaluated partial emergency exercises of CNPGS (Offsite Emergency Exercise), K-1 (Site Emergency Exercise) and PARR-1 (Facility Emergency Exercise). An inspection of PARR-1 was also conducted to verify the implementation status of corrective actions recommended by PNRA at the conduct of the exercise in 2014.

In addition, a national exercise involving several organisations, code-named Air Time-3, was conducted near the federal capital in 2015. PNRA participated in the exercise that kicked off on 4 May and concluded on 8 May 2015.

During the exercise, the capabilities for aerial monitoring during nuclear accidents and radiation emergencies were tested. The field teams of different organisations including PNRA were deployed on the ground for testing the radiation monitoring capabilities to locate the hotspots identified through aerial survey.

Emergency Exercises at International Level

PNRA regularly participates in various types of Convention Exercises (ConvEx) conducted by the Incident and Emergency Centre of IAEA, known as ConvEx-1, ConvEx-2 and ConvEx-3 with varying scope and objectives.

The objective of these exercises is to test the emergency notification and communication arrangements; response capabilities in various emergency situations; and the mechanisms in place to offer and receive international assistance in case of nuclear and radiation emergencies.

PNRA participates in these exercises to test the availability and capabilities of national contact point and competent authorities designated under Early Notification and Assistance Conventions.

In 2015, PNRA participated in six ConvEx exercises including ConvEx-2b, which continued for about three days.

A summary of all these exercises conducted during the year 2015 is given in Table 5.

Table 5: Emergency Exercises Conducted During 2015

Sr. No	Type of Exercise	Conducted
Exercises at PNRA Level		
1	COMTEX	February
2	MRML	May
3	COMTEX	June
4	COMTEX	October
5	MRML	November
Exercises at National Level		
1	CNPGS Partial Offsite Emergency Exercise	June
2	K-1 Site Emergency Exercise	December
3	PINSTECH Facility Emergency Exercise	December
Exercises at International Level		
1	ConvEx-2a	March
2	ConvEx-1c	April
3	ConvEx-1a	July
4	ConvEx-2b	August
5	ConvEx-1b	November
6	ConvEx-2c	December

Training and Awareness on Emergency Preparedness and Response

NRECC conducts various types of training courses for the licensees – among them are nuclear installations and radiation facilities – as well as for the first responders to a nuclear accident or a radiological emergency. Most of these courses are organised through the National Institute of Safety and Security (NISAS)–PNRA's own training arm based at PNRA headquarters – while some are conducted with the support of the IAEA.

In 2015, PNRA organised three training courses through NISAS and one training course with the assistance of the IAEA. More than 200 participants from various organisations – including users of SRS from industries, hospitals and research institutions; personnel from NPPs, rescue services, police and customs; and doctors & paramedical staff – were provided training on various aspects of handling radiation emergencies.

The NRECC also provided support to the SPD and National Institute of Disaster Management (NIDM) of National Disaster Management Authority (NDMA) in organizing training courses on emergency preparedness and response at national level.

PNRA also participated in disaster management exhibition for the awareness of general public, students, responders and other organisations, organised by the Centre for Disaster Preparedness and Management, University of Peshawar (UoP) from 2-3 December 2015.

Radiation detection equipment, personal protective equipment, brochures and pamphlets were displayed at PNRA stall for the information of the visitors. The exhibition was attended by approximately 25,000 visitors, including the general public and the students of various educational institutions.

IAEA Response and Assistance Network (RANET)

As part of the IAEA's strategy for supporting the implementation of the Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency, the IAEA Incident and Emergency Centre (IEC) manages the IAEA Response and Assistance Network (RANET). RANET is an IAEA member states network dedicated to providing international assistance upon request from a member state, following a nuclear or radiological incident or emergency.

Pakistan is a member of RANET since 2008 and PNRA is the National Assistance Coordinator for RANET activities in Pakistan. Pakistan has registered national assistance capabilities with RANET in four areas, i.e. Radiological Assessment and Advice; Source Search and Recovery; Radiation Monitoring; and Environmental Sampling and Analysis.

NRECC coordinates all the activities related to RANET with other stakeholders in Pakistan as well as with the IAEA. In 2015, PNRA activated the national arrangements for the provision of assistance under an IAEA ConvEx-2b emergency exercise.

National Workshop on Decision Making During Emergency at PNRA Headquarters

7. HUMAN RESOURCE MANAGEMENT

The human resource of an organisation is its very backbone. The role of competent human resource becomes even more vital for a knowledge-intensive organisation, like PNRA, for performing regulatory tasks.

Nuclear regulatory bodies' need a motivated workforce well versed in all regulatory disciplines and equipped with up-to-date knowledge of nuclear and radiation safety. This calls for continuous training and development of human resources in all areas of regulatory disciplines.

Mindful of the significant nature of its mission, PNRA is continuously striving to enhance the competence of its workforce through training and retraining in all the areas of technical disciplines; legal and regulatory framework; regulatory processes and practices; management system; personnel skills and behaviour; etc.

After the establishment of PNRA in 2001, to supplement the available experienced workforce, young engineers and scientists were recruited in the organisation. They were knowledgeable in basic sciences and engineering, but their knowledge and skills of regulatory practices; application of technical skills; and personal and interpersonal skills required to be strengthened.

PNRA undertook competence need assessment of its workforce to quantify the capacity gaps and identified a range of training courses needed to help enhance their required competencies. Today, the Authority has a comprehensive capacity building programme for its workforce, which includes capacity building through training, both in-house and with national and international institutions. What follows is a summary of PNRA's capacity building activities:

In-House Capacity Building

The efficacy of PNRA's education and training programme in nuclear and radiation safety is evident from the rapid development of regulatory competence which PNRA has achieved in the short period since its inception. Owing largely to this programme, PNRA has been able to provide capable indigenous regulatory oversight to nuclear installations and radiation facilities in the country.

Over the years, PNRA has also worked to help cultivate advanced knowledge among its licensees and other stakeholders by inviting their participation in training sessions, workshops and seminars.

PNRA is of the firm belief that such activities help further understand nuclear safety and security requirements as well as the scope and nature of the Authority's regulatory role. This understanding ultimately contributes to an improvement in both the safety culture of the nuclear installations and radiation facilities and their regulation by PNRA.

Demonstration of Training Facilities to Course Participants and Visitors

PNRA, slowly but steadily, built its training infrastructure from the ground up through PSDP-funded projects. These efforts culminated in the establishment of the School for Nuclear and Radiation Safety (SNRS) and Nuclear Security Training Centre (NSTC), which were later merged in 2014 to form the National Institute of Safety and Security (NISAS).

Based at PNRA headquarters, NISAS has a faculty well versed in nuclear science and technology and equipped with valuable knowledge and experience of regulatory matters.

NISAS has identified and initiated, in light of the competence need assessment, a number of training modules at junior, intermediate and senior levels. One of these training modules has been specifically designed for the new entrants and is named as "Basic Professional Training Course Level-I" which focuses on areas like nuclear regulatory perspective, fundamentals of nuclear safety and security, radiation protection, regulatory practices and control, etc. This training course has been conducted 14 times in PNRA since 2003. In order to provide in-depth and comprehensive knowledge of nuclear power plant systems, radiation safety, radioactive waste management and nuclear security & physical protection; separate training modules have been specifically designed for the intermediate cadre officials. This course has been named as "Professional Training Course Level-II". During the period 2003-2015, this training course has been conducted 16 times in PNRA.

Training in Nuclear and Radiation Safety

Training activities in various areas of nuclear and radiation safety attract participants from both the Authority as well as the nuclear installations and radiation facilities under the regulatory oversight. Majority of the participants of such courses come from health and industry sectors.

It is essential that radiation protection officers, supervisory staff, technologists and technicians of radiation facilities have good understanding of the application methodology of ionising radiation, radiation protection fundamentals and regulatory requirements.

Notably, no institute in Pakistan offers professional training specific to nuclear safety and radiation protection, therefore, PNRA has taken the lead in training and educating personnel from all stakeholder organisations including radiation workers to ensure that they have good understanding of the regulatory processes and requirements.

Since 2006, NISAS and its predecessor institutions have conducted 186 training courses, drawing around 4,100 personnel from the Authority and the regulated sector. In 2015, NISAS continued its training programme, organising 16 training courses for more than 450 personnel from PNRA, PAEC, and other stakeholders.

