2024 ANNUAL REPORT

PAKISTAN NUCLEAR REGULATORY AUTHORITY

PNRA

The Authority

Mr. Faizan Mansoor, S.I.
Chairman PNRA

Full Time Members

Mr. Muhammad Rahman, PoP
Member (Executive), PNRA

Mr. Naveed Maqbul, S.I.
Member (Corporate), PNRA

Part Time Members

Lt. Gen. Yusuf Jamal, HI (M)

Ms. Farzana Altaf

Mr. Mohsin Fayyaz, S.I.

Prof. Dr. Anisa Qamar

Prof. Dr. Hafiz Muhammad Noor ul Huda Khan Asghar

Dr. Akhtar Ahmed

Dr. Rana Muhammad Safdar

Our 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.

Our 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

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

CHAIRMAN'S MESSAGE

Faizan Mansoor, S.I.

Presenting the Pakistan Nuclear Regulatory Authority annual report, which encapsulates the remarkable achievement and significant milestones of 2024, is a matter of great privilege for me. Along with significant progress toward sustainability, stakeholders' engagement and international collaboration, this year also remained a testament to our unwavering commitment to ensuring nuclear safety and radiation protection in Pakistan.

I truly believe that the changes are made thoughtfully, and with that in mind, we always remain vigilant in the continuous improvement of our processes to keep ourselves on track for perpetual progression. In this respect, to optimize our processes, we updated our Management System. In an effort to further improve and sustain a culture for safety within our organization, we have developed our first safety culture continuous improvement action plan. This initiative will promote our safety practices, thereby ensuring that safety remains a fundamental priority throughout all levels across the organization. In addition, we simulated international missions at the national level in light of IAEA practice and guidance to identify areas of further improvement in various crucial domains, such as occupational radiation protection (ORPAS), emergency preparedness and response (EPREV) and the security of nuclear and radioactive materials (IPPAS). These simulations not only facilitated a comprehensive assessment of our current capabilities but also provided us the opportunities to identify way forward for further strengthening of our regulatory system.

Here, I must also admire and acknowledge my team for their exceptional efforts and commitment in comprehensively reviewing and making decisions on multiple licensing activities, within a tightly-bound time frame, without compromising safety and security. For instance, the issuance of site registration to Pakistan's first nuclear fuel fabrication facility and granting construction license to the C-5 unit, an advanced third-generation Pressurized Water Reactor (PWR), are some notable activities that demonstrate the effective role of PNRA in regulating these facilities in a safe, secure and sustainable manner.

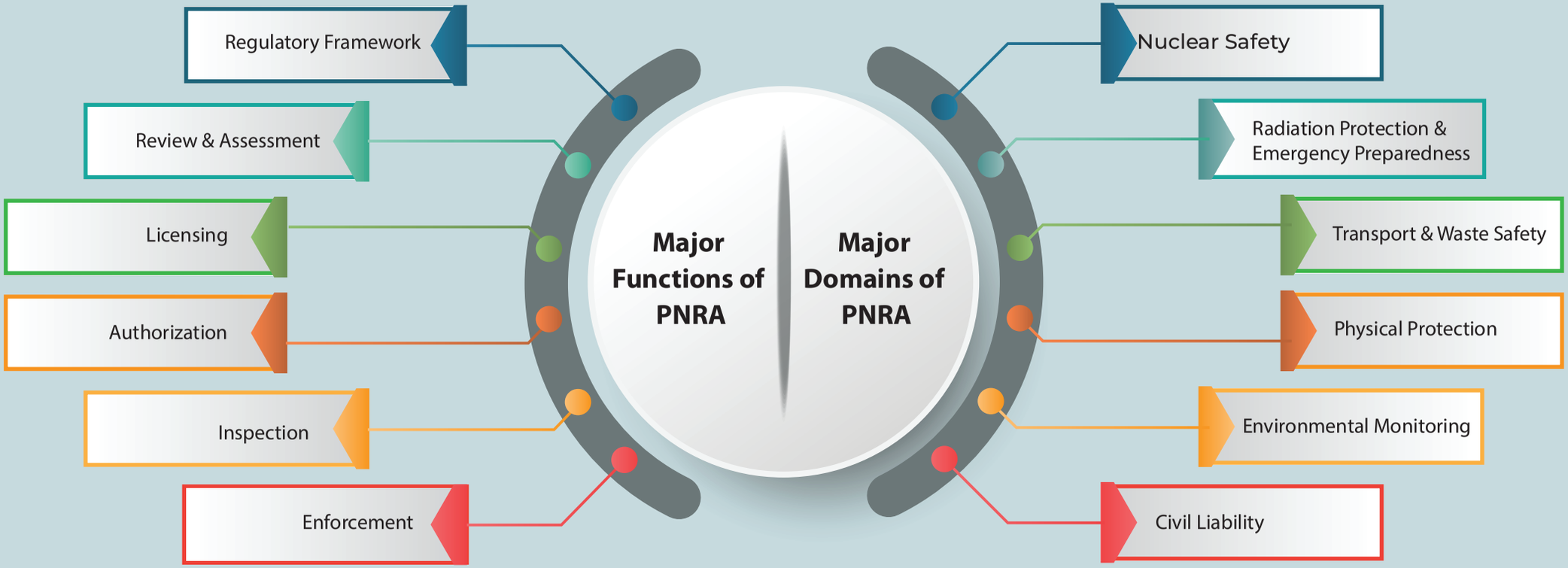
This year, for the first time, Pakistan conducted a National Radiation Emergency Exercise. The exercise aimed to evaluate the readiness of relevant national organizations and their capabilities to respond to a radiological or nuclear emergency and raise awareness about their roles and responsibilities. Its successful completion not only highlighted Pakistan's commitment to maintaining a robust radiological emergency preparedness and response framework in line with the IAEA standards but also showcased the capability of all major national stakeholders to effectively manage and coordinate radiation emergency preparedness and response at the national level.

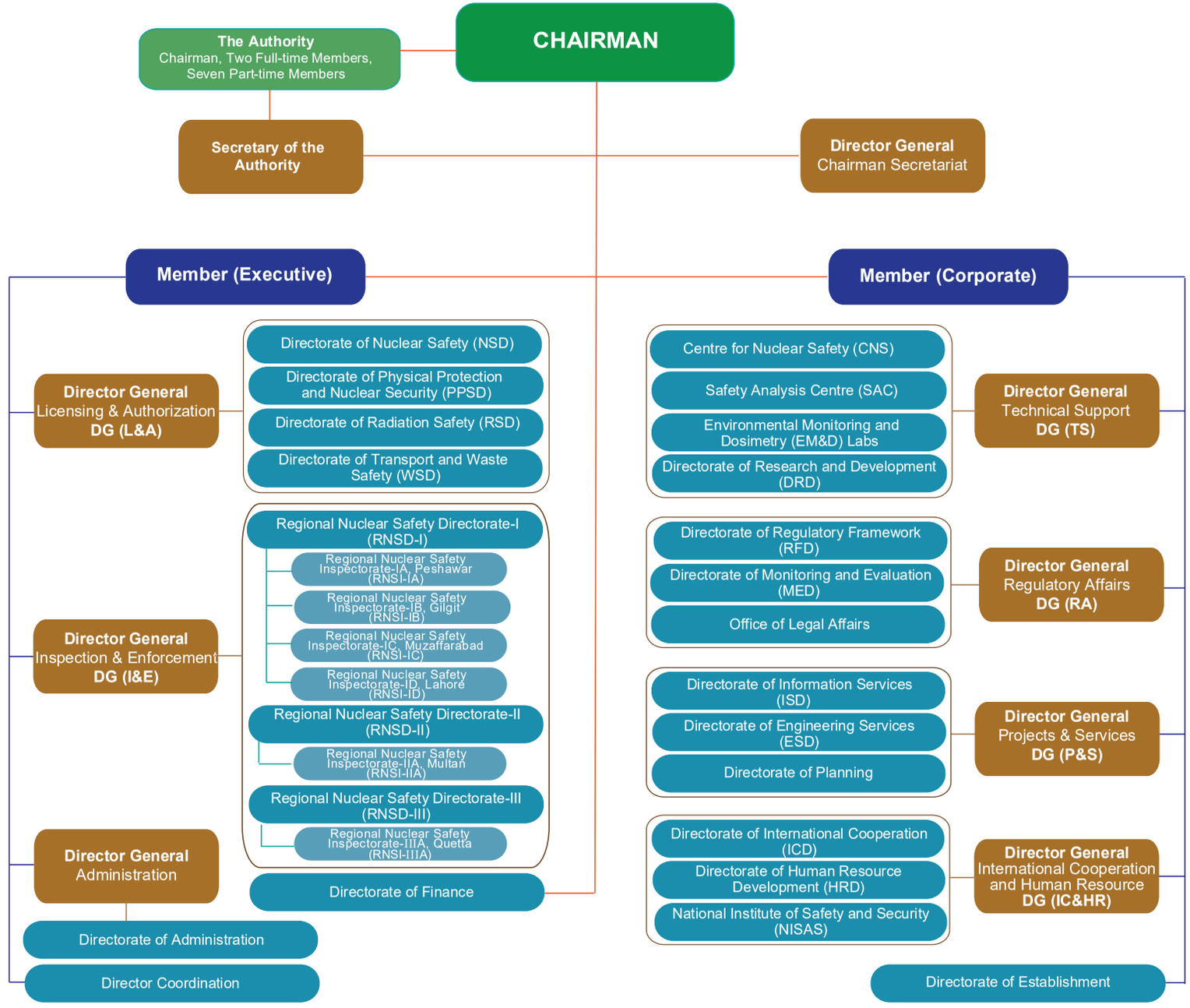
Today, PNRA, with its comprehensive regulatory infrastructure, is providing technical experts for various IAEA activities along with technical assistance to embarking countries and other member states also under the auspices of IAEA. Notably, in the year 2024, PNRA played a significant role on the international stage by leading the IRRS Mission for Bulgaria and by delivering services to Poland on assessment and oversight of leadership and culture for safety within the regulatory body and its licensees. These missions were aimed to support these countries in their activities. We are looking forward to extending our expertise to other countries as well in this domain.

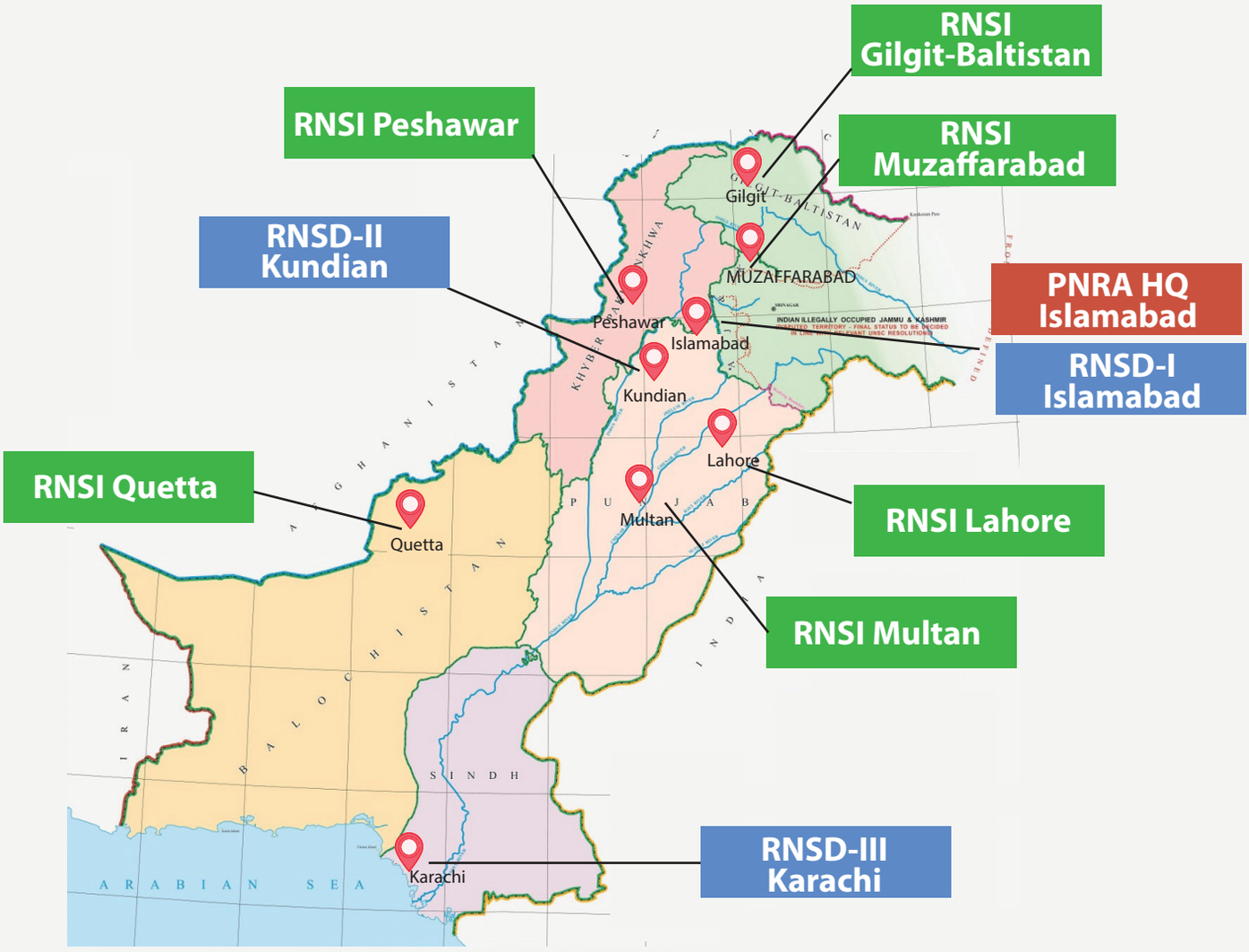
Pakistan also took pride in 2024 by being elected as the President of the Tenth Review Cycle of the Convention on Nuclear Safety (CNS) for the first time. This achievement is a true reflection of the trust placed in Pakistan by the Contracting Parties of the Convention and the international community in the field of nuclear safety and underscores the recognition of the vital role being played by PNRA in this respect. Holding the presidency until 2026 presents a unique opportunity for Pakistan to further contribute to strengthening nuclear safety worldwide and reinforcing our commitment in this critical field.

As I reflect upon the achievements, we have made in the year 2024, I am filled with immense pride and gratitude for the relentless dedication and steadfast support of PNRA team. I also acknowledge the confidence and trust shown by our stakeholders which have been vital to our continued success. Looking ahead to another year, I have every confidence, with this exceptional team by my side, that, together, we will continue to better serve our country and accomplish our mission, contributing to a safer and more sustainable future.

Powers and Functions of PNRA




CHAIRMAN
The Authority
Chairman, Two Full-time Members, Seven Part-time Members
Secretary of the Authority
Director General
Chairman Secretariat
Member (Executive)
Member (Corporate)
Director General
Licensing & Authorization
DG (L&A)
Directorate of Nuclear Safety (NSD)
Directorate of Physical Protection and Nuclear Security (PPSD)
Directorate of Radiation Safety (RSD)
Directorate of Transport and Waste Safety (WSD)
Director General
Inspection & Enforcement
DG (I&E)
Regional Nuclear Safety Directorate-I (RNSD-I)
Regional Nuclear Safety Inspectorate-IA, Peshawar (RNSI-IA)
Regional Nuclear Safety Inspectorate-IB, Gilgit (RNSI-IB)
Regional Nuclear Safety Inspectorate-IC, Muzaffarabad (RNSI-IC)
Regional Nuclear Safety Inspectorate-ID, Lahore (RNSI-ID)
Regional Nuclear Safety Directorate-II (RNSD-II)
Regional Nuclear Safety Inspectorate-IIA, Multan (RNSI-IIA)
Regional Nuclear Safety Directorate-III (RNSD-III)
Regional Nuclear Safety Inspectorate-IIIA, Quetta (RNSI-IIIA)
Director General
Administration
Directorate of Finance
Directorate of Administration
Director Coordination
Centre for Nuclear Safety (CNS)
Safety Analysis Centre (SAC)
Environmental Monitoring and Dosimetry (EM&D) Labs
Directorate of Research and Development (DRD)
Director General
Technical Support
DG (TS)
Directorate of Regulatory Framework (RFD)
Directorate of Monitoring and Evaluation (MED)
Office of Legal Affairs
Director General
Regulatory Affairs
DG (RA)
Directorate of Information Services (ISD)
Directorate of Engineering Services (ESD)
Directorate of Planning
Director General
Projects & Services
DG (P&S)
Directorate of International Cooperation (ICD)
Directorate of Human Resource Development (HRD)
National Institute of Safety and Security (NISAS)
Director General
International Cooperation and Human Resource
DG (IC&HR)
Directorate of Establishment



PNRA Headquarters,

Islamabad

HQs

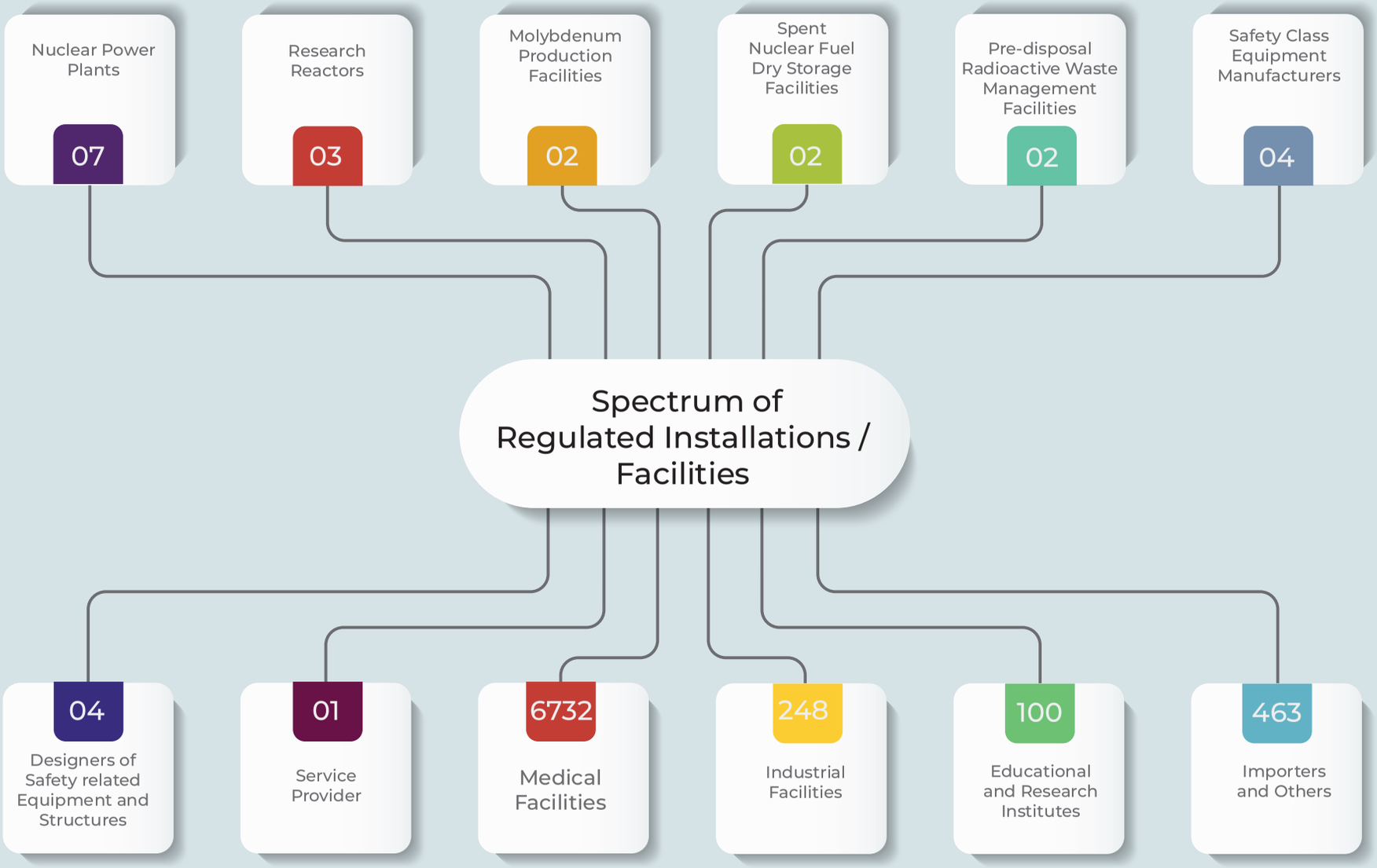
RNSDs

RNSIs

REGIONAL NUCLEAR SAFETY DIRECTORATE-I ISLAMABAD
REGIONAL NUCLEAR SAFETY DIRECTORATE-II CHASHMA
REGIONAL NUCLEAR SAFETY DIRECTORATE-III KARACHI

REGIONAL NUCLEAR SAFETY INSPECTORATE-IA PESHAWAR
REGIONAL NUCLEAR SAFETY INSPECTORATE-IB GILGIT-BALTISTAN
REGIONAL NUCLEAR SAFETY INSPECTORATE-IC MUZAFFARABAD
REGIONAL NUCLEAR SAFETY INSPECTORATE-ID LAHORE
REGIONAL NUCLEAR SAFETY INSPECTORATE-IIA MULTAN
REGIONAL NUCLEAR SAFETY INSPECTORATE-IIIA QUETTA

Statistics of Regulated Installations, Facilities and Associated Activities



ACHIEVEMENTS 2024

01 Issued Regulatory Guide on Format and Contents of Physical Protection Program of Nuclear Installations (PNRA-RG-909.02) (Rev.1)

02 Revalidated Design Approval Certificate of HMC-3 for KANUPP Spent Nuclear Fuel Dry Storage Cask (SC-108)

03 Issued Design Approval Certification of Spent Fuel Dry Storage and Transfer Casks (SC-21 & TC-21) to CNPGS

04 Issued Construction License to C-5

05 Revalidated Operating License of PARR-2

06 Issued Design and Manufacturing License to NEW-1

07 Registered Site of Fuel Technology Facility (FTF)

08 Conducted first-ever National Radiation Emergency Exercise (NREE-2024) with the participation of all relevant national organizations and Hosted IAEA Convention Exercise (ConvEx-2c)

09 Conducted internal Emergency Preparedness Review (EPREV), Occupational Radiation Protection Appraisal Services (ORPAS) and International Physical Protection Advisory Service (IPPAS) Missions

10 Provided more than fifty expert services in nuclear safety, security and radiation safety to member states on request of IAEA

11 Completed seven R&D Projects

12 Conducted 22 training courses at national level for around 500 participants.

13 Conducted 21 Public Awareness Seminars for around 3000 participants.

14 Designation of NISAS by IAEA as one of its Collaborating Centre for Nuclear Safety and Radiation Safety

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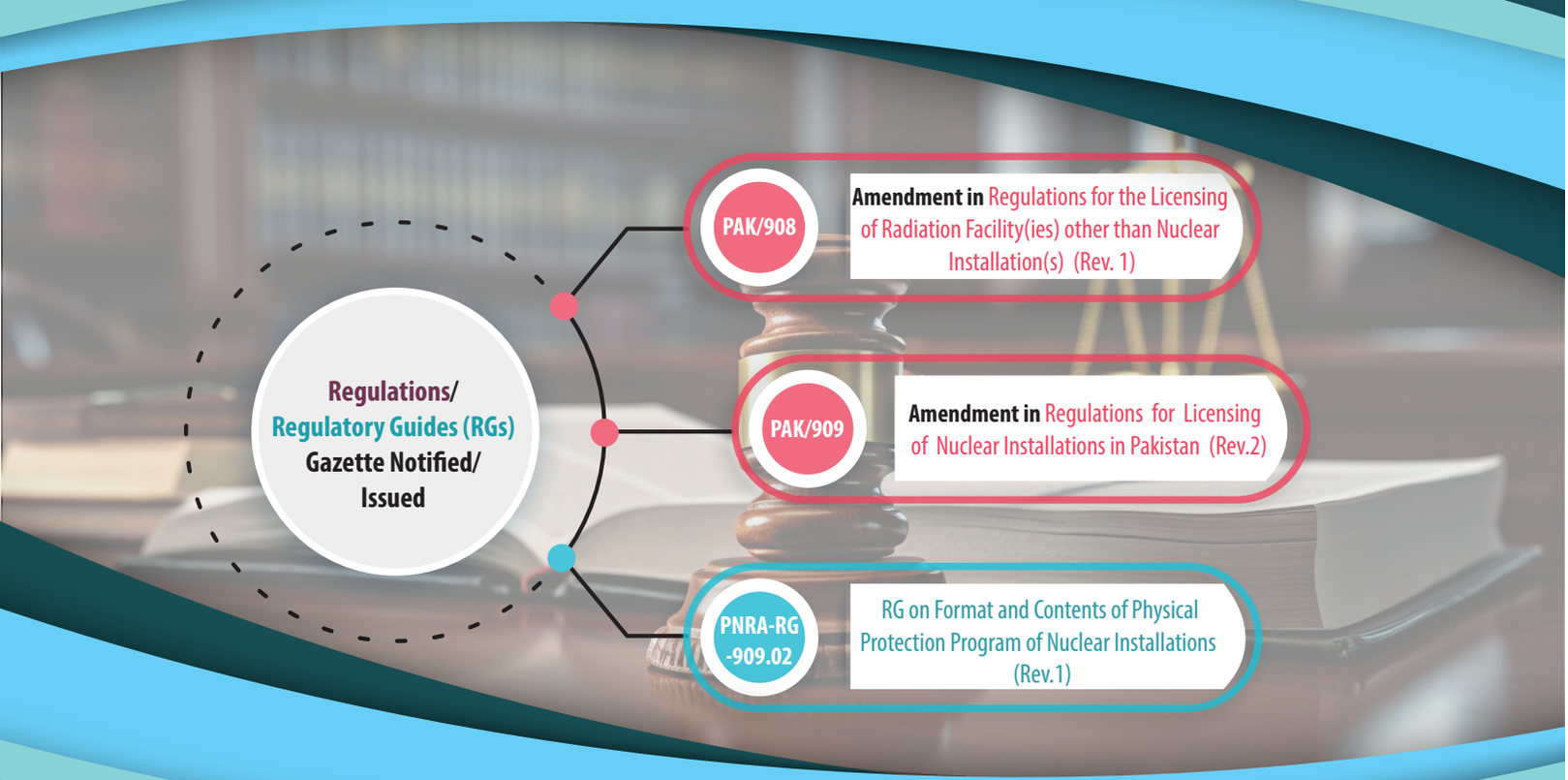
01 Legislative and Regulatory Framework



The legislative and regulatory regime of PNRA comprises three tiers namely PNRA Ordinance, Policies/Regulations/Orders and Regulatory Guides as depicted in Figure 1.

