



ANNUAL REPORT 2018



PAKISTAN NUCLEAR REGULATORY AUTHORITY



Present Members of the Authority



Mr. Zaheer Ayub Baig
Chairman



Mr. Mohammad Saleem Zafar
Member Corporate



Mr. Faizan Mansoor
Member Executive



Lt. Gen. Sarfraz Sattar, HI(M)
Part-time Member



Dr. M. Nuruddin Qazi
Part-time Member



Mr. Hussain Ahmad Siddiqui
Part-time Member



Prof. Dr. Tariq Mahmood
Part-time Member



Mr. Saeed-ur-Rehman
Part-time Member



Ms. Farzana Altaf
Part-time Member



Former Members of the Authority



Mr. Jamshed Azim Hashmi, TI
Chairman, PNRA
(16.02.2001 – 15.02.2009)



Mr. Mohammad Anwar Habib, HI
Chairman, PNRA
(16.02.2009 – 15.02.2017)



Mr. Jawad Azim Hashmi
Member, PNRA
(25.04.2001 – 24.04.2005)

Dr. Inam-ur-Rahman, SI, AK
Part-time Member, PNRA
(28.02.2002 – 27.02.2010)

Mr. Anwar Ali, NI, HI, PoP
Part-time Member, PNRA
(28.02.2002 – 27.02.2006)

Prof. Dr. Mohammad Ali Maud
Part-time Member, PNRA
(28.02.2002 – 27.02.2010)

Syed Badshah Husain
Member, PNRA
(23.06.2003 – 11.07.2007)

Prof. Dr. Inayat Shah Roghani
Part-time Member, PNRA
(23.02.2006 – 22.02.2010)

Dr. Shahid Ahmed Mallick
Member, PNRA
(16.02.2009 – 10.02.2011)

Mr. Mahboob Ali, SI
Member, PNRA
(25.04.2011 – 24.04.2016)

Mr. Mohammad Iqbal
Member, PNRA
(08.05.2012 – 07.05.2015)

Syed Yusuf Raza, SI
Part-time Member, PNRA
(01.08.2014 – 31.07.2018)

Lt. Gen. Mazhar Jamil, HI(M)
Part-time Member, PNRA
(24.04.2015 – 25.09.2017)



Lt. Gen. (R) Khalid Ahmed Kidwai, NI, HI, HI(M)
Part-time Member, PNRA
(28.02.2002 – 27.02.2014)

Dr. M. Younus Sheikh
Part-time Member, PNRA
(28.02.2002 – 27.02.2006)

Mr. Asif Shuja Khan
Part-time Member, PNRA
(28.02.2002 – 27.02.2014)

Dr. Qazi Abdus Saboor
Part-time Member, PNRA
(21.03.2002 – 20.03.2014)

Mr. Muhammad Shakil ur Rahman
Member, PNRA
(25.04.2005 – 24.04.2011)

Mr. Zia-ul-Hasan Siddiqui
Part-time Member, PNRA
(01.07.2006 – 30.06.2011)

Prof. Dr. Mustafa Kamal
Part-time Member, PNRA
(29.04.2011 – 28.04.2015)

Mr. Saeed Alam Siddiqi
Part-time Member, PNRA
(01.07.2011 – 31.07.2014)

Lt. Gen. Zubair Mahmood Hayat, NI(M)
Part-time Member, PNRA
(01.03.2014 – 23.04.2015)

Dr. Muhammad Khurshid
Part-time Member, PNRA
(17.10.2014 – 16.10.2018)

Dr. Huma Qureshi, TI
Part-time Member, PNRA
(24.01.2017 – 19.09.2017)



Message from the Chairman

I feel immense pleasure to express that we have been successful for another year in performing an effective regulatory oversight to ensure protection of the workers, the public and the environment from the harmful effects of ionizing radiation. I am glad to present the annual progress of the organization for the year 2018.

The scope of regulatory responsibilities has broadened because of the increase in the use of nuclear and radioactive material in Pakistan. This requires highly dedicated and competent professionals to supervise and regulate nuclear installations, radiation facilities and associated activities. I feel honored to acknowledge that our competent and skilled team effectively executed their responsibilities.

Availability of a comprehensive regulatory framework, commensurate with national infrastructure is imperative for an effective regulatory control. We have been successful in strengthening the national regulatory framework in line with the international standards and best practices. During the last year, we continued to further fortify the framework by promulgating three new regulations, one national policy, one regulatory order and one regulatory guide. Furthermore, work on development of several regulations and regulatory guides is in progress.

I am proud to say that PNRA awarded operating licences to Chashma Nuclear Power Plants Unit-3 and Unit-4; and registered site for establishment of a spent nuclear fuel dry storage facility at Chashma. We also granted licence to NOVEL Engineering Works-2 for manufacturing of nuclear safety class equipment and have expanded the licensing network of radiation facilities in the country to encompass more than 5300 facilities.

PNRA understands the importance of competence building of the regulatory officials for meeting the current and future regulatory challenges. I am delighted to reveal that we arranged a number of training courses and workshops inside PNRA and a number of our professionals participated in the trainings arranged by the International Atomic Energy Agency (IAEA) at its Headquarters in Vienna and in other countries.

Liaison with national and international organizations is extremely important in regulatory matters. We continued implementation of the public awareness programme and conducted seminars in schools, colleges, universities and other institutions. Our officers have shown excellent performance at national as well as international horizons. It is very encouraging that a number of PNRA officers represented Pakistan as experts in the IAEA Missions abroad.

I am glad to express that this year, we successfully completed the construction of residential colony for our officials at Chashma. We have also started construction of a building to house National Radiological Emergency Coordination Centre in Islamabad.

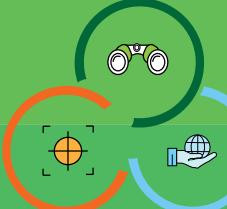
In the end, I acknowledge that the progress made by PNRA is the reflection of the dedicated efforts of its employees. I am confident that with such a professional and devoted team, PNRA will continue its endeavors to fulfill its national obligation of ensuring protection of the workers, the public and the environment from harmful effects of ionizing radiation.

I wish PNRA to flourish more in the years ahead.



(Zaheer Ayub Baig)

VISION



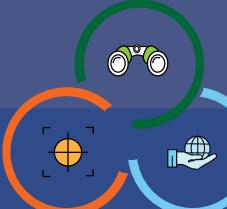
To become a world class regulatory body with highly trained, competent and dedicated personnel working in unison with a zeal to foster a positive safety culture in their licensees and to regulate nuclear safety to protect the public, the workers and the environment from the harmful effects of radiation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

MISSION



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

CORE VALUES



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

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



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1. Introduction

1.1 Background

In any modern society of today's science and technology era, ionizing radiation has wide range of applications to help and improve common citizen's life and has become integral to everyday life. The paradigm of using ionizing radiation emitting sources such as nuclear material, radioactive material and radiation generators in Pakistan is much diverse. It includes nuclear power plants, nuclear research reactors, molybdenum production facility, nuclear medicine centres, radiotherapy centres, irradiators, industrial and diagnostic X-ray centres, etc.

It is pertinent to mention that all such applications carry the potential of exposing the workers, the public and the environment to ionizing radiation. Therefore, every application needs to be carefully regulated. The Government of Pakistan has given Pakistan Nuclear Regulatory Authority (PNRA) the task to regulate the use of all such applications throughout the country.

Pakistan Nuclear Regulatory Authority was established in 2001 through the promulgation of PNRA Ordinance, i.e. Ordinance III of 2001, as

the national nuclear regulatory authority. It was assigned the responsibility to regulate all nuclear installations, radiation facilities and associated activities in Pakistan to ensure nuclear safety and radiation protection. The evolution of regulatory setup in Pakistan is depicted in Figure-1.

The Ordinance assigns PNRA with the responsibility of establishing and enforcing implementation of regulatory framework to ensure the safe and secure use of nuclear material, radioactive sources and radiation generators in the country. PNRA performs licensing and authorization of all nuclear installations, radiation facilities and associated activities based on review and assessment of submissions. PNRA also performs inspections to verify compliance of safety requirements and has the mandate to take appropriate enforcement actions in case of non-compliance. In addition, PNRA ensures availability of arrangements for effective preparedness and coordination for managing nuclear accident or a radiological emergency. Figure-2 presents the regulatory functions and domains of PNRA.