Figure 25 presents the number of participants and training courses held by NISAS during the past five years.

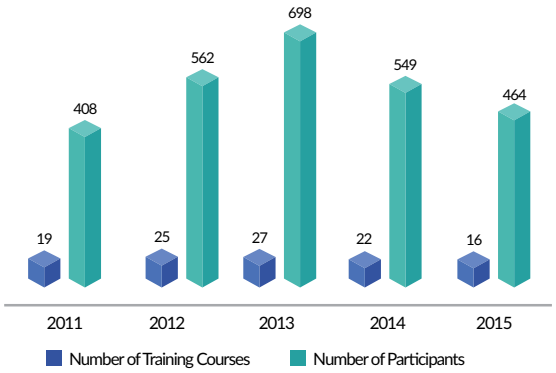


Figure 25: Training Courses and Number of Participants

Trainings in Nuclear Security and Physical Protection

Nuclear and radioactive materials are widely used for peaceful purposes in the country under regulatory supervision of PNRA. However, the possibility that there would be people bent upon using such materials for malicious purposes cannot be ruled out.

Every effort, therefore, must be made to guard against radioactive materials being stolen, lost or illegally acquired; or associated facilities being sabotaged by individuals or groups. Hence, the need arises to establish and strengthen a nuclear security regulatory regime to help prevent, detect and respond to such nuclear security threats, in order to protect the public, workers and the environment from the consequences of any malicious actions.

To this end, the responsible organisations and their employees must be qualified, skilled and experienced in analysing national nuclear security needs, preventing and detecting the use of nuclear and radioactive materials for malicious intent; and well prepared to respond to nuclear security incidents.

PNRA has been playing very prominent role in knowledge sharing and providing hands-on-training to nuclear security personnel in Pakistan including licensees, front-line officers, response organisations and security agencies.

Over the last five years, PNRA has conducted 61 training courses in the area of nuclear security in which more than 1,250 officials from various organisations have participated. In 2015, it arranged seven such courses, drawing a total of 155 participants from PNRA, PAEC, SPD and other relevant organisations.

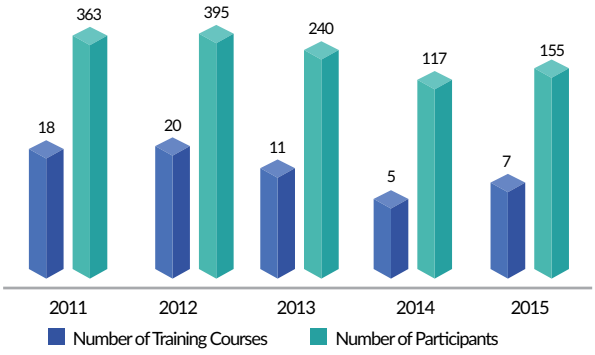


Figure 26: Overview of Nuclear Security Training Courses

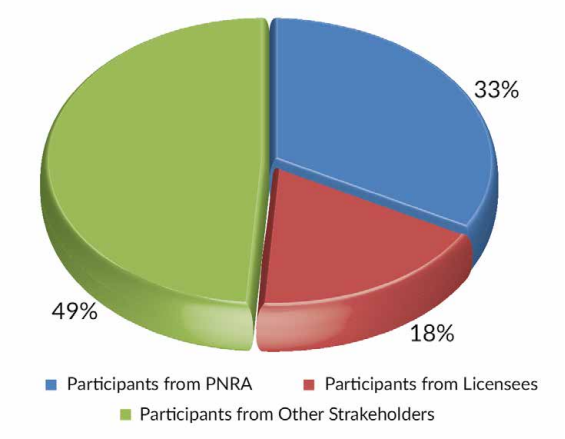


Figure 27: Distribution of Participants from Various Organisations Trained in 2015

The number of nuclear security training courses and participants from 2011 to 2015 are shown in Figure 26.

Figure 27 represents participants from different organisations in courses organised by NISAS in 2015.

Hands-on Training

NISAS possesses necessary training aids; state-of-the-art laboratories including a Non-Destructive Testing (NDT) laboratory, a radiation detection equipment laboratory, physical protection laboratories having intrusion detection, access control and CCTV systems; and a nuclear mock-up facility with scaled-down physical models of main NPP components like reactor pressure vessel, fuel assembly, steam generator, reactor coolant pump and pressuriser.

These training facilities are utilised mainly for hands-on training of the participants of various courses conducted by NISAS. The institute has also developed NPP Soft Panel Training Simulator (SPTS) for hands-on training of nuclear power plant start-up and shutdown to study various accident scenarios for R&D purposes. The simulator has been designed and developed with the collaboration of PAEC. In 2015, the SPTS was expanded by adding five more panels to enable extended execution of abnormal operating events and accident conditions at NPPs.

A computer centre has been established to assist learning,

Soft Panel Training Simulator at NISAS

automated examination, training on computer codes and development of CAD-based simulations and other virtual training aids. This centre has played a pivotal role in the competence development of PNRA workforce and stakeholders in nuclear safety, regulatory control, radiation protection and nuclear security in Pakistan.

The scaled-down physical models of the main components of a Pressurised Water Reactor (PWR) type NPPs, maintained at PNRA's training institute have been used for training of the regulatory personnel as well as students from other organisations.

Virtual Training Aids

PNRA has developed virtual models and videos of major plant equipment to further supplement trainings. The virtual models have been indigenously developed using CAD-based 3D prototypes and video tools to show the design and assembling of different parts of major nuclear power plant components to form a single entity. Labeling and audio commentary is included to facilitate learning.

These training facilities are also used during visits of local and foreign delegates as a showcase of regulatory competence. In 2015, NISAS also arranged visits for 24 delegations in which 315 participants visited various laboratories in PNRA.

Among our visitors were DG SPD, participants of IAEA Physical Protection Regional Training Course, participants of PIEAS Senior Officers Management Course (SOMC), CHASCENT engineers, participants of workshop for Law Enforcement Agencies and SPD female security force.

Knowledge Sharing Programme

PNRA has initiated a Knowledge-Sharing Programme under which it invites senior officials of the strategic organisation and other prominent dignitaries. The idea is for the veterans to share their pioneering experiences with young scientists and engineers from PNRA and other scientific establishments of the country. After listening to such eminent personalities, young professionals always emerge inspired to meet future professional and regulatory challenges in a proficient manner.

In 2015, PNRA invited Mr. Jamshed Azim Hashmi, the founding Chairman of PNRA; Dr. Inam-ur-Rahman, the founding Rector of PIEAS; Mr. Pervez Butt, former Chairman, PAEC; Dr. Anis Ahmad, Vice Chancellor, Riphah University; and Dr. Ansar Parvez, former Chairman, PAEC to share their proud legacy with the young generation.

Panel Discussions

In order to strengthen the capabilities of our regulatory personnel, PNRA has instituted a series of panel discussions. Panelists, invited to participate in such discussions, are experts in various regulatory disciplines. A structured discussion followed by a questions & answers session is an effective tool for knowledge enhancement. In 2015, four panel discussions were organised on various regulatory issues.

In-House Lectures

On routine basis, PNRA arranges in-house informatory lectures by subject-matter experts and invites renowned speakers from various organisations. In 2015, PNRA arranged a number of lectures covering various aspects in the domain of leadership and management.

Capacity Building through National Institutions

PNRA is always striving to enhance the capacity of its workforce through strong collaboration at national level with PIEAS, KINPOE, Secretariat Training Institute, Pakistan Manpower Institute and other national institutions.

Collaboration with PIEAS and KINPOE

PNRA sponsors promising and hardworking Pakistani graduates for masters degree programmes in Nuclear Engineering, Systems Engineering, Medical Physics and Nuclear Power Engineering at Pakistan Institute of Engineering and Applied Sciences (PIEAS) and Karachi Institute of Power Engineering (KINPOE). These fellows join PNRA after completion of their degree from these institutions.

Since 2003, this practice has resulted in the induction of 95 scientists and engineers into the ranks of PNRA. In 2015, 15 young graduates were awarded fellowships for master's degree in nuclear and system engineering at PIEAS and KINPOE while 14 fellows from the earlier batch (2013-2015) joined PNRA workforce after successful completion of fellowship.

PNRA also offers a number of projects to such fellows in the areas of regulatory importance. One such project in 2015 focused on the assessment of concentration of Naturally Occurring Radioactive Materials (NORMs) in the residues generated by processes involved in the oil and gas industry within Pakistan.

