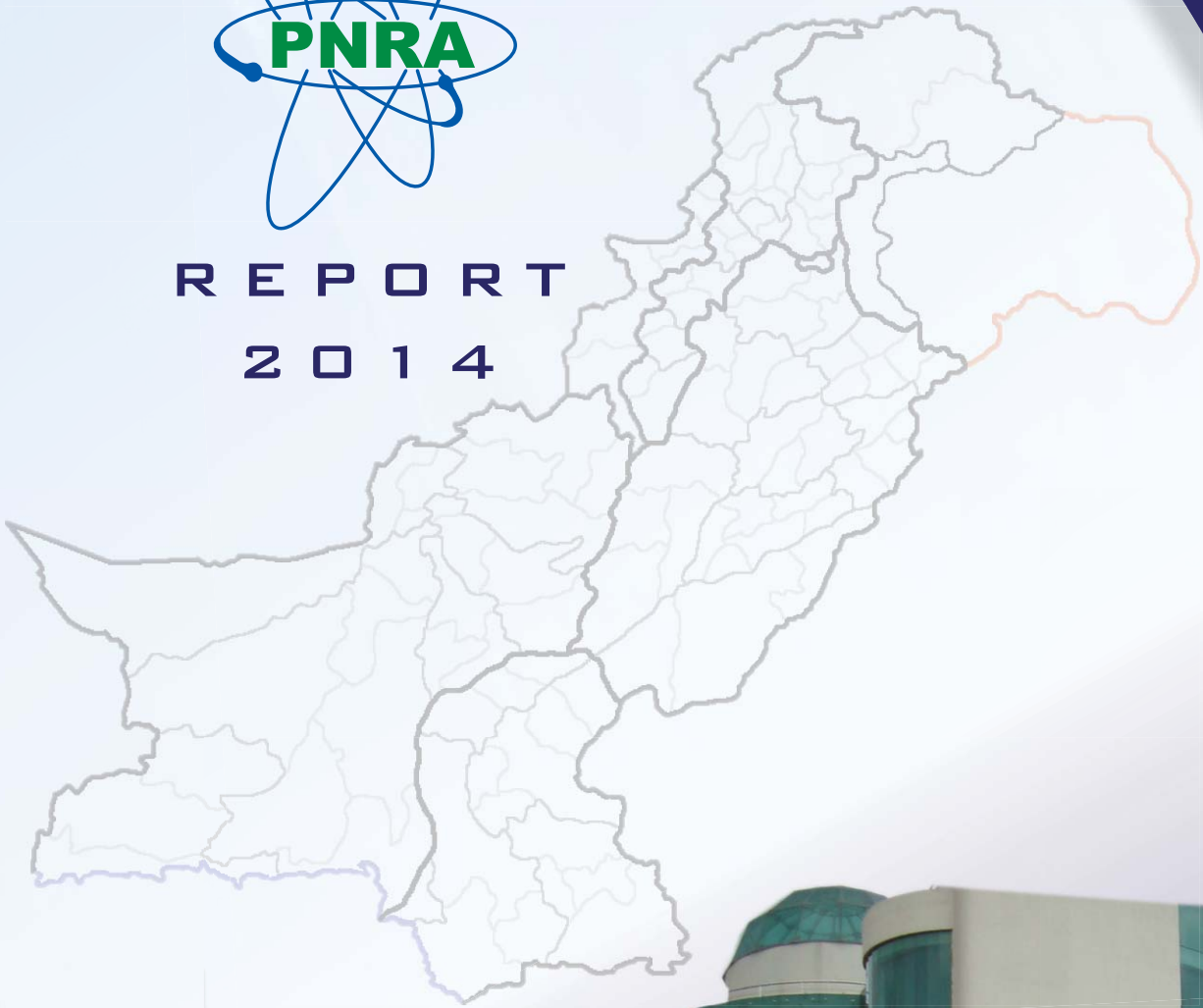




REPORT  
2014



PAKISTAN NUCLEAR REGULATORY AUTHORITY

# MEMBERS OF PNRA

## PRESENT

Mr. Mohammad Anwar Habib (Chairman)

Mr. Mahboob Ali

Mr. Mohammad Iqbal

Lt. Gen. Zubair Mahmood Hayat

Dr. Muhammad Nuruddin Qazi

Mr. Hussain Ahmad Siddiqui

Prof. Dr. Mustafa Kamal

Dr. Muhammad Khurshid

Syed Yusuf Raza

## FORMER

Mr. Jamshed Azim Hashmi (Chairman)

Lt. Gen. (R) Khalid Ahmed Kidwai

Dr. Younus Sheikh

Mr. Anwar Ali

Mr. Jawad Azim Hashimi

Syed Badshah Husain

Dr. Inam-ur- Rahman

Prof. Dr. Mohammad Ali Maud

Prof. Dr. Inayat Shah Roghani

Mr. Zia-ul-Hasan Siddiqui

Mr. Mohammad Shakilur Rahman

Dr. Shahid Ahmed Mallick

Mr. Saeed Alam Siddiqi

Mr. Asif Shuja Khan

Dr. Qazi Abdus Saboor

## MESSAGE FROM THE CHAIRMAN



PNRA is continuously striving to achieve its vision, fulfill its mission and uphold its core values since its inception in 2001. PNRA has shown an outstanding growth in all regulatory arenas. PNRA has made great strides in the development of its human resource and regulatory infrastructure, implementation of its regulatory regime and fulfillment of Pakistan's national and international obligations towards nuclear safety and radiation protection. While PNRA is regarded as a mature regulatory body, it is time for us to pause and look back over the preceding years to appraise what we have achieved viz-a-viz our vision and mission.

PNRA started with limited human, financial and material resources with a colossal responsibility of regulating ever increasing nuclear installations and radiation facilities. The last decade was utilized to set-up an effective regulatory framework, amassing much needed resources and achieving the required technical expertise. The challenging task facing PNRA now is of consolidation and assuring its sustainability in the upcoming years.

Despite the challenges of scarce resources and infrastructure, PNRA continued its journey towards achieving the vision and mission of becoming a world class nuclear regulator, both in quality and capacity. We struggled to cope with the targets of enhancing the organizational infrastructure, regulatory framework and effectiveness of regulatory oversight. The outcome of such strenuous efforts is now visible from the improved performance of the existing three operating nuclear power plants. Endeavors for safety improvements in the radiation facilities continued, and it is believed that our efforts will soon bear the desired fruit.

There is no doubt that the licensing and supervision of nuclear power plants, research reactors, equipment manufacturing industry and radiation facilities is a critical and challenging task for any regulatory body in view of the constantly evolving technology. PNRA is taking necessary measures to keep its staff abreast of the latest technological developments.

PNRA believes in transparency & openness and has always offered itself for peer reviews by international organizations like IAEA. One such review mission - Integrated Regulatory Review Services (IRRS) Mission - comprising of experts from all over the world visited PNRA for the assessment of regulatory infrastructure of nuclear and radiation safety in Pakistan and regulatory effectiveness and efficiency of PNRA. The Mission reviewed nuclear regulatory regime meticulously and acknowledged the level of expertise available within PNRA along with certain good practices which can be a source of inspiration for nuclear regulatory bodies across the world. This would ultimately enhance the confidence of stakeholders in the robust regulatory framework of PNRA at national and international levels.

PNRA continues to share expertise, regulatory experiences and good practices with other nuclear regulators under the auspices of IAEA. PNRA is extending its support to the countries embarking on nuclear power in establishing their regulatory infrastructure, developing legislation/regulations and capacity building through different IAEA forums with the objective to contribute to the IAEA's efforts in strengthening nuclear safety worldwide.

We are deeply aware that our work is a source of confidence for our stakeholders, particularly for the people of Pakistan. On behalf of PNRA, I would like to reiterate that my team and I would continue to work with sturdy dedication to ensure safe operation of nuclear installations and radiation facilities and to protect radiation workers, the public and the environment from harmful effects of ionizing radiation. We have planned to utilize the feedback that we have received from self assessment, regulatory audit, safety culture assessment programme, assessments conducted by external organizations and our stakeholders.

All this has been achieved and will further be improved because of the untiring zeal of my PNRA family. I am proud to have such a dedicated team whose commitment in overcoming future challenges is unmatched. By moving together in unison to accomplish PNRA's mission through prudent planning and continued hard work, there is no doubt in my mind that we would soon (by the Grace of Almighty) be recognized, as one of the best regulatory authorities at the national and international levels.



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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# ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
C-1	Chashma Nuclear Power Plant Unit 1
C-2	Chashma Nuclear Power Plant Unit 2
C-3	Chashma Nuclear Power Plant Unit 3
C-4	Chashma Nuclear Power Plant Unit 4
CHASCENT	CHASNUPP Centre for Nuclear Training
CNPGS	Chashma Nuclear Power Generating Station
COMTEX	Communication Test Exercise
ConvEx	Convention Exercise
CNS	Centre for Nuclear Safety
DNSRP	Directorate of Nuclear Safety and Radiation Protection
DPP	Document Preparation Profile
DRLs	Derived Release Limits
DSRS	Disused Sealed Radioactive Sources
FSAR	Final Safety Analysis Report
GBq	Giga Becquerel (10 <sup>9</sup> Becquerel)
GoP	Government of Pakistan
IAEA	International Atomic Energy Agency
K-1	Karachi Nuclear Power Plant Unit 1
K-2	Karachi Nuclear Power Plant Unit 2
K-3	Karachi Nuclear Power Plant Unit 3
KINPOE	Karachi Institute of Nuclear Power Engineering
KWt	Kilo-Watt thermal
MOFA	Ministry of Foreign Affairs
MPF	Molybdenum Production Facility
MRML	Mobile Radiological Monitoring Laboratory
mSv	mili Sievert (unit of dose)
MWe	Mega-Watt electric
MWt	Mega-Watt thermal
NDCL	National Dosimetry and Protection Level Calibration Laboratory
NERSP	National Environmental Radioactivity Surveillance Programme
NISAS	National Institute of Safety and Security
NPP	Nuclear Power Plant
NRECC	National Radiation Emergency Coordination Centre
PAEC	Pakistan Atomic Energy Commission
PARR-1	Pakistan Research Reactor-1
PARR-2	Pakistan Research Reactor-2
PIEAS	Pakistan Institute of Engineering and Applied Sciences
PINSTECH	Pakistan Institute of Nuclear Science and Technology
PNRA	Pakistan Nuclear Regulatory Authority
PSAR	Preliminary Safety Analysis Report
PSDP	Public Sector Development Programme
PSR	Periodic Safety Review
PWR	Pressurized light Water Reactor
RFO	Refueling Outage
SAC	Safety Analysis Centre
SARIS	Self Assessment of Regulatory Infrastructure for Safety

# 1 INTRODUCTION

From the very beginning, there was a realization that regulatory affairs in nuclear and radiation safety should be independent from the operational aspects. This independence was initially maintained and progressed by utilizing organizational means and approaches. However, signing the Convention on Nuclear Safety in 1994 by Pakistan, worked as a catalyst to this process. One of the main obligations of the Convention is that the Contracting Parties need to ensure that functions of the regulatory body are institutionally separated from activities related to promotion and utilization of nuclear energy in the country. In order to fulfill its international obligations, the Government of Pakistan promulgated the Pakistan Nuclear Regulatory Authority Ordinance 2001, under which the Directorate of Nuclear Safety and Radiation Protection (DNSRP), formerly a part of the Pakistan Atomic Energy Commission (PAEC), was transformed into a separate and independent institution, i.e., the Pakistan Nuclear Regulatory Authority (PNRA).

The organization of PNRA comprises a Chairman, two full-time Members and seven part-time Members, including eminent professionals from the science, engineering and medical sectors; and representatives of the Ministry of Health, Pakistan Environmental Protection Agency, Pakistan Atomic Energy Commission and the Strategic Plans Division of the Joint Staff Headquarters. The Authority has established different directorates to perform its regulatory functions. The organizational structure of PNRA is presented in Figure 1.

The mission of PNRA is to ensure safe operation of nuclear installations and radiation facilities, and to protect the radiation workers, the public and the environment from harmful effects of ionizing radiation. This is to be accomplished by formulating and implementing effective regulations, building a relationship of trust with the licensees, and maintaining transparency in regulatory actions and decisions. PNRA Ordinance empowers PNRA to control, regulate and supervise all matters related

to nuclear safety and radiation protection so as to ensure safety of the workers, the public and the environment from harmful effects of ionizing radiation. PNRA regulates the nuclear and radiation safety aspects of nuclear installations and radiation facilities; grants authorizations, issues licences to nuclear installations and radiation facilities and their operators; and inspects all such facilities to verify that regulations concerning safety measures are being properly implemented. PNRA also issues "No Objection Certificates (NOCs)" to importers and exporters of radioactive sources and "Radiation Free Certificates" for exportable food items. Transportation and disposal of radioactive materials also falls under the purview of PNRA. In addition, PNRA ensures that effective preparedness, coordination and measures for managing nuclear and radiological accidents and emergencies is maintained by the licensees.

At the national level, PNRA has close interaction with organizations such as National Disaster Management Authority (NDMA), Pakistan Environmental Protection Agency (PEPA), Planning Commission, other governmental organizations / ministries / departments, etc., in the arenas of nuclear safety and regulatory activities. PNRA also maintains links with national universities and research institutes for keeping itself abreast with latest national / international research in disciplines of nuclear and radiation safety along with human resource development activities.

PNRA on behalf of the Government of Pakistan is responsible for the execution of international obligations under four international conventions to which Pakistan is a signatory.

As a forward-looking organization, PNRA lays great emphasis on enhancing its regulatory effectiveness and efficiency, particularly through capacity building and working in a manner that ensures the confidence of the government, the public and the licensees.

With respect to striving for continuous



## INTRODUCTION

improvement, PNRA invited an IAEA Integrated Regulatory Review Services (IRRS) Mission to Pakistan from 28<sup>th</sup> April to 09<sup>th</sup> May, 2014 for the assessment of regulatory infrastructure for nuclear and radiation safety in Pakistan and regulatory effectiveness and efficiency of PNRA. The Mission reviewed the national nuclear regulatory regime as well as working of PNRA in areas of nuclear safety and radiation protection, including licensing and authorization, review & assessment, inspection and enforcement processes. The Mission acknowledged the high level of expertise available within PNRA. The Mission also identified certain good practices of PNRA that can be beneficial, if adopted by nuclear regulatory bodies of other countries.

PNRA believes that its real strength lies in its capable and highly trained regulatory professionals and is constantly striving to improve its technical expertise. At the international front, PNRA collaborates with international institutions and organizations under various bilateral and multilateral cooperation programmes to place its staff for higher studies and technical trainings. The International Atomic Energy Agency (IAEA) also provides support to PNRA under various technical cooperation programmes for capacity building of its regulatory staff. There are a number of bilateral agreements with various organizations under which these organizations provide specialized technical support to PNRA in performing its regulatory functions.

PNRA continues to contribute to international endeavors in promoting the objectives of nuclear safety and security. To this objective, 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 e.g. technical & consultancy meetings, expert missions, workshops and training courses.

Under the auspices of IAEA, PNRA is extending support to the countries embarking upon use of nuclear technology, in establishing regulatory

infrastructure and developing legislation / regulations. A Malaysian delegation comprising of eight officials visited PNRA from 24-28 November, 2014 for establishment of radiation detection equipment laboratories and maintenance capability in Pakistan in order to benefit from Pakistan's experience.

### Major Activities in 2014

Major activities of PNRA during 2014 are summarized as follows:

1. Monitored activities at three operational nuclear power plants (Karachi Nuclear Power Plant Unit-1, Chashma Nuclear Power Plants Units 1 & 2) and two under construction nuclear power plants (Chashma Nuclear Power Plant Units 3 & 4). Releases to the environment from the operating NPPs and radiation doses to workers remained well below the regulatory limits;
2. Enhanced the licensing net for diagnostic radiation facilities by more than 17 percent. More than 600 new facilities were registered during the reported period;
3. Initiated review and assessment of the licence application for the issuance of construction licence of the Karachi Nuclear Power Plants Unit-2 & Unit-3 (K-2/K-3). The review is expected to be completed in the first half of 2015;
4. Granted operating licence to PARR-1 till December 31, 2018 and PARR-2 till December 31, 2024;
5. Approved and gazette notified amendments in the following regulations:
  - a. Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority - (PAK/900);
  - b. Regulations on the Safety of Nuclear Power Plant Design - (PAK/911);
  - c. Regulations on the Safety of Nuclear Power Plants-Quality Assurance - (PAK/912); and
  - d. Regulations on the Safety of Nuclear Power Plants Operation - (PAK/913);



6. Continued the licensing activities for the PINSTECH Pre-disposal Radioactive Waste Management Facility (RWMF). The review of Safety Analysis Report (SAR) of RWMF and inspection of the facility for verification of SAR was completed during the reported period;
7. Concluded two PSDP Projects "National Environmental Radioactivity Surveillance Programme" and "National Dosimetry and Protection Level Calibration Laboratory" on 30<sup>th</sup> June, 2014 and submitted project completion reports to the Government of Pakistan;
8. Conducted IAEA Integrated Regulatory Review Services (IRRS) Mission to Pakistan for the assessment of regulatory infrastructure of nuclear and radiation safety in Pakistan and regulatory effectiveness and efficiency of PNRA;
9. Represented Pakistan in the 6<sup>th</sup> Review Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS) held at IAEA Headquarters in March-April, 2014. Chairman PNRA presented the national report highlighting the measures taken by Pakistan to ensure nuclear safety for peer review by fellow Contracting Parties;
10. Finalized PNRA Strategic Plan 2015-2018.
11. Continued Safety Culture Self-Assessment using interview, focus-group, survey, observation and document review tools in collaboration with IAEA;
12. Organized about ninety lectures / seminars as part of its campaign to improve public awareness of hazards associated with radiations in different national universities / colleges / institutes in Islamabad, Faisalabad, Lahore, Multan, Bahawalpur, DG Khan, Abbottabad, Karachi, Gujranwala, Sargodha and Peshawar in which about twelve thousand personnel participated;
13. The seventh Steering Committee Meeting of PNRA and National Nuclear Safety Administration (NNSA) of China was held at Beijing to oversee the cooperation arrangements in the field of Nuclear Safety;
14. Approved the initial decommissioning plan of K-1 and the decommissioning strategies for C-1 and C-2;
15. Reviewed radioactive waste management programmes of eleven nuclear medical centres;
16. Monitored the emergency exercises at K-1, CNPGS and PINSTECH;
17. Initiated the implementation of project for construction of PNRA residential colony at Chashma for providing residences to its employees posted at RNSD-II, under Public Sector Development Programme (PSDP) of the Government of Pakistan;
18. Merged SNRS and NSTC to establish the National Institute of Safety and Security (NISAS), inaugurated by DG-IAEA in March, 2014;
19. Conducted nineteen training courses in the field of nuclear and radiation safety & five training courses in the field of nuclear security and physical protection. More than 650 personnel from PNRA and other stakeholder organizations benefited from these training courses; and
20. Established Dr. Ishfaq Ahmad Auditorium at PNRA Headquarters, Islamabad.