1.1 PNRA Ordinance

PNRA Ordinance constitutes the top tier of the regulatory pyramid. It includes the statutory basis for the creation of PNRA, commitment to use of nuclear technology only for peaceful purposes along with reducing unnecessary radiological risk to public and environment, establishing and enforcing regulations for the above objectives; and also establishing the financial indemnification for nuclear damage. PNRA Ordinance establishes the mandate, composition, powers and functions of the Authority.

1.2 Policies, Regulations and Orders

Policies, regulations and orders form the second tier of the regulatory pyramid. PNRA issues two types of regulations: administrative and technical. Administrative regulations establish the organized processes for licensing, rules of business of the Authority and fixation of

regulatory fee. While technical regulations delineate requirements to applicant and licensee for compliance in order to ensure safety and security of nuclear installations, radiation facilities and associated activities.

The requirements are mandatory in nature and require adherence in the areas of nuclear safety, radiation protection, emergency preparedness & response, radioactive waste management, transport safety, physical protection and nuclear security in order to protect the workers, the public and the environment from harmful effects of ionizing radiation. The technical regulations are mostly based on latest IAEA safety standards while national and international experience feedback is also considered during preparation.

According to a structured process, draft regulations prepared by PNRA are shared with relevant stakeholders for their review and comments, and these are also made available on PNRA website for information and comments of the stakeholders and general public. Additionally, PNRA notifies the general public through national press about opportunity to provide comments on these draft regulations when posted on PNRA website.

During 2024, the following draft regulations were shared with stakeholders and also uploaded on PNRA website for comments:

i. Regulations for Licensing of Design Organizations - (PAK/905);

ii. Regulations for Licensing of Nuclear Installations in Pakistan - (PAK/909) (Rev.2);

iii. Regulations on the Safety of Nuclear Installations Site Evaluation - (PAK/910) (Rev.2);

iv. Amendment in Regulations on the Safety of Nuclear Power Plants Operation - (PAK/913) (Rev. 2); and

v. Regulations on the Safety of Nuclear Fuel Cycle Facilities- (PAK/917).

The regulations, once approved by the Authority, are notified in the official gazette of Pakistan and are placed on the PNRA website (www.pnra.org) for information and compliance by all concerned. During the reported period, amendments in “Regulations for the Licensing of Radiation Facility(ies) other than Nuclear Installation(s) - (PAK/908) (Rev. 1)” and "Regulation for licensing of Nuclear Installations - (PAK/909) (Rev. 2)" were approved by the Authority and gazette notified.

Besides the above, development of following new regulations are in progress:

i. Regulations on Licensing of Design

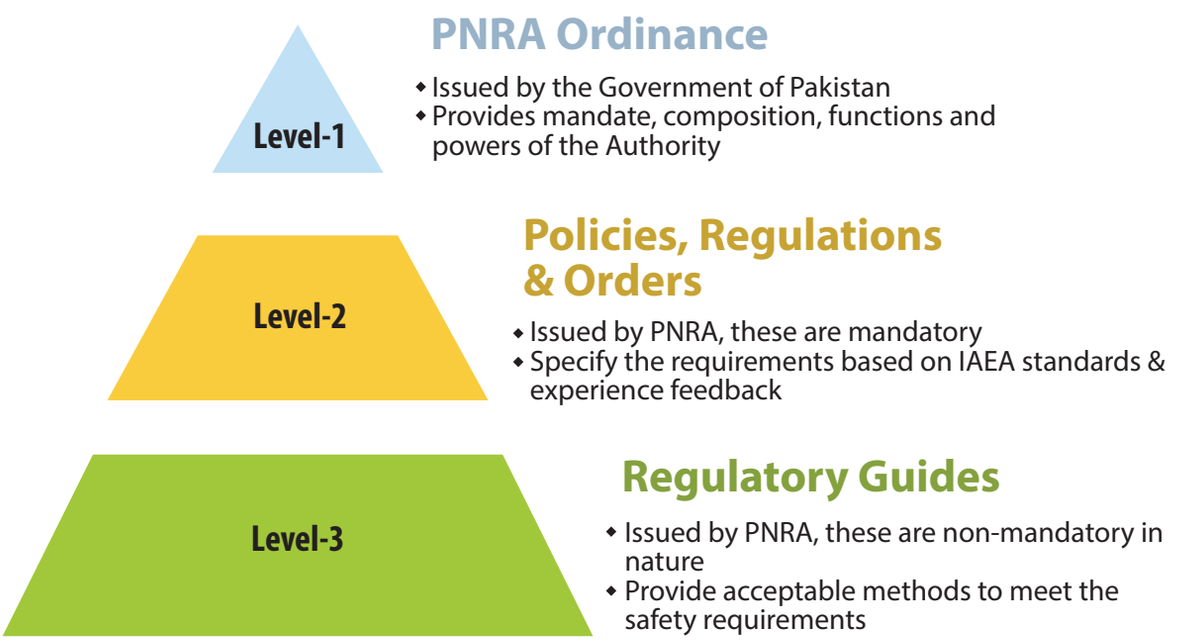


Figure 1: Legislative and Regulatory Framework

Organizations - (PAK/905);

ii. Regulations on the Safety of Nuclear Fuel Cycle Facilities - (PAK/917); and

iii. Regulations on Safety of Research Reactors - (PAK/932).

The policies are an important part of the regulatory regime for ensuring the safety of the public and adherence to international commitments. There are two types of policies: national policies for which Government has the responsibility and it can ask any organization to draft the policy on its behalf while making policies for the protection of life, health and property against the risk of ionizing radiation As referred in section 16 of the Ordinance, PNRA formulates and implements the policies on behalf of Government of Pakistan.

Orders are also issued by PNRA to halt or amend any practices to protect the workers, the public and the environment from harmful effects of ionizing radiation. The policies and regulations are periodically reviewed and revised, if needed, once every five years or earlier, if required. During the reporting period, following regulatory documents remained under review for revision:

i. National Policy on Safe Management of Radioactive Waste, Decommissioning and Spent Nuclear Fuel in Islamic Republic of Pakistan - (RWP-01/2018) (Rev. 1);

ii. Regulations on Transaction of Business of Pakistan Nuclear Regulatory Authority - (PAK/901) (Rev.1);

iii. Amendment in Regulations on Radiation Protection - (PAK/904) (Rev.1);

iv. Regulations for Licensing of Nuclear Safety Class Equipment and Components Manufacturers - (PAK/907) (Rev.2);

v. Regulations for Licensing of Nuclear Installations in Pakistan - (PAK/909) (Rev.2);

vi. Regulations on the Safety of Nuclear Installations Site Evaluation - (PAK/910) (Rev.2);

vii. Amendment in Regulations on the Safety of Nuclear Power Plants Operation - (PAK/913) (Rev. 2); and

viii. Pakistan Nuclear Regulatory Authority Enforcement Regulations - (PAK/950) (Rev.1).

In order to facilitate the general public, translation of Regulations on Radiation Protection - (PAK/904) in 'Urdu' is in progress.

1.3 Regulatory Guides

Regulatory Guides (RGs) form the third tier of PNRA's regulatory pyramid providing guidelines to the users on how to implement the regulatory requirements as established in PNRA regulations. The RGs are non-mandatory in nature and the licensees may choose any alternate methodology, if they can demonstrate that their alternative approach achieves similar or higher level of safety, security and quality. The development process of the RGs includes steps to seek feedback from all stakeholders.

Draft regulatory guides are shared with relevant stakeholders for review and comments and are also uploaded on PNRA website (www.pnra.org) for information and comments of the public.

During the reported period, PNRA issued RG on Format and Contents of Physical Protection Program of Nuclear Installations (PNRA-RG-909.02) (Rev.1).

Development and revision of following RGs remained in progress during 2024:

i. Format and Contents of Radiation Protection Program (PNRA-RG-904.06);

ii. Radiation Safety and Regulatory Requirements in Medical Diagnostic X-ray facilities (PNRA-RG-904.08);

iii. Radiation Protection and Safety in Nuclear Medicine (PNRA-RG-904.09);

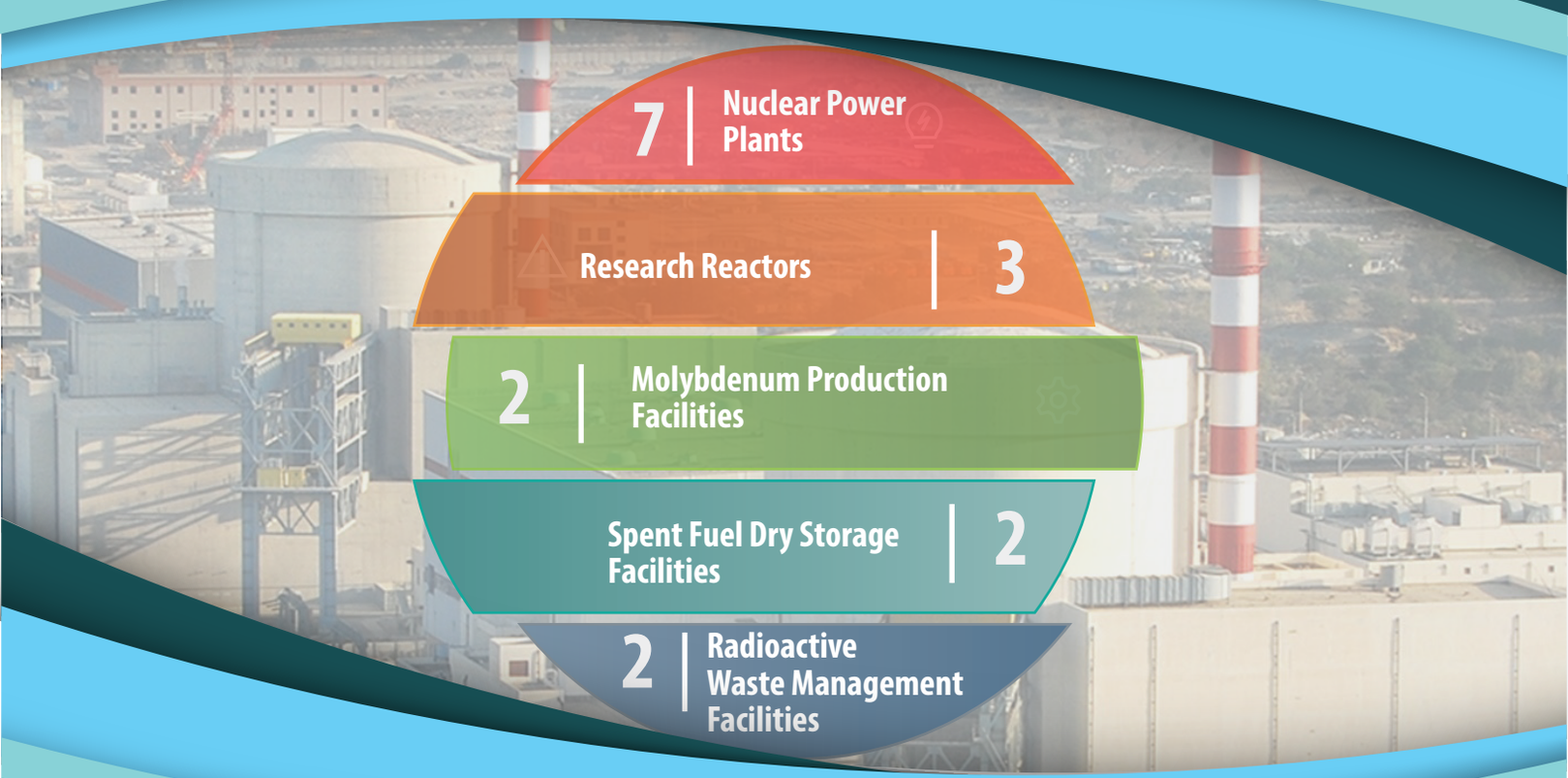
iv. Periodic Safety Review (PSR) of Nuclear Installations (PNRA-RG-909.05);

v. Iodine Thyroid Blocking (ITB) during a Nuclear or Radiological Emergency (PNRA-RG-914.01) (Rev. 1);

vi. Preparation of Radiation Emergency Plan for Radiation Facilities and Activities (PNRA-RG-914.02); and

vii. Operation Interventional Levels and their use during Nuclear and Radiological Emergencies (PNRA-RG-914.04).

02 Regulating Nuclear Installations



PNRA regulates nuclear facilities and activities, in order to ensure protection of the radiation workers, the public and the environment from harmful effects of ionizing radiation. Accordingly, PNRA performs the core functions of issuing licenses and authorizations to facilities and activities by performing review and assessments of licensing submissions, conducting regulatory inspections for verifying compliance with regulations and the license conditions and takes necessary enforcement actions in case of any non-compliances. The regulatory domain of PNRA in the area of nuclear installations mainly includes Nuclear Power Plants (NPPs), Research Reactors (RRs), Isotope Production Facilities (MPFs), Spent Fuel Dry Storage Facilities (SFDSFs), Pre-Disposal Radioactive Waste Management Facilities and Near Surface Waste Disposal Facilities. Further, PNRA also issues licenses to operating personnel of NPPs and RRs.

2.1 Nuclear Power Plants

2.1.1 K-Series NPPs

These include KANUPP Decommissioning Project (KDP), a pressurized heavy water reactor, which was permanently shut down in 2021

and is currently being decommissioned. Apart from KDP, there are two operating units called, K-2 and K-3 comprising advanced pressurized water reactor (PWR) of Haulong Pressurized Reator-1000 design having a generation capacity each of 1100 MWe.

During the reporting period, K-3 was shut down on September 05, 2024 for second refueling outage (RFO-2) and performing planned maintenance activities, in-service inspections and testing. After completing the refuelling activities, K-3 submitted an application to achieve re-criticality along with necessary submissions required by PNRA regulations. These documents were reviewed by PNRA, and based on satisfactory fulfillment of all regulatory requirements, K-3 was authorized to make the reactor critical on October 05, 2024.

During 2024, PNRA reviewed a number of routine and non-routine submissions of K-series NPPs as dipicted in Figure 2 while Figure 3 shows statistics of inspections performed at K-series NPPs.

2.1.2 C-Series NPPs

C-series NPPs include four units i.e., C-1, C-2, C-3 & C-4 of pressurized water reactors (PWRs) type located at Chashma site near Mianwali. These units have been in operation since 2000, 2011, 2016 and 2017 respectively.

Figure 2: Review and Assessment of Licensing Submissions of K-Series NPPs

During the reporting period, C-1 was disconnected from grid on January 02, 2024 for its 16th refueling outage (RFO-16). After completing all the refuling activities, C-1 submitted the required documents along with the application to make the plant critical again. Upon satisfactory fulfillment of all regulatory requirements, PNRA granted permission to C-1 for making the plant critical on February 06, 2024.

C-2 was disconnected from the national grid on June 21, 2024 for 10th refueling outage (RFO-10) to carry out the planned outage activities. Upon completing the RFO activities, C-2 applied for plant criticality along with the required documents under PNRA regulations. Upon fulfillment of all regulatory requirements, C-2 was granted permission to make the reactor critical on August 21, 2024.

C-4 was shut down for its 5th refueling outage (RFO-5) on April 01, 2024. After completing the refueling activities, C-4 applied for permission to make the plant critical along with required documents. Consequently, PNRA granted criticality permission to C-4 on April 19, 2024.

The detail of submissions received from C-series plants and reviewed by PNRA is dipicted in Figure 4 while Figure 5 shows statistics of inspections performed at C-series NPPs. Additionally, PNRA witnessed one national level emergency exercise at the C-series NPPs.

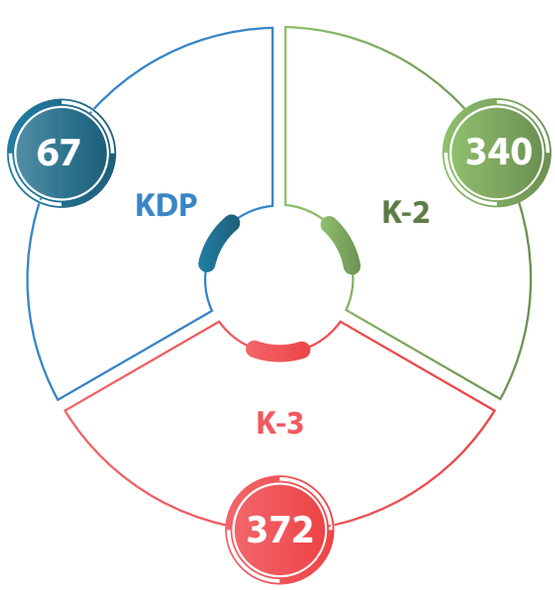


Figure 3: Inspections Performed at K-Series NPPs

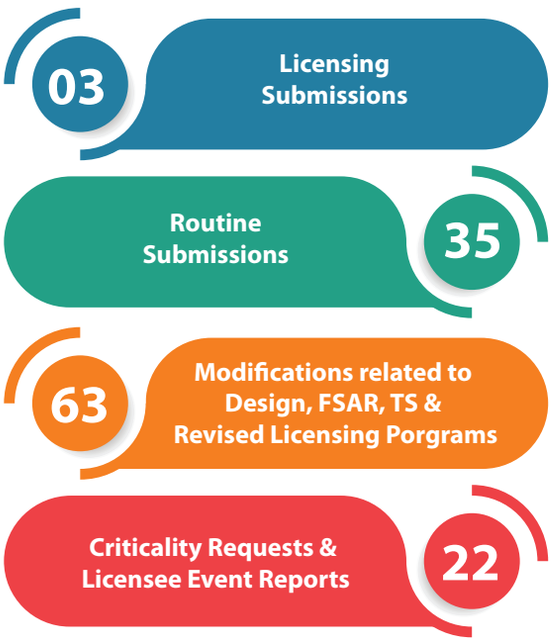


Figure 4: Review & Assessment of Submissions of C-Series NPPs

Figure 5: Inspections Performed at C-Series NPPs

2.2 NPP Project

Application for Construction License (CL) for C-5 NPP project was submitted to PNRA on April 24, 2024 along with Preliminary Safety Analysis Report (PSAR), Management System and PSA Report which were reviewed by PNRA. In this context, two review meetings were held with the licensee and designer in September and December 2024 in China to discuss and resolve the safety concerns identified during the review process. In addition, PNRA performed inspections during manufacturing of C-5 Reactor Pressure Vessel (RPV) and Steam Generators (SGs) at manufacturing sites in China.

Upon successful completion of the review process, PNRA granted construction license to C-5 in December 2024.

2.3 Research Reactors

Two nuclear research reactors, Pakistan Research Reactor-1 (PARR-1) and Pakistan Research Reactor-2 (PARR-2) are currently operating at the Pakistan Institute of Nuclear Science and Technology (PINSTECH), near Nilore, approximately 25 km from Islamabad city. The operating license of PARR-1 is valid up to December, 2031. During the reporting period, the Periodic Safety Review of PARR-2 was completed and its Safety Evaluation Report (SER) was prepared by PNRA. After fulfilling all the regulatory requirements and resolution of all safety issues, PARR-2 operating license was revalidated upto December 2034. Additionally, the third research reactor, PARR-3 of 10 MWt, is under construction at PINSTECH.

In 2024, PNRA carried out review and assessment of various routine submissions of PARR-1 and PARR-2, including Monthly Technical Reports, Safety Performance Indicators (SPIs), etc. Additionally, PNRA conducted regulatory inspections at PARR-1 and PARR-2. During the reporting period, the construction and commissioning activities for PARR-3 remained in progress and PNRA conducted regulatory inspections to verify licensee's compliance with regulatory requirements.

2.4 Molybdenum Production Facility (MPF)

One Molybdenum Production Facility (MPF Unit-1), adjacent to PARR-1 is in operation since 2015 to produce Molybdenum radioisotope (Mo-99). Construction of a second unit of Molybdenum Production Facility (MPF Unit-2) adjacent to PARR-3 remained in progress in 2024. Figure 6 shows statistics of inspections performed at research reactors and MPF.

2.5 Occupational Exposures of Workers at Nuclear Installations

Radiation workers are potentially at a high risk

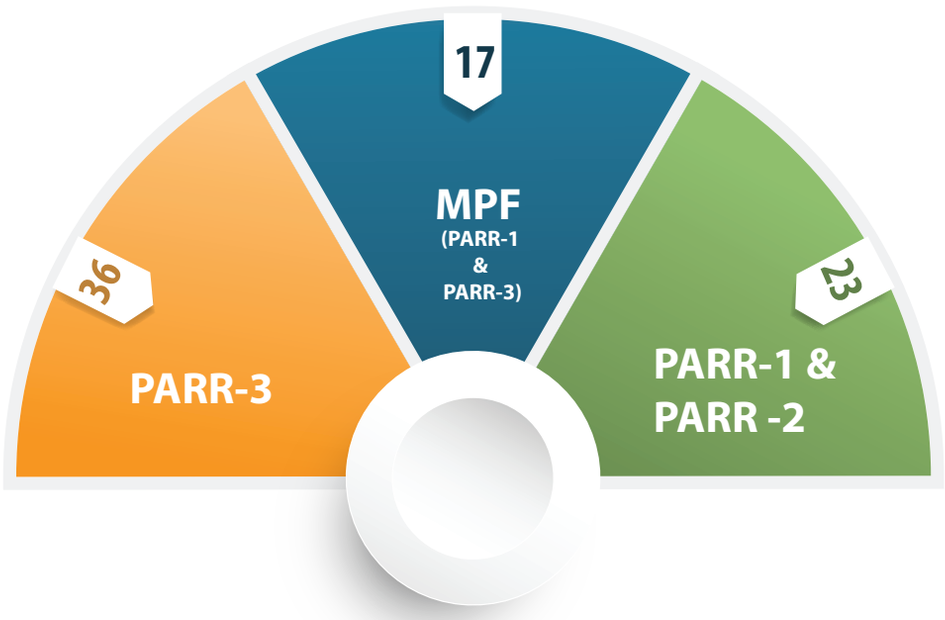


Figure 6: Inspections Performed at Research Reactors and MPF

to the exposure of ionizing radiation during their involvement in various activities at the nuclear installations. This necessitates control of and protection against radiation exposure to the workers. Radiation dose monitoring of individuals enables to determine whether the exposure received by a radiation worker is within or beyond the authorized regulatory limits.

During the reporting period, radiation doses received by the workers during operation and refueling outages at NPPs were well within the regulatory limits and the data of doses received by the workers of C-1, C-2, C-3, C-4, K-2 & K-3, are presented in Figures 7, 8, 9, 10 and 11 respectively.