The legislation also provides basis for the composition of the Authority which consists of a

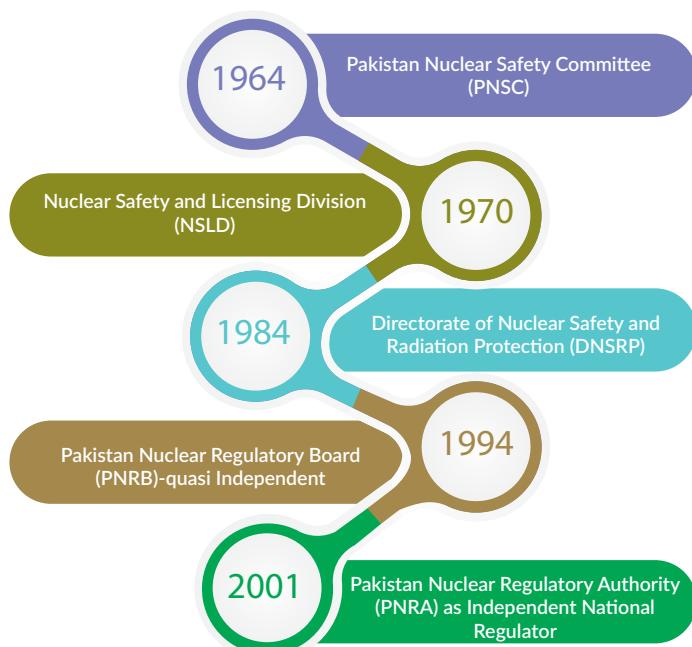


Figure-1: Evolution of Independent Regulatory Regime in Pakistan



Figure-2: Regulatory Functions and Domains of PNRA

Chairman, two full-time Members and seven part-time Members representing the various stakeholders of PNRA. The operational working of the Authority is managed by various organizational units; with its headquarters in Islamabad and six regional offices across the country. The organizational structure of PNRA is presented in Figure-3.

1.2 Structure of Annual Report

The Annual Report of PNRA for the year 2018 presents activities and accomplishments of this year in ten distinct Chapters.

Nuclear regulatory regime; obligations and functions entrusted to PNRA; and major achievements of 2018 along with expected targets for the next year are reflected in Chapter one of this report.

PNRA activities to strengthen its regulatory framework for the safety of nuclear installations; radiation facilities; and associated activities are highlighted in Chapter two. This Chapter also presents an overview of management system of PNRA and actions taken for monitoring its effective implementation.

Chapter three highlights various regulatory oversight activities conducted during 2018 with respect to

nuclear installations and associated activities in the country. Regulatory oversight activities related to radiation facilities in the country are presented in Chapter four of this report.

PNRA activities related to regulatory control of radioactive waste; spent fuel; decommissioning and transport of radioactive materials are presented in Chapter five. Chapter six reflects regulatory activities related to preparedness and response to nuclear accidents and radiological emergencies.

PNRA efforts for the capacity building of regulatory officials made during 2018 are highlighted in Chapter seven of this report. Chapter eight gives information about coordination of PNRA at national level with different stakeholders including the public. It also highlights PNRA's cooperation with international organizations and contributions made at international level.

Progress of activities of PNRA's technical support centres, its laboratories and infrastructure development during 2018 is highlighted in Chapter nine. Performance review of PNRA based on predefined performance indicators and contributing elements for the year 2018 is presented in Chapter ten of this report.

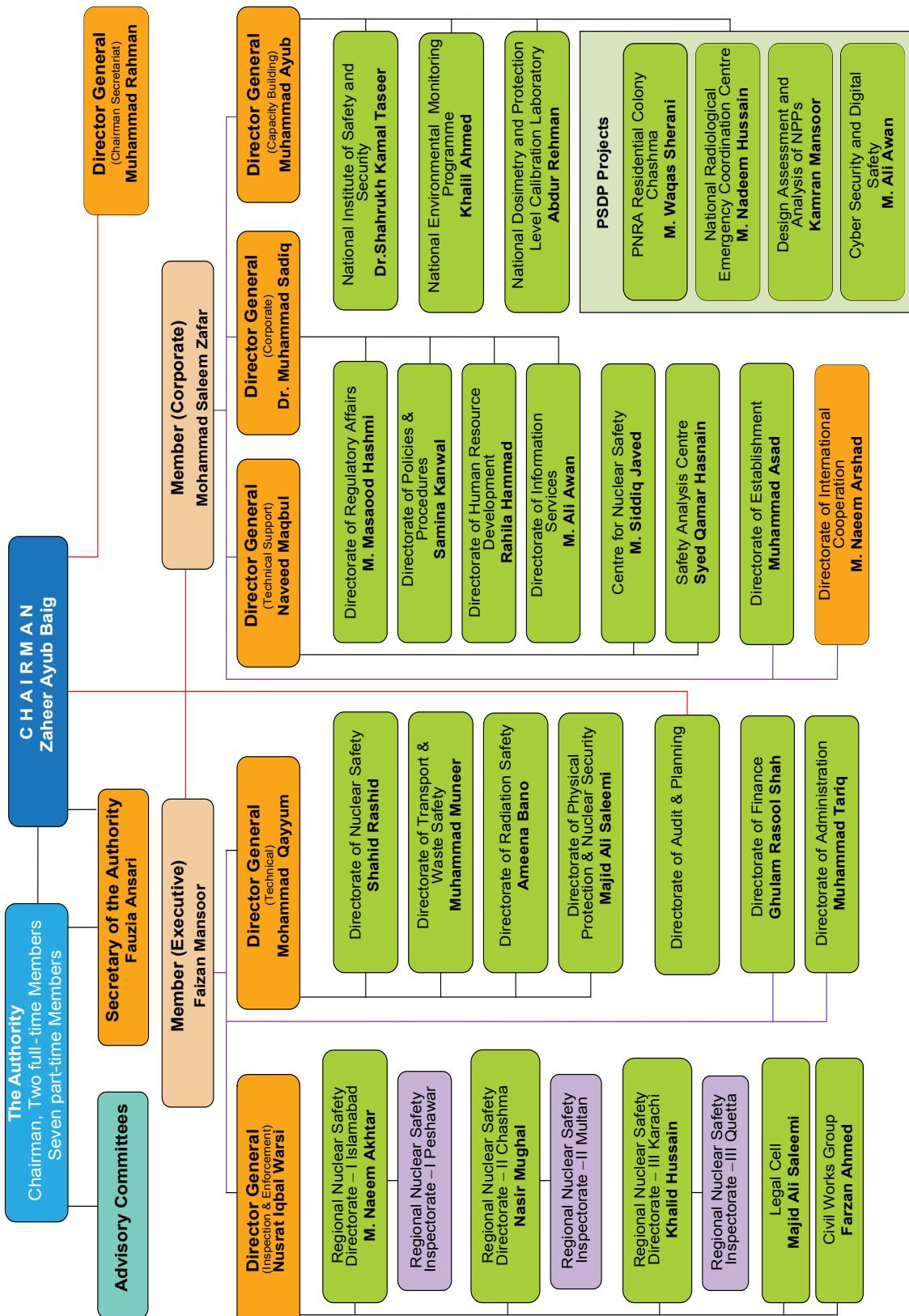


Figure 3: Organizational Structure of PNRA



Chairman PNRA Awarding C-3 & C-4 Operating Licence to Chairman PAEC



Visit of Director General IAEA Mr. Yukiya Amano and Pakistan's Ambassador in Vienna H.E. Ayesha Riyaz to PNRA HQs.