### Targets for 2015

The targets set for 2015 are summarized as:

1. Continual monitoring of licensees' activities for compliance of regulatory requirements;
2. Enhancing the licensing net for diagnostic radiation facilities by another 10 percent;
3. Enhancing cooperation with national regulators and international organizations;
4. Implementation of action plan for further improvement in the regulatory framework and processes in the light of IRRS Mission's recommendations & suggestions;

## INTRODUCTION

5. Completion of Safety Culture Self Assessment (SCSA) of PNRA;
6. Implementation of PNRA Strategic Plan 2015-2018;
7. Issuance of the regulatory decision on the application of construction licence for K-2/K-3;
8. Improvement in the regulatory framework based on the experience feedback of Fukushima NPPs accident;
9. Issuance 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);
10. 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)
11. Revision of PNRA Management System Manual;
12. Commencement of work on PNRA residential colony at Chashma; and
13. Establishment of Physical Protection Exterior Laboratory (PPEL) with assistance of IAEA under the PNRA-IAEA Nuclear Security Cooperation Programme at Pakistan Centre of Excellence, Chakri.



Integrated Regulatory Review Services (IRRS) Mission to Pakistan, 2014

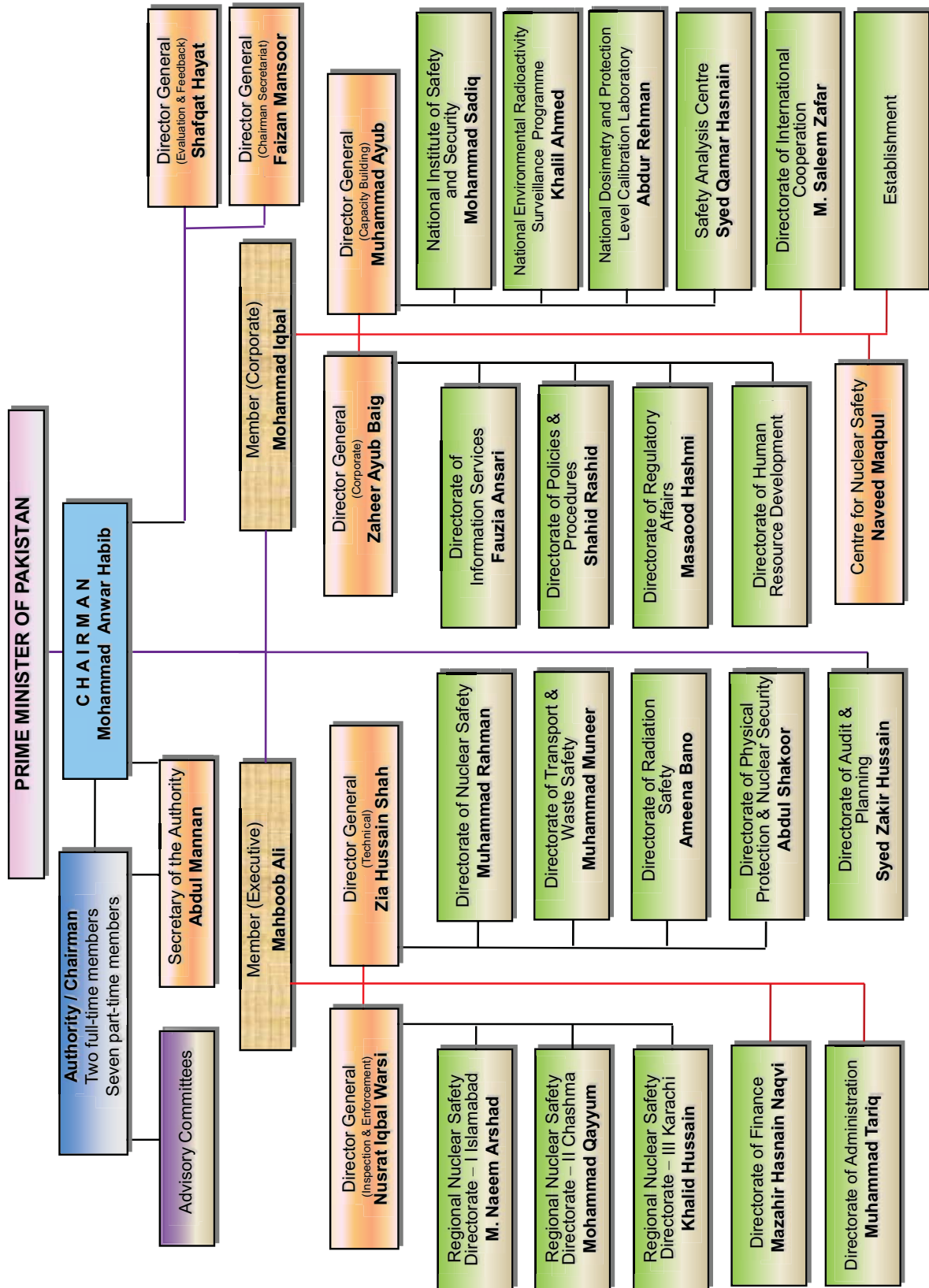


Figure 1: Organizational Structure of PNRA

## 2 REGULATORY FRAMEWORK

PNRA is continuously developing its regulatory framework to strengthen the regulatory effectiveness over nuclear installations and radiation facilities & activities. The regulatory framework comprises three tiers as illustrated in Figure 2. The first tier is PNRA Ordinance, followed by PNRA regulations and regulatory guides issued there-under in the subsequent tiers. The highest level document i.e., PNRA Ordinance, describes the mandate, powers, functions and responsibilities of PNRA assigned by the Government of Pakistan. Under the Ordinance, PNRA is empowered to formulate regulations and policies in order to regulate safety of nuclear installations and radiation facilities to protect against risks arising from ionizing radiations. The regulations are placed in the second tier of regulatory framework. PNRA regulations are mandatory for the licensees and their compliance is verified through regulatory inspections of the actual work practices in licensee's premises and review & assessment of their submissions required by the regulations. Non-compliance with the regulatory requirements are managed through an enforcement process which is based on persuasions, serving of notices and hearings whereas prosecution is used as a last resort when all other actions do not result in any constructive outcome.

The third tier of regulatory framework consists of regulatory guides which describe acceptable methodology for implementation of requirements set forth by PNRA regulations. Since, these

regulatory guides are non-mandatory in nature therefore the licensee may choose other acceptable approaches to satisfy the regulatory requirements. In such cases, the licensee is required to demonstrate that the proposed approach provides at least the same level of safety as would have been achieved, if the methodology provided in the prescribed regulatory guides had been applied.

### Regulations

The regulations developed by PNRA transform its mission of protecting the radiation workers, the public and the environment from harmful effects of ionizing radiation into realization. A comprehensive process is established for the development of regulations including rigorous internal reviews at various levels within PNRA followed by inviting comments from the stakeholders such as the licensees, the government and the public.

The regulations are reviewed after every five years taking into account obligations of PNRA Ordinance and international conventions, feedback from licensing experience, feedback from stakeholders and the international practices. PNRA has so far published 17 regulations as shown in Table 1. These regulations are also placed at PNRA website ([www.pnra.org](http://www.pnra.org)).

Following new regulations remained under development at PNRA during 2014:

1. Regulations on Physical Protection of Nuclear Installation(s) and Nuclear Material(s)- (PAK/925); and
2. Regulations on Decommissioning of Facilities using Radioactive Material - (PAK/930).

Revision of the following regulations remained in progress in year 2014, as a result of their periodic review:

1. Regulations for Licensing of Nuclear Safety Class Equipment and Component Manufacturers - (PAK/907);
2. Regulations for the Licensing of Radiation Facility(ies) other than Nuclear Installation(s) -

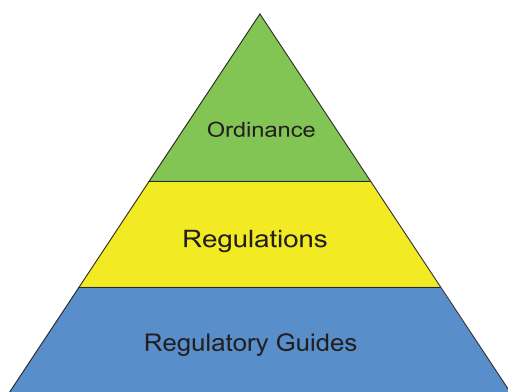


Figure 2: Regulatory Framework



(PAK/908);

3. Regulations on the Safety of Nuclear Power Plant Design - (PAK/911);
4. Regulations on the Safety of Nuclear Power Plants Operation - (PAK/913);
5. Regulations on Radioactive Waste Management - (PAK/915); and
6. Regulations for the Safe Transport of Radioactive Material - (PAK/916).

Moreover, the Authority approved the amendments in the following regulations which have been duly gazette notified during the year 2014:

1. Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority - (PAK/900);
2. Regulations on the Safety of Nuclear Power Plant Design - (PAK/911);
3. Regulations on the Safety of Nuclear Power Plants-Quality Assurance - (PAK/912);
4. Regulations on the Safety of Nuclear Power Plants Operation - (PAK/913).

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

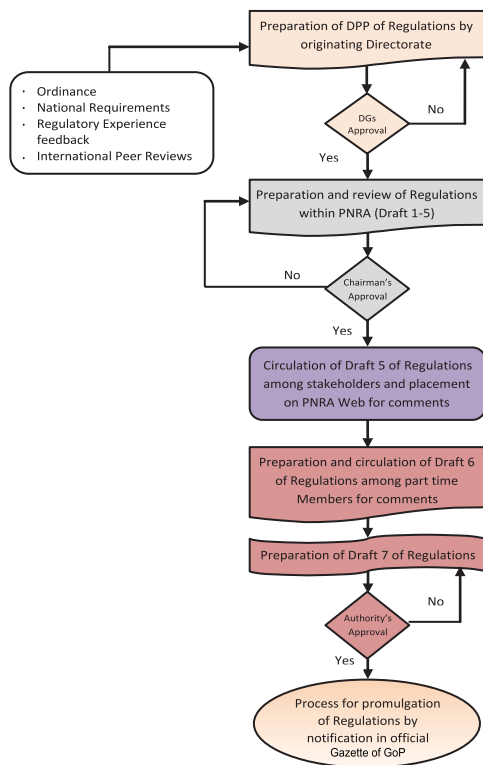


Figure 3: Process for Development of PNRA Regulations

### Regulatory Guides

During 2014, development of following regulatory guides remained in progress:

1. Radiation Safety in Industrial Radiography (RG 904.03);
2. Protection of Patients in Diagnostic Radiology (RG 904.05);
3. Radiation Protection and Safety in Radiotherapy (RG 904.06)
4. Format and Contents of Radiation Protection Programme (RG 904.07);
5. Guidelines for Medical Professionals on Transport, Diagnosis & Management of Overexposed & Contaminated Individuals in Radiological Emergency (RG 904.08);
6. Format and Contents of Radiation Emergency Plans of Radiation Facilities and Activities (RG 914.02); and
7. Format and Contents of Physical Protection Programme of Nuclear Installations (RG 925.01).

### Central Registry

PNRA maintains a central registry of all regulatory and management system documents, including regulations, regulatory guides, policies and internal working procedures. Figure 4 represents the number of regulations, regulatory guides, policies and procedures registered so far in the central registry.

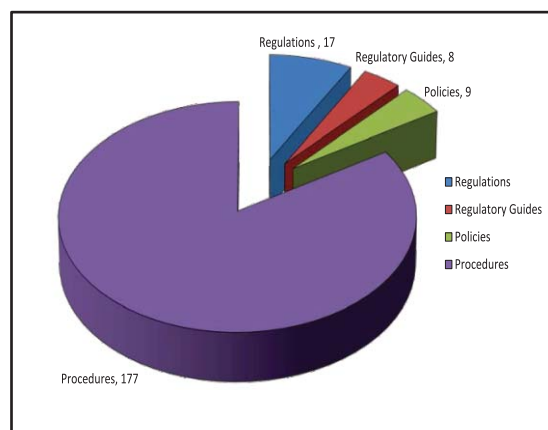


Figure 4: Status of PNRA Central Registry

## REGULATORY FRAMEWORK

**Table 1: List of Gazette Notified Regulations**

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



**Visit of Chinese Delegation for Overview of Regulatory Framework Related to Emergency Preparedness**

### 3 REGULATORY OVERSIGHT OF NUCLEAR INSTALLATIONS

The civilian nuclear installations in the country are regulated by PNRA. Licensing, review & assessment and inspection & enforcement are the main processes of PNRA for regulating nuclear installations and associated activities. PNRA registers sites and issues licences, permits and authorizations during various stages of nuclear installations after thorough review and assessments of licensees submissions. These registrations, licences, permits and authorizations are accompanied by generic and specific conditions, as applicable. Inspections are conducted to verify the compliance with the safety requirements during and after the licensing process.

There are five (05) operational nuclear installations in Pakistan which include three (03) Nuclear Power Plants (K-1, C-1 and C-2) and two (02) Research Reactors (PARR-1 and PARR-2). In addition, construction of two nuclear power plants (C-3 and C-4) is progressing towards commissioning in 2015. The commercial operation of C-3 and C-4 is expected in 2016. Site for Karachi Nuclear Power Plant Units 2 & 3 (K-2 & K-3) has already been registered and PNRA started review & assessment of K-2/K-3 PSAR and PSA report submitted by the applicant along with the construction licence

application. Details of nuclear installations that are in operation and under construction in the country is provided in Table 2.

PNRA reviews and assesses the submissions made by licensees and applicants in support of their applications for licensing as required under PNRA regulations. A number of other documents related to the modifications in the installation's design, event reports, routine reports and other documents submitted by the licensee from time to time are also reviewed by PNRA. The objective of regulatory review and assessment is to verify compliance of licensees' activities with the regulatory requirements. In case of non-compliance with regulatory requirements, PNRA issues directives for corrective actions and subsequently takes other necessary enforcement actions.

During 2014, PNRA reviewed ten (10) design modifications of K-1 and one (01) of C-1; issued one (01) directive to K-1, one (01) to C-2 and one (01) to PARR-2; and reviewed four (04) event reports of K-1, six (06) of C-1 and six (06) of C-2. PNRA also performs integrated safety assessment of the operating nuclear power plants biennially based on selected safety performance indicators and

**Table 2: Nuclear Installations under Regulatory Control**

S. No.	Installation	Status	Type	Capacity	Commercial Operation
1.	Karachi Nuclear Power Plant Unit 1 (K-1)	In Operation	Pressurized Heavy Water Reactor	137 MWe	1972
2.	Chashma Nuclear Power Plant Unit 1 (C-1)	In Operation	Pressurized Light Water Reactor	325 MWe	2000
3.	Chashma Nuclear Power Plant Unit 2 (C-2)	In Operation	Pressurized Light Water Reactor	340 MWe	2011
4.	Chashma Nuclear Power Plant Unit 3 (C-3)	Under Construction	Pressurized Light Water Reactor	340 MWe	2016 (expected)
5.	Chashma Nuclear Power Plant Unit 4 (C-4)	Under Construction	Pressurized Light Water Reactor	340 MWe	2016 (expected)
6.	Karachi Nuclear Power Plant Unit 2 (K-2)	In Planning Phase	Pressurized Light Water Reactor	1100 MWe	2020 (expected)
7.	Karachi Nuclear Power Plant Unit 3 (K-3)	In Planning Phase	Pressurized Light Water Reactor	1100 MWe	2021 (expected)
8.	Pakistan Research Reactor-1 (PARR-1)	In Operation	Swimming Pool	10 MWt	1965
9.	Pakistan Research Reactor-2 (PARR-2)	In Operation	Tank-in-Pool	30 KWt	1991



feedback of review, assessment and regulatory inspection processes.