Furthermore, doses of workers of research reactors and MPF are shown in Figure 12.

2.6 Radioactive Waste Management at Nuclear Installations

PNRA is effectively regulating the radioactive waste management activities at nuclear installations through an established regulatory framework. PNRA ensures that radioactive waste is being managed in accordance with regulatory requirements.

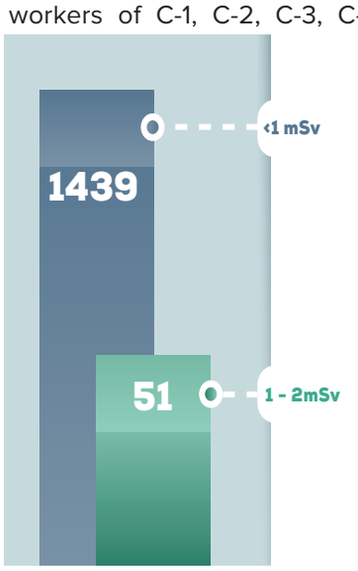


Figure 7: Annual Radiation Doses of C-1 Workers

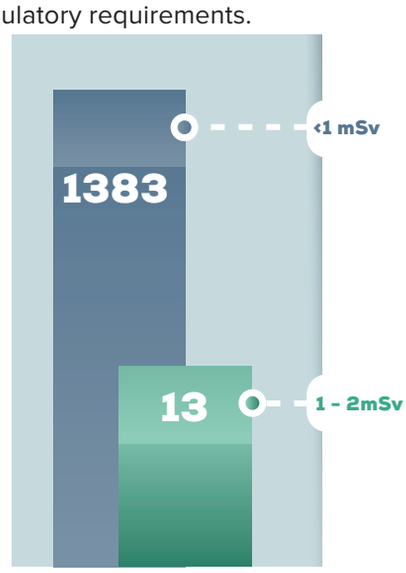


Figure 8: Annual Radiation Doses of C-2 Workers

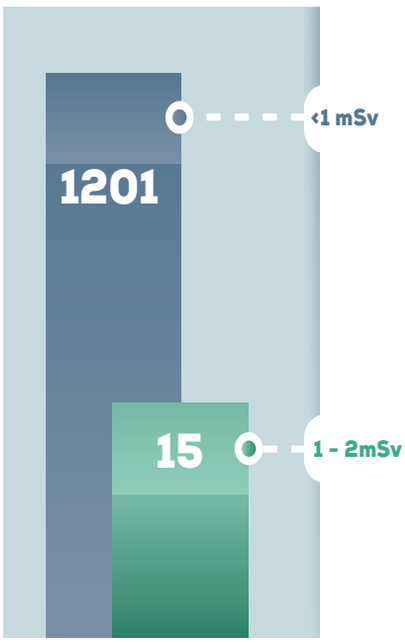


Figure 9: Annual Radiation Doses of C-3 Workers

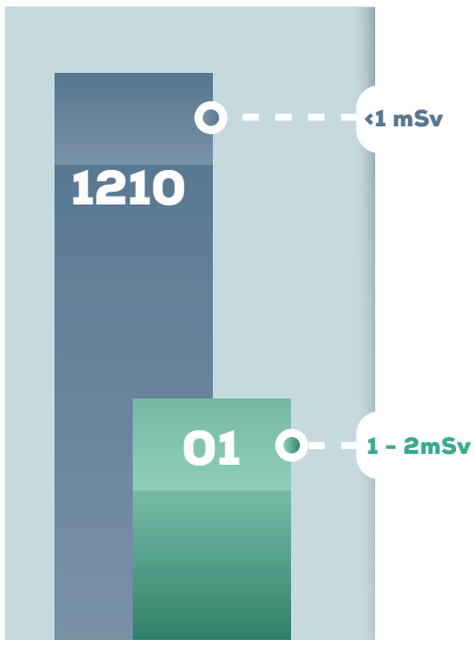


Figure 10: Annual Radiation Doses of C-4 Workers

Onsite storage of solid radioactive waste and controlled release from NPPs of liquid and gaseous effluents to the environment with radiation level below certain limit are legitimate practices around the world which are also being followed in Pakistan. PNRA ensures that the generation of radioactive waste and discharges are minimized through suitable design, operation and other technical & administrative measures. Further, the licensee is required to perform continuous monitoring of releases of gaseous & liquid effluents and report to PNRA.

During the reporting period, the radioactive effluents releases and generation of solid radioactive waste from all NPPs remained well below the authorized limits. The data of radioactive waste and effluents generated is given in Figure 13, 14, 15, 16 and 17.

2.7 Spent Fuel Storage Facilities

A spent fuel dry storage facility is operational at Karachi site for interim storage of spent nuclear fuel of KANUPP (KSFDS) while another such facility PWR Spent fuel Dry Storage facility (PDS) is being constructed at Chashma site.

At KANUPP site 3,672 spent fuel bundles have

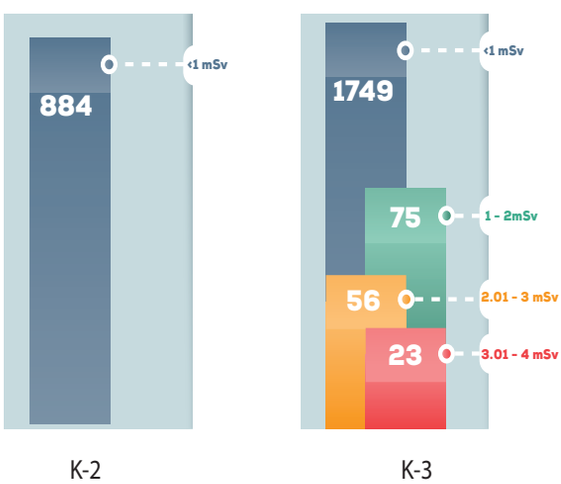


Figure 11: Annual Radiation Doses of K-2 & K-3 Workers

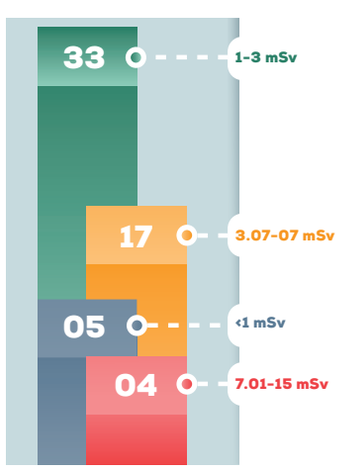


Figure 12: Annual Radiation Doses of Research Reactors and MPF

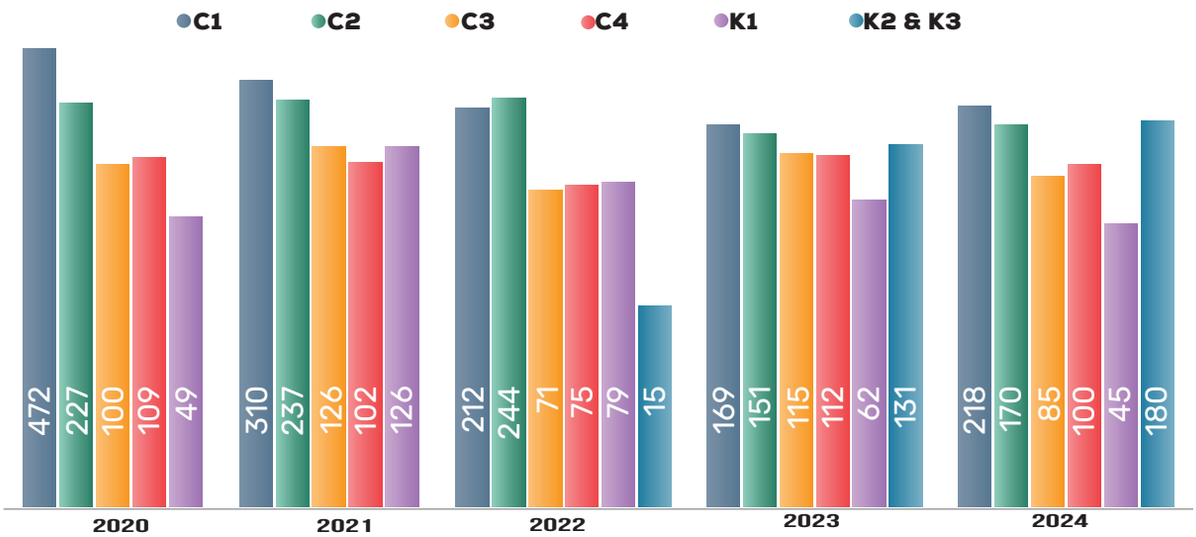


Figure 13: Trends of Generation of Solid Radioactive Waste (Drums) at C-1, C-2, C-3, C-4, K-1/KDP, K-2 and K-3

been loaded in 34 PNRA certified casks (SC-108) and are placed in KSFDS facility.

Construction activities of PDS are in progress and almost 80% construction work has completed. PNRA conducts routine regulatory inspections related to civil works and QA administrative inspections of main contractor of PDS.

2.8 Radioactive Waste Management Facilities

2.8.1 Pre-disposal Facilities

At present, there are two pre-disposal facilities for interim storage of radioactive waste generating from nuclear installations and radiation facilities. One is PINSTECH Predisposal Radioactive Waste Management Facility (PPRWMF) located at PINSTECH site, Islamabad and the other one is Radioactive Waste Storage Area (RAWSA), located at KNPGS site, Karachi.

PPRWMF hosts the waste generated from the research reactors (PARRs), molybdenum production facility (MPF), isotope production facility (IPD) and disused sealed radioactive sources (DSRS). RAWSA accommodates the solid radioactive waste generated from KDP as well as DSRS. Radioactive waste is stored in these pre-disposal facilities for an interim period prior to its shipment to a centralized disposal facility, when available.

PNRA through its regulatory oversight ensures compliance of all practices and activities for the

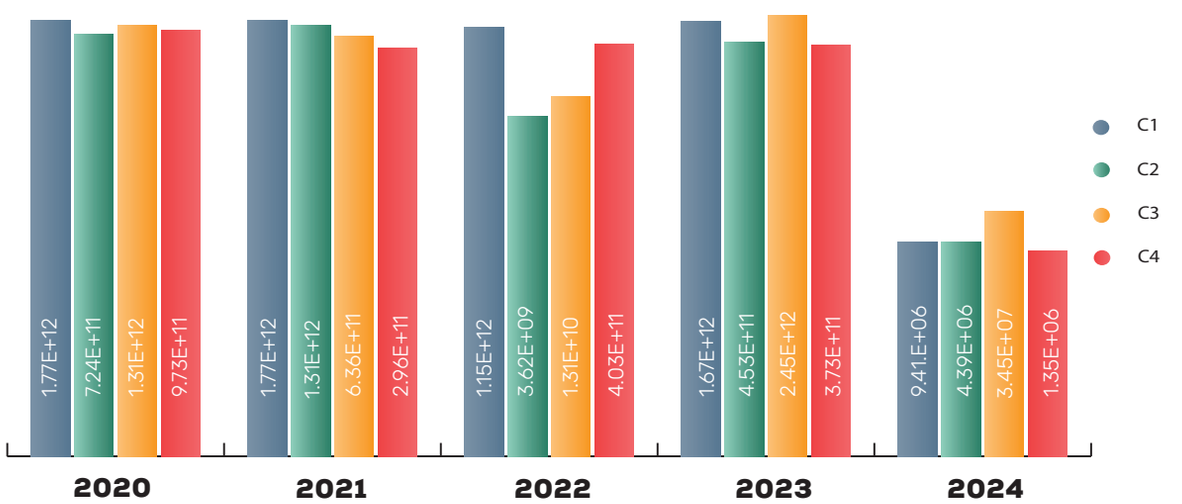


Figure 14: Trends of Liquid Effluent Releases from C-Series NPP (Bq)

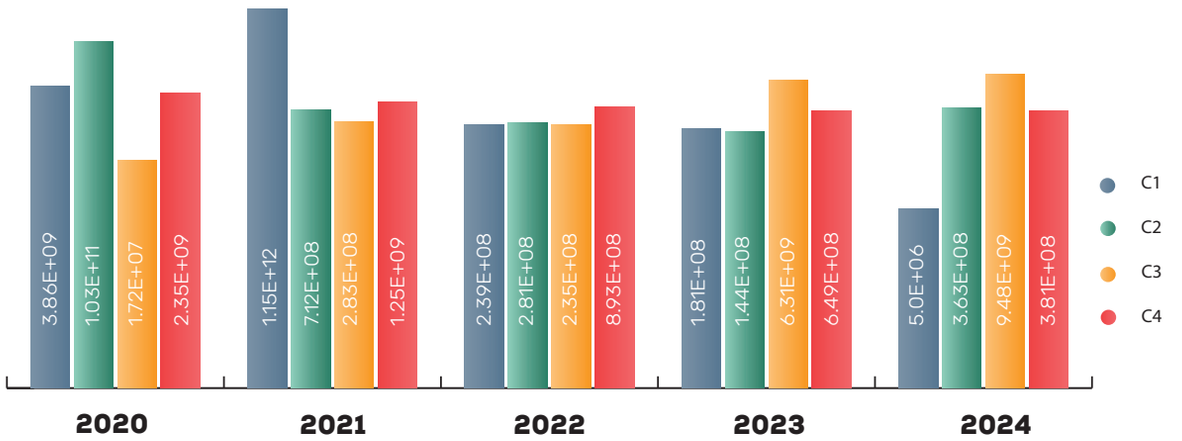


Figure 15: Trends of Gaseous Effluent Releases from C-Series NPPs (Bq)

safe pre-disposal management of radioactive waste. During the reporting year, two regulatory inspections of these facilities were carried out to verify regulatory compliance of radioactive waste management program.

2.8.2 Disposal Facilities

According to PNRA Regulations, the disposal of radioactive waste is only permitted in a designated waste disposal facility.

PAEC is establishing two near surface disposal facilities in the country for disposal of low-level radioactive waste. One is located in the north region and known as National Institute for Conservation of Environment (NICE). The second one is located in south region at KANUPP site and called Regional Repository South (RRS). During the reported year, codes and standards for the construction of NICE have been agreed between PNRA and PAEC and an application for construction license along with the required submissions has been received in the last week of December 2024. Further, application for site registration of Regional Repository South (RRS) has been submitted and is under review.

2.9 Nuclear Fuel Cycle Facilities

During 2024, PNRA reviewed application for site registration for two fuel fabrication facilities i.e. Fuel Technology Facility (FTF) at Chashma and Fuel Fabrication Plant (FFP) at Wan Bhachran near Chashma. After verification of fullfilment of regulatory requirements, PNRA registered site for FTF, whereas, decsion on site registration of FFP is expected in the year 2025 (subject to fulfillment of all regulatory requirements).

Internal Hearing for Site Registration of Fuel Technology Facility (FTF)

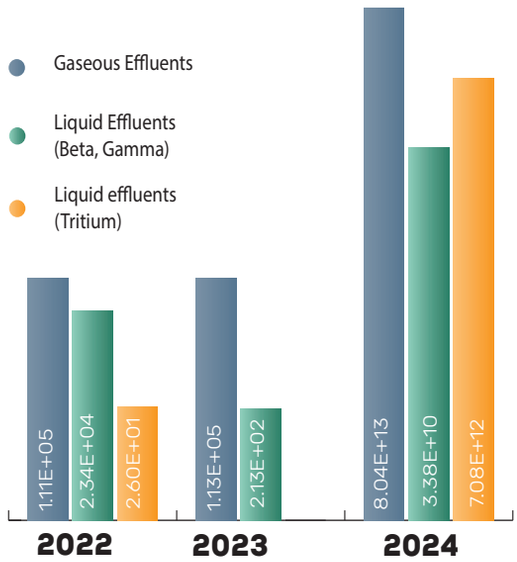


Figure 16: Trends of Liquid & Gaseous Effluent Releases from K-1/KDP (Bq)

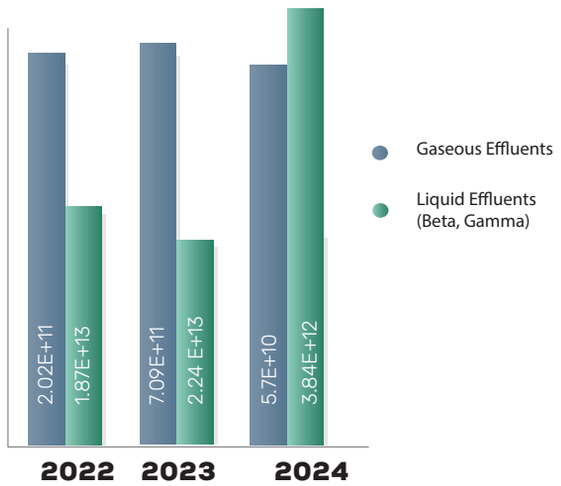


Figure 17: Trends of Liquid & Gaseous Effluent Releases from K-2 & K-3 (Bq)

2.10 Operating Personnel

Recognizing the critical role of qualified and trained personnel in ensuring the safe operation of nuclear power plants and research reactors, PNRA has established specific criteria for the qualification and competence of operating staff. PNRA awards licenses to operating personnel after conducting licensing examination for the positions of Shift Supervisors (SSs) and Shift Engineers (SEs). These operating licenses are renewed annually, contingent on meeting PNRA regulatory requirements, which include technical and professional competence, completion of minimum shift duties, re-training, medical and psychological fitness, etc. During the reporting period, PNRA's licensing committee conducted licensing examinations for the operating personnel of nuclear power plants (both K-series and C-series) as well as research reactors (PARR-1 and PARR-2). Statistics of issuance and renewal of licenses of operating personnel for nuclear installations is depicted in figure 18.

Figure 18: Statistics of Issuance / Renewal of Licenses of Operating Personnel of Nuclear Installations

03 Regulating Radiation Facilities

The areas such as industry, medical field, agriculture sector, research & development etc. are all benefitted from the versatile use of radiations for the betterment of humankind. If appropriate safety measures are not followed during their use, they can be harmful to the workers, public and the environment.

Such facilities and practices are therefore regulated through PNRA authorizations (licences, Permits & NOCs) reinforced with reviews, inspections and enforcement under the national regulations and agreed codes & standards.

The regulatory oversight remains graded with significance of safety and overall risk assessment. In 2024, more than 572 documents from radiation facilities were reviewed such as Safety Analysis Reports (SARs), Radiation Protection Programs (RPPs), Physical Protection Plans (PPPs) and shielding calculations.

3.1 Medical Radiation Facilities

The use of radiations in medical is spanned from X-rays to angiographs, CT scans, mammograms and then to nuclear medicine (Technetium/ Thallium Scanning; PET/CT) and radiotherapy (Conventional Units, LINACs). The facilities,

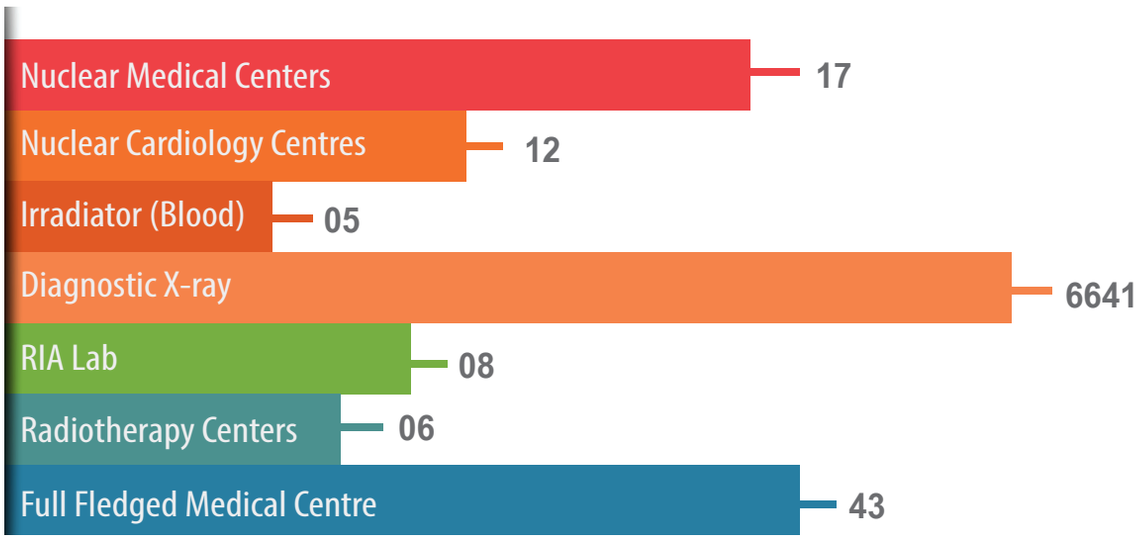


Figure 19: Statistics of Medical Radiation Facilities in Regulatory Net of PNRA

in order to be granted with operating license, are obligated to qualify the submissions on radiation, waste & transport safety; emergency preparedness and physical protection.

In 2024, the total number of licensed medical radiation facilities increased upto 6732 with an addition of 386 new facilities. Figure 19 shows the number of various types of radiation facilities licensed by PNRA.

Followed by authorizations, inspection of operating premises is a regular feature to ensure that compliance is never compromised. Facility design; shielding; inventories; personnel credentials; management system, transportation, storage, physical security, etc. remain primary areas of concern during physical inspections by PNRA inspectors.

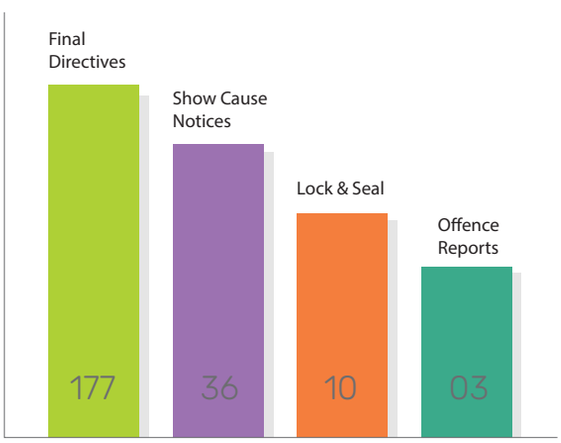


Figure 20: Enforcement Actions against Non-compliances at Medical Radiation Facilities

In 2024, a total of 2909 inspections were performed in medical sector. To verify the effectiveness of emergency plans, in 2024, 14 emergency exercises/drills were witnessed at medical radiation facilities.

Facilities not complying with regulatory requirements are dealt under enforcement regulations. PNRA have the mandate to issue work stoppage notice or perform lock & seal operation, or suspend/cancel an authorization/ license.

In 2024, a number of show cause notices and offence reports were issued by PNRA on non-compliance of regulatory requirements as shown in Figure 20.

3.2 Industrial Radiation Facilities

Industrial uses of radioisotopes and radiation generators include nuclear gauges for process control/monitoring; well logging for oil exploration; NDT for material inspection; irradiators for preservation of food items, sterilization of medical equipment/items and preservation of blood, etc.

Figure 21 shows distribution of various types of industrial facilities using radiation sources.

PNRA ensures radiation protection and safety through review & assessment of submissions, inspections of practices and enforcement against non-conformances. The total number of licensed industrial facilities reached to 248 by the end of 2024.

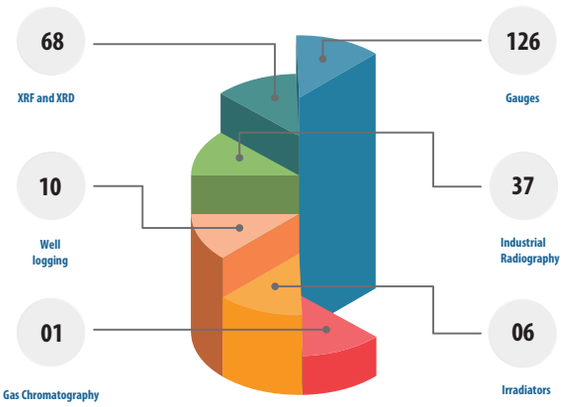


Figure 21: Statistics of Licensed Industrial Radiation Facilities in the Country

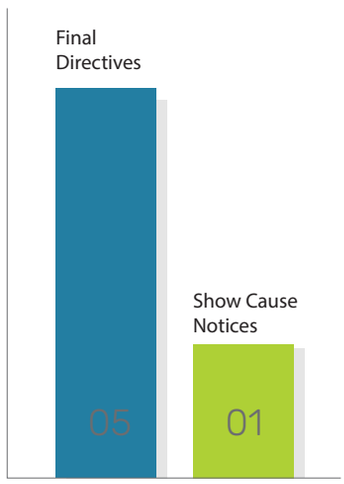


Figure 22: Enforcement Actions against Non-compliances at Industrial Radiation Facilities

During 2024, number of submissions were reviewed at PNRA as part of licensing process or as periodic submissions. In addition, PNRA performed 91 inspections for verification of compliance with regulatory requirements and initiated appropriate enforcement actions against the violators. The overall number and distribution of different enforcement actions is illustrated in Figure 22. PNRA also witnessed 11 emergency exercises conducted by industrial radiation facilities.