1.3 Major Activities in 2018

Major achievements of PNRA during 2018 are summarised as follows:

- Issued Regulations on Security of Radioactive Sources
- Revised Regulations for Licensing of Nuclear Safety Class Equipment and Components Manufacturers
- Amended Regulations on Transaction of Business of Pakistan Nuclear Regulatory Authority
- Issued National Policy on Safe Management of Radioactive Waste, Decommissioning and Spent Nuclear Fuel
- Issued Regulatory Order on Prohibition of 660 Series Gamma Radiographic Projectors Use in Pakistan
- Issued Regulatory Guide on Format and Contents of Physical Protection Programme of Nuclear Installation(s)
- Continued Regulatory Oversight of Nuclear Installations, Radiation Facilities and Associated Activities
- Issued Operating Licence to Chashma Nuclear Power Plants Unit-3 and Unit-4
- Issued Licence to NOVEL Engineering Works-2 for Manufacturing Nuclear Safety Class Equipment
- Conducted Performance Assessment of PNRA Based upon Feedback from Nuclear Installations and Associated Activities
- Registered Site for Establishment of Spent Nuclear Fuel Dry Storage Facility at Chashma
- Expanded the Licensing net of Radiation Facilities to more than 5300
- Issued Reports on the Progress of Implementation of International Regulatory Review Service (IRRS) Mission Action Plan
- Conducted 4th Regulatory Audit of PNRA Departments and Issued the Integrated Audit Report
- Completed Implementation of PNRA Strategic Plan 2015-2018
- Conducted 38 Training Courses for more than 850 Personnel from PNRA and other Organizations
- More than 90 PNRA Officials Participated as Technical Experts in around 80 IAEA Events in different Countries
- Conducted 31 Seminars for the Awareness of the Public attended by more than 4200 Personnel
- Continued Successful Implementation of IAEA TC Project for the Cycle 2018-2021
- Successfully Completed PNRA Residential Colony at Chashma Site and Continued Execution of three other PSDP Projects



1.4 Targets for 2019

The targets set for 2019 are summarised as follow:

- 
- Issuance of Regulations on Physical Protection of Nuclear Material(s) and Nuclear Installation(s)
 - Issuance of Pakistan Nuclear Regulatory Authority Dispute Resolution Regulations
 - Revision of Regulations on Radioactive Waste Management
 - Amendment in Regulations on Radiation Protection
 - Issuance of Regulatory Guide on Format and Content of Radiation Protection Programme
 - Issuance of Regulatory Guide on Format and Content of Environmental Monitoring Programme of Nuclear Installation(s)
 - Issuance of Regulatory Guide on Format and Content of Radioactive Waste Management Programme of Nuclear Medicine Centres
 - Issuance of Regulatory Guide on Format and Content of Radioactive Waste Management Programme of Nuclear Installation(s)
 - Design Certification of Spent Nuclear Fuel Dry Storage Cask for Karachi Nuclear Power Plant Unit-1 (K-1)
 - Perform Safety Assessment of Spent Nuclear Fuel Dry Storage Cask for Chashma Nuclear Power Generating Station (CNPGS)
 - Issuance of Construction Licence to CNPGS Spent Nuclear Fuel Dry Storage Facility
 - Conduct Safety Assessment of Radiation Facilities based on Performance Objectives and Criteria
 - Preparation of 8th National Report under Convention on Nuclear Safety
 - Issuance and Implementation of PNRA Strategic Plan 2019-2023
 - Continue Implementation of Recommendations and Suggestions of IRRS Mission
 - Continue Cooperation with National and International Organizations
 - Continue Implementation of Public Awareness Programme
 - Continue Implementation of IAEA Technical Cooperation (TC) Projects for the Cycle 2018-2021
 - Continue Execution of PSDP Projects of PNRA



2. Regulatory Framework and Management System

PNRA was established through promulgation of Pakistan Nuclear Regulatory Authority Ordinance 2001, with the mandate to regulate nuclear installations, radiation facilities and associated activities in the country.

In order to fulfill this mandate effectively, a comprehensive regulatory and management system framework is required. This framework provides requirements and guidance for licensees and for performing regulatory processes at PNRA.

2.1 Regulatory Framework

The regulatory framework of PNRA comprises three tiers as depicted in Figure-4. The first tier of this framework is the PNRA Ordinance. It empowers PNRA to ensure nuclear safety by issuing necessary regulations; authorizing the nuclear installations, radiation facilities and associated activities; performing inspections to verify compliance of regulations; and taking enforcement actions in cases of non-compliance.

The 2nd tier comprises PNRA regulations. These establish the administrative and technical regulatory requirements in the areas of nuclear safety; radiation protection; waste and transport safety; and physical protection. These regulations are mandatory for licensees to follow.

The 3rd tier consists of regulatory guides which present the acceptable methodologies to comply with the regulatory requirements set forth by PNRA regulations. The regulatory guides are non-mandatory in nature and the licensees may choose any alternate approach to comply with the regulatory requirements by demonstrating that the adopted approach provides similar or higher level of safety as that of the methodology presented by the regulatory guides.

PNRA regulations and regulatory guides are approved by following a pre-defined process. The same are also placed at PNRA website (www.pnra.org). Figure-5 presents the process for preparation and issuance of PNRA regulations and regulatory guides.

2.1.1 PNRA Regulations

PNRA regulations present regulatory requirements to ensure protection of the workers, the public and the environment from harmful effects of ionizing radiation. The process for development of regulations has been prepared with the intent to involve all the interested parties including public. During this process, comments of the interested parties are invited by sharing the draft regulations and uploading these drafts on PNRA website.

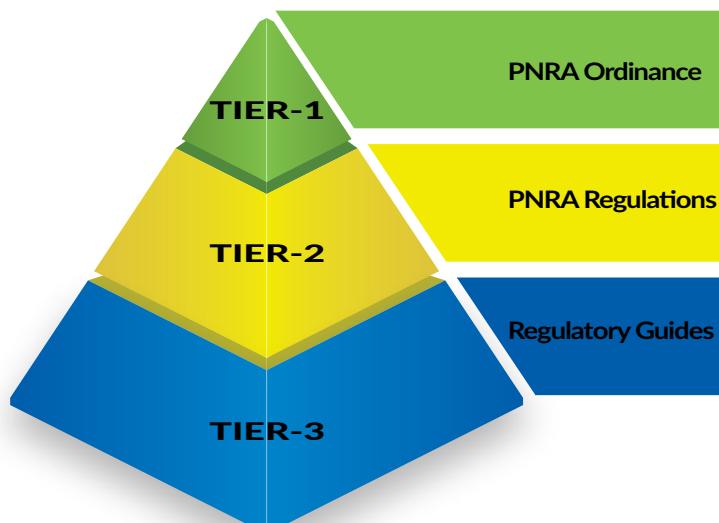


Figure-4: Statutory Framework for the PNRA's Regulatory Operations

During the year 2018, following regulatory documents were approved and gazette notified:

- i. Regulations for Licensing of Nuclear Safety Class Equipment and Components Manufacturers - (PAK/907) (Rev.1);
- ii. Regulations on Security of Radioactive Sources - (PAK/926);
- iii. Amendment in Regulations on Transaction of Business of Pakistan Nuclear Regulatory Authority - (PAK/901);

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

v. Regulatory Order on Prohibition of 660 Series Gamma Radiographic Projectors' Use in Pakistan - (01/2018);

During 2018, development of following new regulations remained in progress:

- i. Regulations on Authorization of Organizations

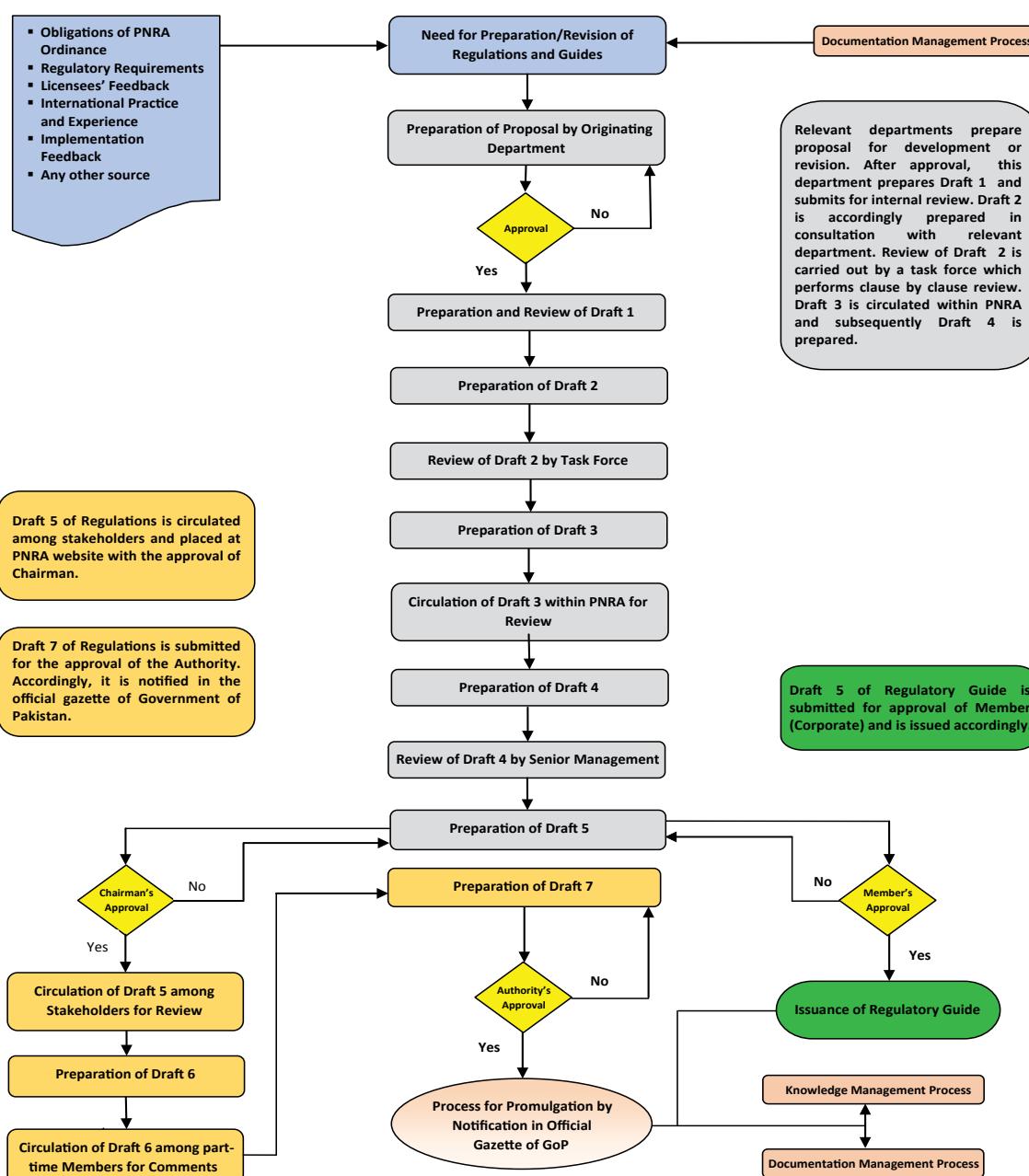


Figure-5: Process for Development of PNRA Regulations and Regulatory Guides



PNRA Officials During Discussion on Draft Regulations in a Review Meeting

- for Non Destructive Examination (NDE) of Safety Class Equipment for Nuclear Installation(s) - (PAK/906);
- ii. Regulations for the Safe Management of Spent Nuclear Fuel - (PAK/918);
 - iii. Regulations on Leadership and Management for Safety - (PAK/921);
 - iv. Regulations on Physical Protection of Nuclear Material(s) and Nuclear Installation(s) - (PAK/925); and
 - v. Regulations on Dispute Resolution - (PAK/949).
- Revision of following regulations also remained in progress during 2018:
- i. Regulations on Radiation Protection - (PAK/904) (Rev.1);
 - ii. Regulations for the Licensing of Radiation Facility(ies) other than Nuclear Installation(s) - (PAK/908) (Rev.1);
 - iii. Regulations on the Safety of Nuclear Power Plant Design - (PAK/911) (Rev.2);
 - iv. Regulations on the Safety of Nuclear Power Plants Operation - (PAK/913) (Rev.2);
 - v. Regulations on Management of a Nuclear or Radiological Emergency - (PAK/914) (Rev.1);
- vi. Regulations on Radioactive Waste Management - (PAK/915) (Rev. 1); and
 - vii. Regulations for the Safe Transport of Radioactive Material - (PAK/916) (Rev.1).

2.1.2 PNRA Regulatory Guides

PNRA regulatory guides provide acceptable methods to meet the regulatory requirements of PNRA regulations and ensure their effective implementation.

During the year 2018, PNRA issued a regulatory guide on “Format and Content of Physical Protection Programme of Nuclear Installation(s) (PNRA-RG-909.02)”. Furthermore, following regulatory guides remained under preparation during this year:

- i. Format and Content of Radiation Protection Programme (PNRA-RG-904.06);
- ii. Radiation Protection and Safety in Radiotherapy (PNRA-RG-904.07);
- iii. Format and Content of Safety Analysis Reports of Nuclear Power Plants (PNRA-RG-909.01);
- iv. Format and Content of Environmental Monitoring Programme of Nuclear Installation(s) (PNRA-RG-909.03);
- v. Format and Content of Radioactive Waste Management Programme of Nuclear Medicine Centres (PNRA-RG-915.01);
- vi. Format and Content of Radioactive Waste

Management Programme of Nuclear Installation(s) (PNRA-RG-915.02); and

- vii. Format and Content of Application for Design and FSAR Modification in Nuclear Installation (PNRA-RG-913.02) (Rev.1).

2.2 PNRA Management System

PNRA management system is a framework of processes and procedures to ensure that regulatory functions and responsibilities are fulfilled in a systematic, effective and efficient manner. This framework is documented in the form of PNRA Management System Manual (MSM).

PNRA management system integrates all the elements of organizational management. These include Vision; Mission; Core Values; Organizational Structure; Tasks and Functions; Leadership and Management for Safety; Policies, Goals, Strategies and Plans; Graded Approach; Resource Management; Conflict Management; Core and Support Processes; Organizational Change; and approach towards Monitoring, Assessment and Improvement; etc.

During year 2018, PNRA completed awareness programme on latest version of MSM by arranging sessions at all PNRA departments. These sessions were conducted to develop common understanding for effective implementation of MSM within PNRA.

2.2.1 Monitoring and Assessment of PNRA Management System

PNRA management system manual describes the monitoring and assessment of all regulatory processes and activities through an established process. Accordingly, PNRA conducts a number of activities related to monitoring and assessment in accordance with pre-defined frequencies in order to evaluate the effectiveness of processes and activities. These include annual progress monitoring of strategic plan, quarterly and annual performance evaluation of all PNRA departments, self assessment, independent assessment, annual performance assessment, etc. The detail of these activities is presented below:

a. Monitoring of PNRA Regulatory Processes and Activities

PNRA monitors all its regulatory processes and activities by reviewing performance of activities planned in PNRA Long Term Strategic Plan 2015-2018 and annual work plans. The Strategic Plan reflects strategic goals, strategies and subsequent activities.

In accordance with PNRA management system, PNRA monitors the progress of activities planned in Strategic Plan for the year 2015-2018 on annual basis and provides feedback in the form of annual progress report to top management, senior management and relevant departments for necessary action(s), if any. During the year 2018, PNRA performed annual progress monitoring of the Strategic Plan 2015-2018 and issued progress report accordingly.

PNRA conducts performance monitoring of its departments on quarterly basis. The activities planned in the annual work plans are monitored against progress mentioned in monthly progress reports. The output of the monitoring is communicated to relevant departments for necessary action(s), where required; and senior and top management for information. During this year, PNRA issued four quarterly performance evaluation reports.

b. Assessment of PNRA Regulatory Processes and Activities

Self Assessment

Self assessment is a continual process and is conducted periodically to identify the weaknesses and improve the management system, enhance safety culture and effectiveness of the processes and activities. The self assessment is conducted at the organizational level as well as at departmental level.

All departments are required to conduct their self assessment on biennial basis. During this year, a number of PNRA departments performed self assessment and identified areas for further improvement in processes and activities.

At the organization level, PNRA assesses its integrated performance to assess the effectiveness of regulatory processes and activities on annual basis and presents in its annual report.

The annual performance assessment is conducted on the basis of 12 Strategic Performance Indicators (SPIs) and subsequent downstream indicators - Specific Performance Elements (SPEs). During the year 2018, PNRA conducted its annual performance assessment which is presented in Chapter ten of this report.

Independent Assessment

For independent assessment, PNRA conducts internal regulatory audit of all departments and also invites international organizations for assessing the performance of PNRA processes and activities.

During this year, the 4th regulatory audit of all departments was conducted and individual

audit reports containing recommendations and suggestions for further improvement were issued. An integrated audit report containing suggestions for top management was also issued.

Furthermore, progress on status of implementation of the actions on recommendations and suggestions of the Integrated Regulatory Review Service (IRRS) Mission of the International Atomic Energy Agency (IAEA) was regularly monitored for completion of all the actions according to the specified time frame. In this regard, PNRA issued quarterly reports on the progress of implementation of IRRS Mission action plan.

2.2.2 Management System Documentation

The management system documentation at PNRA is clearly categorized, controlled and made available to all PNRA officials at point of use. The documents include Manuals, Policies, Plans, Programmes, Procedures, Checklists, Guidelines, Reports, etc.

The documents are reviewed and revised based on experience feedback, lessons learned and changes in organizational policies & strategies for further improvement.

The hierarchy of management system documentation is categorized in three levels. The Level-1 documents include Management System Manual, Vision, Mission, Core Values, Organizational Structure, Delegation of Power, Tasks and Functions, Strategic Plan, Policies, etc.