The assessment was based on sampling and survey of oil and gas well sites in the Sindh province. The evaluation also identified various approaches to manage NORMs waste based on acceptable international practices.

Collaboration with other National Institutions

PNRA maintains strong liaison with several national institutes for capacity building and knowledge

enhancement of its regulatory personnel in a variety of technical fields as well as management sciences.

In 2015, 172 PNRA officials participated in 79 training courses at various national institutes such as Pakistan Institute of Management (PIM), Secretariat Training Institute (STI), Pakistan Welding Institute (PWI), etc.

Figure 28 shows the participation of PNRA employees in various training courses arranged by these institutes from 2011 to 2015.

Capacity Building through International Institutions

To keep abreast of the avant-garde nuclear regulatory knowledge and practice, PNRA is always alive to learn from international experiences and developments. To this end, PNRA interacts with various institutions and organisations at international level for the capacity building of its workforce.

PNRA seeks assistance from IAEA through various technical cooperation programmes for organisational capacity building and to enhance expertise of its workforce in the relevant fields.

During 2015, young engineers and scientists from PNRA benefited from various IAEA programmes designed to enhance capacity of its member states through international workshops, training courses, fellowships, etc. On the whole, during this year, 48 PNRA officials participated in 42 international events. Figure 29 presents a summary of PNRA's quest for knowledge at the international level.

Capacity Building through Public Sector Development Projects

PNRA considers PSDP projects invaluable for acquisition of appropriate infrastructure, human resources and state-of-the-art technology to strengthen nuclear regulatory regime in the country. Designed with an eye on the future expansion of civil nuclear technology in Pakistan, these projects are geared towards institutional strengthening, enhancing regulatory effectiveness and human resource development of PNRA. At the moment, we have three such projects in progress.

The Safety Analysis Centre (SAC), an ongoing PSDP project of PNRA since 2010, is aimed to harvest enhanced regulatory support in NPP safety analyses indigenisation in Pakistan. It has improved PNRA expertise in several technical areas such as deterministic and probabilistic safety analyses; design basis and beyond design basis accident analyses; structural analysis; electrical and Instrumentation & Control (I&C) systems; NPP modeling and design assessment etc. along with acquisition of various state-of-the-art software systems and techniques to strengthen regulatory capabilities.

Another project "PNRA Residential Colony Chashma", initiated in 2014, is aimed to provide safe and secure housing facilities to PNRA officials in the vicinity of Chashma Nuclear Power Complex where no urban area or proper residential facilities exist.

In the aftermath of Japan's Fukushima accident, PNRA has recently initiated a project for upgrading its National Radiation Emergency Coordination Centre (NRECC). This project has been started to develop and enhance PNRA's capabilities to access technical information, meteorological data of the NPP sites and environmental radiation levels on real time basis in case of a nuclear accident or radiological emergency. This centre will help PNRA to monitor accident progression and advising the decision makers about necessary protective measures to be taken at appropriate time so as to avoid undue exposure to the general public.

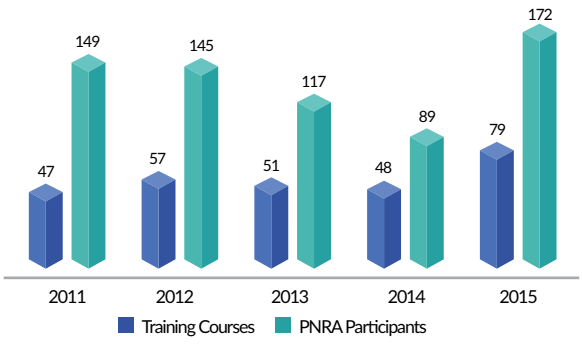


Figure 28: Capacity Building Through National Institutions

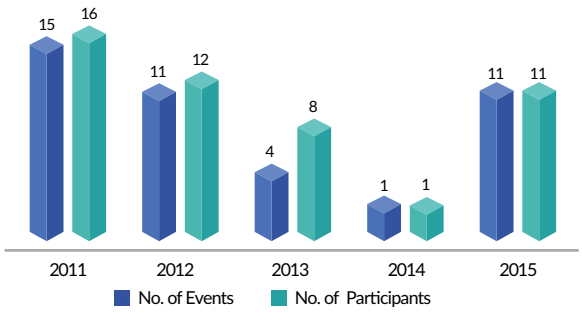


Figure 29: Capacity Building Through International Institutions

8. NATIONAL & INTERNATIONAL COOPERATION

The ability of an organisation to follow sustainable development derives from its adaptability, its approach towards creative change and its extent of cooperation with other organisations. PNRA considers cooperation with the national and international community is an important and integral element contributing to its sustainable development.

This national and international cooperation is a powerful source of harmonisation in the regulatory practices and processes for effective regulatory control of the regulated facilities and activities. Moreover, it helps in ensuring the smooth, safe and secure functioning of nuclear installations and radiation facilities all over the country.

At the national level, PNRA coordinates with the relevant governmental authorities, organisations and departments for the purpose of effective regulatory control; and with research institutes and universities for research in various areas of nuclear and radiation safety for human resource development.

At the international level, PNRA is continually making efforts to establish effective linkages with international community through a range of bilateral and multilateral cooperation programmes and is striving to keep-up these linkages.

PNRA seeks IAEA's technical cooperation through Technical Cooperation Projects for organisational capacity building. PNRA highly appreciates the efforts of the IAEA for continuous improvement and looks forward to become a role model for the international community through exemplary conduct.

PNRA not only generates expertise in the relevant areas for its own working but also provides its expert support to international regulatory missions and training courses in other countries. Moreover, PNRA provides assistance to IAEA in the development of IAEA documents and provides experts for implementing IAEA safety and security programmes.

PNRA is also a point of contact for international conventions related to nuclear safety, physical protection, and nuclear and radiological emergencies to which Pakistan is a signatory.

National Cooperation

PNRA firmly believes that collective efforts along with licensees and relevant government departments are very important for enhancing nuclear safety and security in the country.

Equally important in this connection is the awareness of the public about the applications of ionising radiation in everyday life; their harmful effects on human health and the environment; protection needed in the use and application of nuclear or radioactive materials; and strategies to reduce the severity and mitigate the consequences, if an incident does occur.

PNRA involves all the stakeholders, including licensees and the general public, in the regulatory process. Draft regulations are circulated among licensees and their feedback sought; any comments or suggestions they volunteer are given due consideration in finalising the regulations. Similarly, draft regulations are placed on PNRA website for input and comments from the general public.

A series of periodic meetings at different levels with nuclear installations' licensees has been initiated by PNRA since 2007. PNRA conducts bi-annual coordination meetings with management of operating nuclear power plants, research reactors, molybdenum production facility and equipment manufacturers. PNRA conducts, on quarterly basis, coordination meetings with management of under construction/commissioning nuclear power projects. Top management level periodic coordination meetings with PAEC being the operator of major nuclear installations are also conducted with quarterly frequency for Chairman to Chairman meeting and with bi-annual frequency between different Members of PAEC and PNRA.

PNRA also conducts training courses on regular basis to develop and enhance understanding of the licensees and radiation workers on the implementation of relevant regulatory requirements.

In 2015, PNRA arranged four courses for industrial radiographers, radiotherapy/nuclear medicine technologists, X-ray radiographers and paramedical staff of various medical radiation facilities. A number of participants from various X-ray facilities, medical centers, industries and irradiation facilities attended these courses.

In addition, more than 400 personnel from nuclear installations, radiation facilities and other relevant

organisations participated in various training courses offered by PNRA.

A public awareness campaign instituted by PNRA in 2008 is underway as part of which, necessary information is disseminated through lectures, seminars and printed leaflets targeting the youth in educational institutions all over the country.

As component of this campaign, such seminars also target government and private organisations. In 2015, PNRA conducted 22 lectures and seminars in Islamabad, Lahore, and Peshawar, which altogether covered more than 2,300 participants. These seminars – addressing the benefits and risks associated with the use of ionising radiation in everyday life and means of protection against these risks – were conducted at hospitals, medical centers, law enforcement agencies, schools, colleges and universities. Figure 30 represents the number of lectures/seminars and participants of the public awareness programme, over past five years.

Among the topics covered in these lectures were safety aspects of radiology, nuclear medicine and radiotherapy; radiological accidents and their consequences; and protection against radiation releases. PNRA utilises these events to inform the audience about the regulatory framework in effect for nuclear power plants and radiation facilities in Pakistan.