3.3 Research and Educational Institutes

In R&D, unsealed sources are used as tracers in field work and in laboratory work, X-ray generators such as diffraction apparatus and accelerators, etc. Material containing NORM is also studied for its potential effects. PNRA issues license to these institutions to ensure the protection of students, researchers and workers.

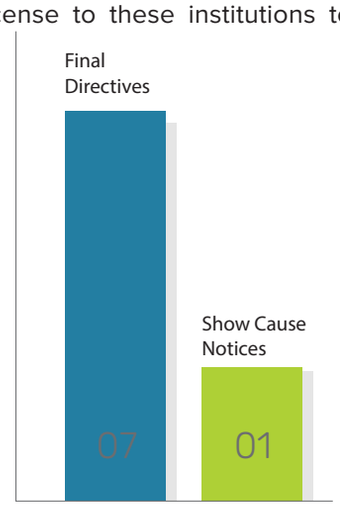


Figure 23: Enforcement Actions against Violators in Research and Educational Institutes

In 2024, PNRA issued 100 licenses to research and educational institutes with an addition of 14 new facilities.

PNRA reviewed licensing documents as part of licensing submissions or as periodic submissions and performed 15 inspections to ensure compliance of regulatory requirements and initiated enforcement actions against violators as depicted in Figure 23.

3.4 Other Applications (Import, Export, Scanners, etc.)

Under other applications, PNRA issues licenses and authorizations to the facilities using X/Gamma-rays based scanners (vehicle and baggage), likewise, PNRA authorizes importers, exporters and traders of radiation sources.

During 2024, PNRA issued 463 licenses with an addition of 38 facilities in the licensing net of PNRA.

Total number of facilities licensed as scanners, importers and exporters is shown in Figure 24.

PNRA reviewed licensing submissions and conducted 73 inspections in order to verify the safety arrangements for compliance of regulatory requirements and took various enforcement actions against the violators. The number of enforcement actions including final directives, show cause notices and offence reports are shown in Figure 25.

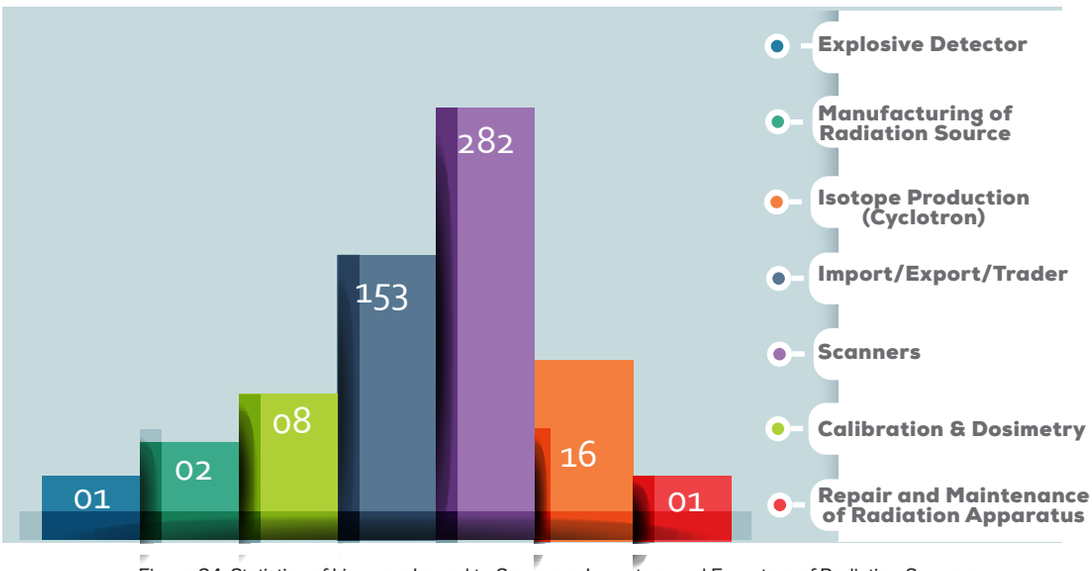


Figure 24: Statistics of Licenses Issued to Scanners, Importers and Exporters of Radiation Sources

3.5 Permits and No Objection Certificates (NOCs)

Import / export of radiation sources is controlled through authorization check on transport and customs clearance of non-exempted products. Such authorizations are termed as permits and NOCs, issued after verification of the intended end use and the user. As a prerequisite for issuance of NOC, it is ensured that a high activity radioactive source can only be acquired / imported upon provision of undertaking by the supplier / manufacturer to accept its return at the end of its useful design life as part of the purchase contract. Some countries of origin require a special permit from regulatory body of the country of destination for placement of order for procurement of radioactive sources or generators. When such requests are received, PNRA carries out necessary verification and issues permits to its licensees to facilitate the process of procurement.

During 2024, PNRA issued 2089 NOCs for the import of new radiation sources / radiation generators and 146 NOCs for the export of empty containers used to carry sources and radiation sources / radiation generators. Figure 26 reflects distribution of different type of import/export authorizations issued during the year.

PNRA has established a close liaison with the Federal Board of Revenue (FBR) through which import / export of radioactive sources

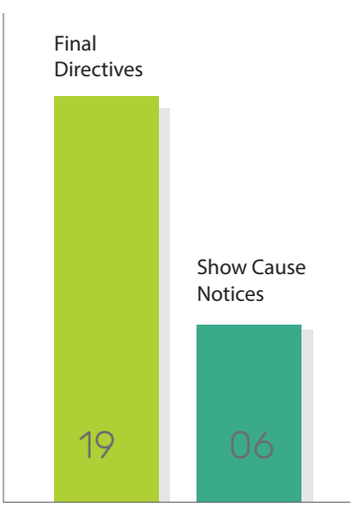


Figure 25: Enforcement Actions against Non-compliances of Others (Scanners, Importers, Exporters, Traders)

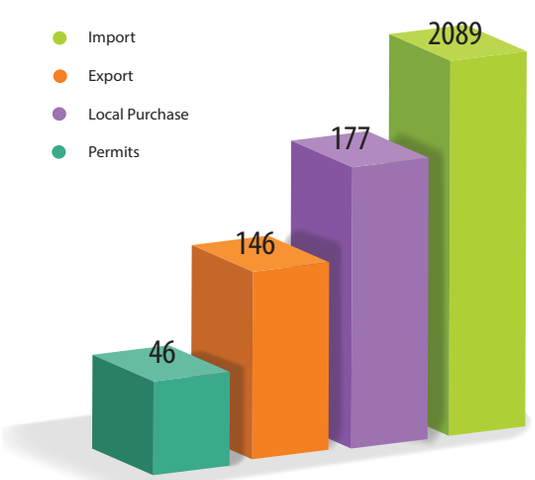


Figure 26: NOCs and Permits Issued by PNRA during 2024

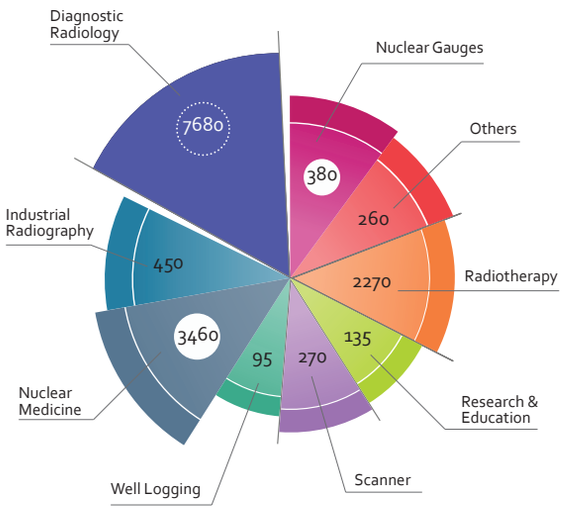


Figure 27: Statistics of Workers in Different Radiation Facilities

is controlled at international entry / exit points throughout the country.

3.6 Disused Sealed Radiation Sources (DSRS)

Once a radioactive source becomes disused for its intended purpose, the risk of being used for unintended purposes increases if discarded as normal waste and may lead to harm to the public and the environment.

As per regulatory requirements, licensee is bound to return the DSRS having half-life or initial activity greater than a defined value. All other DSRS are stored in designated radioactive waste storage facilities located at PINSTECH (Islamabad) and KANUPP (Karachi).

PNRA ensures that licensee establishes proper arrangements for waste management through implementation of its regulatory requirements.

During 2024, more than 35 disposal authorizations were issued by PNRA.

3.7 Occupational Exposure

PNRA is maintaining a National Dose Registry (NDR) of occupational exposure to radiation workers. The NDR is utilized to observe exposure trends and assess effectiveness of radiation protection programs & implementation of ALARA plans. The NDR enables PNRA to identify the itinerant workers and retrieval of dose records. Currently, the NDR has exposure record of about 15000 radiation workers working in various types of radiation facilities.

Distribution of workers in different radiation facilities is shown in Figure 27.

During 2024, arround 98% of radiation workers received dose less than 5 mSv whereas a small fraction (0.01%) of the workers received more than 20 mSv.

Figure 28 reflects overall occupational exposure of radiation workers in different dose ranges.

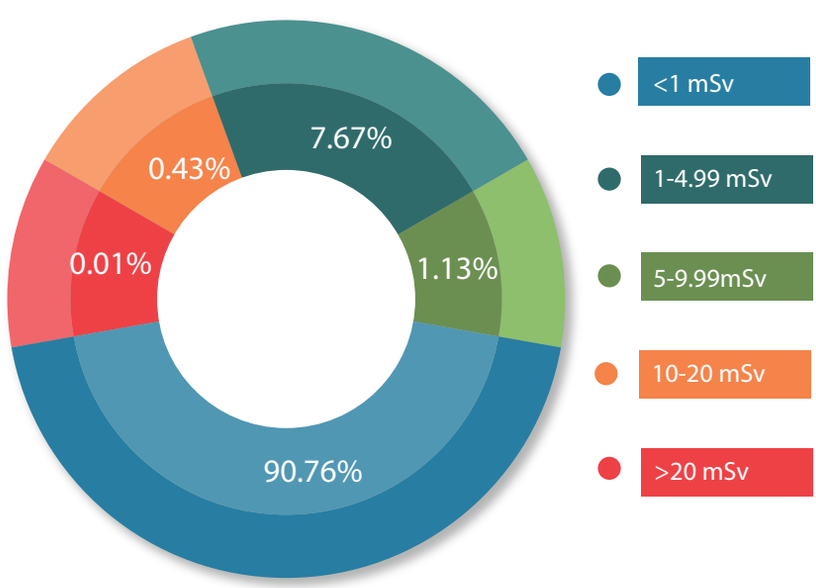
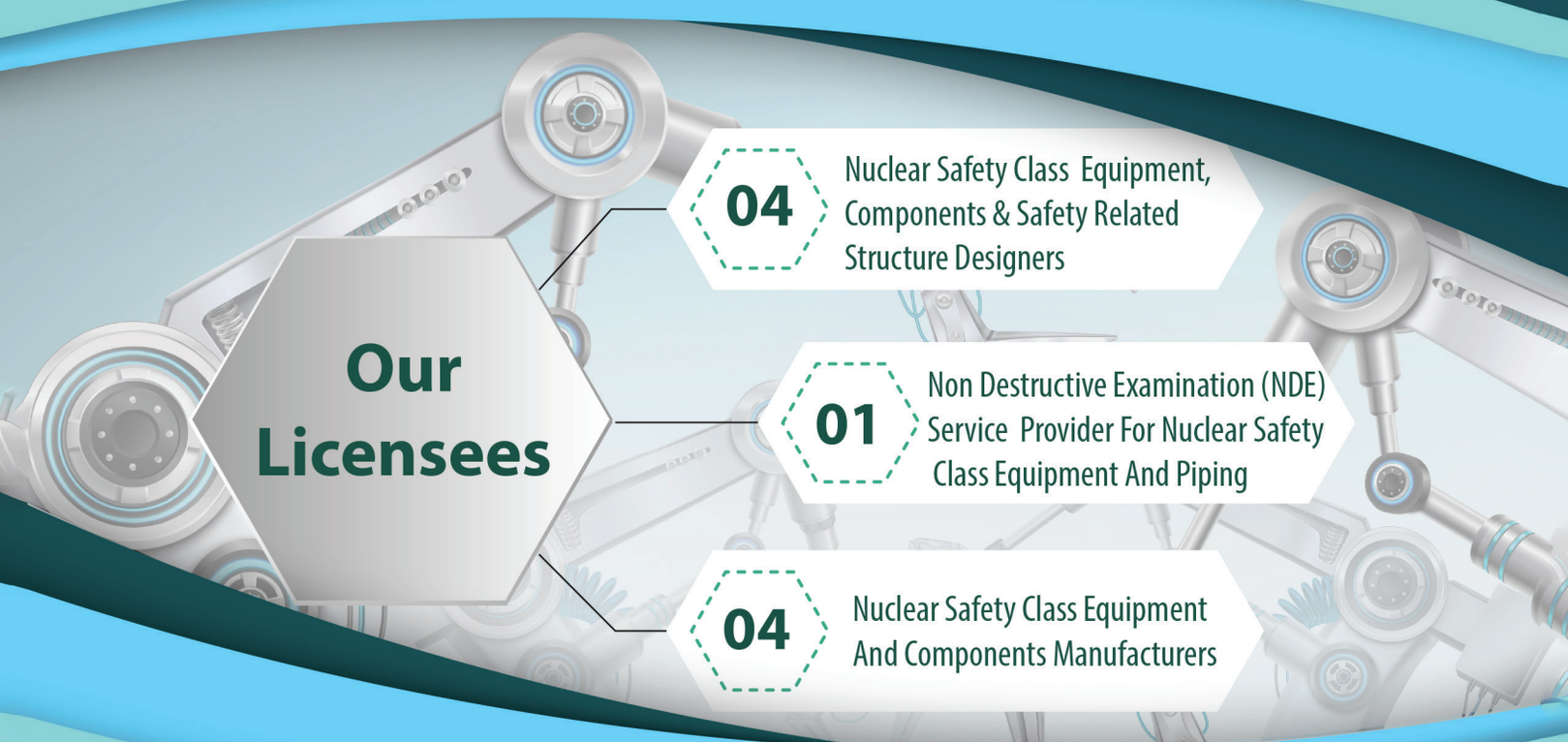


Figure 28: Statistics of Doses Received by Radiation Workers during 2024

04 Regulating Manufacturers, Designers and Service Providers



Pursuant to PNRA Ordinance 2001, PNRA grants license or authorization, as the case may be, to the organizations involved in the activities like design, manufacturing and service providers to nuclear installations and radiation facilities. To obtain such license/authorization, organizations involved in the design and manufacturing of nuclear safety-related structures, systems and components, as well as service providers, are required to possess necessary knowledge, technical expertise, supporting infrastructure and an effective management system to carry out their functions in compliance with the regulatory requirements.

In this regard, relevant PNRA regulations specify the regulatory requirements for various submissions, demonstration of capabilities, processes and demonstration of effectiveness of management system as part of the licensing application. Upon successful completion of regulatory processes and confirmation that the applicant meets all regulatory requirements, PNRA issues licenses to manufacturers and designers of Nuclear Safety Class (NSC) structures, systems and components. Additionally, PNRA also certifies the design of fresh and spent nuclear fuel casks and transport packages.

Furthermore, regulatory inspections of the activities performed under the license/ certification are also carried out by PNRA to verify compliance with the regulatory requirements, license/authorization/certification conditions and applicable codes & standards.

4.1 Designers of Safety Related Structures, Equipment and Instrumentation and Control (I&C) Systems

So far, PNRA has licensed the following three organizations for the designing of equipment, systems and structures under their respective domains:

i. Heavy Mechanical Complex-3 (HMC-3) to design nuclear safety class-3 equipment;

ii. Instrumentation Control & Computer Complex (ICCC) to design safety class analogue instrumentation and control (I&C) systems for research reactors; and

iii. Works and Services Organizations (WASO) to design nuclear safety related structures.

NEW-1 submitted an application for obtaining license as a designer for safety class-3 mechanical equipment and components. Review of design documents, quality assurance inspection of the licensing process and demonstration of design capabilities has been completed. After fulfilling related regulatory requirements, PNRA has awarded license to NEW-1 for the design of safety class-3 equipment.

In 2024, design documents of eight safety class-3 equipment of PARR-3 submitted by HMC-3 were reviewed and approved. Furthermore, seven design documents of safety systems for PARR-3 submitted by ICCC are under review, while one design package was approved after the review process.

During 2024, HMC-3 application for obtaining license as a designer of safety class-1 equipment and components remained under review at PNRA.

4.2 Manufacturers of Safety Class Equipment

HMC-3, Taxila and NOVEL Engineering Works-2 (NEW-2), Karachi are licensed by PNRA as manufacturers of NSC-1 equipment and components while ICCC is licensed to manufacture analogue safety I&C equipment for research reactors. During reporting period, two applications of ICCC on scope enhancement in manufacturing license i.e., “Manufacturing of analogue safety class I&C equipment for NPPs” and “Manufacturing of In-core Detector Assemblies of KNPGS” received which are under review.

In addition, after completion of review of documents submitted as per PAK/907, subsequent inspection of selected control points of mock-up equipment and on completion of all pre-requistes & regulatory requirement, PNRA awarded manufacturing license to NEW-1.

According to the license condition, licensee submits Quality Plans describing various steps of equipment manufacturing for selection of control points by PNRA. The control point inspections are conducted to verify compliance with the regulatory requirements. Figure 29 shows the statistics of inspections performed at NSC equipment manufacturers and service providers.

4.3 Service Providers to Nuclear Installations and Radiation Facilities

PNRA awards authorization to service providers for conducting activities such as Non-Destructive Examination (NDE) of NSC equipment, repair and replacement, maintenance and testing of radiation apparatus, dosimetry services, and calibration, etc. National Centre for Non-Destructive Testing (NCNDT) has been authorized by PNRA to provide non-destructive examination (NDE) services to nuclear industry in Pakistan. The authorization issued to NCNDT is valid till December 2025.

During the reporting year, China Nuclear Power Operation Technology Corporation (CNPO) Ltd., submitted application to perform NDE activities at nuclear power plants in Pakistan. CNPO is the first foreign organization which has applied for authorization at PNRA. Further, two national organizations i.e., DTS/CNPGS and DTS/KNPGS also applied for authorization to provide NDE services to nuclear power plants in Pakistan. These applications are under review at PNRA.

NCNDT also applied for enhancement of the scope of authorization to perform NDE of

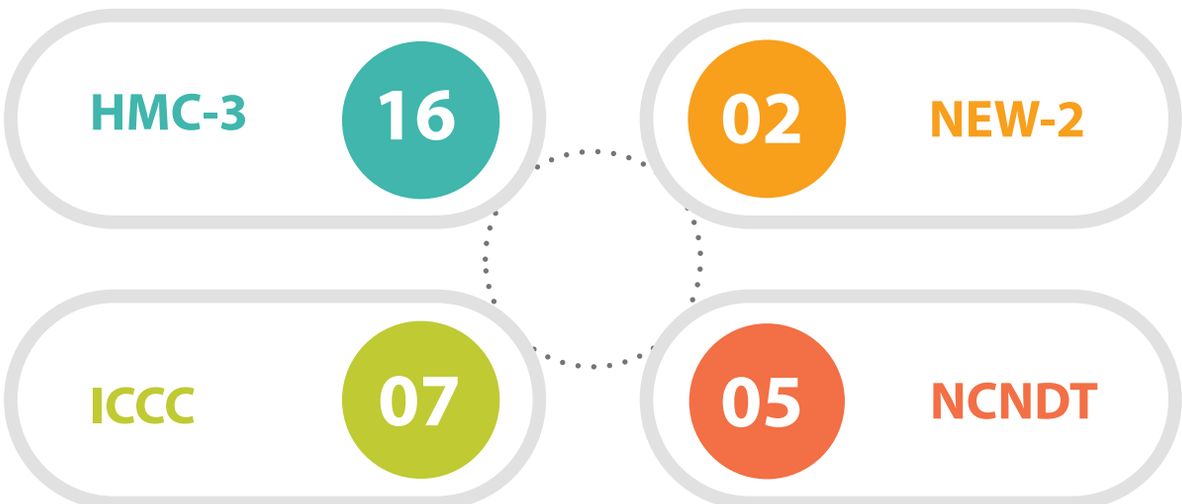


Figure 29: Inspections Performed at Nuclear Safety Class Equipment Manufacturers and Service Providers

mechanical components of nuclear islands of PWRs as per RSE-M Code which is in its final stage.

PNRA reviewed the Q-Plans of NCNDT for performing NDE at NPPs and conducted control point inspections. During the reporting period, PNRA conducted a total of five regulatory inspections during NDE activities performed by NCNDT at NPPs.

4.4 Design Certification of Casks/ Packages

4.4.1 KANUPP Spent Fuel Dry Storage Cask (SC-108)

Dry storage casks are designed and manufactured for storing the spent nuclear fuel that have completed the necessary cooling time of minimum 10 years. The design of KANUPP spent fuel dry storage cask is certified from PNRA and HMC-3 is authorized to manufacture such casks.

During the reporting period, the Design Approval Certificate for SC-108 spent fuel storage package issued to HMC-3 was revalidated after fulfillment of regulatory requirements of PAK/918. PNRA remained involved in oversight inspections for the manufacturing of these packages to verify conformance with the regulatory requirements.

4.4.2 CNPGS Spent Fuel Dry Storage Cask and Transfer Cask (SC-21 & TC-21)

The certification process of HMC-3 to design/ manufacture CNPGS Spent Fuel Dry Storage Cask and Transfer Cask (SC-21 &TC-21) has been completed and PNRA issued design approval certificate to HMC-3 upon compliance with all regulatory requirements,.

4.4.3 CNPGS Fresh Nuclear Fuel Type AF Packages

PAEC has applied for design and manufacturing of Type AF Package which is used to transport fresh nuclear fuel. PNRA has provisionally accepted the design and granted authorization to HMC-3 to start manufacturing of the prototype. The manufacturing activities of the prototype have been completed and qualification of the package is in progress.

4.4.4 Type B(U) Package with Tungsten Shielding Material

PAEC showed intention for design certification of Type B(U) package with Tungsten shielding material. In this regard, HMC-3 has submitted SAR and management system as per PAK/916. During the reporting period, PNRA completed the review of SAR & MS, and on satisfactory compliance of PNRA licensing queries by

HMC-3, the submitted design was provisionally accepted. HMC-3 was granted permission to start manufacturing of prototype package.