## Nuclear Power Plants

### Nuclear Power Plants in Operation

Karachi Nuclear Power Plant Unit 1 (K-1) is a pressurized heavy water reactor (CANDU type) with natural uranium fuel and heavy water as reactor coolant and moderator. During 2014, the plant remained shut down for about six months from February 03, 2014 to August 01, 2014 to carry out necessary periodic maintenance, testing, assessment and refurbishment jobs. Based on satisfactory completion of the outage jobs and resolution of safety issues identified by PNRA, permission was granted to make the reactor critical and subsequent power operation.

K-1 submitted one hundred (100) reports as part of periodic safety review. These reports were reviewed and the queries were resolved in various review meetings with the licensee.

Chashma Nuclear Power Plant Unit 1 (C-1) is a pressurized light water reactor with enriched uranium fuel. During 2014, C-1 underwent 9<sup>th</sup> refueling outage for which the plant remained shutdown for about five (05) weeks in April-May, 2014. PNRA witnessed selected activities and conducted various regulatory inspections during refueling outage. PNRA allowed criticality and subsequent power operation of C-1 upon satisfactory completion of RFO activities.



C-3/C-4 Commissioning Programme Review Meeting at Chashma Site

Chashma Nuclear Power Plant Unit 2 (C-2) is an improved version of C-1 with certain safety enhancements. C-2 underwent its 2<sup>nd</sup> refueling outage in June, 2014 and remained shutdown for four (04) weeks. PNRA witnessed selected activities and conducted various regulatory inspections during refueling outage. PNRA allowed the licensee to make C-2 critical and subsequent operation after 2<sup>nd</sup> RFO on the basis of its assessment of RFO activities.

During the year 2014, PNRA performed Integrated Safety Assessment (ISA) of K-1, C-1 & C-2 and issued three (03) separate reports. The objective of Integrated Safety Assessment (ISA) was to assess the safety level of NPPs based on feedback of review and assessment, regulatory inspections and safety performance indicators. The overall plant safety assessment of K-1, C-1 and C- 2 was assessed as 'minimally acceptable'.

### Nuclear Power Plants Under Construction

Construction of civil structures and manufacturing and installation of equipment for C-3 and C-4 remained in progress under regulatory supervision of PNRA. Review and assessment of commissioning programme and Pre-Service and In-Service Inspection programme of C-3 have been completed by PNRA during 2014. PNRA selected a number of control points for inspection.

During 2014, PNRA received an application from PAEC for allowing fuel loading in C-3. The request was accompanied with the Final Safety Analysis



PNRA Inspectors Conducting Inspection of C-3 RPV at Chashma Site

Report (FSAR) and other documentation as required by PNRA regulations PAK/909. The docketing phase of the licensing submissions was completed during the reported period to assess the completeness of the application.

**Nuclear Power Plants in Planning Phase**

Pakistan Atomic Energy Commission (PAEC) has submitted Preliminary Safety Analysis Report (PSAR) and Probabilistic Safety Analysis (PSA) report along with the application for issuance of construction licence for K-2 / K-3. The review of PSAR is under progress and is expected to be completed in the first half of next year so as to make a regulatory decision on the application.

**Research Reactors**

Pakistan Research Reactor-1 (PARR-1) is a swimming pool type research reactor of 10 MWt which is in operation since 1965. Pakistan Research Reactor-2 (PARR-2) is a tank-in-pool type research reactor of 30 KWt which is in operation since 1991. During 2014, PARR-1 was granted operating licence till December 31, 2018 after thorough review of Periodic Safety Review (PSR) reports. PARR-2 submitted PSR reports on eleven safety factors as agreed by PNRA for revalidation of operating licence. After completion of the review, PSR of PARR-2 was accepted and operating licence was revalidated till December 31, 2024.

**Molybdenum Production Facility (MPF)**

PNRA has licensed PINSTECH to operate Pakistan's

first Molybdenum Production Facility (MPF). The facility produces Molybdenum-99 (Mo-99) as the mother product for production of Tc-99m which is used in health sector for diagnosis of different types of cancers. Previously, Mo-99 was imported from South Africa.

The licence to MPF has been issued after a thorough review and assessment process and conducting regulatory inspections at all important stages to ensure that the facility can be operated safely without any undue risk to the workers and the general public. Initially, the operating licence was issued till December, 2014 which has been revalidated till December 31, 2015 based on safe operation of the facility.

**Licensing of Operating Personnel**

As per regulatory requirements, PNRA ensures that qualified and trained operating personnel, working as shift supervisors, shift engineers, and reactor operators, remain available throughout the operating lifespan of the nuclear installations. PNRA conducts oral and operating examinations for award of licences to these operating personnel. The operator's licences are renewed annually by PNRA based upon operators technical/professional competence assessment provided by the plant management, completion of necessary retraining and medical fitness recommendation by qualified medical practitioner.

Detail of new licences issued to C-1 and C-2



PNRA Inspector at C-4 Dome Placement Activity



K-2/K-3 PSAR First Review Meeting held at Beijing, China

## REGULATORY OVERSIGHT OF NUCLEAR INSTALLATIONS

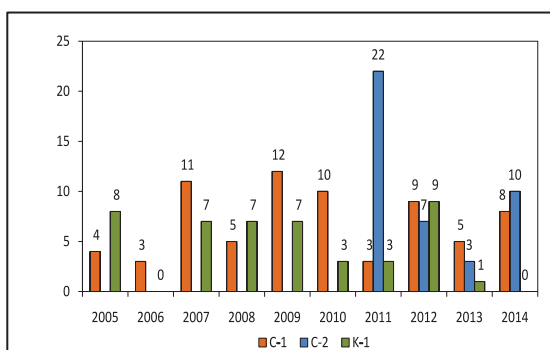


Figure 5: Issuance of New Operators' Licences for NPPs

operating personnel is shown in Figure 5; and renewal of licences of C-1, C-2 & K-1 operating personnel is shown in Figure 6. Figure 7 represents the number of operating licences renewed at PARR-1 and PARR-2 during 2014.

### Inspections of Nuclear Installations

PNRA conducts regulatory inspections during all phases (including construction, commissioning and operation, etc.) of nuclear installations. The main purpose of these inspections is to verify that the licensees are conducting their activities in accordance with PNRA regulations, licence conditions and the directives issued from time to time. It is also verified that appropriate measures are being taken by the licensees to promote safety culture within their organizations. The deficiencies observed during these inspections are communicated to the licensees in the form of inspection reports along with necessary requirements for corrective actions, which are then followed up for satisfactory implementation.

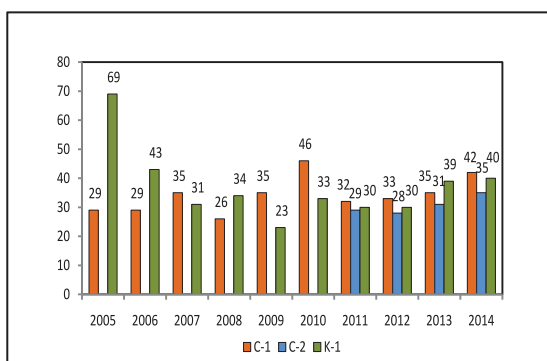


Figure 6: Renewal of Operators' Licences for NPPs

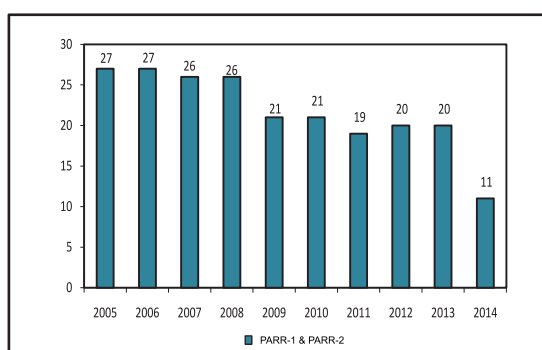


Figure 7: Renewal of Operators' Licences at PARR-1 and PARR-2

PNRA has three Regional Nuclear Safety Directorates (RNSDs) located in Islamabad, Kundian and Karachi, namely RNSD-I, RNSD-II and RNSD-III respectively, where resident inspectors have been posted to conduct regulatory inspections in their respective regions. The directorates at PNRA headquarters provide technical support to the regional directorates during the inspections, if required.

Various routine and planned inspections of nuclear installations are carried out in accordance with the annual inspection programme. In addition to these inspections, control point inspections are carried out during manufacturing of safety related equipments, construction, commissioning and operation of NPPs. Unplanned and reactive inspections are also carried out as and when required. Furthermore, general surveillance of different plant areas is also conducted on daily basis.

Figure 8 represents total number of inspections conducted at C-1, C-2, C-3, C-4 and K-1 in 2014.

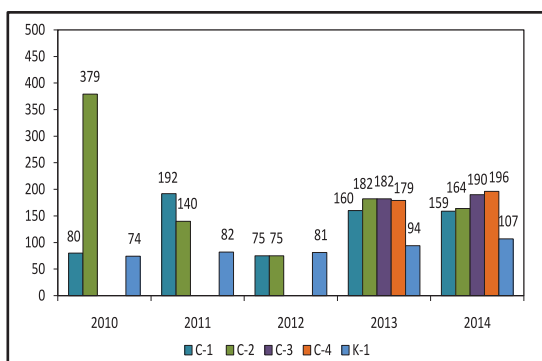


Figure 8: Regulatory Inspections of K-1, C-1, C-2, C-3 and C-4

Further, a number of inspections of C-3/C-4 and K-2/K-3 were also carried out by PNRA at equipment manufacturing sites in China.

Detail of number of inspections conducted at PARR-1 and PARR-2 in 2014 is shown in Figure 9.

### Radiation Safety at Nuclear Installations

PNRA has been mandated to regulate radiation safety at nuclear installations in order to protect the worker, the public and the environment from the harmful effects of ionizing radiation. PNRA employs regulatory tools like development and implementation of regulations and regulatory guides, review and assessment of licensee's submissions, licensing and inspection of installations and where necessary enforcement actions to fulfill its regulatory obligations.

Review and assessment is one of the regulatory tools to assess radiation safety at licensed facilities. The radiation safety at nuclear power plants is ensured through the review of various documents such as radiation protection programmes, ALARA plans, annual safety reports, annual dose reports, etc., submitted by the licensees as required by PNRA. These documents/submissions are reviewed against existing regulations, licence conditions and agreed codes and standards.

#### Karachi Nuclear Power Plant Unit 1 (K-1)

Karachi Nuclear Power Plant Unit 1 (K-1) submitted information related to number of persons exposed,

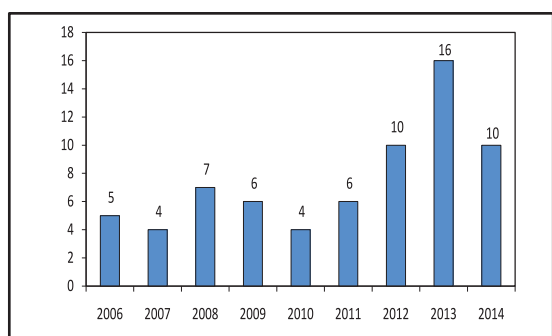


Figure 9: Regulatory Inspections of PARR-1 and PARR-2

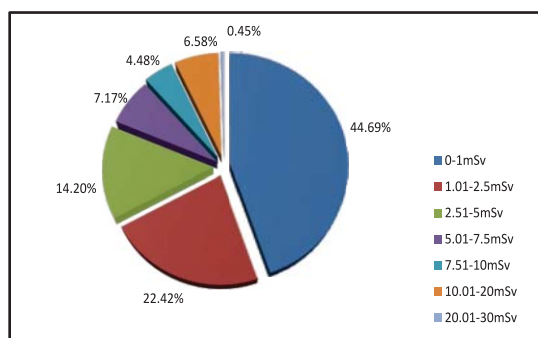


Figure 10: Annual Radiation Doses to K-1 Workers

monthly collective dose, average and maximum individual doses in its monthly technical reports.

During the reported period, the doses of most of the radiation workers were well within regulatory limits. Whereas, few workers received individual dose of more than 20 mSv. In such cases, it is verified that total dose received is less than 100 mSv over the last five years. Figure 10 represents the percentage of workers exposed to different dose ranges during 2014.

#### Chashma Nuclear Power Plant Unit 1 and Unit 2 (C-1 & C-2)

Chashma Nuclear Power Plant Unit 1 (C-1) and Chashma Nuclear Power Plant Unit 2 (C-2) submitted monthly technical reports during the year 2014 which included information and data about radiation exposures of workers. Monthly technical reports normally provide information, inter alia, about number of workers exposed, monthly collective dose and average and maximum individual dose. Review of reports submitted to PNRA indicated that individual doses of radiation

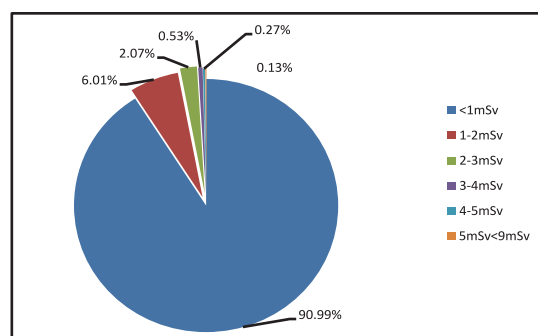


Figure 11: Annual Radiation Doses to C-1 Workers

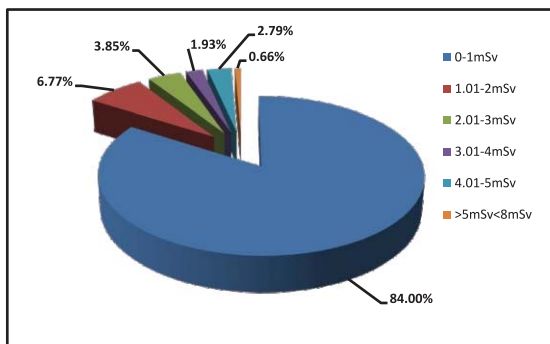


Figure 12: Annual Radiation Doses to C-2 Workers

workers at C-1 & C-2 were well within regulatory limits. Figures 11 and 12 represents the graphical distribution of doses of workers of C-1 and C-2 respectively.

C-1 completed its 9<sup>th</sup> Refueling Outage (RFO) and C-2 went through its 2<sup>nd</sup> refueling outage in 2014. During RFO-9 at C-1, the actual collective dose received by workers at C-1 remained well below estimated collective dose as shown in Figure 13. During RFO-2 at C-2, the actual collective dose was higher than the estimated collective dose as shown in Figure 14. The increase in the estimated dose was due to some additional maintenance jobs that were not presumed earlier. However, individual doses of workers at C-2 remained well within the regulatory limits.

**Research Reactors (PARR-1 & PARR-2)**

Radiation safety aspects at Pakistan Research Reactors (PARR-1 & PARR-2) are also continuously evaluated through review and assessment of submissions and inspections. Research reactors submit monthly technical reports and annual safety

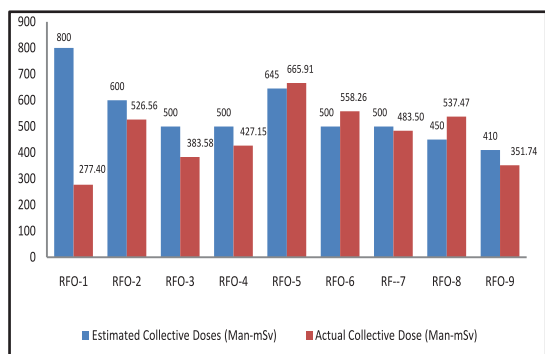


Figure 13: Estimated and Actual Collective Doses during C-1 RFOs

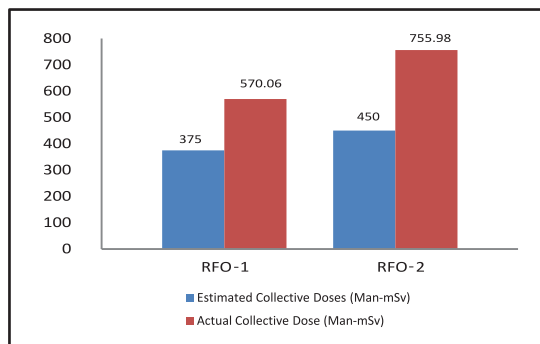


Figure 14: Estimated and Actual Collective Doses during C-2 RFOs

report describing operation history, reportable incidents, system performance & evaluation tests, personal radiation exposures and QA activities, etc.

During reported period, review of the submitted reports indicated that occupational exposure of radiation workers for the year 2014 remained well within the regulatory limits. Figure 15 represents the percentage of workers exposed to different dose ranges during 2014.

**Equipment Manufacturer**

PNRA has issued licence to equipment manufacturing industry for manufacturing safety class equipment. Under the licence, a number of equipment for Chashma Nuclear Power Plant Unit-3 (C-3) and Chashma Nuclear Power Plant Unit-4 (C-4) have been manufactured including NaOH Storage Tank, Volume Control Tank, Boric Acid Holdup Tank, Emergency Feed Water Tank, etc. During the manufacturing of these equipment, PNRA inspectors performed a number of inspections to verify compliance with the regulatory requirements.