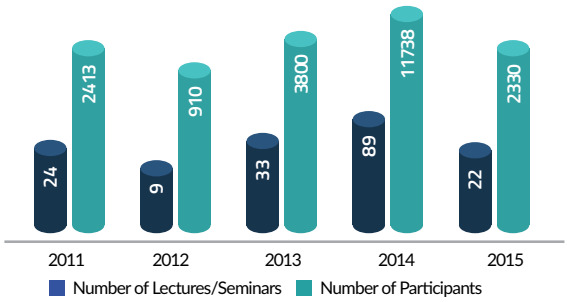


Figure 30: Lectures/Seminars and Participants of Public Awarness Programme

International Cooperation

Meeting International Obligations

Pakistan is a signatory to four international conventions related to nuclear safety, physical protection, and nuclear and radiological emergencies.

Pakistan acceded to Convention on Early Notification of a Nuclear Accident and Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency on 11 September 1989. Pakistan signed the Convention on Nuclear Safety on 20 September 1994; and acceded to the Convention on Physical Protection of Nuclear Materials in September 2000. In addition, Pakistan also follows the Code of Conduct on Safety and Security of Radioactive Sources.

PNRA is the national point of contact for the purposes of these conventions. The Authority also serves as focal organisation and assists the Government of Pakistan in the execution of its obligations under these international conventions.

PNRA attaches great importance to the fulfillment and implementation of its international obligations and represents the country at the respective international forums.

During the year under review, Pakistan participated in the "Diplomatic Conference for Discussing Swiss Proposal for Amendment to Article-18 of the Convention on Nuclear Safety", held at IAEA headquarters, Austria from 9 to

Public Awareness Seminar at Police College, Sihala

10 February 2015. PNRA provided necessary feedback and input to Pakistan's delegation participating in the conference.

At the Nuclear Security Summit 2014, the Prime Minister of Pakistan announced the prospective ratification of CPPNM amendment. Since PNRA is the focal organisation and the national point of contact for this convention, it is upgrading its regulatory framework to fulfill the forthcoming obligations.

Bilateral & Multilateral Cooperation

Nuclear regulatory bodies worldwide deem it crucial to share experience in order to improve, harmonise, strengthen and promote nuclear safety and security regime and regulatory infrastructure through bilateral and multilateral cooperation.

PNRA in its capacity as Pakistan's national nuclear regulatory authority attaches a high priority to establishing and maintaining close cooperation with other international regulatory authorities, and promotes sharing of necessary information and experiences among the nuclear regulatory bodies to provide support in regulatory matters.

The Authority has a working protocol for cooperation in the field of nuclear safety, assistance in safety reviews, exchange of information and human resource development with National Nuclear Safety Administration (NNSA) of China since April 1992, which was further extended in 2014.

Since April 2011, a bilateral agreement with Northern Regional Office (NRO) and Nuclear and Radiation Safety Centre (NSC) of NNSA, China has been in place for technical exchange and cooperation in the field of nuclear safety and radiation protection. In March 2013, this bilateral agreement was renamed Long-Term Cooperation Framework Agreement between PNRA and China Nuclear Power Operation Technology Corporation (CNPO) for cooperation in the fields of training, consultation, scientific research, information exchange, development and technical support for nuclear power plant safety.

Meanwhile, efforts are underway to expand bilateral and multilateral cooperation with the regulators of other countries and international organisations.

PNRA and NNSA of China have set up a joint Steering Committee to review and discuss the issues of bilateral cooperation and mutual interests and progress made on agreed actions. During the year under review, the eighth Steering Committee Meeting (SCM) between PNRA and NNSA of China was held on 11 and 12 May at Rongcheng City, Shandong, China.

Further, two PNRA officers were attached for six-month joint work with Northern China Regional Office (NCRO) and NSC of NNSA after completing their Chinese language course.

Collaboration with IAEA

The Authority collaborates with IAEA and contributes to various IAEA activities including implementation of IAEA codes and standards; and participation in various IAEA committees and networks related to nuclear safety and security.

Through these IAEA platforms, PNRA shares its expertise, regulatory experiences and good practices with nuclear regulators of other countries. The Authority contributes to IAEA activities by providing the services of its experts in the fields of nuclear safety and security; and by offering training opportunities to embarking countries in the fields of nuclear safety and security.

PNRA hosts delegations from IAEA member states who are interested in learning about Pakistan's established nuclear regulatory infrastructure and to benefit from our regulatory experience.

PNRA facilitated five IAEA experts on a visit to Pakistan to conduct an IAEA sponsored national workshop on "Radiological Crime Scene Management (RCSM)" held at Pakistan's Centre of Excellence in Nuclear Security (PCENS) during November of this year. The Authority also hosted an IAEA mission to discuss the progress on the implementation of IAEA TC Projects and their benefits.

During the reported year, PNRA also participated and contributed – as part of Pakistan's delegation – in the proceedings and activities of the 59th Regular Session of the IAEA General Conference.

Participation in IAEA Committees and Other Forums

PNRA contributes to several IAEA activities conducted through various IAEA committees and other related forums and networks.

The Authority represents Pakistan and participates in activities as member of Commission on Safety Standards (CSS), Nuclear Safety Standards Committee (NUSSC), Transport Safety Standards Committee (TRANSSC), Waste Safety Standards Committee (WASSC), Radiation Safety Standards Committee (RASSC), Nuclear Security Guidance Committee (NSGC), Emergency Preparedness and Response Standards Committee (EPReSC), Advisory Group on Nuclear Security (AdSec) and Global Nuclear Safety and Security Network (GNSSN).

In addition, PNRA participates in the activities related to IAEA International Nuclear Event Scale (INES) and

International Reporting System (IRS) as a designated national coordinator.

In 2015, experts from PNRA attended the following meetings and conferences under the aegis of the IAEA:

- Meeting of the Director General's Advisory Group on Nuclear Security (AdSec);
- The 37th Meeting of the Commission on Safety Standards;
- The 39th Meeting of the Radiation Safety Standards Committee (RASSC);
- The 39th Meeting of the Waste Safety Standards Committee (WASSC);
- The 1st Meeting of Emergency Preparedness and Response Standards Committee (EPReSC);
- The 4th Meeting of the Working Group on Radioactive Source Security;
- The International Generic Ageing Lessons Learned (IGALL) Working Group Meeting;
- Programme Element Working Group (PEWG 4) Meeting of AdSec;
- The 3rd Technical Meeting on the Practical Illustration and use of the Safety case concept in the Management of near-surface Application (PRISMA);
- Incident and Trafficking Database (ITDB) Meeting;
- The 2nd Meeting of the Programme Committee for the International Conference on Effective Nuclear Regulatory Systems;
- The 6th and Seventh Steering Committee Meetings of the Global Nuclear Safety and Security Network; and
- The 20th Annual Nuclear Forensics Expert Meeting.

Pakistan is a permanent member of the United Nations Scientific Committee on the Effects of Atomic Radiations (UNSCEAR) and PNRA represents Pakistan in UNSCEAR by contributing to its activities through sharing necessary information and expertise. During the year under review, PNRA participated in the 62nd session of the UNSCEAR and remained involved in the review of UN Resolution on Effects of Atomic Radiations for the year 2015.

IAEA Technical Cooperation Projects

PNRA has been participating in the implementation of two IAEA Technical Cooperation Projects "PAK/9/035: Further Strengthening of Regulatory Performance for the Pakistan Nuclear Regulatory Authority" and "PAK/9/037: Strengthening Infrastructure for Radiation, Transport and Waste Safety".

These projects were successfully completed during the year under review achieving their intended objectives and completing the scheduled activities. Among the activities carried out under PAK/9/035 and PAK/9/037 during 2015 were:

- A workshop on ageing management and periodic safety review of research reactors;
- A workshop on capability in the review and assessment and validation of preventive and mitigative Symptom based Emergency Operating Procedures (SEOPs) and Severe Accident Management Guidelines (SAMGs) for NPPs;
- A workshop on decision making and termination of protective measures during a nuclear or radiological emergency;
- A workshop on safety culture self assessment of PNRA;
- A workshop on environmental radiation monitoring in Pakistan;
- A workshop on Level-2 PSA model development in Pakistan;
- A workshop on internal dosimetry;
- A workshop on management system for radiation safety, technical & dosimetry services; and
- A workshop on atmospheric dispersion analysis.