4.5 X-ray Baggage Scanner Manufacturer

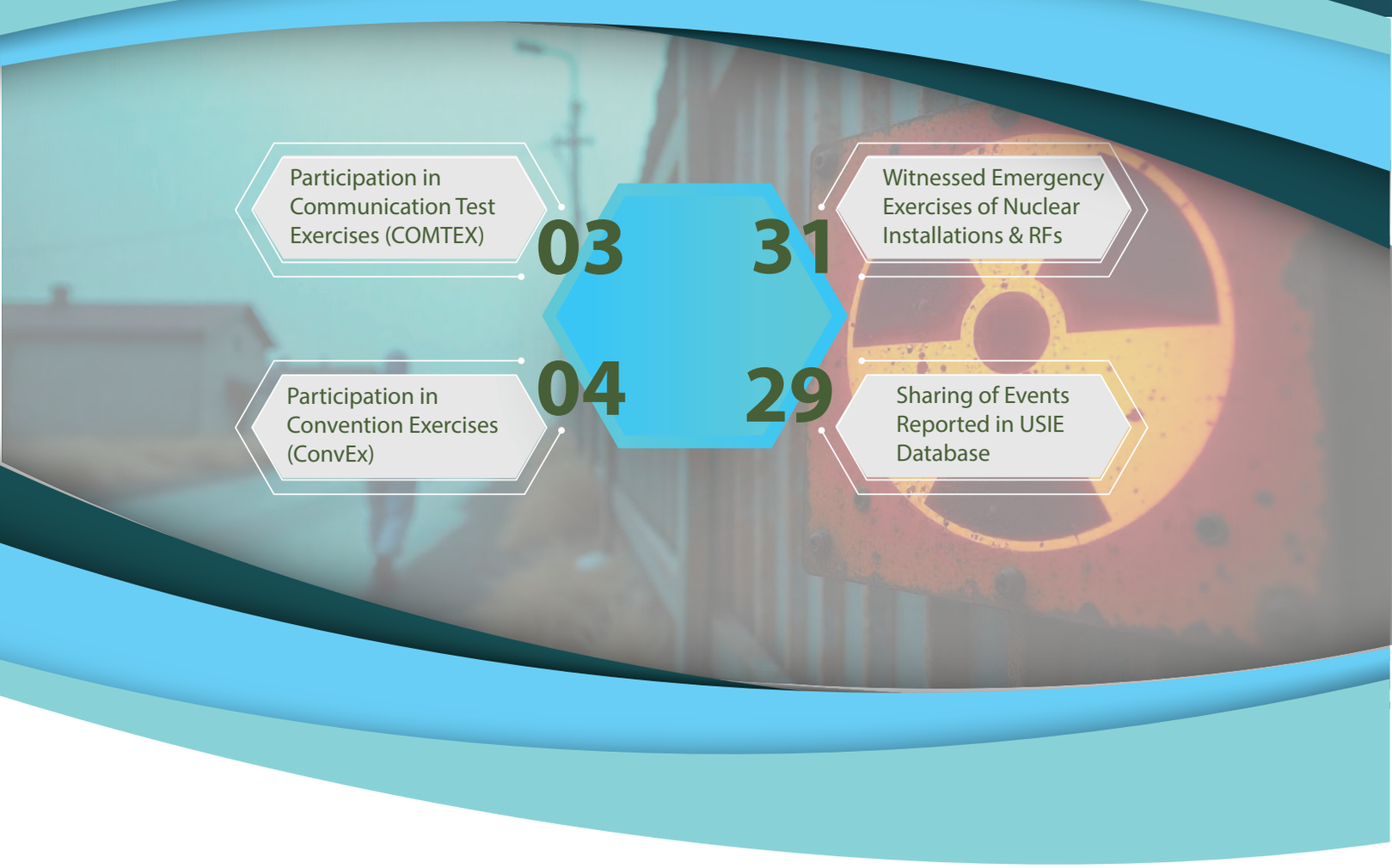
During the reporting period, application for license renewal of Defense Science and Technology Organization (DESTO) as a manufacturer of X-ray baggage scanners was reviewed and its license was renewed up to June 30, 2025.

4.6 Sealed Radioactive Sources Manufacturer

Sealed Radioactive Source Manufacturing Facility (SMF), PINSTECH is licensed by PNRA as manufacturer of sealed radioactive sources (SRS) for category 4 and below. The license is valid till December 2028. During the reporting period, PNRA reviewed the Quality Plan and conducted a control point inspection of qualification and final gamma spectrometry of Sealed Radioactive Sources (SRS). In addition, SMF, PINSTECH application for enhancement of scope of the authorization to manufacture SRS of Category 2 & 3 is also under review.

License Awarded to ICCC by Chairman PNRA in a Ceremony Held at PNRA HQs

05 Emergency Preparedness and Response



Under the PNRA Regulations on Management of Nuclear and Radiological Emergencies - PAK/914, the applicants and licensees of nuclear installations and radiation facilities are required to develop off-site and on-site emergency response plans and perform periodic emergency drills and exercises to demonstrate the effectiveness of these plans. The licensees are also responsible for implementation of the on-site emergency plans and coordinate with response authorities at the local, provincial and federal levels, as appropriate, for implementation of off-site plans. These emergency plans are required to be submitted to PNRA for approval. Apart from performing regulatory review, PNRA also conducts regulatory inspections and witnesses the drills and exercises performed by the licensees in order to ensure effective implementation of the emergency plans.

The National Radiation Emergency Plan (NREP) is in place which specifies the emergency response arrangements at national level according to which PNRA provides advice to the Government and technical support to the response organizations in implementation of protective and other response measures.

The emergency plans and implementing procedures of licensees describe measures to cope with emergency situations. These include communication systems, response measures, protective actions and also comprise details on handling of contaminated individuals, protection of public, restrictions to avoid the spread of contamination and other long-term safety actions.

During the reporting period, PNRA approved two emergency response plans for nuclear installations and six emergency plans for radiation facilities and activities, such as irradiators, hospitals, industrial radiography facilities, etc. Furthermore, PNRA also witnessed six emergency exercises conducted by nuclear installations and 25 emergency exercises by radiation facilities.

5.1. National Radiation Emergency Coordination Centre (NRECC)

PNRA has established a National Radiation Emergency Coordination Centre (NRECC) at its headquarters in Islamabad which operates continuously to fulfill the requirements of PNRA Ordinance and obligations under international conventions.

NRECC is responsible for coordination with licensees, response organizations, and the IAEA for notification of an emergency, sharing of related information, assessment of emergency consequences and providing technical advice in the case of a nuclear or radiological emergency.

NRECC is maintaining eight radiation monitoring teams (RMTs) which are equipped with redundant means of communication, radiation detection equipment, personal effective equipment and Mobile Radiological Monitoring Labs (MRMLs) stationed at PNRA offices across the country to monitor radiation levels in the field in case of a radiation emergency.

PNRA emergency response plan for nuclear and radiological emergencies outlines PNRA's actions in case of a nuclear or radiological emergency. A number of drills and exercises, including those for the Mobile Radiation Monitoring Laboratory (MRML), Communication Test Exercises (COMTEX), IAEA ConvEx Exercises, PNRA-level exercises and national exercises are carried out to evaluate the efficacy of this response plan.

PNRA regularly takes part in international exercises known as Convention Exercises (ConvEx) to evaluate the operational readiness of the resources and capabilities that are identified at the national level in accordance with Convention on Early Notification of a Nuclear Accident and Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency. During the reporting period, PNRA participated in four ConvEx exercises. In April 2024, Pakistan Nuclear Regulatory Authority (PNRA) hosted official visit of Director of the Incident Emergency Centre (IEC), IAEA who visited the state of the art National Radiation Emergency Coordination Centre (NRECC) at PNRA HQ Islamabad. The NRECC was

Group Photo of IEC Director and PNRA Representatives at PNRA HQ

Celebration of Pakistan Independence Day at PNRA HQs

EID Festival Celebrations at PNRA HQs

Group Photo During Women in Nuclear Safety and Security Event

Address of Chairman PNRA on the occasion of PNRA Day

Inauguration of Officers Hostel D-18, Islamabad

PNRA Annual Program on Milad Un Nabi (S.A.W)

Award of Medal for best R&D work

Health Awareness Session Arranged at PNRA HQs

Member (Executive) Presenting Trophy to Winner of Badminton

Member (Corporate) Presenting Trophy to Winner of Table Tennis

Inauguration of Golra Hostel, Islamabad

Inauguration of IAEA Collaboration Center by DDG NS IAEA

inaugurated last year by the Director General of IAEA. During the visit, Director IEC discussed several areas for cooperation including the hosting of a ConvEx-2C by Pakistan during 2024, conduct of national training courses and deployment of emerging technologies such as virtual reality and artificial intelligence in emergency preparedness and response.

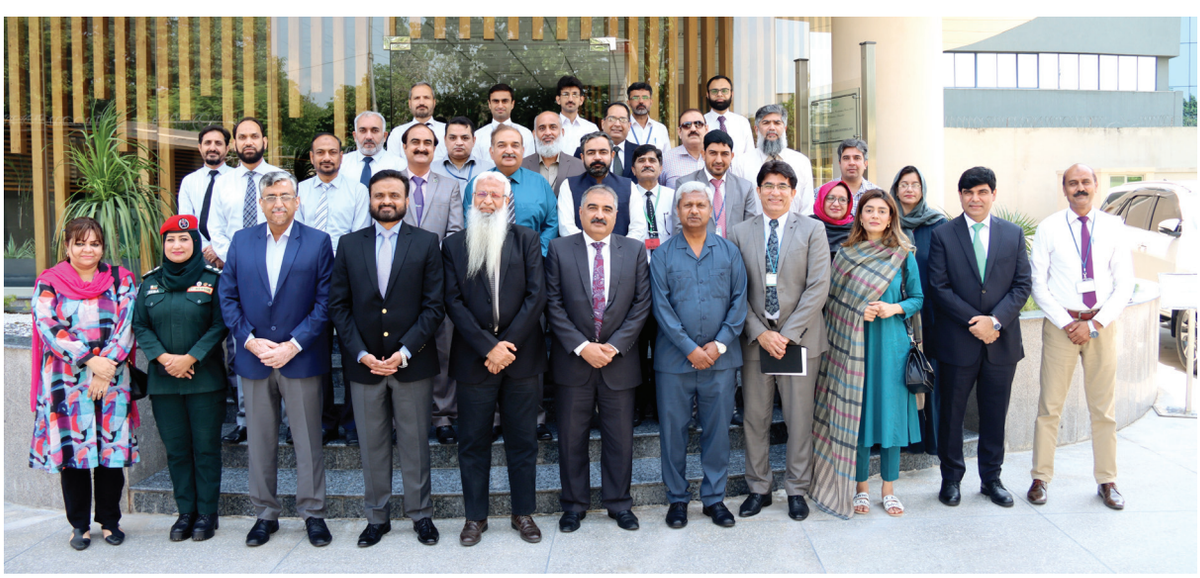
Consequently, in October 2024, Pakistan hosted the ConvEx-2c exercise based on a nuclear accident with transnational implications. The objective of convEx-2c was to test national and international arrangements in Pakistan in response to a transnational emergency. This exercise was participated by 47 other IAEA Member States and two international response organizations.

IAEA also conducts Emergency Preparedness Review (EPREV) Mission of Host States to review nuclear and radiological emergency preparedness arrangements and capabilities against the IAEA safety standards. On similar lines, a national-level EPREV Mission was conducted in September 2024. The objective of this mission was to review emergency preparedness and response arrangements and capabilities at national level against IAEA safety standards on emergency preparedness and response. The participating organizations were PAEC, SPD, NDMA, Federal Board of Revenue, Ministry of Foreign Affairs, Ministry of Information & Broadcasting, Rescue 1122, NH&MP, PDMA (Punjab), DDMA (Mianwali), etc.

11 exercises were conducted in 2024 by using Mobile Radiation Monitoring Labs (MRML) as part of the exercise calendar to assess the preparedness of Radiation Monitoring Teams (RMTs) for field operations and deployment. In addition, three Communication Test Exercises (COMTEX) were held to evaluate the accessibility and operability of authorized communication channels between PNRA headquarters, regional directorates, inspectorates, licensed nuclear installations and other pertinent national response agencies. PNRA also assisted other national organisations in enhancing their emergency response capacities by purchasing equipment and providing trainings on the use of these equipment.

NRECC coordinated and played a lead role in the conduct of a two-day National Radiation Emergency Exercise (NREE-2024) held in October 2024 based on a hypothetical scenario of a nuclear power plant accident. All the relevant organizations from Federal, Provincial and local level contributed in this exercise according to their roles and responsibilities defined in national radiation emergency plan (NREP). A mock press briefing including representatives from PNRA, PAEC and NDMA was also conducted to test the public communication arrangements. The exercise was also observed by an international observer.

During the reporting year, officials from IEC, IAEA and other national organizations also visited NRECC to understand the role and working of



Representatives of Different National Organizations Participated in NREE-2024

the centre. The main functions of NRECC are shown in Figure 30.

5.2. Participation in IAEA's Response and Assistance Network

A Response and Assistance Network (RANET) has been established by the IAEA in accordance with the International Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. This network is used to organize international assistance to and from its member states in the event of a nuclear or radiological emergency. Being the state Party to the Convention, Pakistan has also registered its National Assistance Capabilities (NAC) in seven functional areas of RANET. The platform of RANET was tested during IAEA ConvEx-2c conducted in October 2024.

5.3. Sharing of Information about Events Involving Ionizing Radiation

IAEA Member States are obligated to report any nuclear or radiological emergency with transboundary implications in accordance with the Convention on Early Notification of a Nuclear Accident. Even in cases when radiation-related incidents do not have transboundary repercussions, Member States are encouraged under the Convention to report such events to the IAEA and other state organizations.

Information about 29 worldwide events were received and disseminated to pertinent national stakeholders during the reporting period. These incidents involved events of radiation over-exposure for the general public or employees, the theft or loss of radiation sources, the spread of radioactive contamination, equipment failure, etc. Similarly, events related to nuclear or radiological emergencies in Pakistan are also reported to IAEA on voluntary basis, as and when occur. Reporting of an event is based on its classification on a Scale, known as International Nuclear and Radiological Event Scale (INES) which serves as a tool for communicating the safety significance of nuclear and radiological events. The INES scale is divided into eight levels, ranging from 0 to 7, measuring the events on the basis of their safety significance.

5.4. Reporting of Radioactive Source Movement

The radioactive sources used in nuclear medicine and industrial radiography are routinely transported from one place to another in the country. PNRA is responsible to regulate the transportation of radioactive sources in the country. To avoid any possible incident during transportation, PNRA ensures that strict safety and security procedures are in place throughout the movement of these sources. The licensees are required to notify NRECC in advance of any movement of radioactive materials in the country. PNRA also conducts inspections during the transport of such sources to confirm compliance with safety and security requirements and to ensure timely response by initiating prompt action in case of any event.

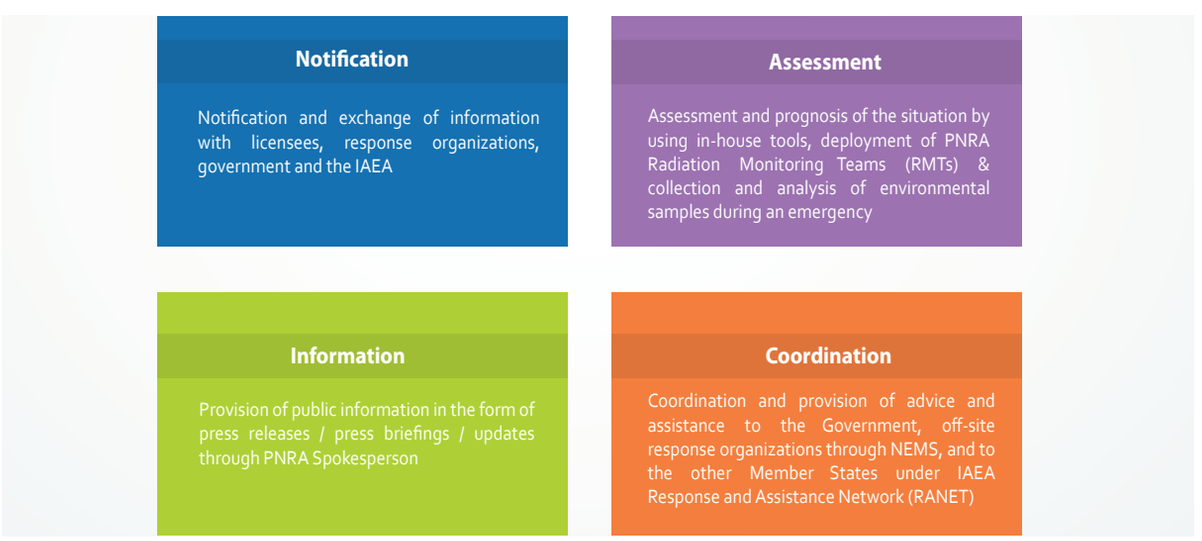
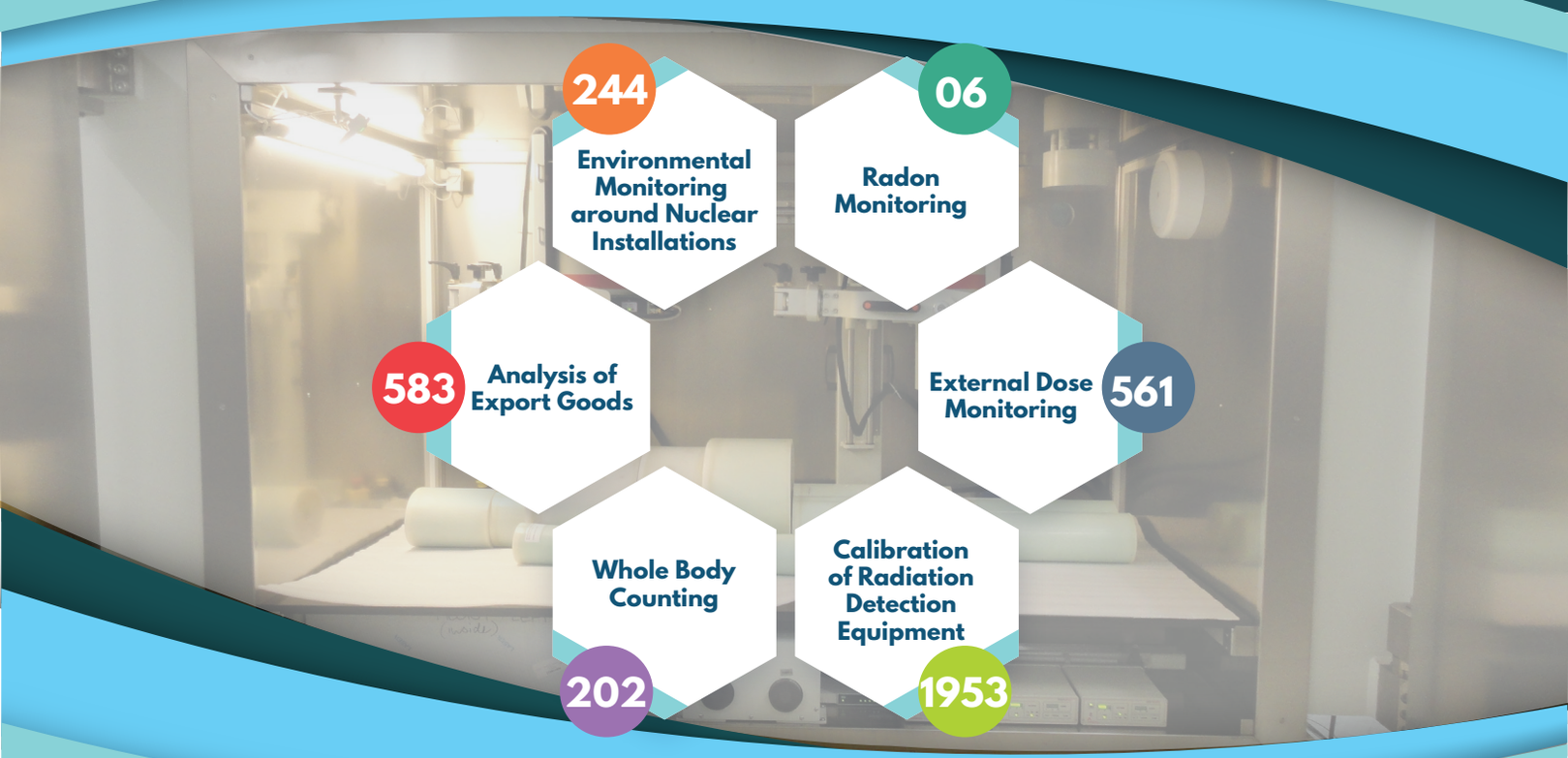


Figure 30: Main Functions of NRECC

06 Environmental Monitoring and Dosimetry



The applications of radiation in fields such as medicine, industry, and research are invaluable for improving the quality of life. However, radiation also poses potential risks to the public health and the environment, requiring stringent oversight. To monitor the radiation levels and associated risks, PNRA has established the Environmental Monitoring and Dosimetry (EM&D) laboratories as part of its internal TSO. These laboratories play a significant role in PNRA's commitment to ensuring public health and the environment from ionizing radiation.

EM&D laboratories are equipped with specialized equipment that ensure precise radiation dose measurements for workers and the public, ensuring compliance with regulatory limits. Further, they provide critical data to validate environmental surveillance around nuclear installations and other radiation-prone areas.

By delivering precise, reliable assessments of both external and internal radiation exposure, EM&D laboratories enhance PNRA's ability to enforce radiation safety regulations and ensure radiation protection across the country. The following sections provide detailed insights into EM&D's activities during the year 2024.

6.1 Monitoring of Radioactivity in the Environment

Radioactivity is present everywhere in the environment and all living organisms are continuously exposed to radiation from both natural and man-made sources. PNRA is monitoring the radioactivity level around/at NPPs, RRs, disposal facility, potential NORM industries, workplaces and air monitoring at different locations in the country to ensure safety of the people and the environment from ionizing radiation. Various radio analytical techniques such as gamma spectrometry, gross alpha-beta counting, and liquid scintillation counting are utilized to measure the concentration of potential radionuclides and estimate public and worker exposure. The major activities undertaken in this regard are detailed in the following subsections.

6.1.1 Environmental Monitoring around Nuclear Installations

Nuclear installations, during normal operations, are allowed to discharge gaseous and liquid radioactive effluents within the limits specified in the approved technical specifications. The discharges are carefully controlled to be within the prescribed limits in order to ensure protection of the workers, the public and the environment from harmful effects of ionizing radiation. The licensee of nuclear installations is responsible for conducting environmental monitoring around its installation and submitting the results to PNRA. In turn, PNRA evaluates these results and also conducts independent environmental surveillance through a confirmatory programme to verify the results. This dual-layered approach ensures that radioactive discharges from nuclear facilities do not compromise public health and environmental safety.

In 2024, PNRA collected and analysed 93 environmental samples, including samples from soil, water, air, vegetation, and food from the vicinity of CNPGS, KNPGS, KDP, PARR-1 and PARR-2. The results confirmed that the operational and decommissioning activities of these facilities do not pose radiological risks to the local population.

In addition, PNRA has installed High and Low Volume Air Samplers (HVAS and LVAS) at nuclear installations and other locations like Multan and Peshawar to monitor levels of airborne radioactive particulates. During this year, 118 samples were collected from these air samplers and analysed. The analysis results revealed that no anthropogenic radionuclides were present in the air samples.

6.1.2 Pre-operational Environmental Monitoring around Near Surface Disposal Facility

NICE is a near-surface disposal facility for low-level radioactive waste (LLW) planned to be developed by the Pakistan Atomic Energy Commission (PAEC). PNRA is independently conducting pre-operational environmental radioactivity level study by analyzing different environmental samples collected from the surroundings of the facility. Accordingly, in 2024, PNRA collected 33 environmental samples, and the analysis revealed no significant radiological risks to local populations.

6.1.3 Radon Monitoring

Naturally occurring Radon can be accumulated

Briefing in Sample Processing Laboratory

in enclosed spaces with the potential for radiation exposure to the individuals posing health hazard. Accordingly, radon monitoring of such places is important. PNRA periodically conducts Radon monitoring surveys at such places. This year, surveys were conducted in the basements of six shopping malls in Rawalpindi and Islamabad. The results showed that radon levels were well below the regulatory limit of 1000 Bq/m^3.

6.2 Assessment of Naturally Occurring Radioactive Material (NORM) at Potential Industrial Sector

NORM exists in varying concentrations in the Earth's crust. Industrial activities such as oil and gas production, coal combustion, and mining using natural materials can enhance the natural radionuclide concentrations in the NORM, potentially posing radiological risks. In order to identify corresponding radiation levels, PNRA diligently monitors and assesses the levels of radioactivity in residue/waste generated from various industrial processes in order to ensure the safety of workers, general public and the environment.

In 2024, a PNRA team visited the Port Qasim coal-fired power plant to assess NORM. A comprehensive radiation survey of the site was conducted, and samples of fly ash, bottom ash, gypsum, raw coal, soil, water, and air, were collected and analysed for potential radionuclides. The results concluded that there is no radiation hazard due to NORM and its concentration is well below the exemption levels prescribed by PNRA regulations PAK/915 (Rev.1). During the visit, a lecture on NORM accumulation due to coal combustion was also delivered to safety officials of the facility to raise their awareness on this issue.

Collection of Sludge Sample from Port Qasim CFPP

6.3 Radiation Analysis of Edible and Non-edible Export Items

PNRA issues “Radiation Analysis Certificates” for export of edible and non-edible items from Pakistan. In 2024, PNRA performed analysis of 583 samples of export items that included food and non-food items.

6.4 Dosimetry and Calibration of Radiation Detection Equipment

Radiation exposure from planned activities must comply with the specific radiation dose limits set by PNRA. To ensure these limits are not exceeded, licensees are required to provide personal dosimeters to their workers for regular dose monitoring. Along with other entities in the country, PNRA’s dosimetry laboratories also provide external dosimetry services to PNRA licensed radiation facilities. Additionally, PNRA provides calibration services to licensees through its calibration laboratories, located in Islamabad and Kundian, to ensure that their radiation monitoring equipment operates effectively with reliability and accuracy.