The Level-2 documents include processes, programmes, procedures, etc. The Level-3 documents include job descriptions, work plans, flow charts, guiding documents, checklists, reports, records, etc. The structure of management system documentation at PNRA is presented in Figure-6.

a. Policies

Organizational policies reflect principles, rules, and

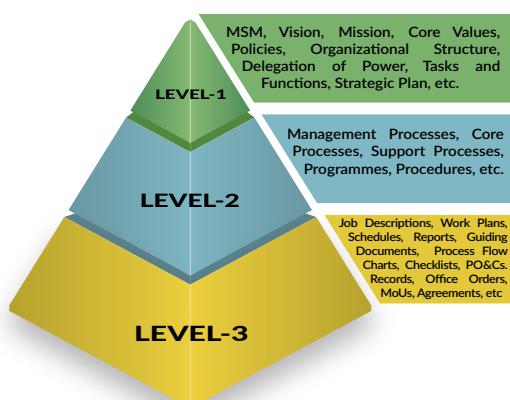


Figure-6: Management System Documentation at PNRA

guidelines formulated or adopted by an organization in order to achieve its goals and objectives in an effective and efficient way.

PNRA issues policies for its routine internal working that usually describe a strategy adopted to determine and guide current and future decisions on organizational matters. PNRA has issued nine policies so far. During the year 2018, PNRA issued two policies for streamlining its routine working whereas, another policy remained in process of development. Implementation of PNRA policies is regularly monitored to enhance the effectiveness of the organization.

b. Procedures

Procedures outline step by step mechanisms for performing tasks assigned to various departments of PNRA. The procedures document a systematic process to accomplish the assigned tasks in an effective manner. PNRA has developed more than 390 technical and administrative procedures for the effective management of its routine affairs.

2.3 Central Registry for Regulatory and Management System Documents

PNRA controls and maintains all the documents generated within PNRA under its regulatory framework and the management system in accordance with documentation management process. These documents include regulations, regulatory guides, policies, programmes, procedures, etc. and are maintained in a central registry.

Figure-7 presents the overall status of documents registered in the central registry.

The regulations promulgated and the regulatory guides published so far are listed in Table-1 and Table-2 respectively.

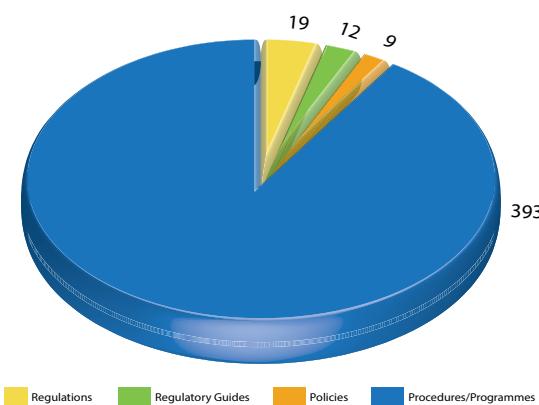


Figure-7: Status of PNRA Central Registry

Table-1: List of Gazette Notified Regulations

Regulations on Licensing Fee by Pakistan Nuclear Regulatory Authority - (PAK/900)	Regulations on Safety of Nuclear Power Plants-Operation - (PAK/913)
Regulations on Transaction of Business of Pakistan Nuclear Regulatory Authority - (PAK/901)	Regulations on Management of a Nuclear or Radiological Emergency - (PAK/914)
Regulations on Radiation Protection - (PAK/904)	Regulations on Radioactive Waste Management - (PAK/915)
Regulations for Licensing of Nuclear Safety Class Equipment and Components Manufacturers - (PAK/907)	Regulations for the Safe Transport of Radioactive Material - (PAK/916)
Regulations for the Licensing of Radiation Facility(ies) other than Nuclear Installation(s) - (PAK/908)	Regulations on the Safety of Nuclear Research Reactor(s) Operation - (PAK/923)
Regulations for Licensing of Nuclear Installation(s) - (PAK/909)	Regulations on Security of Radioactive Sources - (PAK/926)
Regulations on Safety of Nuclear Installations – Site Evaluation - (PAK/910)	Regulations on Decommissioning of Facilities using Radioactive Material - (PAK/930)
Regulations on the Safety of Nuclear Power Plant Design - (PAK/911)	Pakistan Nuclear Regulatory Authority Enforcement Regulations - (PAK/950)
Regulations on the Safety of Nuclear Power Plants-Quality Assurance - (PAK/912)	Pakistan Nuclear Safety and Radiation Protection Regulations, 1990

Pakistan Nuclear Safety and Radiation Protection (Treatment of Food by Ionizing Radiation) Regulations, 1996

Table-2: List of Regulatory Guides

Quality Assurance in Nuclear Medicine (PNRA-RG-904.01)
Guidance for the Users of Iodine - 131 in Nuclear Medicine Centres (PNRA-RG-904.02)
Radiation Safety in Industrial Radiography (PNRA-RG-904.03)
Protection of Patients in Diagnostic Radiology (PNRA-RG-904.05)
Format and Content of Physical Protection Programme of Nuclear Installations (PNRA-RG-909.02)
Probabilistic Safety Assessment of Nuclear Power Plants Level-1 (PNRA-RG-911.01)
Format and Content of Application for Design Modifications in Nuclear Power Plants (PNRA-RG-913.02)
Format and Content of Application for Modifications in Technical Specifications and Operating Policies and Principles of Nuclear Power Plants (PNRA-RG-913.03)
Dosage and Distribution of Potassium Iodide Tablets (a Thyroid Blocking Agent) in Radiation Emergencies (PNRA-RG-914.01)
Preparation of Radiation Emergency Plan for Radiation Facilities and Activities (PNRA-RG-914.02)
Transportation of Radioactive Material by Road in Pakistan (PNRA-RG-916.01)
Registration/Licensing and Issuance of NOC to the Exporter(s) of Radiopharmaceuticals (PAK/9801)



3. Oversight of Nuclear Installations and Associated Activities

An effective regulatory oversight is essential for ensuring safety and preventing degradation of nuclear installations. PNRA has the responsibility to regulate all civilian nuclear installations and associated activities in Pakistan. Nuclear installations include nuclear power plants, research reactors and molybdenum production facility. Whereas, the associated activities include nuclear safety class equipment manufacture and provision of specialized nuclear services.

Presently, five nuclear power plants, two research reactors and one molybdenum production facility

are in operation, while construction of two nuclear power plants is in progress. In addition, there are two nuclear safety class equipment manufacturers and two nuclear service providers in Pakistan. PNRA has a set of regulations for all nuclear installations and associated activities in the country and utilizes the tools of licensing, authorization, review, assessment, inspection and enforcement to regulate them. Table-3 presents information about all civilian nuclear installations and associated activities in the country.

Table-3: Civilian Nuclear Installations and Associated Activities in the Country

S. No.	Licensee / Applicant	Status	Type	Capacity	Start of Operation
1.	Karachi Nuclear Power Plant Unit-1 (K-1)	In Operation	Pressurized Heavy Water Reactor	137 MWe	1972
2.	Karachi Nuclear Power Plant Unit-2 (K-2)	Under Construction	Pressurized Light Water Reactor	1100 MWe	2020 (expected)
3.	Karachi Nuclear Power Plant Unit-3 (K-3)	Under Construction	Pressurized Light Water Reactor	1100 MWe	2021 (expected)
4.	Chashma Nuclear Power Plant Unit-1 (C-1)	In Operation	Pressurized Light Water Reactor	325 MWe	2000
5.	Chashma Nuclear Power Plant Unit-2 (C-2)	In Operation	Pressurized Light Water Reactor	340 MWe	2011
6.	Chashma Nuclear Power Plant Unit-3 (C-3)	In Operation	Pressurized Light Water Reactor	340 MWe	2016
7.	Chashma Nuclear Power Plant Unit-4 (C-4)	In Operation	Pressurized Light Water Reactor	340 MWe	2017
8.	Pakistan Research Reactor-1 (PARR-1)	In Operation	Swimming Pool Reactor	10 MWt	1965
9.	Pakistan Research Reactor-2 (PARR-2)	In Operation	Tank-in-Pool Reactor	30 KWt	1991
10.	Molybdenum Production Facility (MPF)	In Operation	Isotope Production	100 Ci	2013
11.	Heavy Mechanical Complex-3 (HMC-3)	Authorized	NSC-1 Equipment Manufacturer	--	2016
12.	NOVEL Engineering Works-2 (NEW-2)	Authorized	NSC-1 Equipment Manufacturer	--	2018
13.	National Centre for Non-Destructive Testing (NCNDT)	Authorized	Service Provider	--	2017
14.	Inspectest Private Limited (IPL)	Authorization in Process	Service Provider	--	2019 (expected)