These projects also facilitated PNRA in the procurement of equipment items – Gamma Irradiator, Alpha and Gamma Spectrometric Systems – for its laboratories; and conduct of scientific visits of PNRA officials in external and internal dosimetry assessment.

IAEA has further extended the technical cooperation for Pakistan for the cycle of 2016-17 by initiating TC Project PAK/9/041: Enhancing Nuclear Safety and Expansion/ Sustainability of Regulatory Framework - Phase II (continuation of PAK/9/035); and TC Project PAK9/040: Strengthening of Infrastructure for Radiation, Transport and Waste Safety - Phase II (continuation of PAK/9/037).

IAEA Regional Asia (RAS) Projects

PNRA participates in IAEA projects specially focused on development in Asia region termed as IAEA Regional Asia (RAS) projects in different areas related to nuclear and radiation safety.

Presently, PNRA is participating and benefiting from the activities of 18 IAEA RAS projects including workshops and training courses organised under these projects. The Authority has also provided extra budgetary contribution in these projects.

During 2015, PNRA also participated in the project review and coordination meeting on "Strengthening Regional Nuclear Regulatory Authorities and Safety Culture" under RAS/9/061 in Bangkok from 21 to 24 April, 2015.

IAEA-Pakistan Nuclear Security Cooperation Programme

Pakistan is striving hard to augment the effectiveness of its nuclear security regime. Pakistan and IAEA are working on a nuclear security cooperation programme since 2005 for establishing, maintaining and sustaining effective nuclear security regime in the country.

Under the IAEA-Pakistan Nuclear Security Cooperation Programme, PNRA is the designated focal point and has the responsibility to coordinate with all the stakeholders for planning and implementing activities under the programme.

The main elements of the programme include human resource development and capacity building in advanced technologies for suitable upgrades in security of nuclear installations and radiation facilities in the country.

Currently, the programme has several ongoing projects including the establishment of nuclear security educational laboratories at PIEAS and establishment of mobile training unit for NISAS.

During the reported period, a major milestone was achieved with the establishment of PNRA Physical Protection Exterior Laboratory (PPEL) in Pakistan's Centre of Excellence near Islamabad. In addition, two courses on project management and advance project management for security professionals were conducted in collaboration with the IAEA.

A remarkable achievement of this project is that since 2014, Pakistan has attained the capability and infrastructure to conduct training course to train the officials of other IAEA member states and embarking countries. In 2015, some 14 foreign participants from Vietnam and Egypt attended the second regional training course on "Practical Operations of Physical Protection Equipment" at PNRA headquarters from 30 March to 10 April 2015.

Expert Missions

PNRA collaborates with the IAEA for institutional capacity building and experience sharing through IAEA expert missions. During the reported year, 57 international experts from the IAEA visited PNRA. Out of these, 26 experts conducted workshops and training courses in the field of nuclear safety and radiation protection under PNRA-IAEA Technical Cooperation Projects. Whereas, four IAEA experts provided operational programme level training to officials of the National Dosimetry and Protection Level Calibration Laboratory and the National Environmental Monitoring Programme of PNRA; and 27 experts visited PNRA under the IAEA-Pakistan Nuclear Security Cooperation Programme for project coordination meetings and training of security professionals.

PNRA also extends expert support to the IAEA for international regulatory missions and training courses in other countries; and assists the IAEA in the development of IAEA documents and training material.

Experts from PNRA participated in the expert missions, to other member states, specifically designed to strengthen

PNRA Expert Participating in IAEA Expert Mission to Review the Human Resource Development Master Plan and Implementation Plan of Sudan Regulatory Body

regulatory infrastructure and enhance the capacity of regulatory personnel on IAEA's request.

During 2015, a number of PNRA officials participated in 95 expert missions. On the course of these missions PNRA experts, specifically to mention, contributed in the IAEA Integrated Regulatory Review Services (IRRS); Emergency Preparedness Review (EPREV); Education and Training Review Services (ETRES); and IAEA Safety Culture Self-Assessment missions.

During the year under review, PNRA officials participated in various meetings and conferences of the IAEA and contributed in the expert and consultancy missions. PNRA officials were also placed on contract and deputation to serve at the IAEA. Figure 31 presents the summary of expert support provided by PNRA during 2015.

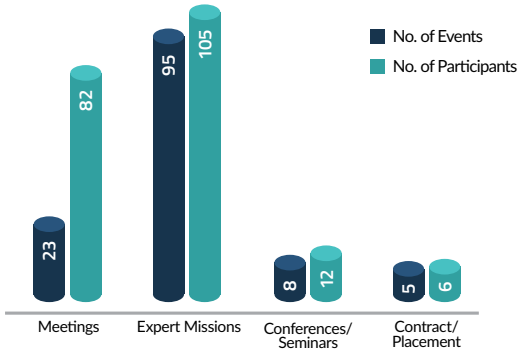


Figure 31: Expert Support in International Events

PNRA officials also participated in the development and revision of the following IAEA documents:

- Safety Guide on Remediation Process for Areas Affected by Past Activities and Accidents (WS-G-3.1);
- Specific Safety Guide on Establishing the Safety Infrastructure for a Nuclear Power Programme (SSG-16);
- Technical Guidance on Computer Security Techniques for Nuclear Facilities (NST047);
- Implementing Guide on Security During the Lifetime of a Nuclear Facility;
- Guidelines on Safety Culture Self-Assessment for the Regulatory Body;
- International Reporting System (IRS) Blue Book;
- TECDOC on Safety Culture in Regulatory Bodies; and
- Guidelines on SCSA for Licence Holders (LHs) and Regulatory Bodies (RBs).

Besides these PNRA officials, during 2015, also participated in various international conferences and summits and shared PNRA expertise and experiences in the relevant areas. Below is the summary of these conferences and summits:

- Middle East & North Africa (MENA) Nuclear Power Plant Summit – 2015;
- The Third Turkey-MENA Nuclear Industry Congress-2015;
- The Sixth Nuclear Power Asia Conference;
- International Conference on Operational Safety;
- International Conference on Research Reactors: Safe Management and Effective Utilisation;
- International Conference on Nuclear Security in a Computer World: Prevention Detection and Response to Emerging Cyber Threats; and
- The Second MENA Nuclear Energy Summit 2015.

PNRA Officials Participating in National Workshop on Capacity Building and Knowledge Management for Regulators - Cameroon

9. PNRA LABORATORIES

PNRA has established National Dosimetry and Protection Level Calibration Laboratory (NDCL) for monitoring personnel radiation dose and cross verification of data reported by licensees; and National Environmental Monitoring Programme (NEMP) to monitor environmental radioactivity and verify environmental monitoring data provided by NPPs.

The progress of these laboratories is briefly described below:

National Dosimetry and Protection Level Calibration Laboratory (NDCL)

PNRA has established the external and internal dosimetry laboratories at Islamabad, Kundian and Karachi. NDCL laboratories are equipped with sophisticated technology that has enabled PNRA to enhance its capabilities in personnel dosimetry and calibration of protection level equipments. Given below is a summary of major activities performed by NDCL during the year under review:

External Dosimetry Setup

The services of NDCL external dosimetry laboratories at Islamabad, Kundian, and Karachi are available to licensees for measuring radiation doses received by radiation workers; and to law enforcement and emergency response agencies for measuring radiation doses received by first responders during a radiological emergency. All the three laboratories of NDCL are equipped with Thermo Luminescent Dosimetry (TLD) and Film Badge Dosimetry (FBD).

Internal Dosimetry Setup

NDCL internal dosimetry laboratories at Islamabad, Kundian, and Karachi are operational and are used for whole body counting of radiation workers.

While working at the nuclear installations or radiation facilities, the workers may ingest or inhale air borne contamination due to presence of volatile radioactive particulates or gases in the environment. The inhaled or ingested radionuclides tend to accumulate in various body organs such as thyroid, lungs, bones, etc.

In such cases, the workers are required to be monitored internally to find out the activity of radionuclides inside the body. Whole Body Counting is the direct method to find out the internal contamination of any worker while Liquid Scintillation Analysis is used for indirect measurements.