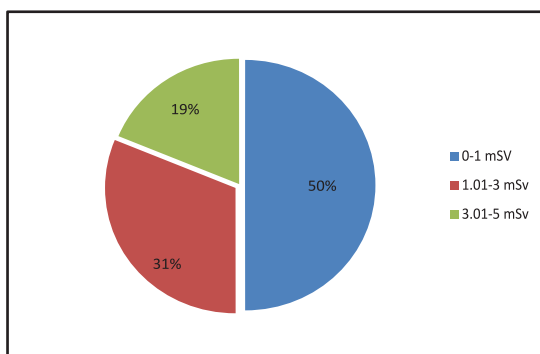


Figure 15: Annual Radiation Doses to Research Reactor Workers



## 4 REGULATORY OVERSIGHT OF RADIATION FACILITIES

In modern world, radiation is widely being used in medicine, agriculture, industry and research to benefit the mankind. Moreover, radiations are also used in a variety of other ways such as in oil and gas exploration, law enforcement, and geological studies, etc. Since exposure from all such applications of radiation presumably involves some risk to the workers, the public and the environment, therefore, they need to be protected against these hazards.

PNRA is responsible to control and supervise all matters related to radiation protection in Pakistan. In order to discharge its responsibilities, PNRA has established various processes for the regulatory oversight of radiation facilities and activities which include authorization, licensing, review & assessment, inspection and enforcement. All radiation facilities in Pakistan are obliged to obtain a licence from PNRA to ensure safe operation of all the sources and equipment installed/used at these facilities. PNRA applies graded approach in regulating the radiation facilities and activities. All regulatory requirements related to radiation protection including submission of various documents at the time of licensing e.g., radiation protection programmes, emergency plans, physical protection plans, training and re-training programmes for radiation workers, etc., are applied in a manner commensurate with the radiation risk associated with that facility or activity. The regulatory process of review and assessment of licensing submissions and inspections are utilized to verify compliance with the regulatory requirements and where necessary enforcement actions are taken to rectify the non-compliances.

### **Radiation Safety at Radiation Facilities**

Radiation safety at the radiation facilities is ensured through review and assessment of radiation protection plan, radiation dose record and health surveillance record during licensing process. Periodic inspections are conducted to verify compliance with regulatory requirements. During

the reported period, PNRA issued regulatory positions on non-medical human imaging by X-ray scanners at international airports for detection of drugs in suspects, new model gamma projector for use in industrial radiography and utilization of various approaches for stuck radiation sources in deep oil and gas exploration wells. Investigation of incidents involving overexposure of workers and review & approval of radiation protection programmes of certain radiation facilities was also completed during the reported period. Detail of regulatory activities concerning radiation safety at radiation facilities during 2014 is presented below:

### **Licensing of Radiation Facilities**

PNRA Ordinance requires that radiation facilities cannot be operated in the country unless they have a valid licence issued by PNRA. These licences are issued after conducting detailed review and assessment of the applicants' submissions specified under PNRA regulations and inspection of the work place and equipment.

All the radiation facilities using radioactive material in the country have been licenced by PNRA including all radiotherapy, nuclear medical centres, industrial radiography, irradiation facilities and activities involving use of radiation sources in industry, research and agriculture, etc. In addition, most of the diagnostic X-ray facilities are also working under PNRA licensing net. During the reported period, strong persuasions continued to bring defaulted diagnostic X-ray facilities into licensing net which has resulted in an appreciable increase in number of licensed X-ray facilities. By the end of 2014, the total number of licensed radiation facilities reached over 4000. Legal proceedings are being initiated against those who have defaulted, following the enforcement procedure under the enforcement regulations.

The number of facilities that have been licensed so far by PNRA include 71 full-fledged medical centres, 150 industrial users, 65 research institutes, 103

## REGULATORY OVERSIGHT OF RADIATION FACILITIES

importers, 3535 diagnostic X-ray facilities, and 103 other radiation facilities.

### Inspections of Radiation Facilities

Regulatory inspections are carried out to verify that the provisions of PNRA Ordinance, regulations, licence conditions and directives issued from time to time are complied with by the licensee. An annual inspection programme to conduct periodic inspections of all radiation facilities is prepared each year with the provisions for special inspections, if required.

During the reported period, inspections of different types of radiation facilities were performed in accordance with the annual inspection plan. A comparison of the regulatory inspections performed during the reported year with the inspections performed during previous years is shown in Figure 16. These inspections are focused on verification of facility layout, shielding design, actual work practices, ALARA implementation and adequacy of physical protection measures being taken by licensees during use, transportation and storage of radiation sources. Periodic inspections such as announced and un-announced inspections of radiation facilities are performed to monitor continued compliance with safety requirements. Directives and recommendations for improvement and compliance with regulatory requirements are communicated to the licensees through inspection reports which are appropriately followed up for compliance.

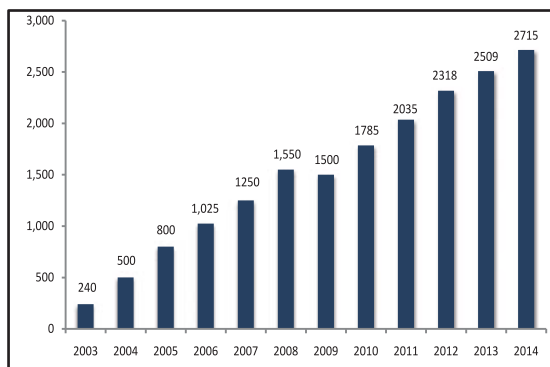


Figure 16: Regulatory Inspections of Radiation Facilities

### Occupational Exposure at Radiation Facilities

PNRA is maintaining occupational exposure record of radiation workers at national level. The database containing record is utilized to evaluate trends in occupational exposures, effectiveness of radiation protection programme of licensee and the ALARA implementation. This database has two main sources of input; records submitted by licensees through regional directorates of PNRA, and the records provided by dosimetry service providers in the country. Currently, the database includes dose records of more than 8000 radiation workers which have been distributed in different activity types such as radiotherapy, nuclear medicine, industrial applications, research and education, diagnostic radiology and some other types. Distribution of radiation workers in various activity types is shown in Figure 17.

According to the record available to date, doses of 95.27 % of workers remained less than 5mSv while 4.09 % of workers received doses between 5-20 mSv in a year. A small fraction (0.64%) of workers received doses above 20mSv. Although, five year average annual dose of these workers remained within the regulatory limit of 20mSv per year, however, the licensees were required to investigate the cause of these high doses and to take corrective actions accordingly. A representation of radiation workers in different dose ranges is given in Figure 18.

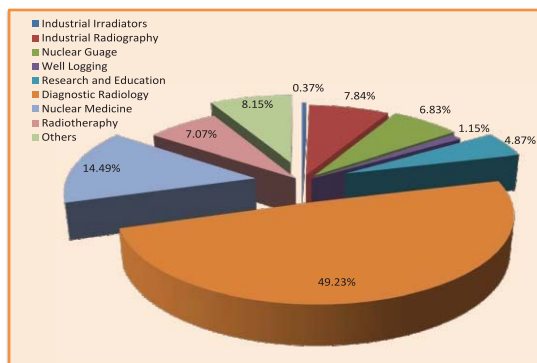


Figure 17: Radiation Workers in Different Radiation Facilities



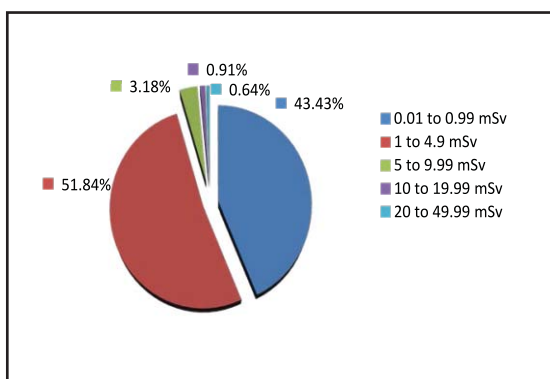


Figure 18: Radiation Workers in Different Dose Ranges

### Authorizations for Import and Export of Radioactive Sources and Radiation Generators

PNRA implements cradle-to-grave approach to keep track of all radioactive sources and radiation generators used in the country. Any person intending to acquire, design, manufacture, construct, install or operate any device that contains any radioactive material or produce ionizing radiation is required to be licensed by PNRA. A "No Objection Certificate" (NOC) issued by

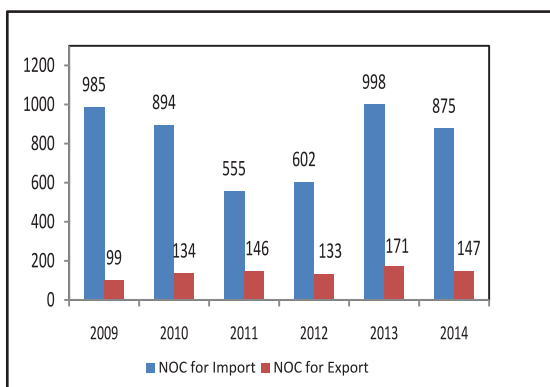


Figure 19: Issuance of Permits for Import-Export of Radiation Sources and Equipment

PNRA is mandatory for custom clearance of radioactive sources and radiation generators when imported into Pakistan. These NOCs are issued to the licensed facilities only. In case of importing high activity radioactive sources, the licensees are bound to submit the undertaking obtained from the supplier/manufacturer of the source to accept the return of these sources at the end of their useful life as a part of their purchase contract. In case of the shipment of disused sources to the vendor/other countries, an export NOC is required to be obtained from PNRA.

Issuance of NOC is based on verification of the intended end-user and fulfillment of technical requirements according to specifications of the radioactive sources or radiation generators being imported or exported. PNRA issues NOCs for import of new radioactive sources or radiation generators into the country and for export of disused radioactive sources and generators / empty containers. Detail of such NOCs issued in 2014 is given in Figure 19, whereas use of sources in different categories is shown in Figure 20.

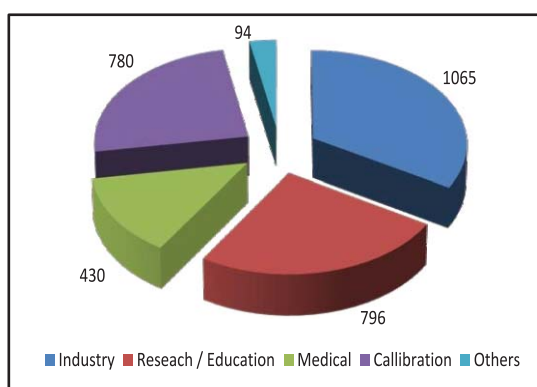


Figure 20: Number of Sealed Radiation Sources by Usage

Radioactive waste is produced from the operation of nuclear installations and radiation facilities. Radioactive waste contains materials that emit ionizing radiation and may be hazardous to human health and the environment, if not handled properly. Safe management of radioactive waste is therefore essential to protect the workers, the public and the environment.

Safe transport of radioactive material in the country is another important element for the protection of the public and the environment from harmful effects of ionizing radiation. Certain industrial applications of radionuclides require frequent transportation of their radioactive sources. In this regard, measures have been taken to ensure that the radioactive sources are being transported safely and securely.

Regulating safe management of radioactive waste and safe transportation of radioactive material is a part of PNRA's mandate under the Pakistan Nuclear Regulatory Authority Ordinance, 2001. In this respect, the Authority has issued "Regulations on Radioactive Waste Management - PAK/915" and "Regulations for the Safe Transport of Radioactive Material-PAK/916" and ensures their implementation through review and assessment and regulatory inspections.

### Radioactive Waste Safety at Nuclear Installations

PNRA regulates the management of radioactive waste at all nuclear installations in the country. At present, the nuclear installations in operation include three (03) operating nuclear power plants (K-1, C-1 and C-2) and two (02) research reactors (PARR-1 and PARR-2).

PNRA ensures that both the activity and the volume of radioactive waste generated at nuclear installations is minimized through suitable design and operation so that doses to the public and the discharges remain As Low As Reasonably Achievable (ALARA). PNRA also ensures that the

operator maintains round-the-clock monitoring of gaseous and liquid effluents while discharging in the atmosphere.

#### Karachi Nuclear Power Plant Unit 1 (K-1)

PNRA ensures through record-review and inspection process that K-1 keeps its radioactive discharges to the environment within acceptable levels. During the year 2014, both the radioactive effluents i.e. gaseous and liquid, remained less than 1% of the Derived Release Limits (DRLs).

Solid radioactive waste generated by K-1 during the reported year was compacted and stored in mild steel drums at K-1. Figure 21 shows the graphical representation of the solid radioactive waste generated at K-1.

#### Chashma Nuclear Power Plant Unit 1 & Unit 2 (C-1 and C-2)

Radioactive waste safety at C-1 and C-2 is ensured through review and assessment of the licensees' submissions and regulatory inspections. PNRA emphasizes that the release of radioactive effluents from C-1 and C-2 to the environment are kept at minimum possible and ensures that radioactive waste is managed in accordance with the Radioactive Waste Management Programme (RWMP), approved by PNRA. The radioactive effluents from C-1 and C-2 i.e. gaseous and liquid, discharged to the environment remained less than 1% of the approved limit.

The solid waste generated at C-1 and C-2 is stored

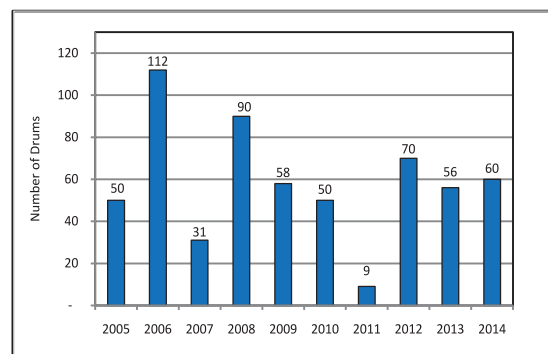
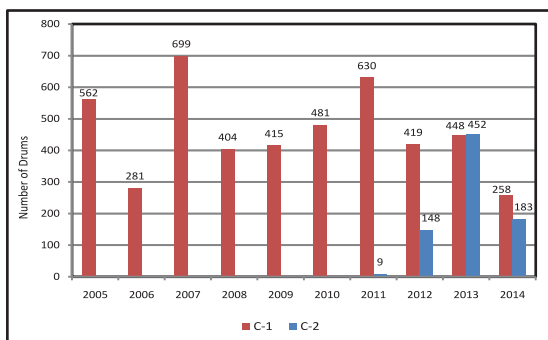


Figure 21: Compacted Solid Waste Drums Generated at K-1



**Figure 22: Accumulated Solid Waste Drums Generated at C-1 & C-2** in mild steel drums at the plant site. The accumulated number of solid waste drums at C-1 and C-2 is shown in Figure 22.

**Pakistan Institute of Nuclear Science and Technology (PINSTECH)**

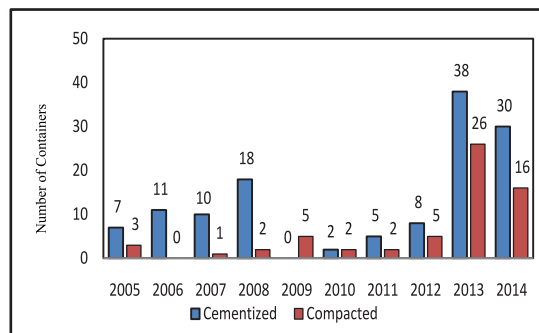
Pakistan Institute of Nuclear Science and Technology is a multidisciplinary research facility of PAEC which houses the country's two (02) research reactors (PARR-1 and PARR-2) and one (01) Molybdenum Production Facility (MPF). The radioactive waste generated from different activities at the institute is stored in steel drums and reinforced cement concrete (RCC) barrels at PINSTECH.

The number of cementized and compacted containers of radioactive waste produced at PINSTECH during 2014 is shown in Figure 23. The increase in number of cementized and compacted drums is due to operation of new Molybdenum Production Facility (MPF).

**Inspections in the Area of Radioactive Waste Management**

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

During the reported period, a number of



**Figure 23: Cementized and Compacted Containers at PINSTECH** inspections were conducted at K-1, PINSTECH and nuclear medical centres. These inspections highlighted certain areas for further improvement in the implementation of radioactive waste management programmes.

**Decommissioning**

At this moment, no nuclear installation is undergoing decommissioning in Pakistan. However, in order to ensure readiness of the licensees for decommissioning, PNRA requires the licensees to prepare and keep updated their decommissioning plan. During the reported period, PNRA reviewed and approved the initial decommissioning plan of K-1 and required K-1 to submit the revised plan within three years by including up-gradation during this period. The decommissioning strategies of C-1 and C-2 have also been approved whereas the decommissioning plan of C-3 remained under review.

PNRA also pays attention to the capacity building of the licensees towards fulfillment of obligations under the regulations. In this respect, a three (03) days workshop was arranged in Karachi for the operators of nuclear installations and radiation facilities. The workshop mainly focused on the understanding of regulations and international standards so that they can implement the regulatory requirements effectively and enhance their capabilities in the area of decommissioning.