3.1 Licensing and Authorization

All civilian nuclear installations and associated activities are operated in the country after fulfilling the regulatory requirements set forth by PNRA regulations. Accordingly, PNRA issues licences and authorizations to nuclear installations for various stages during their lifetime; namely, site registration, construction licence, fuel load permit, operating licence, revalidation of operating licence, etc. Furthermore, an authorization of PNRA is required for criticality of a nuclear power plant after refuelling or long shutdown. These authorizations and licences are granted after satisfactory verification of applicable regulatory requirements. PNRA also conducts licensing of operating personnel of nuclear power plants and research reactors to ensure that qualified and trained personnel operate these installations. The information about licensing and authorization activities is presented below:

3.1.1 Nuclear Power Plants

In Pakistan, Nuclear Power Plants (NPPs) are located at Karachi and Chashma. At Karachi site, Karachi Nuclear Power Plant Unit-1 (K-1) is in operation, while Unit-2 (K-2) and Unit-3 (K-3) are under construction. At Chashma site, four nuclear power plants namely Chashma Nuclear Power Plants Units 1, 2, 3 and 4 (C-1, C-2, C-3 and C-4) are in operation.

K-1 is a CANDU type reactor. In 2017, K-1 operating licence was extended up to September, 2018 subject to the conditions that K-1 will perform the reassessment of its steam generators, fuel channel integrity assessments and necessary maintenance for further operation. To fulfill the regulatory requirements, Long Shut Down (LSD) of K-1 started in September, 2018 and accordingly licence for LSD of K-1 was issued up to March 2019. During LSD, K-1 will perform repair, maintenance, refurbishment, testing and overhauling, etc. of its structures, systems and components. Accordingly, K-1 will submit the analyses, evaluations and assessment reports to PNRA as per regulatory requirements for further extension in its operating licence.

K-2 and K-3 are three loop pressurized water reactors which are under construction. During 2018, civil construction of safety related structures and installation of primary coolant system of K-2 was completed, whereas installation of other auxiliary equipment and systems remained in progress. Major construction activities for K-3 included construction of containment building; installation of reactor pressure vessel and steam generators; and placement of containment dome. In addition, construction of water intake and outfall tunnels for the plants remained in progress. PNRA performed

the regulatory oversight of construction activities. PNRA expects that the licensee will submit application for loading of nuclear fuel in 2019.

The C-Series NPPs (C-1, C-2, C-3 and C-4) are two-loop pressurized water reactors. PNRA granted operating licences to C-3 and C-4 on May 02, 2018. During 2018, PNRA conducted operational safety trend analysis of C-1 and C-2 to identify any degradation in safety performance and promoting safety improvements. On the basis of trend analysis, it was concluded that grid fluctuation was the major cause of plant trips. Accordingly, the licensee was advised to contact relevant national organizations to ensure and enhance grid stability. Furthermore, the trend of leakage in reactor coolant system for both identified and un-identified leakages was noted to be increasing in C-1, though it was still much below the regulatory limit defined in plant's technical specifications. In this regard, C-1 was advised to take corrective actions as proactive approach.

C-1 underwent its 12th Refuelling Outage (RFO-12) in 2018. The plant was shutdown manually and was disconnected from the national grid on July 26, 2018. The RFO-12 continued for 51 days during which all the planned outage jobs were completed under the regulatory oversight. PNRA granted permission for criticality and subsequently the reactor was made critical on September 13, 2018 and connected to grid on September 15, 2018.

C-2 completed its 5th Refuelling Outage (RFO-5) during 2018. The plant was manually shutdown for RFO-5 on January 23, 2018 which continued for 38 days to complete all the planned outage jobs under the regulatory oversight. PNRA granted permission to make reactor critical and subsequently the reactor was made critical on March 01, 2018 and connected to grid on March 02, 2018.

C-3 went through its first Refuelling Outage (RFO-1) during 2018. The plant was shutdown manually on May 09, 2018 and remained shutdown for 64 days to complete all the planned outage jobs under the strong regulatory oversight. PNRA granted permission for making the reactor critical and subsequently the reactor was made critical on July 08, 2018 and connected to grid on July 11, 2018.

3.1.2 Research Reactors and Molybdenum Production Facility

Pakistan has two research reactors which are used for training and research purposes. These are Pakistan Research Reactors-1 and 2 (PARR-1 & PARR-2). During the year 2018, the follow-up of corrective action plan corresponding to Periodic Safety Review (PSR) of PARR-1 remained in progress. All the pending corrective actions of PSR were completed and the associated licensing submissions



Visit of Member Executive PNRA at Intake Structure of K-2 Site



Meeting of Member Corporate PNRA with the Inspectors Posted at K-2 / K-3 Site

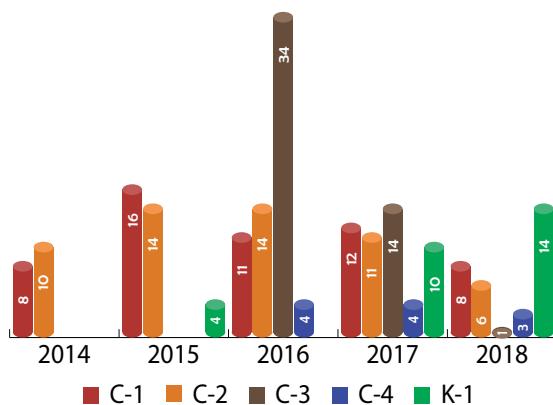


Figure-8: New Licences Issued to Operating Personnel of NPPs

updated and accordingly approved. Based on PSR and current documentation, the operating licence of PARR-1 was extended till December 31, 2021. The licence of PARR-2 is valid till December, 2024.

Pakistan has one Molybdenum Production Facility (MPF) in operation. MPF is being utilized for the production of Molybdenum-99 isotope as the mother product for production of Technetium-99m, which is widely used in medical diagnostic procedures. The operating licence of MPF is valid till December, 2022.

3.1.3 Nuclear Equipment Manufacturers and Service Providers

There are two licensed Nuclear Safety Class-1 (NSC-1) equipment manufacturers in the country, namely Heavy Mechanical Complex-3 (HMC-3); and NOVEL Engineering Works-2 (NEW-2). The licence of HMC-3 is valid till June, 2022. PNRA awarded manufacturing licence to NEW-2 in 2018, which is valid till December, 2022. Moreover, PNRA received a letter of intent from the Instrumentation Control & Computer Complex (ICCC) for licensing as NSC-1 equipment manufacturer in 2018 which is under review.

The National Centre for Non-Destructive Testing (NCNDT) is the authorized nuclear service provider for provision of specialized services to nuclear power plants. Its authorization is valid till December, 2020. PNRA has also received an application from Inspectest Private Limited (IPL) in 2018 for authorization as nuclear service provider, which is presently under review at PNRA.

3.1.4 Licensing of Operating Personnel

PNRA ensures that operating personnel of nuclear power plants are well qualified and trained according to applicable regulatory requirements. In this regard, PNRA issues licences to operating personnel of nuclear installations for the positions of shift

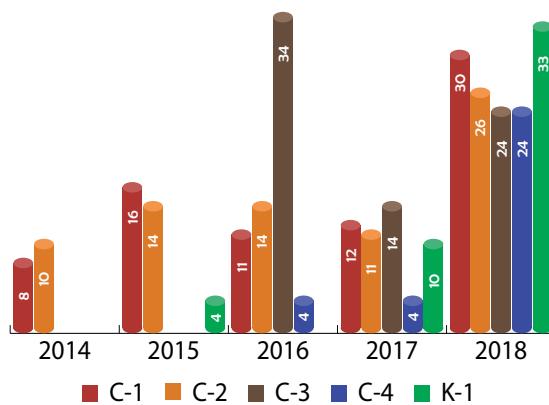


Figure-9: Renewal of Licences to Operating Personnel of NPPs

supervisors, shift engineers and reactor operators. PNRA conducts oral and operating examinations for the award of licences to the operating personnel. The licence is renewed annually based on verification of technical and professional competences, fulfillment of requirements of minimum shift operation, re-training and medical fitness.

The detail of new licences issued to nuclear power plant operating personnel is reflected in Figure-8, whereas the detail of operating personnel licences renewed, during last five years, is presented in Figure-9. Similarly, the issuance and renewal of licences to operating personnel of PARR-1 and PARR-2 is reflected in Figure-10.