The internal dosimetry laboratories at Karachi and Kundian are equipped with Stand-up type Whole Body Counting (WBC) System comprising of high efficiency sodium-iodide detectors for measurement of radioactivity inside human body. These laboratories are providing internal dosimetry services to licensees on routine basis. During the year 2015, more than 700 personnel in Karachi (including K-1 workers and IAEA Inspectors) were monitored for internal contamination. Similarly, this service was provided to more than 500 personnel in Kundian (including C-1 & C-2 workers of RFO, Chinese contractors and IAEA inspectors).

The internal dosimetry laboratory at Islamabad is equipped with a state-of-the-art bed-type WBC system, which can

Briefing to SOMC Participants about Dosimetry Laboratories

Internal Dosimetry Laboratory

Installation of Gamma Irradiator at NDCL, Kundian

Collection of Onsite Soil Samples

be used for both whole body counting as well as organ counting of radiation workers.

In case of identification of internal contamination of any person at Kundian and Karachi laboratories, the person is referred to WBC laboratory Islamabad for detailed examination and organ counting. After detailed WBC, the results are evaluated and communicated along with necessary recommendations to the licensees for implementation.

During the reported period, a number of local and international delegations visited NDCL and were briefed about the working of laboratories.

Protection Level Calibration Laboratory

During the year 2015, the installation and commissioning of a gamma irradiator at NDCL Kundian was successfully completed. Efforts are underway through IAEA for procurement of another gamma irradiator for the Karachi calibration laboratory and X-rays generators for Kundian and Karachi laboratories. These equipment will be used for calibrating various radiation monitoring instruments.

National Environmental Monitoring Programme (NEMP)

The NEMP – previously named "National Environmental Radioactivity Surveillance Programme (NERSP)" – is aimed to enhance PNRA's capability of monitoring and evaluating any buildup of radioactivity due to a nuclear or radiological accident in Pakistan or in neighboring countries; and to verify the environmental data provided by the NPPs. Another important objective of NEMP is monitoring radon and the NORM producing industries.

PNRA has established three state-of-the-art environmental monitoring laboratories equipped with radiation measurement equipment at Karachi, Kundian and Islamabad. The Authority is now in a position to conduct effective and comprehensive environmental monitoring throughout the country.

These laboratories are used for establishing background radiation levels all over the country by collecting different kinds of samples such as soil, air, water, etc. that can be used as a reference in case of any nuclear or radiological emergency. These laboratories also conduct independent environmental monitoring around nuclear installations and radiation survey at NORM producing industries.

Environmental Monitoring Around Nuclear Power Plants

Independent environmental monitoring is performed around NPPs to verify the environmental monitoring data provided by NPPs and to ensure that the radioactive discharges from the operation of nuclear installations (C-1, C-2 and K-1) to the environment are within the specified limits.

Verification of CNPGS Environmental Monitoring

PNRA reviews the "Annual Radiological Environmental Operating Reports" submitted by CNPGS and has initiated verification of environmental monitoring data provided by the CNPGS. In order to verify radiation measurement results given in these reports, samples were collected from selected Environmental Monitoring (EM) points around the CNPGS and subjected to gamma spectrometric and beta analysis. The analysis results showed that the results are comparable with CNPGS data.

Environmental Monitoring Around K-1

For independent environmental monitoring around K-1, about 100 environmental samples of soil, sea water, drinking water and fish were collected and gamma & beta analysis of these samples were conducted. Sea water samples were collected from twelve different points within the radius of 20 km around K-1 which

were analysed to check the tritium activity. The results of monitoring programme indirectly showed that impact of K-1 releases on ambient environment is negligible during normal operation of plant and poses no risk to marine ecosystem.

Establishment of Independent Pre-operational EM Data Around K-2 and C-3/C-4

During the year 2015, about 200 different environmental samples from the vicinity of under-construction nuclear power plants (K-2, C-3 & C-4) were collected with a sample collection grid of mesh size 500 x 500 m. This sample collection is part of a campaign for establishing the independent pre-operational environmental monitoring data. This data is aimed to serve as baseline for verification of licensee's data and will help to measure the impact on environment from radioactive releases after the plants go into operation.

Establishment of National Background Radiation Levels

During the reporting period, NEMP initiated preparation of a plan to establish countrywide radiation levels to serve as national background to be used as a reference in case of any radiological or nuclear emergency. The plan for collection of environmental samples is under preparation in coordination with the Survey of Pakistan. For this purpose, the whole country has been divided into a grid of mesh size 23×24 Km containing approximately 1500 sample collection points to study the concentration level of natural and anthropogenic radionuclides.

Radiation Analysis at NORM Producing Industries

NEMP has established a liaison with Oil and Gas Development Company Limited (OGDCL) to conduct NORM survey. Samples from six OGDCL sites namely Qadirpur Oil & Gas field, Tando Alam Oil Complex, Kunnar Oil field, Hundi Sari Oil field, Bobi Oil Complex and Sinjhorro Oil/Gas Plant were collected for the assessment of NORM. By the end of reported period, analysis of around 50 samples of shale, sludge, water, crude oil, soil, etc. collected from these sites was under way.

Radon Monitoring

NEMP has started a radon monitoring project aiming to cover initially the district and tehsil headquarters hospitals of the Punjab and KPK provinces; and gemstone mines of Gilgit-Baltistan. In the first phase of the project, radon monitoring of Rawalpindi district was completed which indicated that radon levels were well within permissible levels.

Analysis of Food Samples

NEMP assists Regional Directorates (RNSDs) for provision of radiation-free certification of food and other items for the purposes of export. During the year under review, samples of starch, rice, meat and sugar were analysed at NEMP laboratories in Chashma and Karachi.

Radiation Survey at Tando Alam Oil Complex

Installation of Gamma Spectrometry System at NEMP Laboratory, Islamabad

10. PERFORMANCE REVIEW

PNRA has a comprehensive process of performance evaluation to assess the efficiency and effectiveness of its regulatory processes on annual basis against 12 pre-defined Strategic Performance Indicators (SPIs).

For this purpose, PNRA has developed specific performance elements for each Strategic Performance Indicator. The annual performance assessment is conducted based on various performance elements assigned to different directorates, projects and groups of PNRA.

These indicators are assessed qualitatively and quantitatively using a ranking scale of five levels – Not Acceptable, Unsatisfactory, Needs Improvement, Minimally Acceptable and Satisfactory. The performance evaluation of PNRA, for the year under review, is discussed below in a comprehensive manner and summed up in Figure 31:

Strategic Performance Indicators

Indicator 1

"Ensures that acceptable level of safety is being maintained by licensees"

This indicator is assessed against two main core functions of PNRA, namely "Inspection and Enforcement" and "Review and Assessment".

Regulatory inspections of nuclear installations and radiation facilities ensure the compliance with regulatory requirements in order to sustain the adequate level of safety. During the year 2015, a number of regulatory inspections of nuclear installations, equipment manufacturing industry and radiation facilities were conducted by PNRA.

Chapter 3 and Chapter 4 of this report present a comprehensive picture of these inspections and efforts of PNRA regarding nuclear safety and radiation safety. During the reported period, PNRA monitored emergency exercises of CNPGS, K-1 and PINSTECH for evaluation of effectiveness of proposed emergency scenarios.

Review and Assessment corresponds to the review of submissions of licensees of nuclear installations and radiation facilities like safety analysis reports, emergency response plans, physical protection plans, etc. During the year 2015, PNRA accomplished the review of the PSARs of new nuclear power plants, K-2 & K-3. After being satisfied that all the safety concerns have been addressed by the applicant, PNRA issued construction licences to these NPPs.

PNRA reviewed and assessed a number of documents submitted by licensees such as radiation protection programmes, ALARA plans, annual safety reports, annual dose reports, emergency response plans, physical protection programmes, decommissioning plans, environmental reports, etc. required by the Authority under existing regulations, licence conditions and agreed codes and standards.

The scope of PNRA licensing expanded during the reported period with the addition of new radiation facilities as part of an effort to provide safe and secure diagnostic facilities across the country. Chapter 3, Chapter 4 and Chapter 5 of this report discuss in detail these activities.

Based on these facts, PNRA has maintained its performance as ***"Satisfactory"*** against this indicator.

Indicator 2

"Ensures that regulations and guides are in position and understood by licensees"

Development of regulatory framework is one of the core functions of PNRA. The assessment of this indicator is based on whether PNRA has instituted the required regulations and regulatory guides, the involvement of licensees in the preparation of regulations and their understanding of regulations.

For this purpose, PNRA has established a well-designed process for the development of regulations and regulatory guides. Involvement of stakeholders in the preparation of the draft regulations and regulatory guides is ensured; and their feedback is given due consideration during preparation, revision or amendment of regulations.