**Radioactive Waste Safety at Radiation Facilities**

PNRA ensures that the radioactive waste generated

## RADIOACTIVE WASTE AND TRANSPORT SAFETY

at radiation facilities i.e. industries and nuclear medical centres is being managed and disposed of in a safe manner. The radioactive waste generated in industry is only the radioactive sources which have completed their useful life. Such sources are stored at designated sites. The radionuclides used in Nuclear Medical Centres (NMCs) are short-lived. PNRA ensures through record review and inspection process that NMCs store the radioactive waste safely for at least ten (10) half lives and after that may treat it as ordinary waste. PNRA approves the radioactive waste management programme of NMCs. In this regards, PNRA reviewed radioactive waste management programmes of eleven (11) nuclear medical centres during the reported year.

### Management of Disused Sealed Radioactive Sources (DSRS)

The Government of Pakistan has approved a national policy on control and safe management of radioactive waste, whereas PAEC has been assigned the responsibility for safe disposal of radioactive waste generated as a result of operation of radiation facilities in the country.

The regulations on radioactive waste management (PAK /915) describe the responsibilities of licensee for the safe and secure management of the radioactive waste including Disused Sealed Radioactive Sources (DSRS). Moreover, the regulations ensure that the disposal of radioactive waste is not unnecessarily delayed; and the licensee reports to the Authority the required information at



Workshop on Decommissioning of Nuclear Installations and Radiation Facilities

such intervals as specified in the licensing conditions.

The importers of radioactive sources having half life more than one year and with initial activity greater than 100 GBq are required to have an agreement to return to the supplier when the source is no longer useful for the intended purpose; not useful for another purpose or; not useful to another user in the country for another purpose. PNRA requires this condition as part of the purchase contract without which NOC for import is not granted by the Authority. Screening of the inventory reveals that out of total sealed radioactive sources, 63 % are safely disposed at designated storage sites, 6% returned to the supplier and the remaining 31 % are in use by licensees. Figure 24 shows the graphical representation of the status of SRS in the country.

The DSRS stored at the designated sites mainly include Cobolt-60, Cesium-137, Irradium-192 and Radium-226.

### Safe Transport of Radioactive Materials

PNRA ensures safe and secure transportation of radioactive material in the country. The Regulations for the Safe Transport of Radioactive Material – PAK/916 are in line with the international requirements.

PNRA ensures that consignors and carriers fulfill their obligations and comply with PNRA requirements for safe transportation of radioactive

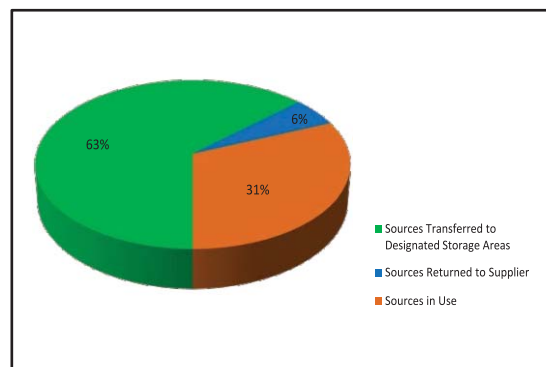


Figure 24: Status of Sealed Radioactive Sources

material/sources within the country. The regional directorates of PNRA conduct routine and periodic inspections, some of which are unannounced, to verify compliance of regulatory requirements. All radioactive consignments imported into the country and sent back under contract are duly authorized by PNRA. The shipping documents of such consignments are evaluated and permissions granted after confirming that the shipments meet national and international requirements for transportation. During the reporting period, PNRA provided technical guidance to licensees, reviewed transportation plans of various establishments dealing with transportation of radioactive materials or radiation sources and evaluated various documents such as certificate of compliance & package design safety report for import/purchase of gamma projector.

### **Certification of Type B(U) Packaging**

The transport packages are the key element to ensure safety during transport. The transport packages used for high activity radioactive material are required to be certified by the regulatory authority of the country of origin. In 2011, PNRA received intention from PINSTECH to design and manufacture Type B(U) transport packaging for transportation of Mo-99 and few other radionuclides for the first time. For the certification of the package, the detailed review of Safety Analysis Report (SAR) of Type B(U) package has been completed.

PNRA inspectors conducted several inspections of prototype of Type B(U) packaging to check the compliance of regulatory requirements during the manufacturing. PNRA inspectors witnessed the functional tests of prototype of Type B(U) package for the normal condition (Leakage, Penetration, Free-Drop) conducted in compliance with national Regulations PAK/916. During the reported period,

the Hypothetical Accident Condition (HAC) tests i.e. Mechanical and Thermal Tests followed by dose mappings on the container were witnessed. Several meetings were also held to resolve the queries on SAR.

### **Re-certification of Type B(U) Packaging:**

In Pakistan, the majority of industrial radiography firms are using type 660 Series Gamma projectors for the NDT purposes. The projectors were certified as Type B(U) packages by the USNRC. The design validity of these projectors expired on June 30, 2013 and the manufacturer did not apply for design revalidation. The NDT firms approached PNRA for the permission to continue transportation of these packages after the expiration of their design validity. PNRA provided the grace period of one year i.e. June 30, 2014 with the condition of transport by road only. During the reported period, PNRA stopped further transportation of these packages after June 30, 2014 and encouraged the licensees to replace these with the projectors having valid design. Moreover, a criteria has also been defined to grant permission for the domestic transport of these projectors by road only.

### **Licensing of Dual Purpose Cask**

The storage of spent nuclear fuel in the dry environment is becoming a famous alternative and viable option due to its passive operational feature. Pakistan Atomic Energy Commission has shown intention to design and manufacture dual purpose cask for the storage and transportation of spent nuclear fuel which is temporarily stored in spent fuel storage pools at plant sites. For this purpose, PNRA has communicated its licensing process to the applicant. During the reported period, the designer & manufacturer (the applicant) of the Cask submitted Quality Assurance Programme (QAP) which remained under review at PNRA.

## 6 EMERGENCY PREPAREDNESS AND RESPONSE

Nuclear installations and radiation facilities are generally designed and operated to a very high level of safety with engineered safety features to prevent accident. Strict regulatory control is exercised throughout the life of such installations and facilities. A possibility of accidents nevertheless remains, even though it is quite low compared to other conventional industries. Therefore, there is always a need for preparedness to respond to and mitigate the consequences of incidents that might occur at a nuclear installation or radiation facility with the possibility for affecting workers, public and the environment.

PNRA is obliged under the Ordinance to ensure preparation and implementation of emergency plans for actions to be taken by the relevant onsite and offsite authorities following foreseeable types of nuclear incidents that might affect the public. Regulations issued by PNRA on the management of a nuclear accident or radiological emergency (PAK/914) require licensees to have in place emergency plans, the necessary workforce, essential equipment and mechanism for responding to such incidents. The licensees are also required to maintain capacity for coordination with offsite response organizations involved in mitigating the consequences of radiological emergency.

PNRA has categorized nuclear installations and radiation facilities according to the hazard associated with them and requirements for emergency preparedness and response are commensurate therewith.

### **Emergency Plans and Exercises**

PNRA reviews and approves emergency plans of the nuclear installations and radiation facilities under its purview to ensure that the plans are commensurate with regulatory requirements, incorporate all possible control and mitigation steps, and are executable. PNRA also requires its licensees to conduct emergency exercises and drills on regular basis to ensure that their emergency plans are

effective and implementable. The frequency of emergency exercises and drills is agreed upon in the approved emergency plans and PNRA witnesses some of these exercises to assess the licensees' capabilities for executing such plans as and when required. During the reported period, PNRA monitored evaluated emergency exercises at KANUPP, CNPGS and PINSTECH.

During 2014, PNRA reviewed contents of K-2/K-3 onsite and offsite emergency plans which are required to be submitted to PNRA as part of application process for issuance of construction licence. At this stage, PNRA requires that the emergency plans should, at least, briefly describe onsite and offsite organizations, their contact details, coordination arrangements made with the response organizations, protective measures to be taken during an emergency, emergency planning zones, first aid and medical treatment facilities, and training programmes for emergency workers.

PNRA also reviewed revised radiation emergency plan of PARR-1 (PINSTECH). PNRA reviewed emergency plans of a number of radiation facilities including radiotherapy, nuclear medical centres, industries and research institutes and provided comments for further improvement.

### **National Radiation Emergency Coordination Centre (NRECC)**

The National Radiation Emergency Coordination Centre (NRECC), based at PNRA Headquarters, is responsible for coordinating response to nuclear accidents or radiological emergencies and functions round-the-clock. NRECC is Pakistan's designated National Warning Point (NWP) under the Conventions on "Early Notification of a Nuclear Accident" and "Assistance in the Case of a Nuclear Accident or Radiological Emergency". It is responsible for notifying the competent authorities (both at PNRA and in the country) and IAEA about any nuclear accident or radiological emergency in the country.

NRECC is equipped with necessary communication



facilities, Mobile Radiological Monitoring Laboratories (MRMLs) and various types of radiation detection and personal protective equipment. The centre conducts different types of emergency exercises including the Communication Test Exercise (COMTEX) in which the availability of communication channels with licensees and regional directorates of PNRA is verified; the MRML exercise which tests the capability to respond to an event involving radiation monitoring; and field exercises. During the reported period, NRECC conducted three (03) COMTEX exercises and one MRML exercise.

NRECC also participates in Convention Exercises (ConvEx) conducted by IAEA under international conventions. The ConvEx exercises focus on verification of international communication channels and the capability of Member States to evaluate and respond to different radiological accidents. NRECC participated in six (06) ConvEx emergency exercises in 2014. As a lesson learnt from ConvEx-3 (2013) exercise and Fukushima accident, PNRA has identified and trained a team consisting of members from its technical directorates for ensuring smooth long term operation of NRECC.

With the expansion in use of nuclear power in the country and based on lessons learnt from Fukushima Nuclear Power Plants' accident, it was felt that a commensurate safety mechanism and

well equipped NRECC at PNRA is essential for timely and effective coordination and bringing together all technical expertise to assess radiological consequences. In this regard, PNRA has submitted a proposal to the Government of Pakistan for up-gradation of National Radiation Emergency Coordination Centre (NRECC) to a robust and technically equipped centre for improving the effectiveness of its response during a nuclear or radiological emergency.

### **Sharing of Information Related to Radiation Incident and Emergencies**

NRECC receives information on radiation incidents and emergencies occurring worldwide through IAEA. These events are usually related to overexposure of workers/members of the public, theft/loss of radiation sources, contamination/spill of radioactive material, malfunction of equipment, etc. NRECC analyzes the information received, identifies the lessons learnt and implement these lessons for improvement of radiation safety in the country. PNRA also shares the information with the licensees regarding radiation incidents happening in the world.

### **Training of First Responders on Response to Nuclear and Radiological Emergencies**

Training of those responding within the first few



**NRECC Personnel Conducting the Emergency Exercise**



## EMERGENCY PREPAREDNESS AND RESPONSE

hours of a radiological emergency (first responders) is very important to avoid spread of contamination and overexposure to radiations. It is also important for initial response, assessment and management of incident scene for the collection of radiologically contaminated samples for detailed analysis. PNRA arranged a national workshop for its licensees on medical response to a nuclear or radiological emergency in coordination with International Atomic Energy Agency (IAEA). The workshop was attended by more than 60 participants from various medical centres of the country. The international experts from IAEA shared their experiences with the participants on handling of overexposed and contaminated individuals following a nuclear accident or radiological emergency.

### **IAEA Response and Assistance Network (RANET)**

The Response Assistance Network (RANET) is an integrated system established by IAEA under

International Convention on Assistance in case of Nuclear Accident or Radiological Emergency. Under this network, interested member states voluntarily register and pool their capabilities to detect, measure, respond or mitigate radiological emergencies as and when required. Any member state can request or offer assistance under this network. Pakistan registered itself in RANET in 2008 and PNRA is the national contact point under this network. Recently, IAEA revised the scope and areas of assistance under RANET. Considering the revised functional areas of assistance, PNRA also identified various experts from different fields which will be communicated to IAEA. PNRA is working on development of a procedure for maintaining, activating and deploying RANET capabilities. Pakistan also participated in RANET workshop conducted by IAEA in Fukushima, Japan by deploying equipment and resources to test the compatibility and harmonization of arrangements at international level.



**National Workshop on Medical Response to a Nuclear Accident or Radiological Emergency**

# 7 HUMAN RESOURCE DEVELOPMENT

## In-House Education and Training

Maintaining a sufficient number of highly skilled professionals with appropriate qualifications and experience is of prime importance for any organization. The licensing and supervision of nuclear power plants, research reactors, equipment manufacturing industry and radiation facilities is a challenging task for a regulatory body in any country. Accordingly, PNRA attaches high priority to the training of its employees. For this purpose, PNRA initially established two training institutes in 2006 through two Public Sector Development Programme (PSDP) Projects, namely the School for Nuclear and Radiation Safety (SNRS) and the Nuclear Security Training Centre (NSTC) of the Nuclear Security Action Plan (NSAP). To stream-line the training activities under one roof, PNRA merged SNRS and NSTC to establish National Institute of Safety and Security (NISAS) in 2014, inaugurated by DG-IAEA. The Institute imparts training and education in various disciplines of nuclear safety, radiation safety and nuclear security. In addition, it conducts management courses and refresher courses for PNRA officers/staff and its stakeholders. NISAS also arranges training for other stakeholders who have a role in maintaining radiation safety and security of radioactive sources in the country. All class rooms and lecture halls have necessary training aids and modern gadgets. Laboratories in NISAS are equipped with relevant tools, a soft-panel training simulator, physical models of nuclear power plant components, physical protection labs,

radiation detection equipment laboratory with troubleshooting capabilities. A limited scale Non-Destructive Testing (NDT) laboratory has also been established for providing training to PNRA inspectors in various NDT techniques.

### Training in Nuclear and Radiation Safety

In 2014, NISAS arranged twenty two (22) training courses on various aspects of nuclear safety and radiation protection, including PNRA regulations, industrial radiography, certification of radiation protection officers, assessment of occupational exposure, radiation exposure control, PWR plant systems, In-Service inspection and welding techniques, decommissioning of nuclear installations and PNRA enforcement process. In addition, courses on personal and behavioral competences such as management skills and personal development were also arranged. A number of personnel from PNRA and other stakeholders participated in these training courses. The number of training courses and the number of participants from 2006 to 2014 are shown in Figure 25. More than 3600 officials have benefited from these courses whereas distribution of participants from various organizations is shown in Figure 26.

### Training in Nuclear Security and Physical Protection

In 2014, NISAS arranged five (05) training courses in nuclear security areas such as radiation detection techniques, physical protection of nuclear material & nuclear facilities, search & survey of radioactive

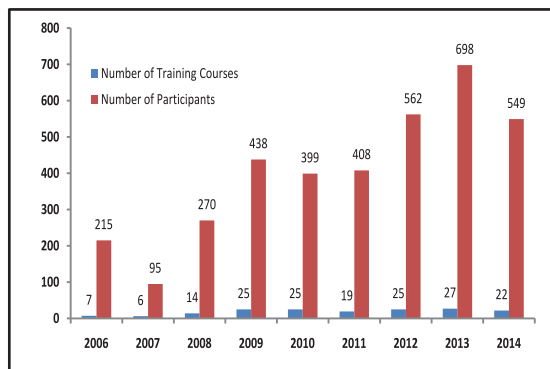


Figure 25: Overview of Nuclear and Radiation Training Courses

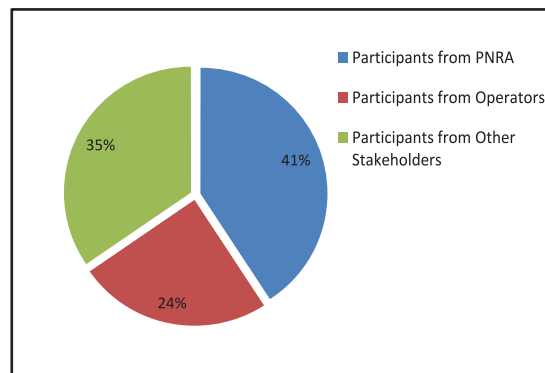


Figure 26: Distribution of Training Participants

## HUMAN RESOURCE DEVELOPMENT



**Inauguration of Nuclear Institute of Safety and Security (NISAS) By Yukiya Amano, DG IAEA**

material in scrap metal, etc. A number of personnel from PNRA and other stakeholder organizations participated in these courses.

Since 2006, one hundred and eighteen (118) training courses have been conducted in nuclear security and physical protection and over 2300 officials have benefited from these courses. The number of nuclear security training courses and the number of participants since 2006 are shown in Figure 27.

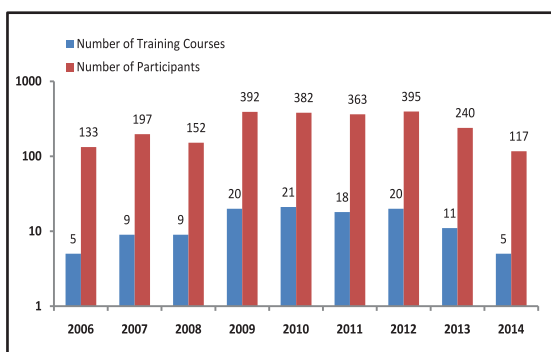
### Hands-on Training

NISAS has well developed laboratories for training as well as research and development purpose.