6.4.1 External Dosimetry Laboratories

PNRA's external dosimetry laboratories are located in Islamabad and Karachi to provide dosimetry services to radiation workers. Figure 31 depicts the statistics of 561 personal dose assessments; monitored at external dosimetry

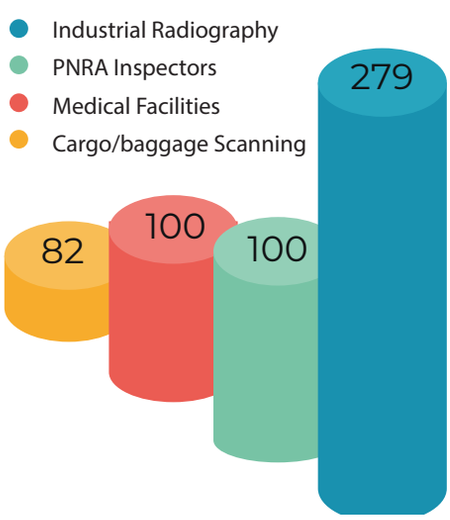


Figure 31: Statistics of External Dose Assessment performed during 2024

laboratories during 2024. The assessment results revealed variations in doses across different facilities. In the industrial and medical sector, dose ranges varied between 0.33–10.31 mSv and 0.33–8.92 mSv respectively. The dose range for workers at cargo scanners ranged from 0.24–1.03 mSv whereas for PNRA inspectors it varied between 0.52–1.43 mSv. All the recorded doses were well below the regulatory limit of 20 mSv.

6.4.2 Internal Dosimetry Laboratories

Internal Dosimetry is the assessment of radiation exposure from radioactive material that has entered into the body of radiation workers through ingestion or inhalation while performing their work. There is a significant likelihood of internal exposure at facilities where airborne radionuclides are present. Additionally, during nuclear accident or radiological emergency situations, the potential of radioactive discharges in environment increases; which can substantially elevate the risk of intake of radionuclides, to radiation workers and public. Therefore, bioassay procedures such as urine analysis, organ counting, and Whole-Body Counting (WBC) are required to determine the quantity of the intake of radioactivity and the resulting radiation dose.

PNRA has established three internal dosimetry laboratories located at Islamabad, Kundian and Karachi to monitor the internal contamination of radiation workers. During the reported period, PNRA performed internal dosimetry of radiation workers involved in handling of unsealed radioactive sources at nuclear medicine department of two public sector hospitals. The results highlighted the potential of internal exposure to radiation workers at Nuclear Medicine Centers (NMCs) emphasizing the need for routine internal dose assessment. This identification of potential exposure area serves as a critical input for strengthening regulatory oversight, with follow-up actions aimed at enhancing safety measures in collaboration with stakeholders.

Furthermore, the WBC of workers, plant personnel involved in maintenance and refueling activities at nuclear power plants and IAEA Safeguard Inspectors who visited CNPGS and KNPGS sites was performed at the PNRA laboratories located at the respective sites.

Figure 32 depicts the statistics of personnel; monitored at WBC during 2024. The WBC results revealed that no radiation worker was found internally contaminated.

6.4.3 Calibration of Radiation Detection Equipment

Accurate radiation measurement is essential for protecting radiation workers, patients, and the public, which can only be ensured by the use of properly calibrated radiation monitoring equipment. PNRA has established two Tertiary Standards Dosimetry Laboratories (TSDLs) in Islamabad and Chashma site to calibrate radiation monitoring equipment of PNRA as well as the licensees. Figure 33 depicts the statistics of RME caliberated at PNRA labortaries during the year 2024.

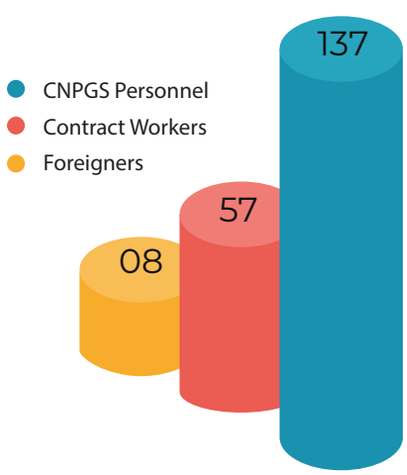


Figure 32: Breakup of Whole Body Counting Performed at PNRA

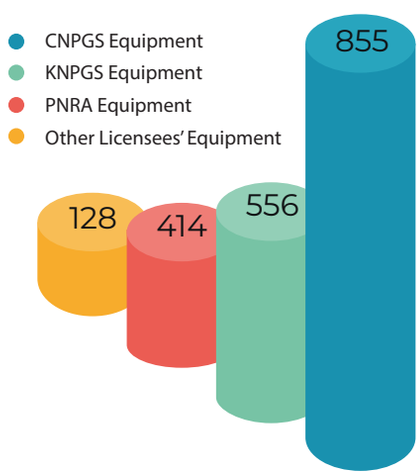
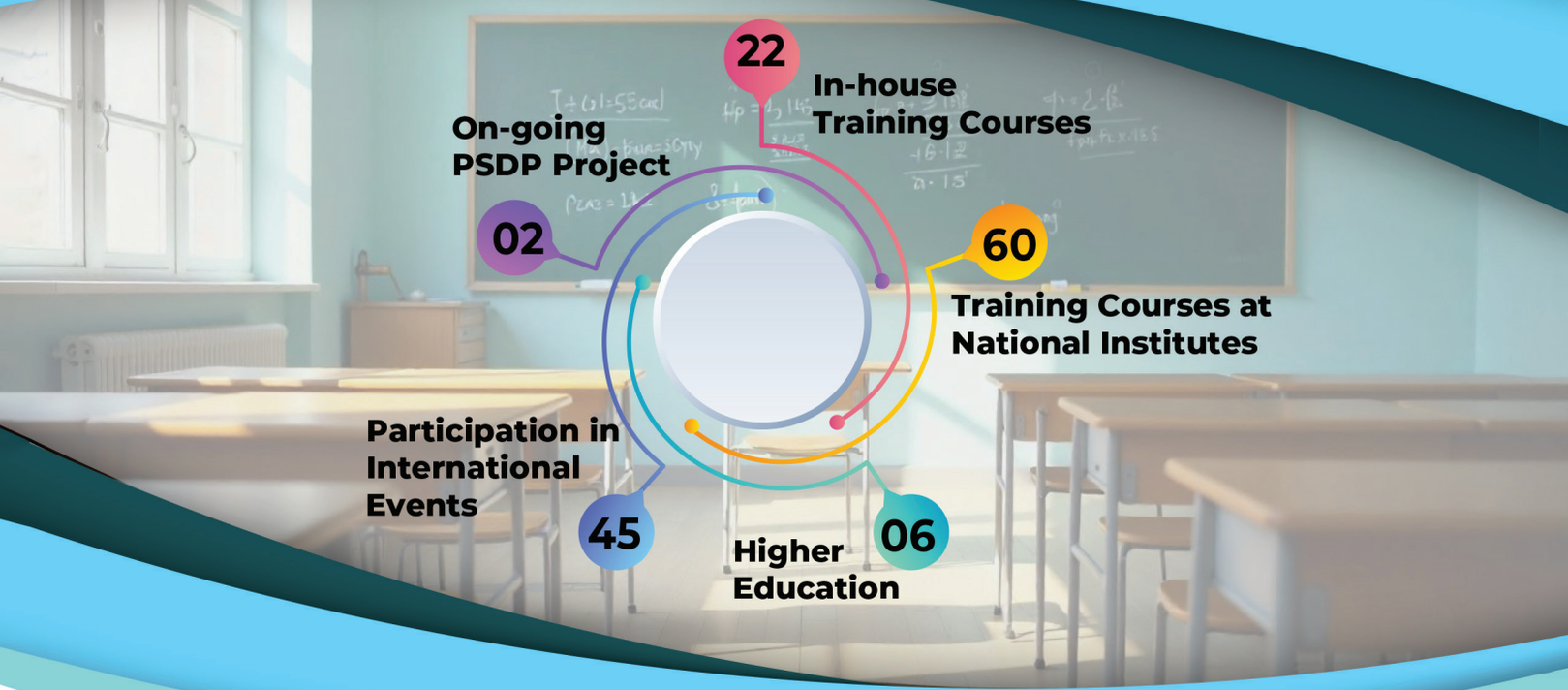


Figure 33: Statistics of RME Calibrated at PNRA

07 Capacity Building and Infrastructure Development



Competent professionals are the backbone of any organization and play a vital role in the growth, success and sustainability of the organization. PNRA recognizes this fact and places high importance on the continuous capacity building of its employees. PNRA uses a structured approach to regularly assess workforce competency, identifying gaps between current skills and evolving regulatory demands. This enables targeted actions to address specific deficiencies.

Three-pronged strategy has been introduced at PNRA for the competence development of its employees. Firstly, in-house training programmes are conducted by using PNRA resources and it is ensured that the participants receive specialized instructions tailored to the organization's immediate needs. Secondly, collaborations with national institutions is made to provide access to advanced learning opportunities in key areas of nuclear safety and radiation protection. Thirdly, international capacity-building initiatives are taken in collaboration with organizations like the International Atomic Energy Agency (IAEA) and PNRA staff is facilitated to liaise with global best practices and innovations.

Infrastructure development is equally essential for enhancing PNRA's regulatory effectiveness. The authority consistently upgrades its technical resources and systems by acquiring state-of-the-art equipment, constructing new testing laboratories, and improving its IT capabilities.

The Government's Public Sector Development Program (PSDP) serves as the primary funding source for these projects, enabling significant enhancements in the regulatory oversight of nuclear installations and radiation facilities. Recent upgrades have improved PNRA's ability to conduct real-time monitoring and proactive risk management.

This chapter outlines PNRA's strategic efforts for enhancement of capacity of workforce and infrastructure during the reported period, reinforcing its commitment to the highest standards of nuclear safety, security and regulatory oversight in Pakistan.

7.1 Competence Development through In-house Resources

To enhance and sustain the competence of its workforce by using in-house resources, PNRA established a National Institute of Safety and Security (NISAS). This institute is responsible for planning and executing training programmes for both PNRA employees and external stakeholders. NISAS is an ISO 9001:2015 certified institute, equipped with essential training aids such as laboratories, radiation detection and physical protection equipment and physical models of key components of nuclear power plants. Additionally, PNRA has established a soft-panel nuclear power plant simulator for training of inspectors. This soft panel simulator helps in the study of plant behavior during normal operations, transients and accident conditions.

The institute boasts a highly qualified faculty capable of delivering training across all regulatory domains, including nuclear safety, radiation safety, radioactive waste & transport safety, nuclear security, emergency preparedness & response, leadership and management systems and behavioral competencies.

During reported period, NISAS conducted 22 training courses in the areas of Nuclear Safety, Radiation Safety, Nuclear Security and leadership & managerial competencies. A total of 477 professionals, including 138 from PNRA and 339 from other organizations attended the training courses during the reported year. Figure 34 illustrates the number of training courses conducted at NISAS and the number of participants during 2024 and preceding years.

In Feb 2024, IAEA recognized NISAS as a collaborating center for training and technical support in the field of Nuclear Safety & Radiation Protection.

7.2 Competence Development through National Organizations

Where in-house training is not feasible, PNRA organizes training programmes for its personnel

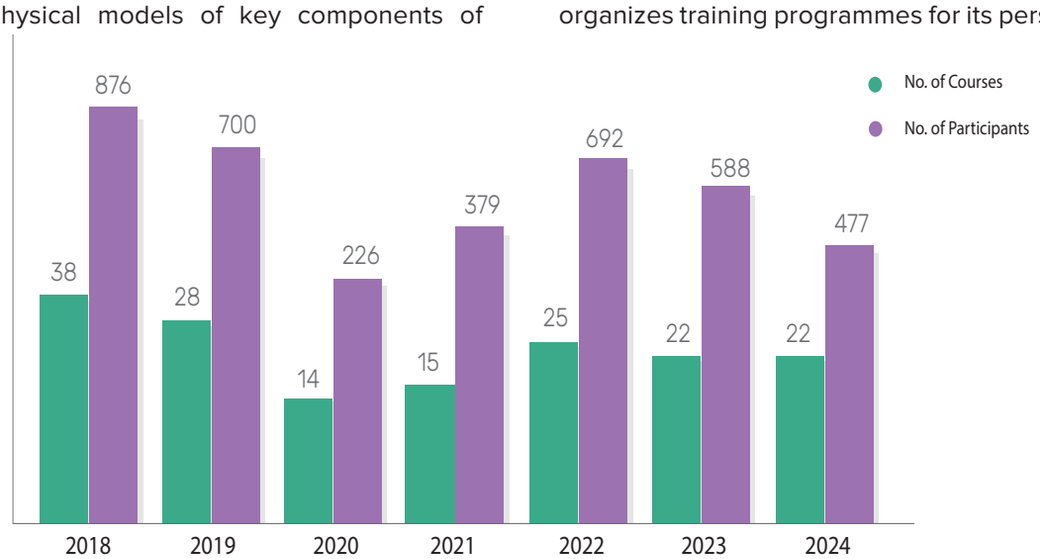


Figure 34: Statistics of Training Courses Conducted at NISAS

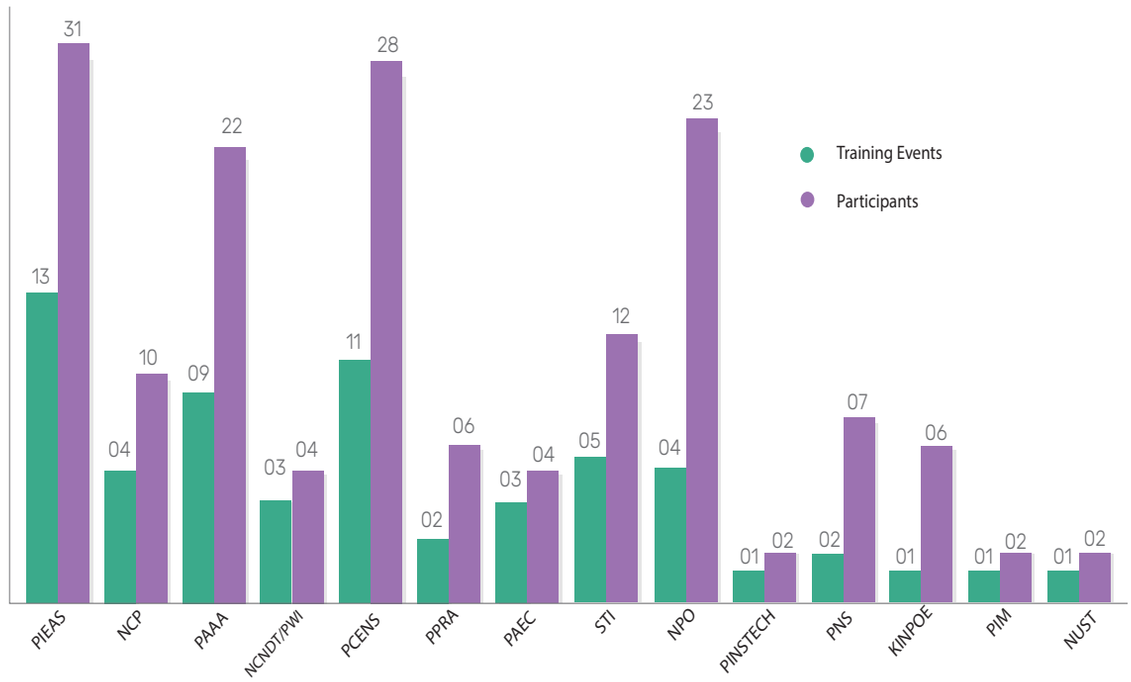


Figure 35: Statistics of Training Courses Arranged at National Institute during 2024

at reputable national universities and training institutes/organizations. PNRA is collaborating with more than 35 national institutes in this regard. The prominent among these are Pakistan Institute of Engineering and Applied Sciences (PIEAS); National Centre for Physics (NCP); Pakistan Welding Institute (PWI); National Centre for Non-Destructive Testing (NCNDT); Pakistan Institute of Management (PIM); Secretariat Training Institute (STI); Pakistan Planning and Management Institute (PPMI); Pakistan Manpower Institute (PMI); National University of Science & Technology (NUST); and Pakistan Center of Excellence in Nuclear Security (PCENS). During 2024, 159 PNRA personnel participated and benefited from 60 training opportunities arranged at various national institutes, as shown in Figure 35.

Specialized management courses are arranged at nationally reputable institutions, including Young Officers Orientation Course (YOOC) at PCENS; Senior Officers Management Course (SOMC) for middle level managers and Senior Officers Leadership Course (SOLC) for executive cadre at PIEAS University. In 2024, three PNRA officials participated in YOOC, 13 officials completed SOMC, and one officer participated in the SOLC.

Moreover, a two-day strategic management training program for senior and top management of PNRA was organized in collaboration with IBA Karachi at RNSD-II from 28-29 May, 2024. Chairman PNRA, Member (E), and all DGs participated in the course. Moreover, PNRA recruitment plan up to 2027 for emerging regulatory domains has been approved based on a knowledge loss risk assessment.

Six PNRA employees are currently pursuing their PhD programs from National and International universities. Moreover, for capacity building, two officers are on attachment at NPP sites.

PNRA has begun transforming its training approach from face to face learning to blended learning by including videos, quizzes, group activities, case studies and exercises as part of training materials. Moreover, systematic career and succession planning strategies are being developed for employees in various national universities in technical disciplines.

7.3 Competence Development through International Organizations

PNRA takes advantage of the capacity building opportunities offered by the IAEA and other international organizations for the capacity building of its employees. PNRA has also signed bilateral agreement with National Nuclear

Safety Administration (NNSA), China to enhance the capacity of its workforce. PNRA's activities in this area are described below.

a) Competence Development through IAEA

IAEA organizes training courses, workshops, fellowships, and scientific visits in the fields of nuclear safety, radiation protection, waste safety, transport safety, emergency preparedness & response and physical protection, among others, for the capacity building of its member states under its technical cooperation program. During the reporting period, 45 PNRA officials physically participated in 40 capacity building events internationally, while 18 PNRA officials virtually participated in five such events.

Moreover, under PNRA TC project PAK-9043, five national workshops were held at PNRA, during which 58 PNRA and 59 officials from other stakeholder organizations were trained. Additionally, workshops were conducted under IAEA Regional Asia and Pacific (RAS) and Inter-regional TC Projects, imparting training to 18 PNRA and 18 stakeholder officials. Furthermore, an IAEA-IPPAS national workshop was held at NISAS training institute, in which eight PNRA and 14 stakeholders' personnel participated.

7.4 Infrastructure Development through Public Sector Development Programme (PSDP) Projects

The Public Sector Development programme (PSDP) projects have played a crucial role in strengthening the regulatory infrastructure of the Pakistan Nuclear Regulatory Authority (PNRA). These initiatives have been the lifeblood of PNRA's mission to ensure the safe and secure use of ionizing radiation in Pakistan.

Since its inception, PNRA has successfully completed 11 projects sponsored through the Public Sector Development Programme (PSDP) of the Government of Pakistan. These projects were focused on establishing regulatory infrastructure, enhancing the regulatory framework, improving safety measures, and upgrading the technical capabilities of PNRA. The funding has also facilitated the acquisition of state-of-the-art equipment, assessment and analysis software, standards, advanced monitoring systems, and specialized trainings. This has significantly enhanced PNRA's ability to effectively inspect, monitor, assess, analyze and regulate nuclear and radiation facilities and activities in Pakistan.

IBA Strategic Management Course

Workshop on Process for Communication with Interested Parties, Building Confidence and Effective Public Participation in Decision Making

a) Establishment of Regional Nuclear Safety Inspectorate at Lahore

Lahore and its suburban areas are home to a significant number of licensed radiation facilities. Moreover, radioactive sources are routinely transported in the area for field applications from the licensed premises to different operating sites. Similarly, import and export of goods through Wagah border, the Lahore and Sialkot dry-ports need vigilant monitoring in collaboration with Pakistan Customs to detect and control any ingress of unauthorized and illicit nuclear or radioactive material or contaminated goods into Pakistan. In the event of a nuclear or radiological emergency, PNRA is responsible for providing immediate response and technical assistance. Currently, all regulatory, coordination and response activities pertaining to Lahore and its suburbs are handled by PNRA Regional office at Chashma, Mianwali, which is quite challenging due to the distance involved. To further strengthen its regulatory oversight, coordination and response, PNRA is establishing a regional inspectorate in Lahore under the Federal PSDP funded project titled “Establishment of Regional Nuclear Safety Inspectorate at Lahore”. The project is anticipated to be completed by the end of Financial Year 2024-25.

b) Installation of On-Grid Solar System at PNRA Buildings

As part of PNRA's commitment to sustainable energy, this project aims to reduce electricity costs by transitioning to green energy sources. To achieve this objective, installation of on-grid solar system, with a total capacity of ~386.1 kWe has been proposed for various PNRA buildings located in different cities of Pakistan. In the first phase, solarization of PNRA Islamabad HQs (main building) with capacity of ~80 kWe has been completed, while solarization of remaining PNRA buildings with a total capacity of ~306.1 kWe is expected to be completed during the on-going Financial Year subject to provision of complete funding by the Government during the financial year 2024-25.

Through these comprehensive efforts in capacity building and infrastructure development, PNRA reaffirms its commitment to advancing nuclear safety, security, and regulatory oversight in Pakistan.

08 Research and Development

Under the PNRA Ordinance, PNRA conducts regulatory Research & Development (R&D) activities to improve regulatory processes, complement the regulatory framework, support regulatory decisions and prepare for challenges associated with regulating emerging technologies. While conducting R&D, PNRA keeps itself abreast with continuously evolving knowledge and aligns its regulatory framework and processes in line with international practice to enhance its effectiveness and efficiency.

During the reporting period, PNRA conducted various R&D activities focused on nuclear safety, radiation safety, security and environmental monitoring. The details of these research activities are presented in the subsequent sections.

This chapter outlines R&D activities carried out by PNRA during the year 2024.

8.1 PNRA Research and Development Projects

In 2024, PNRA continued working on 21 ongoing research projects, of which seven have been completed. Furthermore, PNRA initiated three

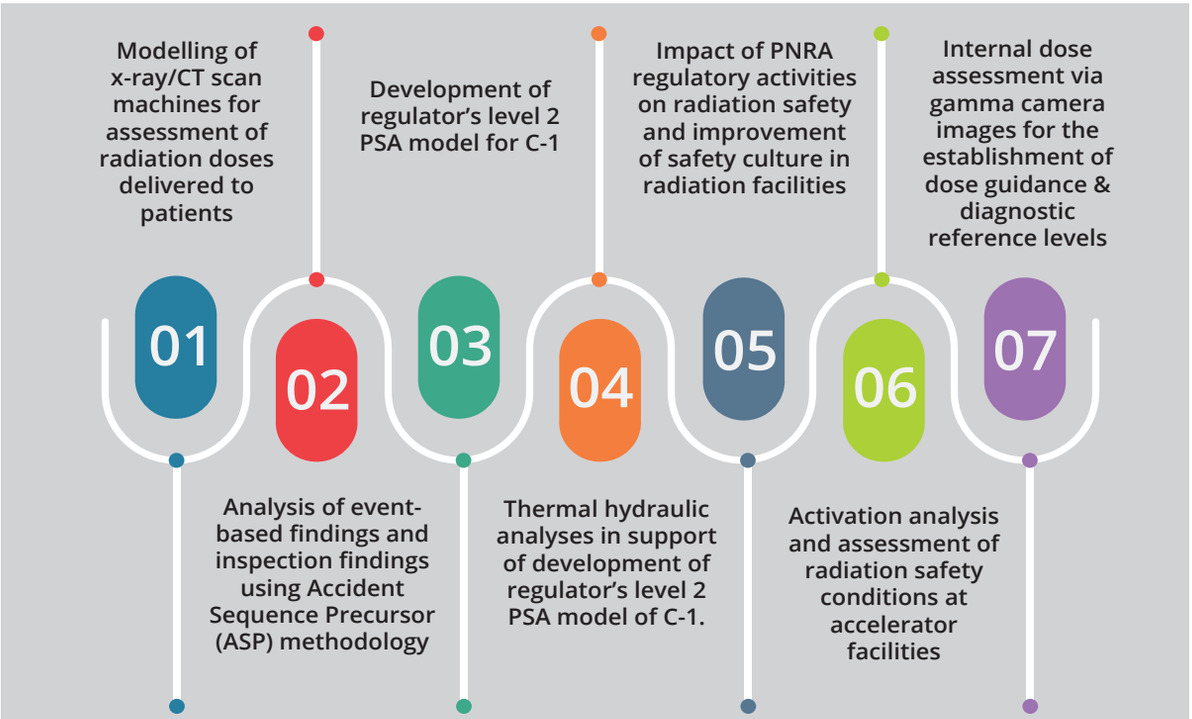


Figure 36: Completed PNRA R&D Projects in year 2024

new projects to implement new technologies such as the use of Artificial Intelligence (AI) in regulatory processes, development of integrated and flexible dynamic component library and an enhanced risk assessment platform for sensitivity & uncertainty analysis. The ongoing R&D projects are listed in Table-1 and completed projects are represented in Figure 36.