PNRA has so far published 17 regulations and eight regulatory guides. During the year 2015, PNRA approved amendment of three regulations. It continued work on the revision of five regulations; development of five new regulations; and development of eight new regulatory guides.

The progress of drafting and revising regulations and regulatory guides is detailed in Chapter 2 of this report.

In view of the foregoing, the performance of this indicator is improved by one level to ***"Minimally Acceptable".***

Indicator 3

"Strives for continuous improvement of its performance"

This indicator is assessed against efforts PNRA undertakes to enhance its regulatory effectiveness based on self-assessment, internal audits, performance assessment; and licensee's, stakeholder's and international feedback.

During the year under review, PNRA completed a Safety Culture Self-Assessment (SCSA) using IAEA methodology, becoming the first regulator worldwide to have reached this milestone. This effort of PNRA, as a role model for other nuclear regulators, has won accolades from the world's premier nuclear agency - the IAEA.

In 2015, PNRA completed third internal audit of its departments and issued departmental audit reports containing audit findings, recommendations and suggestions to the respective departments for further improvement.

PNRA also performed quarterly evaluation of all directorates, projects and laboratories during the year under review and issued Quarterly Performance Evaluation Reports (QPERs) for the fourth quarter of 2014 and three quarters of 2015 to assess the performance of PNRA based on the implementation of annual work plans.

Weekly performance overviews were conducted to assess the implementation of weekly planning. In addition, self-assessment at department level is assigned to all directorates, projects, laboratories, groups and cells of PNRA on biennial basis. A number of PNRA departments conducted self-assessment during the reported year to identify and improve weaknesses that stand in the way of meeting departmental objectives; as well as to improve the management system, enhance safety culture and effectiveness of the processes and activities.

In view of these activities, the performance for PNRA against this indicator has been upgraded from ***"Minimally Acceptable"*** to ***"Satisfactory"***.

Indicator 4

"Takes appropriate actions to prevent degradation of safety and to promote safety improvements"

This indicator is assessed based on regulatory inspections, which is one of PNRA's core functions; assessment of licensees' submissions like periodic safety reports and design modifications based on latest international guidelines; and implementation of relevant international experience feedback at nuclear installations and radiation facilities.

PNRA is continuously striving for enhancing the competency level of its regulatory officials in order to augment its capabilities to assess level of safety at the licensed facilities and to help prevent degradation of safety at regulated installations and facilities. In order to provide hands on training to regulatory personnel, PNRA expanded its STPS by adding more panels to enable extended execution of abnormal operating events and accident conditions.

PNRA conducted a number of inspections of nuclear installations, radiation facilities and equipment manufacturers in the reported year and issued various directives requiring necessary action for further improvement. Chapter 3 and Chapter 4 of this report provide summary of activities falling in this category.

In 2015, PNRA reviewed various safety related submissions such as modification requests, technical reports, event reports, plans and periodic safety reports submitted by nuclear installations, radiation facilities and equipment manufacturers. During the year under review, PNRA issued or renewed licences for a number of operating personnel of nuclear installations after conducting written and oral examination to evaluate their knowledge, operational competency and capability.

In the year under review, K-1 went through forced outages a number of times; and the RFO-10 at C-1 went beyond the schedule.

Chapter 3, Chapter 4 and Chapter 5 of this report include details of all these activities.

Based on the above evaluation, the performance rating of this indicator has been lowered from ***"Satisfactory"*** to ***"Minimally Acceptable".***

Indicator 5

"Takes appropriate steps for human resource development and has competent and certified regulatory staff"

Rating for this indicator is based on human resource planning and competency development of regulatory workforce to meet the future challenges. This is achieved through monitoring and evaluating core competencies of the regulatory workforce as per a systematic Competence Need Assessment (CNA) and implementing its findings by subsequent trainings at national and international level in the relevant domains.

During the reported period, PNRA initiated rationalisation of the workforce to ascertain whether the human resources assigned to various directorates are commensurate with the tasks and functions assigned to them. Rationalisation was initiated as a pilot project, initially targeting only a few directorates. Upon the success of the pilot phase, this exercise has been expanded to cover the rest of the directorates which are currently performing rationalisation based on the approved methodology.

PNRA is continuously striving for enhancing the competency level of regulatory officials through training and retraining in all areas of legal and regulatory framework; technical disciplines; regulatory processes & practices; management system; and personnel skills & behaviour.

In 2015, PNRA continued to implement its training programme, offering various training courses for officers as well as staff of PNRA. PNRA has also initiated a Knowledge-Sharing Programme, under which it invites senior officials of the relevant organisations and other prominent dignitaries, who have played pioneering role in the development of nuclear science and technology in Pakistan, to share their experiences with young engineers and scientists. In 2015, PNRA invited a number of officials for sharing their proud legacy with the younger generation.

PNRA is always striving to enhance the capacity building of its workforce through strong collaboration with national institutions. During the reported period, PNRA officials participated in several training courses in different technical and related disciplines.

PNRA interacts with various institutions and organisations at international level for the capacity building of its workforce through various technical cooperation programmes of IAEA for organisational capacity building.

A detail of all such activities is reflected in Chapter 7 of this report.

Based on the foregoing, PNRA rated its performance during the year under review for this indicator as ***"Satisfactory"*** – the same as last year's.

Indicator 6

"Ensure legal actions are taken in case of violations of regulatory requirements"

The assessment of this indicator is based on the availability of updated enforcement regulations and relevant SOPs; and implementation of these tools for effective enforcement action against violators under section 44 of PNRA Ordinance.

PNRA is empowered to cancel or revoke any of the authorisation(s) if deemed necessary in case of serious violation(s) of regulatory requirements. Sections 24, 29 and 44 of PNRA Ordinance empower PNRA to initiate legal action against violators in accordance with the severity of the offence(s).

For the effective implementation of these sections, PNRA promulgated Enforcement Regulations-PAK/950 in 2010.

As an outcome of effective and gradual advocacy techniques and enforcement methodology adopted by PNRA, all radiotherapy centers, nuclear medical centers, irradiators, practices involving use of radiation sources in industry, research and industrial radiography, etc. have been licensed by PNRA. However, a number of medical diagnostic facilities (i.e. X-ray facilities) still remain outside the licensing network. PNRA continued its strong persuasions to bring such facilities under the licensing net, thereby achieving significant increase in the number of licensed X-ray facilities during the current year.

By the end of reporting year, the total number of licensed radiation facilities exceeded 4,400.

Legal proceedings have been initiated against those found in violation of the law in line with the enforcement regulations of PNRA. Several radiation facilities were served with legal notices or called for hearing during the reported period. Chapter 4 of this report covers these activities in some detail.

In view of the above, the rating of ***"Minimally Acceptable"*** is retained against this indicator for the Authority's performance during the year under review.

Indicator 7

"Performs its functions in a timely and cost-effective manner"

This indicator is assessed against the achievement of overall targets, conduct of planned and unplanned activities and optimisation of resources.

During the year 2015, PNRA achieved several major defined targets within estimated budget and schedule. Review and acceptance of C-3/C-4 FSAR and K-2/K-3 PSAR resulting in granting authorisation for commissioning to C-3/C-4 and issuance of K-2/K-3 construction licence, respectively, are among the important PNRA achievements for the year under review.

The Authority performed daily and routine inspections, surveillance and other activities at all nuclear installations, equipment manufacturers and radiation facilities in accordance with the annual work plan.

The control point inspections of C-3/C-4 and K-2 NPPs went according to schedule. PNRA also reviewed a number of submissions from equipment manufacturer, nuclear installations and radiation facilities as planned. Chapter 3 and Chapter 4 of this report present details of these activities.

Nevertheless, the Authority missed some of the targets set for the year 2015. These include, inter alia, issuance of some regulations and regulatory guides and revision of management system manual.

In view the above facts, the performance of PNRA against this indicator is retained as ***"Minimally Acceptable"***.

Indicator 8

"Ensures that a well established quality management system exists"

The assessment of this indicator is based on the availability of the management system manual being up-to-date, awareness of the management system among PNRA officials, and implementation of the management system at organisational level.

PNRA Management System Manual (MSM) is a top-level document in the documentation structure of PNRA management system which was developed based on IAEA General Safety Requirements (GSR-3) "The Management System for Facilities and Activities". It determines organisational structure, policies, processes, activities, resources and related procedures; and provides direction to all individuals on how to carry out their assigned tasks in order to achieve PNRA's mission, vision and goals.