- A soft panel training simulator is available at NISAS for training of technical officers who are involved in review & assessment, inspections, enforcement and research & development activities of NPPs. The Soft Panel Training Simulator has provisions to

simulate plant operational states including normal, abnormal and accident conditions.

- Physical scaled cut-away models of main equipment of Pressurized light Water Reactor (PWR) are available at NISAS to train regulatory body staff for developing better understanding of internal structures and working principles of main equipment of the reactor coolant system.
- NISAS has developed video lectures on major mechanical equipment of a PWR nuclear power plant. The video lectures are based on three-dimensional virtual proto-types of equipment using 3D CAD software as well as latest video editing tools. Virtual modeling allows vivid visualization of individual components and their assembly into a functioning equipment. These lectures are used for training of young engineers and scientists of PNRA and PIEAS fellows undergoing MS degree programme. Labeling of components and synchronized



**Figure 27: Overview of Nuclear Security Training Courses Organized by NISAS**



**Training Course on PNRA Regulations**





**Advance Training Course on Physical Protection Systems**

commentary have been added to these video lectures to ensure a better understanding of these equipment.

### **Capacity Building at National Institutions**

#### **Collaboration with PIEAS and KINPOE**

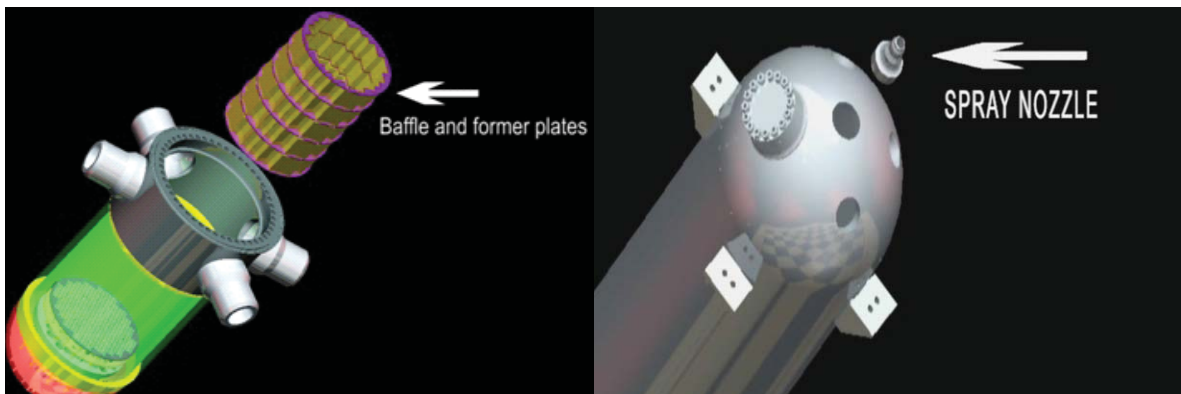
PNRA holds agreements with the Pakistan Institute of Engineering and Applied Sciences (PIEAS) and Karachi Institute of Nuclear Power Engineering (KINPOE) for MS programmes. Since 2003, eighty two (82) PIEAS and KINPOE graduates have been inducted into PNRA. In 2014, fifteen (15) officers have been awarded fellowships for MS degrees in nuclear engineering at PIEAS and KINPOE. This year eleven (11) fellows joined PNRA after completion of their Masters degree from these institutions.

A collaborative research project with the involvement of experts from PNRA, PIEAS and

National Institute of Agriculture and Biotechnology (NIAB), initiated in 2013 for development of Chashma Site-Specific Ingestion Model concluded in 2014. The scope of the collaborative research project was to conduct experimental work for determining the Soil-Plant and Plant-Animal transfer functions by considering actual site related parameters. In this perspective, the soil samples and crops types were collected from the vicinity of operational NPP site to simulate the behavior of radioactive iodine (I-125) under the local environmental conditions. The experiment of transfer functions was repeated 3 to 4 times with various seasonal crops and environmental conditions. Compilation of final results is in progress that will be used in Site-Specific Ingestion Model.

#### **Collaboration with other National Institutions**

PNRA collaborates with various national institutes



**Snapshots of Video Lecture on Major Equipment of NPP**

## HUMAN RESOURCE DEVELOPMENT

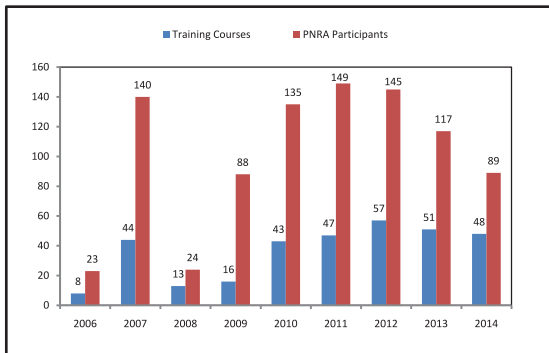


Figure 28: Training Courses/Participants in Various National Institutes

for knowledge enhancement of its regulatory staff in management and technical areas of interest. In 2014, a number of PNRA officials participated in various courses at different national institutes such as Pakistan Institute of Management (PIM),



Training Course on International Conventions and Treaties

Secretariat Training Institute (STI), Pakistan Welding Institute (PWI), etc. Figure 28 provides year-wise information about PNRA participation in various training courses arranged by these institutes.



Research Project on Development of Chashma Site-Specific Ingestion Model



Visit of DG IAEA to PNRA HQs. Islamabad



## 8 NATIONAL & INTERNATIONAL COOPERATION

PNRA believes in keeping a close cooperation with its national and international stakeholders in technical as well as support processes to enhance the safety measures for smooth functioning of nuclear installations and radiation facilities.

Liaison is maintained with other governmental organizations for coordination in safety and regulatory activities. PNRA's links are maintained with national institutes and universities to keep abreast with latest national and international research & development and human resource development activities.

At the international level, PNRA interacts with various institutions and organizations under bilateral and multilateral cooperation programmes. PNRA provides assistance to the Government of Pakistan for fulfilment of its obligations under the four international conventions to which Pakistan is a signatory. In addition, IAEA assists PNRA under various technical cooperation programmes for capacity building. PNRA also provides support to IAEA in the form of experts for international regulatory missions, training courses in other countries and development of IAEA documents and training material.

### **National Cooperation**

#### **Relation with Licensees**

PNRA has established strong interaction with its licensees including nuclear installations and radiation facilities in the country. In order to strengthen this relationship, PNRA established an Advisory Committee for Improving Utility Regulatory Interface (ACIURI) to ensure that the licensees and the regulatory body have the same spirit for ensuring the safe operation of the nuclear installations and radiation facilities within the country. ACIURI is working effectively since its establishment in 2005.

As a regular practice, PNRA involves all the stakeholders including licensees and the general public in the review process of its national

regulations. The drafts of the regulations are sent to the licensees for their feedback; and their comments are incorporated, if found appropriate.

PNRA holds regular meetings with its licensees and conducts training courses regularly to develop their technical skills and understanding on the implementation of relevant regulatory requirements. In 2014, PNRA arranged three (03) courses for radiographers and three (03) courses for Radiation Protection Officers (RPOs) of radiation facilities. A number of radiographers and Radiation Protection Officers (RPOs) from different x-ray facilities, medical centres, industries and irradiators participated in these courses. Furthermore, more than six hundred and fifty (650) personnel from nuclear installations, radiation facilities, PNRA, and other stakeholder organizations participated in various training courses arranged by PNRA.

#### **Relation with General Public**

PNRA is in contact with the public to communicate information through lectures, brochures, booklets and timely press releases regarding hazards associated with ionizing radiation and protective measures in case of emergency. PNRA updates its stakeholders about its activities through its website ([www.pnra.org](http://www.pnra.org)). PNRA also involves general public in regulation development process by placing draft regulation on its website for feedback from the general public.

In order to create awareness among the general public and workers, PNRA delivers lectures in hospitals, medical centres, schools, colleges and universities on the risks, benefits and effects of ionizing radiation as well as protective measures. It also covers radiation protection in radiology, nuclear medicine; radiotherapy; radiological accidents & their consequences; and protection against radiation releases. The audience in these special lectures is also made aware about the regulatory framework for nuclear power plants and radiation facilities in Pakistan. During 2014, PNRA organized a number of lectures/seminars in Islamabad, Faisalabad, Lahore, Multan,



## NATIONAL & INTERNATIONAL COOPERATION

Bahawalpur, DG Khan, Abbottabad, Karachi, Gujranwala, Sargodha and Peshawar in which around twelve thousand (12000) personnel participated. Detail of public awareness programme is shown in Figure 29.

### International Cooperation

#### Fulfillment of International Obligations

Pakistan is required to fulfill its respective international obligations under four international conventions to which it is a signatory. These include Convention on Nuclear Safety; Convention on Early Notification of a Nuclear Accident; Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; and Convention on Physical Protection of Nuclear Materials. In addition, Pakistan follows the code of conduct on safety and security of radioactive sources.

In this regard, PNRA continues to fulfill and implement its international obligations and represents the country at related international forums. During the reported period, Pakistan participated in the 6<sup>th</sup> Review Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS). Pakistan's National Report was Presented by Chairman, PNRA and was shared with the international community in compliance with the Articles 5 and 20 of the Convention. The 6<sup>th</sup> Review Meeting of the Contracting Parties (CPs) to the Convention on Nuclear Safety (CNS), appreciated Pakistan's efforts in safety enhancement of its nuclear installations in response

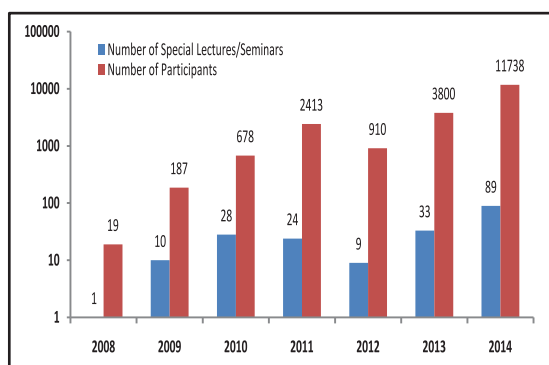


Figure 29: Summary of Special Lectures/Seminars and Participants

to feedback from Fukushima Daiichi accident. The Contracting Parties also approved by consensus, a number of revisions in the Convention, including a proposal by Pakistan for enhancing international technical cooperation, in the light of lessons learnt from Fukushima Daiichi accident.

#### Bilateral and Multilateral Cooperation

It is widely considered that the bilateral and multilateral cooperation among nuclear regulatory bodies is crucial for promoting nuclear safety and security and strengthening nuclear regulatory infrastructure worldwide. The accident of Fukushima has further highlighted the need for such cooperation and experience sharing especially to harmonize the nuclear safety standards. The nuclear regulatory authorities accordingly establish cooperation with each other and share information/experiences and provide support in regulatory matters. PNRA ordinance also empowers the Authority to enter into bilateral agreements with other countries for the peaceful uses of nuclear technology.

Presently, PNRA has a protocol for cooperation with National Nuclear Safety Administration (NNSA) of China, and Bilateral Agreement with Northern Regional Office (NRO) & Nuclear and Radiation Safety Centre (NRSC) of NNSA, China Nuclear Power Operation Technology Corporation (CNPO), Nuclear Safety Centre (NSC) of China and VUJE Inc. Slovakia, on providing assistance in nuclear safety reviews and inspection of Nuclear Power Plants. Moreover, efforts are continued to expand bilateral and multilateral cooperation with other national regulators and international organizations. In addition, PNRA has also signed an agreement with the Department of Nuclear Science and Technology of XI'AN Jiao Tong University of the People's Republic of China, for providing education and training, research and development and information exchange in the areas of nuclear safety assessment.

The seventh Steering Committee Meeting between PNRA and NNSA of China was held from May 26-

27, 2014 at Beijing, China to review and discuss the issues of bilateral cooperation. A number of cooperation activities have been agreed during the meeting. Besides, a delegation from China visited National Radiation Emergency Coordination Centre (NRECC) to explore further cooperation in the area of emergency and response.

PNRA also interacts with United States Nuclear Regulatory Commission (USNRC) for the institutional strengthening and capacity building related to nuclear safety. Both organizations have an understanding to exchange information on safety significant issues. Moreover, two PNRA officers completed training in operation / maintenance of physical protection training laboratories from Sandia Labs, USA under Pakistan-IAEA nuclear security cooperation programme.

### **Collaboration with IAEA**

PNRA works closely with IAEA and actively contributes in its efforts to promote nuclear safety and security internationally. These efforts include implementation of IAEA codes and standards, participation in its various committees and networks related to nuclear safety and security. During 2014, PNRA continued to share expertise, technical information, regulatory experiences and good practices with other nuclear regulators through IAEA.

During 2014, PNRA invited IAEA Integrated Regulatory Review Services (IRRS) Mission to Pakistan from 28<sup>th</sup> April to 09<sup>th</sup> May, 2014 for the

assessment of regulatory infrastructure of nuclear and radiation safety in Pakistan and regulatory effectiveness and efficiency of PNRA. The Mission reviewed nuclear regulatory regime as well as working of PNRA in areas of nuclear safety and radiation protection including regulations, licensing and authorization, review and assessment, inspection and enforcement processes. The Mission acknowledged the level of expertise available within the Authority. The Mission also noted that certain good practices in Pakistan can be useful for other nuclear regulatory bodies. Twenty three (23) experts from IAEA and other Member States including China, Ukraine, Czech Republic, Belgium, Slovenia, Canada, USA, Germany, Hungary, South Korea, Cuba, Bosnia, Egypt, Japan and Lithuania participated in the Mission.

An IAEA Office of Internal Oversight Services (OIOS) Mission reviewed and evaluated the implementation of IAEA TC Projects at PNRA. During their visit, IAEA Mission judged IAEA performance in Pakistan and assessed the relevance through visits, interviews, physical verification, efficiency, effectiveness, impact and sustainability of its work and to make recommendations for improving the Agency's country level strategy and practices. The Mission has commended the efforts of Pakistan for the proper utilization and implementation of the resources provided by the Agency through Technical Cooperation Programme. During the reported period, Director General IAEA, Mr. Yukiya Amano visited Pakistan in



Glimpses of the Public Awareness Lectures

## NATIONAL & INTERNATIONAL COOPERATION

March, 2014. During his visit to PNRA Headquarters, he inaugurated National Institute of Safety And Security (NISAS). DG-IAEA also visited NPP Physical Models Laboratory, where Chairman PNRA briefed him on various NPP components' models available in the laboratory.

PNRA is extending support to the countries embarking upon nuclear technology in establishing regulatory infrastructure and developing legislation/regulations under the auspices of IAEA. As a first step, on the request of IAEA, a Malaysian delegation comprising of eight officials visited PNRA from November 24-28, 2014. During their stay at PNRA, the delegates discussed technical details regarding establishment of radiation detection equipment laboratories and maintenance capability in Pakistan in order to benefit from Pakistan's experience.

On the request of IAEA, PNRA is providing expert services to the Member States in the field of nuclear safety and security. In addition, PNRA has offered IAEA its readiness and willingness to provide training to the developing countries in the field of nuclear safety and security and to accept delegations from IAEA member states who are interested in learning about nuclear regulatory systems working in Pakistan and benefiting from our regulatory experience. In this connection, PNRA in collaboration with other national institutes organized a Regional Training Course (RTC) on the security of radioactive sources at one of Pakistan's Centres of Excellence in Nuclear Security (PCENS) during December 15-19, 2014. It was attended by twelve (12) officials from the IAEA member states including Bangladesh, Cambodia, Malaysia, Myanmar, Thailand, and Vietnam. Two IAEA experts also visited Pakistan to contribute in the RTC on the security of radioactive sources. At present, three (03) officials of PNRA are serving at IAEA on contract placement.

### **a. Participation in IAEA Committees and Other Forums**

PNRA is member of various IAEA committees and

other related forums/networks working to promote nuclear safety and security. These include 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), Advisory Group on Nuclear Security (AdSec) and Global Nuclear Safety and Security Network (GNSSN). In addition, PNRA is National Coordinator of IAEA for the activities of International Nuclear Event Scale (INES) and International Reporting System (IRS).

PNRA also represents Pakistan as a permanent member and contributes in the activities of United Nations Scientific Committee on the Effects of Atomic Radiations (UNSCEAR) through sharing necessary information and expertise. During the reported period, PNRA participated in 61<sup>st</sup> session of the UNSCEAR and contributed in review of UN Resolution on Effects of Atomic Radiations for the year 2014.

During 2014, experts from PNRA participated in a number of consultancy meetings and steering committee meetings, such as in working group meeting of the NUSSC volunteers, working group meeting of the International Nuclear Security Education Network (INSEN), meeting of the Commission on Safety Standards (CSS), 28<sup>th</sup> meeting of the Transport Safety Standards Committee (TRANSSC), 36<sup>th</sup> meeting of the Radiation Safety Standards Committee (RASSC), meeting of the Nuclear Security Guidance Committee (NSGC), 37<sup>th</sup> meeting of the Waste Safety Standards Committee (WASSC), 4<sup>th</sup> Global Nuclear Safety and Security Network (GNSSN) meeting, 26<sup>th</sup> Advisory Group on Nuclear Security (AdSec) meeting and Technical meeting of International Nuclear Event Scale (INES). PNRA also participated in the activities of Regulatory Cooperation Forum (RCF) of IAEA to improve collaboration and coordination for regulatory capacity building among member states with established nuclear power programme and those

considering the introduction or expansion of such programmes. Officials from PNRA attended a project design workshop that was organized by IAEA to help the project counterparts to design the TC projects for the cycle 2016-17. PNRA also participated in international project on innovative nuclear reactors and fuel cycles dialogue forum.