3.2 Review and Assessment

PNRA reviews and assesses licensing submissions of nuclear installations and associated activities to determine the compliance with applicable regulatory requirements prescribed through regulations, licence conditions, applicable codes and standards, etc. In case of non-compliance, PNRA may take necessary actions as per enforcement regulations and subsequent procedures to ensure safety of the installation, the workers, the public and the environment.

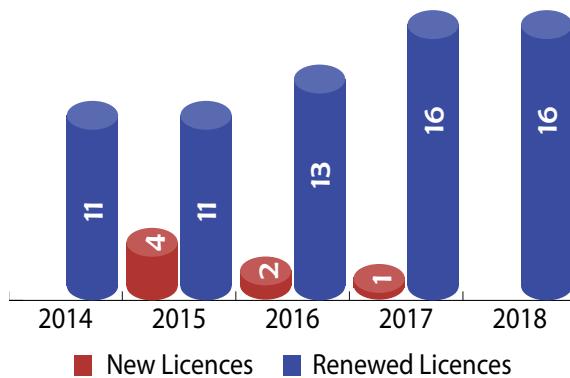


Figure-10: Issuance and Renewal of Licences to Operating Personnel of PARR-1 & 2



PNRA Team Conducting Inspection at K-3 During Construction Activities

PNRA regulations require submission of various documents to support application for licensing or authorization which are reviewed in detail by PNRA. In addition, other documents such as modifications in design and technical specifications, event reports, routine reports, etc. required under various regulations, licence conditions and directives issued from time to time are also reviewed by PNRA.

During 2018, PNRA critically assessed the submitted event reports to verify compliance of regulatory requirements and implementation of corrective actions. All these events were level zero events as per International Nuclear Event Scale (INES). Furthermore, PNRA evaluated experience feedback and events reported from different international platforms highlighting lessons to enhance safety of nuclear installations in Pakistan. In this regard, reports on international operating experience feedback and evaluation of events were prepared and shared with relevant stakeholders.

Summary of review and assessment activities performed during the year is presented in Table-4.

Table-4: Summary of Review and Assessment Activities

S. No.	Licensee	Licensee Submissions	Design Modifications	Event Reports
1.	K-1	01	02	03
2.	K-2/K-3	10	01	--
3.	C-1	08	03	07
4.	C-2	08	03	03
5.	C-3	08	--	02
6.	C-4	08	--	05
7.	PARR-1	03	--	02
8.	PARR-2	01	--	01
9.	MPF	10	01	--

3.2.1 Nuclear Power Plants

During 2018, PNRA reviewed and approved two design modifications received from K-1, whereas, review of final decommissioning plan of K-1 remained in progress.

A number of K-2 and K-3 submissions were reviewed during 2018. These included different programmes related to radiation protection, fire protection, chemistry control, in-service and pre-service inspections, containment leakage rate testing, etc. PNRA also reviewed and approved an application for design modification in K-2 and K-3.

PNRA reviewed several submissions related to C-Series NPPs during the year 2018. These included reports on radioactive waste generation, ambient dose levels, occupational exposures, environmental monitoring, operational statistics, radiological effluent release and refuelling outage. PNRA also reviewed various submissions including CNPGS physical protection programme; radiation protection programme of C-3 and C-4; chemistry control programme of C-2; quality assurance programme of C-4; and scope and strategy for periodic safety reviews of C-1 and C-2. PNRA also reviewed and approved three design modifications of C-1 and C-2 NPPs.

3.2.2 Research Reactors and Molybdenum Production Facility

During 2018, PNRA reviewed a number of licensing submissions of research reactors. These included monthly technical reports, quarterly safety performance indicator reports and annual safety reports. PNRA approved revised physical protection programme of PARR-1 and PARR-2 and initial decommissioning plan of PARR-1. Furthermore, review of radiological emergency plan and revised Final Safety Analysis Report (FSAR) of PARR-1; and initial decommissioning plan of PARR-2 remained in progress during the year.

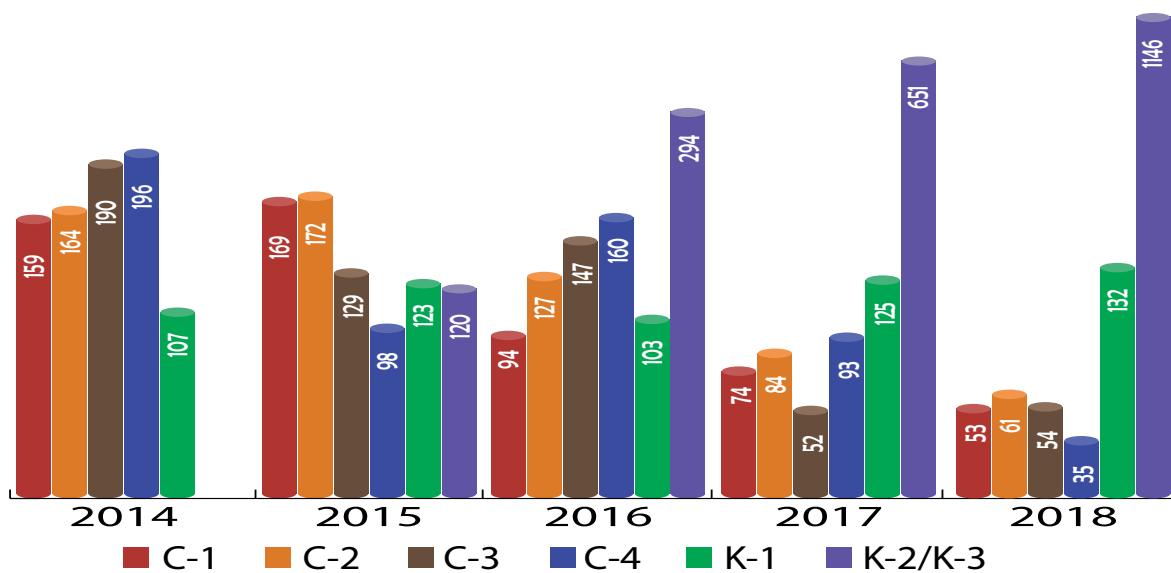


Figure-11: Regulatory Inspections Conducted at Nuclear Power Plants

A number of submissions from MPF were reviewed during 2018. These include the revised FSAR, emergency preparedness plan and a design modification.

3.2.3 Nuclear Equipment Manufacturers and Service Provider

During 2018, PNRA reviewed several documents submitted by HMC-3 like Q-plans, manufacturing drawings, production technology, product completion reports and technical specification of manufacturing items. In addition, PNRA also reviewed quality manual and relevant procedures submitted by NEW-2.

Furthermore, PNRA reviewed several documents of NCNDT including Q-plans and relevant procedures regarding provision of services related to safety class systems and components during refuelling outages. Moreover, Inspectest Private Limited (IPL) submitted documents for licensing for providing pre-service and in-service inspection services to nuclear power plants. Accordingly, these submissions were reviewed and regulatory position was communicated to IPL.

3.3 Inspection and Enforcement

PNRA performs regulatory inspections of nuclear installations and associated activities to ensure compliance with its regulations, licence conditions and other commitments made by the licensee / applicant. The inspection activities are conducted in accordance with PNRA inspection programme for nuclear installations and subsequent procedures.

In order to ensure safety at nuclear installations, PNRA has established three Regional Nuclear

Safety Directorates (RNSDs) - RNSD-I (Islamabad), RNSD-II (Chashma) and RNSD-III (Karachi). These regional directorates conduct inspections of nuclear installations in their respective jurisdiction. PNRA departments located at PNRA HQs. also provide technical support in inspections, when needed.