8.2 IAEA Coordinated Research Projects (CRPs)

Apart from carrying out the research and development activities described above, PNRA also actively participates in IAEA Coordinated Research Projects (CRPs) aimed to support Member States in research and development activities.

PNRA is currently participating in the following two IAEA Coordinated Research Projects (CRPs);

i. The first CRP is titled "Advancing the Maintenance, Repair, and Calibration of Radiation Detection Equipment" in which PNRA has been actively contributing since 2020. The objectives of this CRP includes: developing technical documents that outlines the requirements of hardware and software tools, designs, developing technical specifications of nuclear security equipment, creating training materials for maintenance; repair, calibration of radiation detection equipment and identifying approaches for sustainability of radiation detection equipment used for nuclear security.

   By the end of 2024, the outcomes of CRP included: trend analysis in accordance with Component Fault Frequency Assessment (CFFA) and Operational Baseline Assessment (OBA) of various hand-held radiation detection equipment through a comprehensive study of failure rates during life-cycle operation and beyond design life, integration of Radiation Portal Monitor and Non-Intrusive Inspection (NII) System at the Port of Karachi, development of sustainability program for PNRA Radiation Detection Equipment and design of a conceptual approach for National Nuclear Detection Architecture (NNDA) training facility in Pakistan.

ii. PNRA is also contributing to the project aimed at enhancing of the use and sustainability of nuclear detection technologies for detection of nuclear & other radioactive materials along with other contraband items, under a three-years IAEA CRP on "Facilitation of Safe and Secure Trade Using Nuclear Detection Technology" since 2023. The objectives

S. No.	Project
1	Development of methodology to perform multi-unit PSA and analysis of specific scenarios to quantify risk at CNPGS site
2	Assessment of cosmic radiation dose for a cabin crew during flight operation
3	Analysis of calibration factors and long-term stability of radiation survey meters and Electronic Pocket Dosimeters (EPDs)
4	Assessment of radionuclides from coal-fired brick kilns in Rawalpindi and Islamabad regions and the consequent hazards on human health and the environment
5	Assessment and evaluation of cyber security risks of physical protection systems
6	Evaluation and enhancement of national nuclear security detection architecture
7	Analysis of Access Control Systems (ACS) for nuclear installations and way forward for the development of acceptance criteria for the approval of physical protection program in accordance with regulatory requirements
8	Validation of severe accident analysis model with k-2/k-3 Full Scope Training Simulator (FSTS)
9	Non-linear fracture assessment of plastic materials
10	Identification of vital areas of nuclear power plants to prevent or reduce the likelihood of sabotage by using PSA methodology
11	Total Harmonic Distortion (THD) assessment and its impact on critical components
12	Study of updated requirements related to Stress Corrosion Cracking (SCC) in the light of Operating Experience Feedback (OEF) and its utilization in future reviews of Nuclear Power Plants (NPPs)
13	Gap analysis in PNRA regulatory framework based on advancements in requirements/international practices for regulatory oversight of Motor Operated Valves (MOVs)
14	Assessment of differences in safety criteria of updated industrial codes and standards applicable to design and safety criteria of NPPs for its effective utilization in licensing of future NPPs
15	Modelling of X-ray-CT scan machines for assessment of radiation doses delivered to patients
16	Analysis of event-based findings and inspection findings using Accident Sequence Precursor (ASP) methodology
17	Development of regulator's level 2 PSA model for C-1 NPP
18	Internal dose assessment via gamma camera images for the establishment of dose guidance & diagnostic reference levels
19	Activation analysis and assessment of radiation safety conditions at accelerator facilities
20	Impact of PNRA regulatory activities on radiation safety and improvement of safety culture in radiation facilities
21	Thermal hydraulic analyses in support of development of regulator's level 2 PSA model of C-1

Table 1: List of ongoing PNRA R&D Projects in 2024

of the CRP are to develop methods and techniques for radiation alarm assessment through performance monitoring, determine pathways for integrated solution of radiation detection system with other contraband system and assess the impact of shielding and masking on contraband detection. During the year 2024, activities related to data collection and assessment concerning containerized cargo have been conducted at seaports and some land border crossings in Pakistan.

8.3 Research Collaboration with National Institutes and International Organizations

PNRA expanded its collaboration with national & international Institutes/organizations to enhance joint research and development in the

areas of mutual interest in the year 2024. PNRA collaborated with National Centre for Physics (NCP), Standing Committee on Scientific & Technological Cooperation (COMSTECH), Institute of SPACE Technology (IST), National University of Science & Technology (NUST), Pakistan Academy of Sciences (PAS) and Pakistan Science Foundation (PSF) for knowledge exchange, expertise development and joint R&D activities. In addition, efforts are underway for collaboration with the Chinese regulatory body National Nuclear Safety Administration (NNSA) and its TSO Nuclear Safety Center (NSC) for joint R&D. Currently; PNRA is collaborating with PIEAES and NCP in following projects.

i. PNRA-PIEAS pilot project on cold immobilization of incinerator ash

ii. PNRA-NCP joint activity of activation analysis and assessment of radiation safety conditions at accelerator facility

8.4 Publications

PNRA promotes R&D activities among its officers by encouraging them to present their research findings in national and international conferences and publish these in national and international technical journals. The R&D work conducted by PNRA researchers, which was presented at various conferences and published at national and international levels, during the reporting period is listed below:

i. "Assessment of Naturally Occurring Radioactive Material (NORM) in the Oil and Gas Industry of Pakistan" published in international journal "Radioanalytical and Nuclear Chemistry", 2024.

PNRA-IST Meeting for R&D Collaboration

ii. "Proton and alpha-particle activation studies of natFe, natCu, natTi and natW targets at low energies" published in international journal "Radiochimica Acta", 2024.

iii. "Newly developed site-specific response spectrum for site in Abbottabad city, Pakistan and its comparison with building code of Pakistan", published in "NUST Journal of Engineering Sciences", 2024.

iv. "Development of Root Cause Analysis Tool for Event Investigation of Nuclear Power Plants" presented at the International Conference on Enhancing Nuclear Safety and Security through Technical and Scientific Support Organizations (TSOs): Challenges and Opportunities in a Rapidly Changing World, 2-6 December 2024, IAEA Vienna.

v. "Growth Assessment of Flaws Discovered in CANDU Reactor Pressure Tube" presented at the International Conference on Enhancing Nuclear Safety and Security through Technical and Scientific Support Organizations (TSOs): Challenges and Opportunities in a Rapidly Changing World, 2-6 December 2024, IAEA Vienna

vi. "Assessment of Containment Filtered Venting to Verify Practical Elimination Concept in Design of ACP1000 NPP" presented at the International Conference on Enhancing Nuclear Safety and Security through Technical and Scientific Support Organizations (TSOs): Challenges and Opportunities in a Rapidly Changing World, 2-6 December 2024, IAEA Vienna.

vii. "Small Modular Reactors (SMR) - A Regulatory Perspective in Pakistan", in IAEA International Conference on Small Modular Reactors and their Applications, 21–25 October 2024, Vienna, Austria.

09 National and International Cooperation

PNRA considers that an active and strong collaboration with relevant national and international organizations is necessary for ensuring safety and security of nuclear and radiation facilities in the country.

9.1 Cooperation and Coordination at National Level

The existence of strong relationships amongst all relevant stakeholders plays an important role for fulfillment of statutory/governmental requirements, building confidence and mutual trust. The prime stakeholders of a regulatory body include the government and its relevant subsidiary organizations, licensees, other national regulatory bodies, education/research institutes and general public. PNRA actively pursues collaboration with its stakeholders in order to discharge its obligations effectively.

9.1.1 Coordination with Governmental Organizations

PNRA coordinates with governmental departments and ministries in order to sensitize them on their role regarding safety and security of nuclear facilities and to facilitate an integrated

response to any nuclear safety or security event. During the reporting period, PNRA held several senior level meetings with the Provincial Disaster Management Authority (PDMA), Secretary Health, KPK, Secretary Health, AJ&K, Islamabad Health Care Regulatory Authority (IHRA) and IG Police Islamabad. In addition, PNRA organized five awareness seminars for the implementation of its national awareness program, in Lahore, Rawalpindi, Karachi and Gujranwala for PDMA and District Disaster Management Authority (DDMA).

Under a plan to equip the first responders with necessary tools to deal with emergencies involving radiological consequences, PNRA prepared a plan for the provision of handheld radiation detection equipment to Rescue 1122 and Bomb Disposal Squads all over Pakistan including GB and AJK.

PNRA has contributed to the inter-agency process for the establishment of National Nuclear Detection Architecture (NNDA) framework at all sea ports, land borders and airports in Pakistan with the aim to monitor and control any illegal movement of nuclear and other radioactive materials at Point of Entry/Exit (POEs) of the country. Conceptual framework was developed by PNRA and presented to NuRESC, SPD for the establishment of NNDA training facility at Physical Protection Exterior Laboratory (PPEL) of PNRA located at Pakistan Center of Excellence in Nuclear Security (PCENS). A total of 14 Handheld Radiation Detection Equipment were handed over to NNDA for deployment at 11 NNDA sites.

PNRA contributed to the amendment of Customs Act-1969 to prevent smuggling of nuclear and other radioactive material. The amendment includes specialized offences in accordance with PAK/925 & PAK/926 which would be determined by PNRA.

During the reporting period, PNRA organized a special briefing session for Chief Secretary, Sindh on nuclear and radiological emergency preparedness activities/exercises conducted at KNPGS site in coordination with PDMA Sindh and District Keamari management. A joint team of PNRA and PAEC headed by Member (Executive) PNRA held a briefing session which was attended by the Secretaries of Sindh Government, Commissioner Karachi, DG PDMA, DG SEPA and DG 1122. Moreover, PNRA also interacted with provincial/local administrations and health care commissions with the aim to collaborate and cooperate for the betterment of nuclear & radiation safety in the provinces. The issues regarding implementation of safety requirements and training of radiation workers at provincial government facilities were also discussed.

In addition, PNRA coordinated with certain other national regulatory authorities like National Electric Power Regulatory Authority (NEPRA), the Drug Regulatory Authority of Pakistan (DRAP), Public Procurement Regulatory Authority (PPRA), etc., for sharing regulatory experiences and learning from each other on how to further enhance effectiveness of the regulatory oversight.

In order to ensure the protection of workers, PNRA coordinated with Directorate General, Mines and Minerals Khyber Pakhtunkhwa (KP) and obtained data of underground mining sites in Mansehra, Battagram, Malakand, Shangla and Chitral Districts of KP for the assessment of radon level. In this regard, coordination was also made with COMSATS University, Islamabad for collaboration with each other.

Collaboration with institutions like Secretariat Training Institute (STI) and Pakistan Audit and Accounts Academy (PAAA) was also made to enhance the skills of PNRA employees.

Recent advancements in the field of Artificial Intelligence (AI) have brought this technology in the limelight. As the scope of applications of Artificial Intelligence is continuously increasing, we need to prepare ourselves to effectively regulate this technological advancement and its use within our organization. Accordingly, collaboration with Artificial Intelligence Technology Center (AITeC) and National Centre for Physics was established in the current year with the goal to develop competence in the field of AI for effective regulation of use of AI in nuclear and radiation regulatory business.

For mutual cooperation in research and development activities, liaison with Academia was also established. This included institutes like National Centre for Physics, National University of Science and Technology (NUST), Institute of Space Technology (IST), Pakistan Administrative Services (PAS) Academy and Pakistan Science Foundation (PSF). Furthermore, collaboration

was also made with IBA Karachi to develop and conduct a customized Strategic Management Course for PNRA Senior & Top Management.

The detail of outcome of such collaborations is presented in Chapter 7.

PNRA is also making efforts for the initiative and commitment of the Government of Pakistan in context of SDGs and "5Es Framework to Turnaround Pakistan". PNRA is committed to align its development and initiatives with the SDGs and 5Es Framework to put Pakistan on sustainable socio-economic path. During the reporting period, PNRA prepared a report on the implementation of SDGs and 5Es Framework at PNRA and shared with the Ministry of Planning apprising about PNRA's contributions.

9.1.2 Interaction with Licensees

PNRA holds periodic coordination meetings with the licensees to discuss issues of regulatory significance and find common ground for smooth implementation of regulatory requirements. This interaction also serves as a feedback mechanism for acquiring the licensees' point of view on regulatory framework and regulatory performance. During the reporting period, PNRA held 16 coordination meetings with different licensees from nuclear installations and radiation facilities.

PNRA regularly conducts training courses, workshops and seminars in areas of nuclear safety, radiation protection and nuclear security for the capacity building of its licensees. During 2024, following training courses, workshops and seminars were conducted by PNRA upon request from the licensees:

i. Training Course on Handling of Radiation Sources in R&D Activities at Academic Institutes

ii. Training Course on Introduction to Radiation, Biological Effects and Radiation Protection Principles

iii. Eight Seminars on Radiation Protection in Diagnostic Radiology and Regulatory Requirements

iv. Seminar on Introduction to PNRA and Radiation Protection Principles

v. Seminar on Licensing & Authorization Process and Regulatory requirements for Import of RGs

vi. Two seminars on "Radiation Protection"

vii. Session for importers on Radiation Protection, and Import/Export of Radiation Generators

viii. Session for industries on Radiation Protection, Security and Emergency Management of Radiation Source at Industrial Facilities

ix. Two sessions on "Radiation Safety"for x-ray technologists

x. Seminar for RPOs of Medical Facilities".

Further, a dedicated one-day seminar titled "Radiation Safety Aspects of NORM and Radon" was organized to educate the radiation workers and safety officials about the radiological safety implications of and regulatory control over these materials. More than 60 participants from various relevant organizations from oil and gas sectors, phosphate industries and universities, attended the seminar.

9.1.3 Interaction with Public

PNRA has established a public awareness programme to enhance awareness about the basic radiation protection principles, applications of ionizing radiation in everyday life, potential hazards to human health associated with ionizing radiation and radiation protection measures. During the reporting period, PNRA conducted more than 20 such seminars at different institutions in Lahore, Multan, Karachi, Peshawar and Quetta and GB which were attended by around 2700 participants.

9.2 Cooperation and Coordination at International Level

PNRA maintains close liaison and effective coordination with International Atomic Energy Agency (IAEA) on matters related to nuclear safety and security. PNRA also maintains bilateral cooperation arrangements with the nuclear regulatory bodies of other countries to exchange experiences, sharing knowledge and competence enhancement.

9.2.1 Collaboration with the IAEA

PNRA works closely with IAEA for the fulfillment

of Pakistan's obligations under international conventions on nuclear & radiation safety; physical protection of nuclear material and facilities; and emergency preparedness & response. PNRA provides technical experts for various IAEA activities and provides technical assistance to other Member States under auspices of IAEA. PNRA also benefits from IAEA Technical Cooperation (TC) programmes for its capacity building. An overview of the cooperation activities organized in this regard during the reporting period is given in subsequent subsections.

a) Visit of DDG Department of Nuclear Safety and Security (NS), IAEA

An IAEA delegation led by Ms. Lydie Evrard, Deputy Director General (DDG) and including Ms. Anna Hajduk Bradford, Director and Mr. Zia Hussain Shah, Senior Nuclear Safety Officer of IAEA visited PNRA. The delegation was briefed about the nuclear safety and security regime of the country. The DDG appreciated the support being offered by PNRA to the IAEA and appreciated the efforts of PNRA for ensuring nuclear safety and security in the country.

During the visit, an agreement was also signed between PNRA and IAEA to extend the scope of PNRA's in-house training centre NISAS, an existing IAEA collaborating centre, to include nuclear safety and radiation protection. Last year, NISAS was declared by the IAEA as one of its collaborating centre on Nuclear Security.

b) Visit of Director Incident and Emergency Centre (IEC), IAEA

During the reporting period, PNRA hosted Mr. Carlos Torres Vidal, Director of the Incident and Emergency Center (IEC), IAEA who was on an official visit to Pakistan. The visit underscored the long-standing partnership between IAEA and PNRA, which plays a crucial role in enhancing nuclear safety and security measures in Pakistan. Mr. Carlos cherished Pakistan's active participation in emergency exercises under the IAEA's Convention, specially hosting of ConvEx-2c in 2024, which demonstrates its perpetual commitment to strengthening global Emergency Preparedness and Response (EPR) arrangements. Mr. Carlos commended Pakistan's regulatory framework for emergency preparedness and response and affirmed its alignment with international standards. He also lauded PNRA's National Radiation Emergency Coordination Centre (NRECC) as a world-class emergency coordination centre equipped with state-of-the-art facilities and staffed with highly skilled professionals. Mr. Carlos also appreciated the national arrangements for EPR established under Nuclear Emergency Management System (NEMS).

c) Visit of Head (Radiation Safety & Monitoring Section) IAEA

On invitation of PNRA, Mr. Miroslav Pinak, Head (Radiation Safety & Monitoring Section) IAEA visited Pakistan from 21-25 October 2024. The purpose of the visit was to enhance the collaboration in the area of radiation safety after providing initial input by PNRA. Mr. Miroslav Pinak also visited PNRA regional office located in Karachi, Environmental Monitoring and Dosimetry Laboratory at PNRA, and various radiation facilities located in Karachi and Islamabad region such as KIRAN Hospital, Jinnah Postgraduate Medical College (JPMC), Dr. Ziauddin University Hospital, NORI Hospital, and PINSTECH.

d) NISAS as IAEA Collaborating Center

Following its declaration as an IAEA Collaborating Center for training and technical support in nuclear safety, radiation protection and nuclear security in February 2024, NISAS contributed in various nuclear safety and security activities within its scope. The scope of Collaborating Center includes conduct of nuclear safety and security training courses; IAEA peer review and advisory missions; development of IAEA guidance documents; training/educational material; hosting fellowships and participation in IAEA Coordinated Research Projects (CRPs).

e) IAEA Committees, Forums and Working Groups

PNRA is a member of the Commission on Safety Standards (CSS) and its respective committees in the areas of nuclear safety (NUSSC), emergency preparedness & response (EPReSC), radiation safety (RASSC), transport safety (TRANSSC) and waste safety (WASSC). The Commission is responsible for endorsement/final approval of IAEA safety standards, while the committees steer their development process in respective areas.

PNRA officials are also members of a number of IAEA scientific and technical forums and networks. These include Global Nuclear Safety and Security Network (GNSSN), Technical Support Organization Forum (TSOF), Regulatory Cooperation Forum (RCF), National Nuclear Security Support Centre (NSSC) Network, International Nuclear Security Education Network (INSEN), etc.

Relevant information is reported to the IAEA through various platforms such as Incident and Trafficking Database (ITDB), Incident Reporting Systems for nuclear power plants (IRS) and research reactors (IRSRR), International Nuclear and Radiological Event Scale (INES), etc. PNRA officers also contribute regularly in different IAEA Working Groups (WG) such as CANDU Probabilistic Safety Assessment (PSA) and the International Generic Ageing Lessons Learned (IGALL), etc. During the reporting period, 33 PNRA officials participated in the meetings of the above mentioned IAEA networks and platforms.

f) IAEA Expert Missions, Consultancies and Technical Meetings

IAEA invites different area experts from Member States to assist and contribute in IAEA activities such as peer review missions, expert missions, consultancy services, etc. During the reporting period, about 90 PNRA experts contributed in 72 such events.

g) Technical Cooperation Programme and Projects

PNRA started implementation of Technical Cooperation (TC) project PAK9043, "Strengthening National Nuclear Regulatory Infrastructure and its Sustainability by Enhancing Competency of Regulatory Staff in Using Emerging Knowledge and Advanced Tools/Technologies" for cycle 2024-25. During the reporting period, following events were organized under this project:

i. TC Expert Mission Workshop (WS) on Certification and Revalidation of Spent Nuclear Fuel Casks during Design/Beyond Design Life at PNRA HQs, Islamabad

ii. TC Expert Mission WS to Develop and Implement the Process for Communication with Stakeholders, Win the Confidence of Public and Involvement of Public in Decision Making at PNRA HQs, Islamabad

iii. TC Expert Mission WS to Identify the Production of NORM Waste, its Management and Regulatory Control on NORM Waste at PNRA HQs, Islamabad

iv. TC Expert Mission on International School of Nuclear and Radiological Leadership for Safety in Pakistan at PNRA HQs, Islamabad

v. TC Fellowship on Determination Process for Categorization of Inspection Findings at Nuclear and Radiation Safety Centre NNSA Beijing, China

vi. TC Fellowship on Licensing of Design Organization Involved in Design of System and Equipment at Nuclear and Radiation Safety Centre NNSA Beijing, China.

vii. TC Scientific Visit to Understand Uncertainty Budget During Sample Processing, Radiochemical Separation and Radiometric Analysis at Debrecen, Hungry.

Moreover, PNRA designed and submitted draft TC project PAK2024004 for Cycle 2026-27 named "Further strengthening the regulatory infrastructure for nuclear and radiation safety and enhancing the capability of regulatory body in advanced and emerging technologies". The draft TC project is currently under review by the IAEA.

PNRA also provides technical and scientific support to other IAEA Member States under the IAEA TC program. During the reporting period, PNRA hosted a scientific visit (SV) of seven officials from Iraq in the field of regulatory infrastructure for nuclear installation safety.

h) Pakistan-IAEA Nuclear Security Cooperation Program

PNRA is the national focal point for coordinating with all national stakeholders and IAEA for effective implementation of the Pakistan-IAEA Nuclear Security Cooperation Program. During the reported period, PNRA coordinated with IAEA, relevant national stakeholders and contractors for execution of several projects under this cooperation program. The project on enhancement of Central Alarm Station (CAS) and provision of maintenance and training

for Physical Protection Exterior Lab (PPEL) at PCENS, Rawalpindi has completed.

i) International Conventions

PNRA is the national contact point for fulfilling the national obligations under the following four conventions:

i. Convention on Nuclear Safety

ii. Convention on Physical Protection of Nuclear Materials & its Amendment;

iii. Convention on Early Notification of a Nuclear Accident; and

iv. Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency.

PNRA, on behalf of the Government of Pakistan, ensures implementation of the Codes of Conduct on Safety and Security of Radioactive Sources and Safety of Research Reactors.

It is worth mentioning that Chairman PNRA was elected as the President of the 10th Review Cycle of Convention on Nuclear Safety. This achievement highlights Pakistan's growing prominence in the global nuclear safety arena. The presidency, which Pakistan will hold until 2026, presents an opportunity for us to further contribute to strengthen nuclear safety worldwide. Further, PNRA participated in the working group meeting in March 2024 and in the 3rd extraordinary meeting to improve the efficiency and effectiveness of processes of Convention on Nuclear Safety.

PNRA participated in the 12th meeting of the Competent Authorities (CAs) of "Convention on Early Notification of a Nuclear Accident" and the "Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency". The objective of the meeting was to exchange information and discuss the operational arrangements for implementation of the Conventions along with the latest developments and challenges in the area of emergency preparedness and response. The main points discussed during the meeting included notification and information exchange, international assistance, communication with the public, assessment and prognosis and international cooperation.

9.2.2 United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR)

PNRA has designated a National Contact Person (NCP) and an Alternate NCP to coordinate the activities of UNSCEAR at national and international level. PNRA regularly reviews the

PNRA Officials Conducting Safety Culture Workshop as Experts at PAA, Poland

draft reports and other technical documents of the Committee and shares its comments/ feedback, as and when requested. During the reporting period, PNRA participated in 71st annual session of UNSCEAR held in Vienna in May 2024.