During the year 2015, the Authority developed "PNRA Strategic Plan 2015-2018" and a number of documents including policies, procedures and processes; and undertook various activities like weekly evaluations, performance evaluation, self-assessment and internal audit – to fulfill the requirements of the management system.

In addition, as per management system requirement, self-assessment was undertaken by a number of PNRA directorates to identify weaknesses at directorate level and take corrective actions for improvement.

During the reported period, PNRA continued work on revising MSM based on feedback from implementation of MSM, IRRS mission, self-assessment of PNRA and updated IAEA reference renamed as "Leadership and Management for Safety - GSR Part 2 (Draft)". Among the major areas identified for improvement were safety culture, graded approach, responsibility of the management, authorities and responsibilities of process owners, interface with external organisations and managing organisational changes, etc.

In view of the efforts made by PNRA regarding the implementation of the management system and revision of MSM, the rating of PNRA against this indicator is elevated from ***"Needs Improvement"*** to ***"Minimally Acceptable"***.

Indicator 9

"Ensures that adequate resources are available for performing its functions and technical support centre is available for specialist assistance when required"

This indicator is assessed based on availability of appropriate financial and human resources to carry out the Authority's activities; and availability of Technical Support Organisations (TSOs).

PNRA put a lot of effort into ensuring adequacy of resources to perform its functions smoothly during the year under review – and most of the activities were indeed fully resourced and right on schedule. Induction in human resources and capacity building through collaborative training programme including rationalisation of human resources, during the reported year, were conducted as scheduled.

Some PNRA activities nevertheless suffered from paucity of financial resources. These included competence development programme, establishment of background radiation level though meshing and the public awareness programme; though all efforts were made for effective utilisation of available resources to achieve most of the intended outcomes from the scheduled activities.

Currently, PNRA has two TSOs, i.e., the CNS and SAC. CNS provides major support in conducting review of all types of SARs including PSARs, FSARs & PSRs along with support in implementing the regulatory inspection programme. SAC focuses chiefly on providing support for critical decision making through the independent analysis of different design basis and severe accident scenarios.

During the year under review, CNS extended extensive support in accomplishing the review of K-2/K-3 PSAR and various other submissions related to NPPs including RFO reports of C-1 and C-2. SAC performed activities such as the transient analysis for different accident scenarios.

Considering all the above facts, the performance rating for PNRA against this indicator is elevated by one level from ***"Unsatisfactory"*** to ***"Needs Improvement".***

Indicator 10

"Performs its functions in a manner that ensures confidence of the operating organisations"

The assessment of this indicator is based on feedback from licensees of nuclear installations and radiation facilities; and participation of licensees in regulator's organised activities and vice versa.

PNRA believes in maintaining intimate liaison with its licensees across the country.

The Authority encourages participation of all the stakeholders – including licensees and the public – in the development of regulations, regulatory guides, etc. Draft regulations are circulated among licensees and their feedback sought; any comments and suggestions they volunteer are given due consideration while finalisation of regulations.

In order to have better mutual understanding, confidence and efficient resolution of issues and queries; PNRA conducts periodic meetings at different levels with licensees of nuclear power plants, research reactors, equipment manufacturer and molybdenum production facility. During the reported period, PNRA conducted coordination meetings with management of operating and under construction nuclear power plants, research reactors, equipment manufacturer and molybdenum production facility at various levels with different frequencies. A detail of these meetings is shared in Chapter 8 of this report.

PNRA also regularly conducts training courses for licensees, radiation workers and other stakeholders to cultivate understanding of regulatory framework and requirements among them with a view to enhancing safety at their respective facilities. In 2015, PNRA arranged several training courses for licensees and radiation workers. Chapter 8 of this report include some information on PNRA activities of this kind.

Considering the quantum and range of activities alluded to above, PNRA performance against this indicator for the year under review is rated as ***"Satisfactory".***

Indicator 11

"Performs its functions in a manner that ensures confidence of the general public"

This indicator is assessed on the basis of development and implementation of public awareness programme, information and communication to general public, and involvement of the public in the preparation of regulatory documents.

PNRA believes in importance of the awareness among the public of the applications of ionising radiations in everyday life; their harmful effects on human health and the environment; protection needed in the use and application of nuclear or radioactive materials; and strategies to reduce the severity and mitigate the consequences if an event or accident occurs.

The Authority disseminated the necessary information about its activities through variety of channels such as annual report; PNRA website (www.pnra.org); and lectures and seminars in different government and private organisations in addition to educational institutions all over the country.

PNRA also informs the public, in seminars, about the regulatory framework for nuclear power plants and radiation facilities in Pakistan. In 2015, PNRA conducted several lectures and seminars at hospitals, medical centers, law enforcement agencies, schools, colleges and universities in different cities. Chapter 8 of this report contains details of these PNRA activities.

In sum, it is fair to say that while PNRA is eager to win the confidence of the public, it has yet to develop communication techniques, channels and mechanisms suited to informing the public adequately and swiftly enough in an emergency – and holding their attention. The task of involving the public in regulatory decision making is even further from finished.

In view of the foregoing, PNRA's performance rating for this indicator is retained at the last year's level - ***"Needs Improvement".***

Indicator 12

Performs its functions in a manner that ensures confidence of the Government

The performance against this indicator is assessed based on information, reports and communication of regulatory decisions to the government and support to government in fulfillment of international obligations.

At national level, PNRA coordinates with relevant federal/ provincial governmental authorities, organisations and departments; national research institutes; and universities for the purpose of effective regulatory control. During the year under review, PNRA coordinated with several governmental departments to keep them informed and to share PNRA's views on matters of interest. Some information about these activities is reflected in Chapter 8 of this report.

PNRA also reports the status of safety of nuclear power plants to the concerned government departments on quarterly basis and follows any instructions received from the government.

PNRA attaches great importance to its twin role in helping meet Pakistan's national and international obligations; and representing the country at international relevant forums. During the reported period, PNRA executed several activities pertaining to national obligations under international conventions related to nuclear safety, physical protection and nuclear and radiological emergencies to which Pakistan is a signatory. PNRA also represented Pakistan in several international events. Details of these activities and events are shared in Chapter 8 of this report.

Based on the above facts, the performance of PNRA against this indicator remained ***"Satisfactory"*** for the current year.

Overall Performance

Based on the evaluation of all the twelve performance indicators, PNRA has rated its overall performance for the reported period as **"Satisfactory"**. An overview of its overall performance during the last ten years is given in Figure 32.

Figure 31: Assessment of PNRA'S Performance in 2015

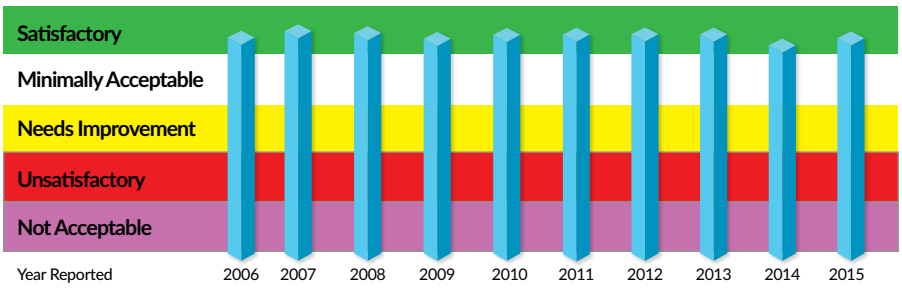
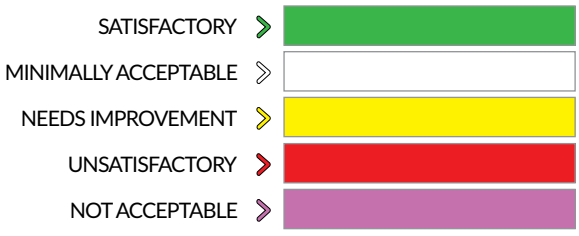


Figure 32: Overall Performance of PNRA Since 2005



RATING SCALE AND COLOUR CODES

Pakistan Nuclear Regulatory Authority

P.O. Box 1912
Islamabad, 44000 Pakistan
Tel: +92 (51) 926 3001-6 | Fax: +92 (51) 926 3007
Email: officialmail@pnra.org

www.pnra.org