In addition, PNRA also contributed towards the activities of Technical and Scientific Support Organization (TSO) Forums. TSO activities mainly addressed the activities pertaining to enhancement of nuclear & radiation safety, security and related infrastructure.

During the reported year, PNRA participated in the following meetings/conferences and contributed on the relevant topics:

- International expert's meeting on severe accident management in the light of the accident at the Fukushima Daiichi Nuclear Power Plant;
- IAEA international conference on human resource development for nuclear power programmes: Building and Sustaining Capacity;
- International conference on challenges faced by Technical & Scientific Support Organizations (TSOs) in enhancing nuclear safety and security: Strengthening Cooperation and Improving Capabilities; and
- Programme element working group meeting of Director Generals' Advisory Group on Nuclear Security (AdSec).

### **b. IAEA Technical Cooperation Projects**

Presently, PNRA is participating in two (02) 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". IAEA has

further extended these projects for the cycle 2016-17. During the current year, various activities such as IAEA missions, workshops, fellowships, scientific visits and procurements were carried out under both these projects to fulfill the needs of the PNRA. The detail of these activities is as under:

- i. IRRS Mission to Pakistan;
- ii. Workshop on severe accident management guidelines for NPPs;
- iii. Workshop on descriptive and normative analysis to analyze safety culture self assessment at PNRA;
- iv. Workshop on review of analysis results of low power shutdown probabilistic safety analysis for CNPP;
- v. Workshop on medical response to nuclear or radiological emergency ;
- vi. Workshop on external and internal dose assessments;
- vii. Workshop on licensing and inspection of radiation therapy, imaging, nuclear medicine and PET/CT/Gamma Knife/Linac;
- viii. Fellowship to establish discharge limits and assess the impact of discharges to the environment from NPPs ;
- ix. Fellowship in operational safety section of IAEA;
- x. Fellowship in the field of medical exposure control;
- xi. Scientific visit to international seismic safety centre to carryout assessments and analysis on Probabilistic Seismic Hazard Assessment (PSHA);
- xii. Scientific visit in the field of licensing and manufacturing of spent nuclear fuel dual purpose cask; and
- xiii. Procurement of equipment.

### **c. IAEA Regional Asia (RAS) Projects**

PNRA is participating in the activities of twelve (12) IAEA Regional Asia (RAS) projects in different areas related to nuclear and radiation safety. Under these projects, officials from PNRA participated in various



## NATIONAL & INTERNATIONAL COOPERATION

activities such as workshops and training courses organized by IAEA. Under these projects, PNRA also carried out procurement of equipment through extra budgetary contribution for the establishment of National Dosimetry and Protection Level Calibration Laboratory (NDCL) and National Environmental Surveillance Programme (NERSP) laboratories.

### **d. IAEA-Pakistan Nuclear Security Cooperation Programme**

The IAEA has been assisting Pakistan in its efforts of establishing effective nuclear security regime in the country. PNRA, being the focal point, coordinated with all the stakeholders for planning and implementation of the programme. The Programme has been focusing on support for Pakistan's efforts for capacity building through training of its personnel on nuclear security related areas. In addition, IAEA has supported in establishment of nuclear security laboratories including state-of-the-art physical protection and radiation detection equipment. Under this programme, the physical protection systems and measures have been upgraded at medical centres using high activity radioactive sources in public and private sectors. The on-going projects under programme include physical protection upgrades at K-1 and nuclear medical centres of PAEC;

establishment of physical protection exterior laboratories of PNRA and nuclear security educational laboratories at PIEAS; and faculty development programme for the Pakistan's Centres of Excellence. During the reported period, the programme achieved another major landmark when the first regional training course on "Security of Radioactive Sources" was conducted at Pakistan's Centre of Excellence at Chakri.

### **e. Expert Missions**

During the reported year, sixteen (16) experts from IAEA visited PNRA to contribute towards workshops and training courses. Moreover, experts from the suppliers also visited PNRA for installation and operational training of staff on various types of radiation, particle detection and dose monitoring systems including Liquid Scintillation Analyzer (LSA) and TLD reader.

Experts from PNRA also participated in expert missions to other member states designed to strengthen regulatory infrastructure and enhance capacity building of regulatory staff in different countries on IAEA request. During reported period, PNRA officials participated in sixty seven (67) expert missions such as workshops, meetings, Integrated Regulatory Review Services (IRRS), Education and Training Review Services (ETRES), etc. in the areas of



Officials from IAEA, Pakistan and Supporting Partners on the Eve of Signing Project Scoping Document for K-1 Physical Protection Upgrades at IAEA HQs., Vienna



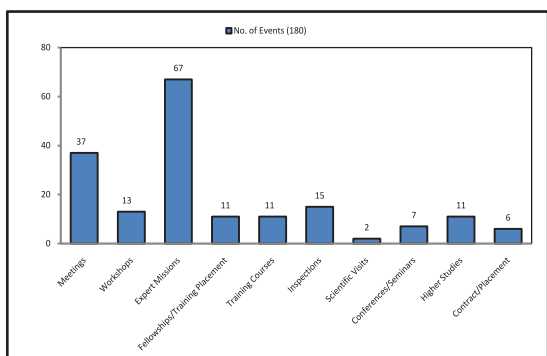


Figure 30: International Training/Activities During 2014

capacity building of its technical professionals. During 2014, young engineers and scientists of PNRA benefited from various IAEA programmes designed to enhance capacity building of its member states through international workshops, training courses, seminars and technical meetings, fellowships, etc. PNRA officials participated in one hundred and eighty (180) various international events. The graphical representation of these events is shown in Figure 30.

regulatory importance and concerning nuclear safety and security.

Furthermore, IAEA is preparing a comprehensive report on Fukushima nuclear disaster. Approximately 120 experts from over 40 countries are supporting IAEA in drafting the report. One expert from PNRA is also a member of the working group and is a lead member of the group for drafting a chapter on "Assessment of the Design Features of Fukushima Reactors". The draft report is now in the editorial process at IAEA and expected to be published in the year 2015.

### Participation of PNRA Officials in International Activities / Events

For discharging its regulatory functions effectively, PNRA is giving due consideration towards the

### Research and Analysis in International Affairs

PNRA closely monitors and analyzes international strategic and technical developments from political point of view that are taking place in the nuclear domain and influence nuclear safety and security in the country and regulatory decision making. For this purpose, PNRA carries out research on international issues that influence regulatory activities, review & analysis of international conventions, treaties and IAEA documents. Moreover, to expand outreach of PNRA at national and international levels, PNRA maintains close liaison with national and international research institutes. During the reported year, PNRA officials regularly attended and participated in the seminars, conferences and lectures organized by various institutes at national level.



Briefing by PNRA Liaison Officer to IRRS Team

PNRA has been working on different Public Sector Development Programme (PSDP) projects since 2005. Some of these projects, which have been completed, have become regular element of PNRA while several others are in progress. The overall objective of PSDP projects is to achieve sustainable regulatory effectiveness for the capacity building and institutional strengthening of PNRA in response to the emerging needs of nuclear and radiological safety and security. During 2014, PNRA continued working on four (04) such projects. A summary of these projects is tabulated below:

S. No.	Name of PSDP	Total Cost (PKR Millions)	Duration
1	Establishment of National Dosimetry and Protection Level Calibration Laboratory (NDCL)	364.45	2007-2014
2	National Environmental Radioactivity Surveillance Programme (NERSP)	310.00	2007-2014
3	Safety Analysis Centre (SAC) to provide regulatory support for indigenization of NPPs in Pakistan	463.00	2010-2015
4	PNRA Residential Colony (PRC) at Chashma	437.00	2014-2018

The progress of these projects is briefly discussed in the following sections:

### **National Dosimetry and Protection Level Calibration Laboratory (NDCL)**

One of the main objectives of PNRA is to ensure the protection of radiation workers, the general public and the environment from the harmful effects of ionizing radiation. In this regard, PNRA has developed regulations on radiation protection and set the annual radiation dose limits for occupational workers as well as for general public so that the risk of adverse effects of radiations could be reduced. Assessment of radiation exposure is a fundamental mechanism to ensure and evaluate the radiation safety of occupational workers at the licensed facilities. In compliance to national regulations, the licensees perform personal dose monitoring of the radiation workers and provide radiation dose record of all personnel to PNRA, which is physically verified by PNRA inspector during the regulatory inspections of licensed facilities including NPPs. Furthermore, for cross verification of personnel radiation dose record submitted by the licensees, PNRA has established the external and internal dosimetry laboratories at Islamabad, Kundian and Karachi. These laboratories were launched in 2007

under PSDP project "National Dosimetry and Protection Level Calibration Laboratory (NDCL)" and project was completed on 30<sup>th</sup> June, 2014. After completion of the project, PC-IV was prepared and submitted to the Government of Pakistan. The detail of major activities of NDCL project during the year 2014 is as under:

#### **External Dosimetry Setup**

NDCL external dosimetry laboratories at Islamabad, Kundian and Karachi are equipped with state-of-the-art equipment and are being operated by trained manpower. These laboratories are utilized for verification of personnel radiation dose record submitted by the licensees and can also be used to assist the licensees for personal radiation dose monitoring of the first responders of different rescue and law enforcement agencies in case of any nuclear accident or radiological emergency. In order to enhance dosimetry capabilities, NDCL has established a film badge dosimetry laboratory. The calibration of film badge dosimetry equipment is in progress and the operation is planned to be started in the first quarter of 2015.

**Internal Dosimetry Setup**

Under NDCL project, internal dosimetry laboratories are made functional at Islamabad, Kundian & Karachi and are used for whole body counting of radiation workers involved in operational and maintenance activities at NPPs. In addition, the Liquid Scintillation Analyzer (LSA) system for internal dosimetry is available in NDCL laboratories at Islamabad and Karachi.

**Protection Level Calibration Laboratory**

The calibration of the radiation detectors is a significant factor in the measurement of radiation doses. In order to verify the calibrations of radiation monitoring equipment being used at radiation facilities and nuclear installations, PNRA is in process to establish protection level calibration laboratories at Kundian and Karachi. In this regard, the gamma irradiator has been procured and is planned to be installed at NDCL, Kundian in the first quarter of 2015. NDCL, in collaboration with IAEA, is also in the process of procurement of another gamma irradiator and X-ray generators for calibration laboratories at Karachi.

**Training of NDCL Personnel**

In the reported period, NDCL organized a national workshop on "Individual Monitoring to Assess the Occupational Exposure: Internal and External Dosimetry". The objective of the workshop was to provide the basic concepts of the external and internal dosimetry to NDCL personnel. Three IAEA



**National Workshop on Dosimetry at PNRA HQs., Islamabad**

experts visited Pakistan and delivered lectures during this workshop. Twenty three (23) participants from PNRA and PAEC attended the workshop.

Furthermore, five (05) NDCL officers and nine (09) technicians have received training in the field of dosimetry and calibration from Secondary Standards Dosimetry Laboratory (SSDL) in the country.

**Construction of Laboratory Building**

The construction of NDCL laboratory building at Chashma was completed in the reported period. The laboratory building is housing whole body counting and protection level calibration laboratory. Whole Body Counting (WBC) system, which was temporarily installed at RNSD-II office, has also been shifted to its designated place in newly constructed building.

Construction of Islamabad laboratory has been initiated in the reported period. In this regard,



**Visit of MOFA Official to NDCL, Islamabad**



**Authority Members Visiting NDCL, Islamabad**



PUBLIC SECTOR DEVELOPMENT PROJECTS



Visit of Malaysian Delegation to NDCL, Islamabad



Visit of Ex. DG, SPD Lt. Gen. (R) Khalid Ahmed Kidwai to NDCL, Islamabad



**PNRA Officials at Dakhni Gas Processing Facility, Attock**

ground breaking ceremony of laboratory building was held on 23<sup>rd</sup> April, 2014 at Islamabad. The ground breaking was performed by DG SPD Lieutenant General Zubair Mahmood Hayaat. Chairman PNRA, Members and DGs honored the ceremony with their presence. The construction work is expected to be completed during the next year.

### **National Environmental Radioactivity Surveillance Programme (NERSP)**

PNRA has the responsibility to ensure that the public is protected from any buildup of environmental radioactivity in the country. The National Environmental Radioactivity Surveillance Programme (NERSP) is aimed at enhancing PNRA's capabilities for monitoring environmental radioactivity, evaluating any build up of radiation, assessing the doses being received by the public, and verifying the environmental data provided by NPPs. The Programme is being implemented by



**Planning Commission Team Evaluating NERSP Laboratories at PNRA HQ's., Islamabad**



**Radiation Survey at N-2 Rig, Chakwal**

PNRA and entails systematic measurements of radioactivity in soil, air, water, flora and fauna, etc., throughout the country. Under this project, three laboratories have been established at Islamabad, Karachi and Kundian. PNRA is now in a position to conduct effective and comprehensive environmental surveillance in the country. Project has been completed on 30<sup>th</sup> June, 2014 and project completion report has been submitted to the Government of Pakistan. The progress of major activities of NERSP project during the year 2014 is described below:

### **Establishment of Environmental Monitoring (EM) Laboratories**

Environmental Monitoring (EM) Laboratory at Karachi is fully operational. Radiation analysis of different kinds of samples such as water, vegetation and fish around K-1 are being performed in this laboratory. For the collection of base line data, soil, water and vegetation samples around K-2 have been collected and analyzed.





Ground Breaking Ceremony of NERSP & NDCL Laboratories

Environmental Monitoring (EM) Laboratory at Chashma is fully operational. Radiation analyses of soil, vegetation and air samples collected from various areas in the region have been performed in this laboratory. Moreover, soil and water samples around C-3 and C-4 were collected for the analysis of pre-operational data.

EM laboratory at Islamabad is temporarily established at NISAS building, PNRA Headquarters. A specified location is allocated for the establishment of EM Laboratory. In this regard, ground breaking ceremony for the construction of EM Laboratory at Islamabad was held on 23<sup>rd</sup> April, 2014. DG SPD Lieutenant General Zubair Mahmood Hayaat graced the occasion.

Under the project, PNRA conducted a survey for radon measurement in all sectors of Islamabad using active radon monitors and documented the results in a report titled "Measurement of Indoor Radon Level in Dwellings of Islamabad Region".

Assessment of Naturally Occurring Radioactive Materials (NORM) in different NORM producing industries has started this year. Initially, PNRA has performed radiation survey at Dakhni Gas Processing Facility (Attock), Rig N-2 (Chakwal) and Kot Sarang (Chakwal).

During the survey, different kind of samples such as

scale, sludge, waste water, soil, crude oil, etc., have been collected for detail radiation analysis. During annual overhauling, more than 30 samples were collected and analyzed during these initial visits of ODGCL sites.

### Safety Analysis Centre (SAC)

Technical Support Organizations (TSO) are playing key role in nuclear power industry by providing technical support to relevant organizations. Role of TSO is significant in countries like Pakistan which has an expanding nuclear power programme. Realizing the importance of TSO, PNRA initiated a PSDP funded project with the name of Safety Analysis Centre (SAC). The aim of the Centre is strengthening PNRA by providing technical support in safety and design analysis in order to facilitate regulatory decision-making. SAC provides support to PNRA in various domains like deterministic safety analysis (DSA), probabilistic safety analyses (PSA), structural and seismic analysis, accident analysis, etc. In addition to this, SAC is also involved in promoting research and development in the areas of safety analysis and building liaison in the applications of safety techniques to resolve safety issues.

SAC has strengthened analytical capabilities of its staff through acquiring and working on state-of-the-art analytical tools and software for safety



Unveiling of Plaque at Ground Breaking Ceremony of NERSP & NDCL Laboratories

assessment and modeling of Systems, Structures and Components (SSCs) of NPPs and providing necessary training.

SAC is developing a 3-Loop 1000 MWe PWR Desktop Simulator. Development of the beta version is complete and the researchers are working to incorporate the improvements in the simulator with collaboration of technical experts.

The progress on major activities of SAC during 2014 is summarized below:

### 3-Loop Model Development for DBA

Design Basis Accident (DBA) analysis group has prepared generic input file and Engineering Hand Book (EHB) for DBA analysis for a three loop 1000MWe nuclear power plant using RELAP code. The process of updating these files and EHB for future NPPs is in progress.

### 3-Loop Model Development for Severe Accident Analysis

In MELCOR, preparation of preliminary double containment model for NPPs was completed and analysis for containment leakages was also performed.

Mass and Energy Releases (MERs) have been used to determine pressure response of containment in the

event of main steam line break scenario with one containment spray line available.

### Electrical Safety Analysis

Electrical Safety Analysis group has performed on-site and off-site power system analyses on AC power distribution systems using industry-wide software ETAP 12.0.0 N for the Nuclear Power Plants located at Chashma and Karachi. SAC is also working on the development of simulation and analysis techniques to study the effects of open-phase faults at the NPPs, with an overall goal of developing necessary counter-measures. Other major activities performed by SAC includes:

- CFD analysis of pressurizer surge-line;
- Thyroid dose assessment in case of a large break loss of coolant accident; and
- Estimation of short term atmospheric dispersion factor.