9.2.3 Bilateral Cooperation

PNRA values cooperation with the nuclear regulatory authorities of other countries for strengthening nuclear safety through exchange of technical knowledge and experiences; capacity building and human resource development; etc. PNRA has instruments of bilateral cooperation agreements with regulatory bodies of China, Nigeria and Ghana.

a) China

PNRA has long-standing cooperation agreements with the Chinese nuclear regulatory body 'National Nuclear Safety Administration' (NNSA) and its TSOs 'Nuclear Safety Centre' (NSC). Under the bilateral arrangement with NNSA and NSC, a forum of steering committee has been established to review the progress of the cooperation activities. The meetings of steering committee are normally held every year alternatively in China and Pakistan. During the reporting period, 10th Steering Committee meeting was held in Xiamen, China which was participated by a five-member delegation led by Chairman PNRA. During this meeting, issues such as status of major regulatory activities since last Steering Committee Meeting, inspections during Equipment Manufacturing in China and cooperation on matters related to nuclear power plant safety were discussed.

Moreover, Member (Executive) PNRA held a meeting with the Administrator NNSA on the sidelines of 68th IAEA General Conference (GC) in Vienna to discuss matters of mutual interest.

b) Nigeria

PNRA and Nigerian Nuclear Regulatory Authority (NNRA) have signed a MoU for capacity building of the regulatory staff of NNRA, provision of support in the development of regulatory framework, experience sharing, etc., in 2019 for a period of three years which is currently in the process of revalidation. During the reporting period, Member (Executive) PNRA held a meeting with Nigerian delegation on the side-lines of 68th IAEA General Conference. During the meeting, both sides agreed to renew the MoU.

c) Ghana

PNRA has signed a MoU for bilateral cooperation in the field of nuclear and radiation safety with the Nuclear Regulatory Authority (NRA), Ghana. During 2024, PNRA corresponded with NRA through designated PoC to reinvigorate the bilateral cooperation between the two regulatory bodies.

d) Russia

PNRA is in the process of signing an MoU for bilateral cooperation with Russian Federal Service for Environmental, Technological and Nuclear Supervision (Rostechnadzor).

e) Poland

A MoU for bilateral cooperation with Poland National Atomic Energy Agency (PAA) in the areas of Nuclear and Radiation Safety is in the process of finalization. PAA invited expert services from PNRA to conduct a workshop on safety culture self-assessment of the regulatory body.

10 Performance Monitoring and Assessment

01 Ensures that appropriate regulatory framework is maintained and understood by licensees

02 Ensures that licensing and authorization is performed effectively and efficiently

03 Ensures that review and assessment of submissions is performed effectively and efficiently

04 Ensures that effective regulatory oversight is maintained

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

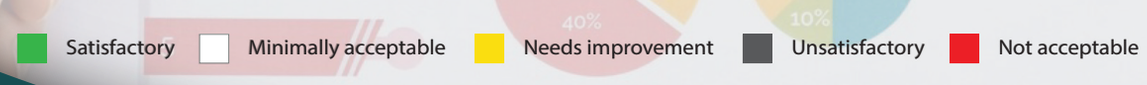
06 Takes appropriate actions to prevent degradation of safety

07 Strives for continuous improvement of organizational performance

08 Ensures availability of adequate resources and their effective management

09 Ensures implementation of an integrated management system

10 Performs its functions in a manner that ensures confidence of the stakeholders



PNRA is a learning organization and believes on continual improvement of its performance and effectiveness. For this purpose, PNRA periodically monitors and evaluates all its activities through various means such as progress monitoring, self-assessment, independent assessment and assessment based on strategic performance indicators, etc. These monitoring & assessment activities provide a holistic view of PNRA performance along with actionable insights to guide future strategies and optimize overall resources to achieve its vision, mission and goals.

The following section presents an overview of PNRA's performance for the year 2024, highlighting key achievements and areas for further improvement.

10.1 Annual Performance Evaluation

PNRA has established Strategic Performance Indicators (SPIs) to evaluate its annual performance. These indicators comprise 10 SPIs, supported by 23 downstream Specific Performance Elements (SPEs). Each year, PNRA assesses its performance using these SPIs and SPEs. The assessment is carried out using a five-level rating scale: satisfactory, minimally acceptable, needs improvement, unsatisfactory and not acceptable along with relevant color coding. The assessment for the current year against each indicator is presented below:

Performance Indicator 1 - "Ensures that appropriate regulatory framework is maintained and understood by licensees"

This performance indicator is evaluated based on the availability of regulations and Regulatory Guides (RGs) and their comprehension by the licensees.

PNRA's current regulatory framework effectively covers all regulated areas. However, the need for development of new regulations & RGs and periodic revision of existing ones are essential due to technological advancements, the emergence of new applications, feedback from operational experience and the ongoing evolution of international standards. Accordingly, PNRA proactively identifies and prioritizes the development and revision of regulations & RGs into strategic plans which are then included in the annual departmental work plans.

During 2024, PNRA remained involved in the development of three new regulations, amendments in four different regulations and Urdu translation of one regulations. Further, seven existing regulations and one national policy also remained under revision. In addition, revision of one RG was completed and updated revision was issued accordingly. Moreover, the development of four new RGs and revision of four existing RGs remained in progress throughout the year.

PNRA is also committed to enhance its licensees' understanding and awareness of the regulatory framework by offering specialized training courses on regulatory framework, as well as addressing licensees' queries through formal correspondence and during scheduled meetings.

During the reported period, PNRA conducted 22 training courses on various regulations/RGs for its licensees to enhance their understanding about the regulatory framework of PNRA. A total of 477 participants benefitted from these training courses. In addition, a number of queries raised by different licensees during formal meetings, inspections and through formal correspondences were effectively addressed throughout the year.

During the assessment, it was also noted that PNRA progress on development/revision of national policy and a number of regulations & RGs was behind the schedule. Review/revision of one RG was also due but could not be initiated. Furthermore, licensees of radiation facilities repeatedly requested PNRA for the preparation of some regulatory guides on the format and contents of licensing documents.

Foregoing in view, the performance of PNRA against this indicator is rated as "Minimally Acceptable" for the year 2024.

Performance Indicator 2 - "Ensures that licensing and authorization is performed effectively and efficiently"

This indicator is assessed on the basis of availability of documented processes for executing licensing and authorization activities for all existing practices according to established plans. It also evaluates the identification and proactive planning for the development of new processes in emerging areas, ensuring internal

stakeholders have access to and have clear understanding of the relevant processes.

PNRA has established a comprehensive set of processes and procedures that are sufficient for the licensing and authorization of all existing practices. These processes and procedures are maintained in a central registry, ensuring easy access for all internal stakeholders. To ensure proper understanding of relevant internal stakeholders about these processes and procedures, PNRA regularly assesses the awareness regarding these processes and procedures during regulatory audits. In addition, PNRA develops detailed work plans to carry out all licensing and authorization activities effectively.

During the reporting period, PNRA registered a site for construction of country's first fuel fabrication facility namely Fuel Technology Facility (FTF). PNRA also granted construction license to C-5, revalidated operation license of PARR-2 and granted permission for criticality to C-1, C-2, C-4 and K-3 after their successful refueling outages and fulfillment of all regulatory requirements. Further, license was granted to NEW-1 for design & manufacturing of Nuclear Safety Class -3 (NSC-3) equipment and design approval certificates were issued to HMC-3 for designing and manufacturing SC-21 & TC-21 fuel casks. PNRA also granted authorization to HMC-3 for manufacturing of prototype of Type AF package and Type B(U) package. In addition, revalidation of design approval certificate of SC-108 fuel cask was issued to HMC-3 and license of DESTO as a manufacturer of X-ray baggage scanners was renewed up to June 30, 2025. Moreover, PNRA conducted licensing examination of operating personnel of nuclear power plants and research reactors and issued 32 new licenses and renewed 190 licenses of operating personnel.

During 2024, PNRA also registered 443 new radiation facilities. In addition, 2235 NOCs for the import/export, 46 permits for procurement and 35 disposal authorizations were also issued during the reported period.

During the assessment, it was noted that all the licensing and authorization activities were performed by PNRA through focusing on fulfilling all the relevant regulatory requirements. Further, most of the licensing and authorization activities performed by PNRA were executed according to the plans. However, some of the licensing and authorization activities such as licensing of NDE service providers, permission for commissioning of PARR-3 and design approval certification for Pakistan New Fuel Assembly Container (PNAFC) could not be completed as per plan due to delays in submissions on part of the licensees.

Considering the accomplishments described above, PNRA performance against this indicator is rated as "Satisfactory" for the year 2024.

Performance Indicator 3 - "Ensures that review and assessment of submissions is performed effectively and efficiently"

PNRA assesses this indicator based on the availability of established processes and procedures for conducting review and assessment of all current practices in accordance with planned schedules. Evaluation for identification and proactive planning for the development of new processes and procedures in emerging areas, understanding of relevant processes and procedures by internal stakeholders and compliance of licensee submissions with the regulatory framework are also assessed through this indicator.

PNRA has established a detailed process along with downstream procedures to perform review and assessment of licensing submissions for all existing practices. This process and downstream procedures are periodically reviewed based on experience feedback and these are maintained in the central registry that is accessible to all internal stakeholders. The understanding of the process and procedure by relevant stakeholders is periodically assessed during regulatory audits.

During 2024, PNRA reviewed PSAR of C-5, PSR of PARR-2, application for grant of construction license to C-5 and QAP for Phase-1 Decommissioning of KANUPP. Applications from C-1, C-2, C-4 and K-3 to achieve criticality after successful completion of RFOs were also reviewed. In addition, a number of routine and non-routine submissions of K-series & C-Series NPPs, research reactors and MPF facility that mainly include MTRs, event reports, metrological, radiological, environmental operating, solid radioactive waste generation and effluent

release reports, ambient dose level records etc. were reviewed. Moreover, PNRA also reviewed 71 modifications related to design, FSAR and Technical Specifications (TS). Moreover, review of application for site registration of Fuel Technology Facility (FTF) was completed while applications for establishment of Regional Repository South (RRS) & Fuel Fabrication Plant (FFP) facilities remained in progress.

Furthermore, PNRA completed review of SAR of Type B(U) Package with Tungsten Shielding Material and reviewed required submissions from NEW-1 to license it as a designer and manufacturer of safety class 3 equipment & components, NCNDT to enhance the scope in its license for performing NDE of mechanical components of C-series & K-series PWRs and DESTO for license renewal as a manufacturer of X-ray baggage scanners. In addition, review of submissions from HMC-3 for licensing as a designer of safety class 1 equipment & components, ICCC for scope enhancement in manufacturing license, SMF (PINSTECH) for scope enhancement of authorization to manufacture sealed radioactive sources of Category 2 & 3, and CNPO, DTS/CNPGS & DTS/KNPGS for performing NDE activities at nuclear power plants remained under review.

PNRA also performed review and assessment of more than 250 submissions related to various radiation facilities. These included Safety Analysis Reports (SARs), Radiation Protection Programs (RPPs), Physical Protection Plans (PPPs), shielding calculations, etc.

During the assessment, it was noted that all review and assessment activities were executed as per plans. Foregoing in view, PNRA performance against this indicator is rated as “Satisfactory” for the year 2024.

Performance Indicator 4 - "Ensures that effective regulatory oversight is maintained"

This performance indicator is assessed on the basis of availability of inspection and enforcement mechanisms, development and implementation of inspection plans in accordance with PNRA inspection programmes and taking enforcement and legal actions against violators in accordance with PNRA enforcement regulations.

PNRA has developed inspection programmes that utilizes graded approach for regulatory oversight of nuclear installations, radiation facilities and associated activities. Initially, the scope of the inspection programme for nuclear installations did not include regulatory oversight for designers and service providers. Accordingly, the revision of inspection programme was issued during 2024 that incorporated oversight for designers and service providers.

Under the inspection programmes, PNRA develops comprehensive inspection plans that encompass all relevant jurisdictions and conduct inspections accordingly. During 2024, PNRA planned and conducted a total of 4540 regulatory inspections of nuclear installations, radiation facilities, equipment manufacturers, designers, service providers, etc. to verify compliance with regulatory requirements. In addition, PNRA witnessed 31 emergency exercises/drills at nuclear installations and radiation facilities to ensure the effectiveness of radiation emergency plans. The findings/directives resulting from these inspections were timely communicated to the licensees for taking necessary corrective actions in compliance with regulatory requirements.

PNRA has established a robust internal process that outlines a range of enforcement actions to address non-compliance with regulatory requirements. These actions include issuing directives, show cause notices, work stoppages, offense reports, facility lock and seal, conducting hearings, and initiating legal proceedings in a court of law. In line with this process, PNRA takes appropriate and necessary enforcement actions against violators to ensure adherence to national regulations.

During 2024, PNRA identified various non-compliances of regulatory requirements made by licensees. Accordingly, PNRA issued 50 show cause notices, 03 offense reports and 208 final directives to the violators. In addition, PNRA conducted 10 hearings. PNRA also locked and sealed 10 facilities which were de-sealed after necessary hearing process and compliance with regulatory requirements during the reported year.

Keeping in view the above activities, PNRA performance against this indicator is rated as “Satisfactory” for the year 2024.

Performance Indicator 5 - "Ensures that acceptable level of safety is being maintained by licensees"

Performance assessment for this indicator is based on several factors, including trends in occupational exposures, radiation dose levels for radiation workers and ambient radiation levels around NPPs. It also considers environmental monitoring results, critical non-conformances made by licensees and incidents at nuclear installations & radiation facilities and their corresponding reports. Additionally, issues raised during licensee peer reviews and self-assessments are also considered during the assessment of this indicator.

In 2024, PNRA conducted a trend analysis of occupational exposure and ambient radiation levels around the C-series and K-series NPPs. The analysis indicates that occupational exposure at both C-series and K-series NPPs remains well within regulatory limits. Similarly, the trends in ambient radiation levels show that radiation doses in the vicinity of these NPPs have remained consistent over the past five years. Additionally, the environmental monitoring results around NPPs and RRs have shown no significant deviations from 2020 to 2024.

In addition, no critical non-conformance was issued by licensee during the reported period. All the reportable events were timely submitted by licensees and accordingly evaluated at PNRA during 2024. Further, during regulatory inspections, PNRA examined the trending of issues identified by licensees in their QA audits and other assessments and found a general decrease in number of issues over time. The issues identified in peer review assessments and self-assessments conducted by licensees were also reviewed and the corrective actions & their implementation by licensees were verified through formal correspondence and during regulatory inspections.

During the assessment, it was revealed that PNRA has not performed trending of radiation doses of occupational workers of radiation facilities during the reported year.

Considering the above evaluation, PNRA performance against this indicator is rated as"Satisfactory" for the year 2024.

Performance Indicator 6 - "Takes appropriate actions to prevent degradation of safety"

The performance assessment against this indicator is carried out on the basis of identification of signs of degradation in safety by considering the operational safety trending and integrated safety assessment of NIs, assessment of radiation facilities against PO&Cs and evaluation of inspection reports. Furthermore, timely implementation of modifications to maintain and enhance safety of these facilities is also counted in the assessment of this indicator.

PNRA has established mechanisms for determining the safety performance of operating nuclear power plants. For this purpose, integrated safety assessment (ISA) and trending of operational safety are carried out to assess the extent of safety being maintained at operating units to verify compliance with the regulatory requirements and to highlight any safety adverse area and recommend actions to enhance safety. During the reporting period, the input data for ISA is compiled and preparation of report for the year 2023-2024 is in progress.

Moreover, 71 modifications related to design, FSAR and Technical Specifications (TS) are reviewed/approved by PNRA to further reinforce the plant safety and performance.

PNRA also performs periodic safety assessment of radiation facilities against pre-established PO&Cs. During the reporting period, assessment of medical and industrial facilities was conducted and reports were issued highlighting overall improvement in performance and compliance. In addition, PNRA evaluated inspection reports of nuclear installations and radiation facilities at Headquarter level and highlighted feedback for regional directorates. This feedback is aimed to foster further improvement in regulatory oversight on licensed facilities.

Considering the above evaluation, PNRA performance against this indicator is rated as "Satisfactory" for the year 2024.

Performance Indicator 7 - “Strives for continuous improvement of organizational performance”

This indicator is assessed on the basis of

performance monitoring, conduct of self-assessment, utilization of international experience feedback, conduct of internal audits and external peer reviews.

PNRA develops Strategic Plan outlining the specific goals, strategies and downstream activities to achieve the vision, mission and objectives of the organization. Under PNRA management system, each department develops its annual workplan by setting the timelines for each task. These workplans draws input from relevant tasks from the strategic plan, task and functions and other anticipated activities. PNRA employs diverse mechanisms to monitor and assess these activities.

PNRA conducted periodic monitoring of PNRA strategic plan and issued two progress reports during the reporting period. Further, quarterly monitoring of implementation of annual work plans of all PNRA departments were carried out in the current year and four reports were issued. In addition, PNRA also monitored the progress of implementation of IRRS Follow-Up Mission observations and report was issued to reflect the progress against IRRS follow-up action plan.

PNRA also conducts various assessments to assess and evaluate its regulatory performance. These include assessments conducted using IAEA SARIS tool, department level self-assessments and safety culture self-assessment. During 2024, PNRA developed 2nd Self-Assessment (SARIS) Action Plan and Safety Culture Continuous Improvement Action Plan on the basis of the outcomes of these assessments to address the highlighted areas for further improvement in the organization. Furthermore, a number of PNRA departments performed their self-assessment as per defined frequency. This self-assessment identified areas for further improvement in their processes and practices. Accordingly, corrective action plans were developed aimed to foster performance, efficiency and overall effectiveness.

PNRA also evaluates international operating experience feedback to learn lessons for bringing improvement in regulatory performance and practices as well as requiring licensees to implement the recommendations highlighted by events to further enhance safety performance. In this year, PNRA evaluated several international events and accordingly issued two reports that highlighted recommendations for further improvement in practice.

During the assessment, it was revealed that self-assessment of some PNRA departments and follow-up of regulatory audit conducted during 2022-2023 were due. However, these were not performed. Furthermore, it was highlighted that PNRA needs to evaluate international operating

Meeting With Senior Management on Draft Tasks and Functions of PNRA Departments for Year 2025-2027

experience feedback regarding radiation facilities and share recommendations with licensees accordingly.

Foregoing in view, the performance of PNRA against this indicator is rated as "Satisfactory" for the year 2024.

Performance Indicator 8 - Ensure availability of adequate resources and their effective management

This indicator is evaluated on the basis of availability of human resources and their effective utilization; existence of technical expertise and knowledge resources; infrastructure, logistics and financial resources and their effective, efficient and optimized utilization in the organization.

PNRA ensures that adequate human resource is available to perform its regulatory activities effectively. PNRA has determined the estimates of required workforce for various PNRA departments till 2030 based on available forecast of regulatory workload. PNRA has completed the Competence Needs Assessment (CNA) and highlighted the lists of desired competence areas. PNRA officials are facilitated to develop capacity in desired competence areas through available mechanisms, viz. in-house training and attachments nationally and training, fellowships, etc. at national and international venues. In the current year, PNRA has identified the areas for higher study on the basis of competence loss risk assessment and identified the minimum knowledge considered as pre-requisite to perform any of the core regulatory functions.

For effective utilization of available human resources, PNRA executed its rotation policy and 35 technical officers were rotated and re-assigned in 2024 for maximum and effective utilization of the experienced workforce, re-skilling of professionals and their job enrichment.

During the reporting year, PNRA conducted 22 in house training courses in which a total of 477 professionals participated. Furthermore, 159 PNRA personnel participated and benefited from 60 training opportunities arranged at various national institutes. Also, 45 PNRA officials in-person participated in 40 capacity building events internationally while 18 PNRA officials virtually participated in 05 such events. Moreover, PNRA continued to execute the higher education policy for acquisition of knowledge and up-skilling in new scientific and technical domains. Further, on-job orientation training was carried out for two new officers recruited for PNRA's GB office.

The Federal Government has allocated the required annual budget to PNRA for effective execution of all its activities. The annual budget was effectively utilized to achieve the targets of the current year. All regulatory functions and planned activities received sufficient resources and were executed effectively. During 2024, PNRA continued execution of planned activities of one PSDP project RNSI-Lahore for further strengthening the infrastructure of PNRA. In addition, one PSDP project i.e. 80 KW on-grid solar system at PNRA HQs buildings was successfully completed during the reporting period.

During the assessment, it was highlighted that PNRA needs to further improve its competence needs assessment methodology and develop a mechanism for its effective monitoring.

Based on the above evaluation, PNRA performance in this area is rated as "Satisfactory" for the year 2024.

Performance Indicator 9 - Ensures implementation of an Integrated Management System

The performance assessment of this indicator is rated on the basis of availability of updated Management System and implementation of requirements of Management System; identification and development of policies/ programs/processes/procedures; and periodic review of management system documentation.

During 2024, the process for revision of PNRA Management System Manual was completed and Rev. 2 of MSM was issued. Further, implementation of PNRA MSM remained continued during this year to achieve the vision, mission and organizational goals. In addition, review and revision of Tasks and Functions of PNRA departments was completed during the reporting period.

PNRA identified, planned and issued 03 organizational policies and one PNRA Inspection Program. Furthermore, 01 existing PNRA level

procedures were revised and 01 procedures were developed to align with organizational best practices. Further, PNRA departments reviewed and revised a number of procedures and also developed a number of new procedures. Further, PNRA organogram was updated to make it consistent with organizational changes to further enhance the effectiveness of PNRA working.

Foregoing in view, the performance of PNRA against this indicator is measured as "Satisfactory" for the year 2024.

Performance Indicator 10 – Performs its functions in a manner that ensures confidence of the stakeholders

The assessment of this performance indicator is done on the basis of measures utilized for winning the confidence of its stakeholders. These include mechanisms for communication & interaction with stakeholders, engagement of licensees and public in the development of regulatory framework, public awareness programmes, consideration of licensee feedback for improvement of regulatory processes & performance and Government trust by providing necessary support for fulfillment of national and international obligations.

During 2024, PNRA shared five regulations with stakeholders by uploading these on PNRA website for seeking input from licensees, public and the interested parties. Further, PNRA held 16 coordination meetings with different licensees from nuclear installations and radiation facilities. PNRA also arranged 21 public awareness seminars across the country. More than 2700 participants attended these seminars. NISAS website is being finalized whose link in www.pnra.org will provide more outreach of stakeholders in Public Awareness Program.

In order to fulfill the obligations of Conventions on Nuclear Safety, preparation of 10th National Report remained in progress during the reporting period. Furthermore, PNRA continued to expand its outreach and conducted meetings with PDMAs of Punjab & Sindh, Emergency Service Department and Bomb Disposal Squad and DDMAs of various districts of the Punjab to sensitize them about security of radioactive material and integrated response to nuclear security events.

During the assessment, it was identified that PNRA must strengthen its outreach and engagement with stakeholders. The public awareness program needs to be re-modeled to align with modern approaches and further expanded across the country. Furthermore, information sharing with all interested parties through both electronic and print media needs to be improved. A more robust mechanism for gathering public feedback needs to be developed to identify areas for improvement. Moreover, PNRA should enhance training opportunities for its licensees by increasing the number of training courses, workshops and seminars.

Keeping in view the above activities, PNRA performance against this indicator is rated as “Minimally Acceptable” for the year 2024.

Targets for the year 2025

01 Issuance of revised National Policy on Safe Management of Radioactive Waste, Decommissioning and Spent Nuclear Fuel in Islamic Republic of Pakistan

02 Issuance of Regulations on Safety of Nuclear Fuel Cycle Facilities - PAK/917 and Regulations on Safety of Research Reactors - PAK/932

03 Issuance of Regulatory Guide on Iodine Thyroid Blocking (ITB) during a Nuclear or Radiological Emergency (PNRA-RG-914.01) (Rev.1)

04 Regulatory decision on HMC-3 application for design certification of 'Fuel Assembly Container' and Type B(U) Package with Tungsten Shielding

05 Regulatory decision on issuance of Operating License to CNPGS spent fuel dry storage facility

06 Regulatory decision on Site Registration of Regional Repository South as near surface disposal facility

07 Regulatory decision on issuance of construction license to Near Surface Disposal Facility (NICE)

08 Regulatory decision on issuance of fuel load permit to PARR-3

09 Regulatory decision on issuance of design license to Directorate General Nuclear Power Engineering (DGNPE)

10 Regulatory decision on issuance of construction and operating licenses to Fuel Technology Facility (FTF)

11 Regulatory decision on authorization of CNPGS and KNPGS Technical Supports as NDE service providers

12 Regulatory decision on authorization of CNPO as NDE service provider

13 Regulatory decision on authorization of M/s Leopards as carrier of radioactive material

14 Regulatory decision on extending the scope of SMF (PINSTECH)'s license to manufacture category 2 and 3 sealed radioactive sources

15 Establishment of Regional Inspectorate (RNSI-1D) at Lahore

16 Submission of Pakistan's National Report to IAEA for the 10th Review Meeting of the Convention on Nuclear Safety

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