Keeping in view the expansion of nuclear power programme of the country and needs of PNRA, SAC is enhancing its capabilities and is committed to provide technical support in all safety analysis domains of NPPs.

### PNRA Residential Colony (PRC) Chashma

In view of the Government of Pakistan's goal for





Inauguration Ceremony of Dr. Ishfaq Ahmed Auditorium at PNRA HQs., Islamabad

expansion of nuclear power programme by constructing more nuclear power plants to achieve 8,800 MWe by the year 2030, the regulatory responsibilities of Pakistan Nuclear Regulatory Authority have increased significantly.

At Kundian, two units of Chashma Nuclear Power Plants are already in operation while construction work on two more units is in progress which are expected to become operational in 2016. PNRA has one of its regional directorate (RNSD-II) located at Chashma site with the purpose of conducting regulatory oversight of the operating and under construction plants as well as regulating radiation facilities in the region.

Development of a PNRA Residential Colony at Chashma had become necessary to provide residential accommodation to the employees of PNRA working at RNSD-II.

In this regard, PNRA pursued a project for the construction of a residential colony at Chashma that has been approved by the Government of Pakistan.

The Master Planning and detailed designing of infrastructure and buildings in PNRA Colony was designed. The work of infrastructure of PNRA colony including roads, water supply, sewerage design was completed whereas BOQ and drawings were finalized for awarding the contract.



Group Photo at Inauguration of Dr. Ishfaq Ahmed Auditorium at PNRA HQs., Islamabad

# 10

## PERFORMANCE REVIEW

As part of its integrated management system, PNRA monitors and evaluates the organizational performance against twelve pre-defined strategic performance indicators on annual basis. These indicators cover areas related to responsibilities and functions of PNRA and its efficiency & effectiveness. A ranking scale of five levels – Not Acceptable, Unsatisfactory, Needs Improvement, Minimally Acceptable, and Satisfactory – is used to evaluate the performance against each indicator. The result of the appraisal for January–December 2014 is discussed below and summed up in Figure 31.

**Indicator 1 (Ensures that acceptable level of safety is being maintained by licensees):** During 2014, PNRA conducted a number of regulatory inspections of nuclear installations as well as radiation facilities. Detail of these inspections is given in Chapter 3 and Chapter 4 of this Report. These inspections were focused on verification of the facility design, operational requirements, work practices, ALARA implementation and adequacy of security measures being taken by licensees during use, transportation and storage of the sources. Directives and recommendations for improvement and compliance with regulatory requirements are communicated to the licensees through inspection reports which are appropriately followed up for compliance. PNRA conducted Integrated Safety Assessment (ISA) of K-1, C-1 and C-2 for the period 2012-2013 as discussed in Chapter 3. PNRA also brought more than 600 new radiation facilities into the licensing net while licenses of about 3000 facilities were renewed during the reported period. PNRA also requires licensees to conduct emergency exercises and drills on a regular basis to ensure that their emergency plans are effective and workable. PNRA monitored emergency exercises at KANUPP, CNPGS and PINSTECH. Furthermore, PNRA arranged a national workshop for medical community on handling of overexposed and contaminated individuals due to a nuclear accident or radiological emergency. Based on these facts,

PNRA has maintained its performance against this indicator as "**Satisfactory**".

**Indicator 2 (Ensures that regulations and guides are in position and understood by licensees):**

A comprehensive process is established and followed for the development of regulations including rigorous internal reviews at various levels within PNRA followed by inviting comments from the stakeholders such as the licensees, the government, and the general public. PNRA organizes courses on regulatory framework for licensees with the goal that the regulations are clearly understood by the licensees. PNRA has so far published 17 regulations and several regulatory guides which are placed at PNRA website ([www.pnra.org](http://www.pnra.org)) for information of all the stakeholders. During 2014, preparation of two new regulations (i) Physical Protection of Nuclear Installations and Nuclear Material – (PAK/925) and (ii) Decommissioning of Facilities using Radioactive Material (PAK/930) remained in progress. In addition, revision of six (06) regulations remained in progress and amendments in four (04) regulations were gazette notified as discussed in Chapter 2 of this report. Preparation of some regulatory guides remained in progress during the reported period. As the regulations and regulatory guides could not be issued according to the annual work plan, therefore PNRA's performance rating on this indicator is retained as "**Needs Improvement**".

**Indicator 3 (Strives for continuous improvement of its performance):**

PNRA is committed to enhance its regulatory effectiveness and efficiency, in pursuit of its vision of becoming a world class nuclear regulatory body. In 2014, PNRA completed its self assessment using IAEA questionnaires in SARIS (Self-Assessment of Regulatory Infrastructure for Safety) database and prepared a detailed report. An Integrated Regulatory Review Services (IRRS) Mission of IAEA visited PNRA for the assessment of regulatory infrastructure of nuclear and radiation

## PERFORMANCE REVIEW

safety in Pakistan during the reported period. PNRA has also started safety culture self assessment and it is expected that this would be completed during the second quarter of 2015. PNRA continued to conduct performance assessment of each directorate and project of PNRA on quarterly basis and accordingly, performance evaluation reports of fourth quarter of 2013 and first three quarters of 2014 were prepared. During the reported period, performance evaluation based on feedback of licensees of nuclear installations was planned for improvement of regulatory activities; however, the activity could not be performed as planned. Based on these facts, the performance of PNRA is lowered from "Satisfactory" to "Minimally Acceptable" during the reporting year.

**Indicator 4 (Takes appropriate actions to prevent degradation of safety and to promote safety improvements):** PNRA conducted the review & assessment of various safety related documents, modifications, technical reports, event reports and periodic safety reports, submitted by nuclear installations and radiation facilities. PNRA has also conducted inspections of nuclear installations and radiation facilities in the reported year. Subsequently, PNRA issued various directives and recommendations to the licensees for taking necessary actions for further improvement. As per regulatory requirements, PNRA ensures that qualified and trained operating personnel are working as shift supervisors, shift engineers, and reactor operators at all operating nuclear installations. PNRA also arranged courses for radiographers and Radiation Protection Officers (RPOs) of radiation facilities. A large number of radiographers and RPOs from different X-ray facilities, medical centres, industries and irradiators successfully completed the courses. PNRA has also conducted a number of training courses in the field of "Nuclear and Radiation Safety" and "Nuclear Security and Physical Protection". Officials from PNRA and other stakeholder organizations

participated in these training courses. In the backdrop of the steps taken by PNRA to prevent the degradation of safety at nuclear installations and radiation facilities, the performance-rating of this indicator has been assessed to be "Satisfactory".

**Indicator 5 (Takes appropriate steps for human resource development and has competent and certified regulatory staff):** PNRA pays attention not only to enhance technical capabilities of existing staff but also emphasizes to increase its technically competent officers' strength, keeping in view the anticipated workload & future assignments. For this purpose, PNRA established National Institute of Safety and Security (NISAS) in 2014. During the year, NISAS has conducted about 30 training courses in the fields of nuclear safety, radiation safety and nuclear security in which about 700 personnel from PNRA and other relevant organizations participated. In addition, a number of PNRA personnel participated in different courses at national institutes such as Pakistan Institute of Management (PIM), Secretariat Training Institute (STI), Pakistan Welding Institute (PWI), etc. during the reported period. PNRA, in collaboration with PIEAS, has already initiated nuclear security education programme and introduced two more courses titled "Nuclear Material Accountancy & Inventory Control" and "Nuclear Forensics & Attributions" in MS programme. In 2014, fifteen (15) candidates have been awarded fellowships for MS programme in nuclear engineering at PIEAS and KINPOE. This year eleven (11) fellows joined PNRA after completion of their Masters degree from these institutions. Detail of these training courses is discussed in Chapter 7 of this Report. IAEA is assisting PNRA to strengthen nuclear security regime in Pakistan. The programme is focused to support PNRA in its capacity building through training of its personnel. PNRA is also participating in the activities of IAEA Regional Asia (RAS) projects mainly in the arena of nuclear education and training, strengthening regional nuclear regulatory



authorities, promoting and maintaining regulatory infrastructure for the control of radiation sources, providing legislative assistance, transfer of experience related to occupational radiation protection of the nuclear industry and other applications involving ionizing radiation, radiation protection of patients in medical exposure, building competence in radiation safety, strengthening compliance assurance regime in transport of radioactive material, national capabilities for response to nuclear and radiological emergencies in line with the international safety standards, human resource development in nuclear security and establishing a radioactive waste management infrastructure, etc. Under these projects, officials from PNRA participated in various capacity-building activities such as workshops and training courses organized by IAEA. Therefore, PNRA's performance against this indicator remained "Satisfactory" during this year.

**Indicator 6 (Ensures that legal actions are taken in case of violations of regulatory requirements):**

Under PNRA Ordinance, it is mandatory for nuclear & radiation facilities in the country to operate only after getting a licence from PNRA. Licences to these facilities are issued after detailed review and assessment of the applicants' submissions specified under the national regulations and inspection of the site and equipment. In case of any non-compliance or violation of the regulatory requirements, PNRA takes enforcement actions under Pakistan Nuclear Regulatory Authority Enforcement Regulations-PAK/950. During the reported period, PNRA continued to bring non-regulated X-ray facilities in the licensing net which has resulted in an appreciable increase in licensed X-ray facilities. However, various facilities also defaulted during this year as discussed in detail in Chapter 4 of this Report. Legal proceedings are being initiated against these defaulters as per enforcement regulations and enforcement

procedure. In this regard, ninety-five (95) hearing notices and forty (40) legal notices were issued to different radiation facilities during the reported period. Keeping in view the facts, the performance of PNRA is retained "Minimally Acceptable" during the reported period.

**Indicator 7 (Performs its functions in a timely and cost-effective manner):**

PNRA has performed most of its regulatory activities and has achieved most of the targets set for the year 2014 within estimated budgets and schedules. PNRA reviewed various safety related design modifications and conducted daily/routine inspections/surveillances at all nuclear installations. In addition, inspections of C-1, C-2 and K-1, and control point inspections of C-3/C-4 were conducted according to schedules. During the reported period, PNRA has conducted inspections of radiation facilities but the targets were not met in accordance with the annual plan. PNRA also reviewed a number of licensees' documents and conducted inspections of nuclear and radiation facilities using graded approach. Some gaps have been identified and so there is still room to improve the resource optimization and cost effectiveness. Therefore, the performance rating of PNRA has lowered from "Satisfactory" to "Minimally Acceptable" against this indicator.

**Indicator 8 (Ensures that a well established quality management system exists):**

PNRA has developed its Management System Manual based on IAEA safety standards and started its implementation since 2010. Under the management system manual, a number of documents describing core and support processes have been developed and are being implemented. The effectiveness of management system is assessed by conducting regulatory audit of PNRA directorates and projects. Based on experience feedback on implementation, revision of the reference document and recommendations of IRRS

## PERFORMANCE REVIEW

for its improvement; it was felt that the management system manual needs to be revised. Accordingly, a revised draft was finalized and is expected to be issued in early 2015. Keeping the progress of activities in view, the performance rating of PNRA against this indicator has been assessed to remain “Needs Improvement” during the reported period.

**Indicator 9 (Ensures that adequate resources are available for performing its functions and Technical Support Centre is available for specialist assistance when required):** Technical support centres of PNRA i.e., "Safety Analysis Centre (SAC)" and "Centre for Nuclear Safety (CNS)" are performing review, assessment and analysis to assist regulatory decision-making and are providing necessary support in the regulatory inspection programme. PSDP projects “National Environmental Radioactivity Surveillance Programme” (NERSP) and “National Dosimetry and Protection Level Calibration Laboratory (NDCL)” have successfully been completed and project completion reports submitted to the Government of Pakistan. Although, PNRA has achieved most of its targets set for the year, however, some of the activities have been affected due to shortage of financial resources. Various activities of competence development programme could not be carried out, the scope of public awareness programme has been restricted, and procurement of certain necessary equipment has been deferred. Therefore, the performance of PNRA against this indicator is lowered from “Minimally Acceptable” to “Unsatisfactory”.

**Indicator 10 (Performs its functions in a manner that ensures confidence of the operating organizations):** In 2014, PNRA conducted coordination meetings with the licensees of NPPs and research reactors, as planned, to discuss the progress of the safety activities being performed at

the plants, to remove any hindrance in the understanding of regulatory requirements and implementation of necessary corrective actions. PNRA arranged training courses for the personnel from NPPs and radiation facilities. PNRA routinely shares the draft regulations with the licensees for their feedback and shares the international feedback on safety related issues with its stakeholders. Therefore, PNRA's performance against this indicator remained “Satisfactory” during 2014.

**Indicator 11 (Performs its functions in a manner that ensures confidence of the general public):** PNRA keeps the general public informed about its activities through its annual report and by placing relevant information at PNRA web site ([www.pnra.org](http://www.pnra.org)). PNRA is arranging seminars and special lectures at the universities & colleges for students as well as professionals in order to make them aware about the application of ionizing radiations in everyday life & medical field, hazards associated with them & means of protection. During 2014, PNRA organized about ninety lectures/seminars in Islamabad, Faisalabad, Lahore, Multan, Bahawalpur, DG Khan, Abbottabad, Karachi, Gujranwala, Sargodha and Peshawar in which around twelve thousand personnel participated. Keeping in view these facts, the performance against this indicator is improved from “Unsatisfactory” to “Needs Improvement”.

**Indicator 12 (Performs its functions in a manner that ensures confidence of the Government):** During the reported period, PNRA participated in the 6<sup>th</sup> Review Meeting of the Contracting Parties to the Convention on Nuclear Safety (CNS). At national level, PNRA regularly holds meetings with Ministry of Foreign Affairs, Strategic Plans Division, Planning Commission, Ministry of Finance and other related governmental departments to inform them about the present status of safety of people and

Figure 31: Assessment of PNRA's Performance in 2014

(Indicator 1) Ensures that acceptable level of safety is being maintained by licensees	(Indicator 2) Ensures that regulations and guides are in position and understood by licensees	(Indicator 3) Strives for continuous improvement of its performance
(Indicator 4) Takes appropriate actions to prevent degradation of safety and to promote safety improvements	(Indicator 5) Takes appropriate steps for human resource development and has competent and certified regulatory staff	(Indicator 6) Ensures that legal actions are taken in case of violations of regulatory requirements
(Indicator 7) Performs its functions in a timely and cost-effective manner	(Indicator 8) Ensures that a well established quality management system exists	(Indicator 9) Ensures that adequate resources are available for performing its functions and Technical Support Centre is available for specialist assistance when required
(Indicator 10) Performs its functions in a manner that ensures confidence of the operating organizations	(Indicator 11) Performs its functions in a manner that ensures confidence of the general public	(Indicator 12) Performs its functions in a manner that ensures confidence of the Government

Rating Scale

Green	Satisfactory
White	Minimally Acceptable
Yellow	Needs Improvement
Red	Unsatisfactory
Pink	Not Acceptable

## PERFORMANCE REVIEW

environment and to look for further strengthening of regulatory regime in the country. PNRA reports on the safe operation of the nuclear installations to the Government of Pakistan and relevant government agencies on quarterly basis. The performance of PNRA against this indicator remained "Satisfactory" for the reported period.

Based on the evaluation of all the twelve performance indicators, PNRA has rated its overall performance for the reported period as satisfactory. A comparison of its overall performance during the last ten years is given in Figure 32.

### Overall Performance

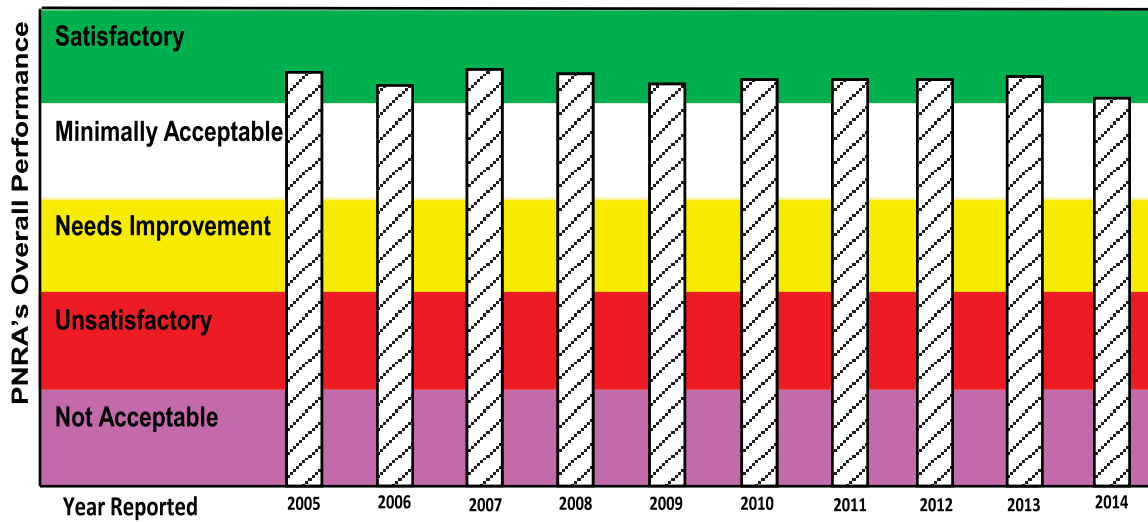



Figure 32: Overall Performance of PNRA Since 2005







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