PNRA conducts regulatory inspections in all phases of a nuclear installation's life cycle. The inspections are conducted according to annual inspection plan whereas un-planned or reactive inspections are also conducted in case of an event or non-compliance. The inspections can be announced as well as un-announced. The planned inspections include control room inspections; general surveillance of nuclear installations on daily basis; periodic inspections of plant systems and processes at a defined frequency; inspections of routine tests of systems and equipment; and control point inspections of selected activities. The inspections are conducted according to the approved procedures and checklists. PNRA issues directives to the licensees in the form of inspection reports in case any deficiencies or

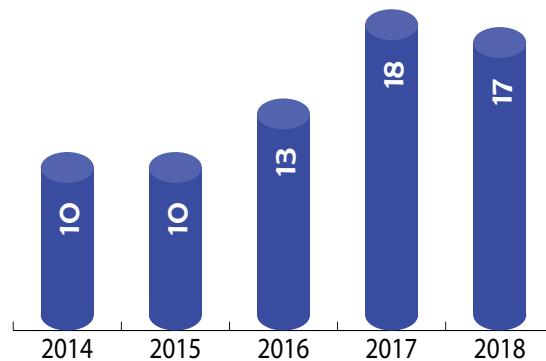


Figure-12: Regulatory Inspection of Research Reactors and MPF

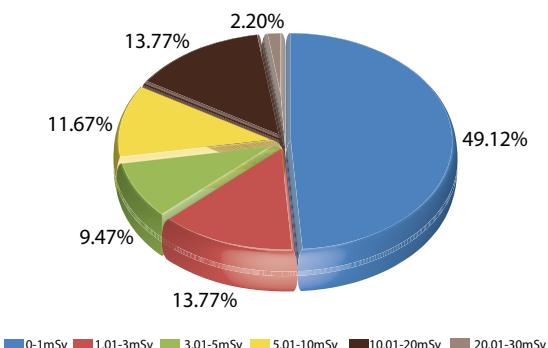


Figure-13: Annual Radiation Doses to K-1 Workers

non-compliances of national regulations, licence conditions, applicable codes & standards and quality assurance programme or procedures are observed. PNRA ensures timely implementation of corrective actions through follow-up inspections. The summary of inspections conducted at nuclear power plants over the past five years is reflected in Figure-11.

Regulatory inspections at research reactors and MPF are conducted in line with annual plans in various areas of regulatory interest. During the year 2018, PNRA conducted a number of regulatory inspections at PARR-1, PARR-2 and MPF. These inspections were conducted in the areas of operation, radioactive waste, radiation protection, emergency preparedness and quality assurance. Figure-12 reflects a summary of inspections conducted at research reactors and MPF over past five years.

In addition to inspections at nuclear installations, PNRA also conducts regulatory inspections of licensed equipment manufacturers and service providers. PNRA selects control points for carrying out inspections during the manufacturing of nuclear safety class equipment of nuclear power plants.

During this year, 79 control point inspections

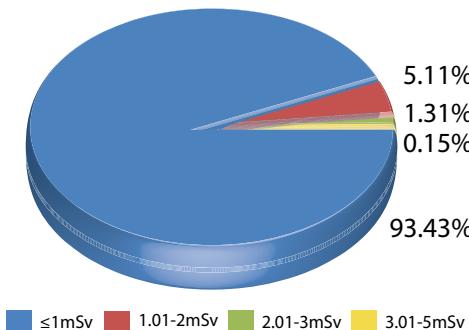


Figure-15: Annual Radiation Doses to C-2 Workers

at HMC-3 and ten inspections at NCNDT were conducted in the areas of processes, testing, qualification and performance examinations. Furthermore, eight control point inspections were carried out to witness the manufacturing activities of Back-up Hot Cell-1 of MPF. PNRA also performed an inspection to verify effectiveness of quality assurance system of NCNDT during 2018.

PNRA also conducts inspections of vendors of nuclear safety class equipment manufacture for new NPPs in addition to inspections during different licensing stages. These inspections are aimed to confirm compliance of applicable standards, regulatory requirements and conditions specified in the authorization which have a potential impact on safety. During 2018, PNRA inspectors conducted 14 control point inspections in China during manufacturing of equipment for K-2 and K-3.

3.4 Occupational Exposures at Nuclear Installations

The licensees submit occupational exposure record of workers involved in radiation work at nuclear installations on annual basis. This includes information about number of persons exposed, collective dose; maximum and average individual

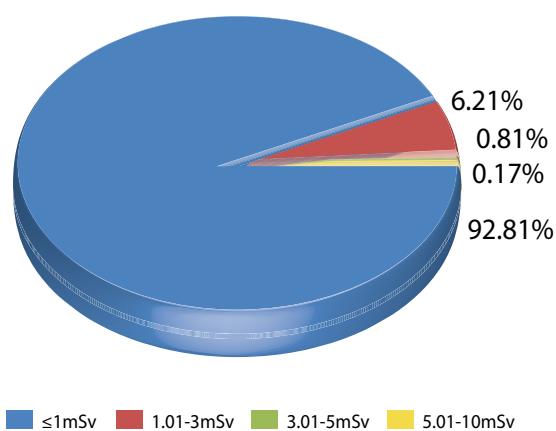


Figure-14: Annual Radiation Doses to C-1 Workers

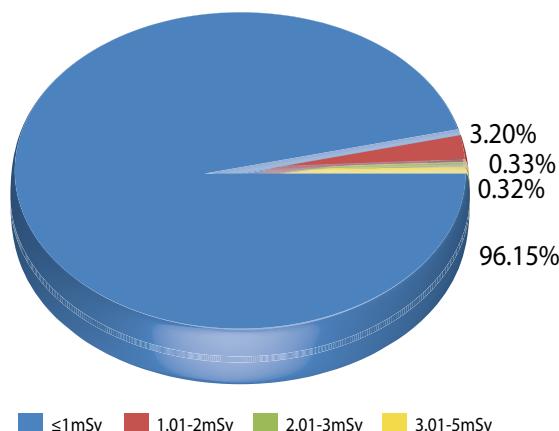


Figure-16 : Annual Radiation Doses to C-3 Workers

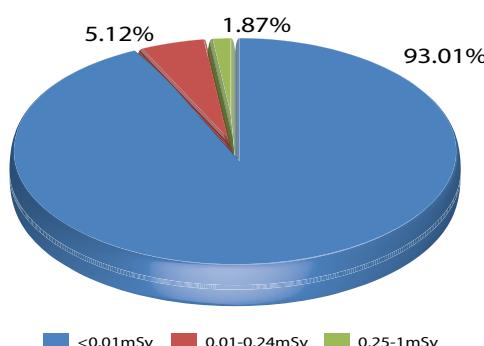


Figure-17: Annual Radiation Doses to C-4 Workers

dose received by radiation workers. PNRA monitors and assesses the data submitted by licensees. As per regulatory requirements, the annual dose limit for a radiation worker is 20 mSv. However, in special circumstances, an effective dose of up to 50 mSv in a single year may be approved by PNRA provided that the average dose over five consecutive years does not exceed 20 mSv/year. During 2018, K-1 requested to allow certain workers involved in specialized jobs during current long shut down to continue work up to an exposure of 30 mSv. PNRA granted permission upon the assurance that five years average dose is to be kept within the regulatory limit.

During 2018, more than 49% workers of K-1 received dose below 1 mSv whereas around 49% workers were between 1-20 mSv dose range. Only a small fraction, around 2% of workers exceeded annual dose limit of 20 mSv. However, it was ensured that average radiation dose over a period of five years was within the prescribed regulatory dose limit. Figure-13 represents the percentage of radiation doses to K-1 workers.

The dose of more than 92% workers at C-1 was below 1 mSv whereas more than 7% workers

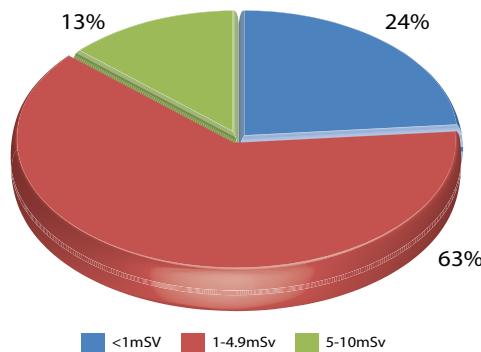


Figure-19: Annual Radiation Doses to Research Reactor Workers

received dose between 1-5 mSv. A small fraction 0.17% of workers received dose in the range of 5-10 mSv. The dose received by more than 93% workers at C-2 was below 1 mSv while the dose of remaining workers was in the range of 1-5 mSv. The dose distribution at C-1 and C-2 is graphically represented in Figures-14 and 15 respectively.

Radiation doses of more than 96% workers of C-3 remained less than 1 mSv while remaining workers received doses in the range of 1-5 mSv. Similarly, doses of all workers at C-4 remained below 1mSv. Figures-16 and 17 reflect dose distribution at C-3 and C-4.

PNRA also monitors the doses to the workers during various activities carried out during refuelling outages. In this regard, trend of doses to workers during refuelling outages at C-Series NPPs is reflected in Figure-18.

Furthermore, occupational exposure of radiation workers at research reactors and MPF for the year 2018 was also noted to be well within the regulatory limits. Figure-19 reflects dose distribution of research reactor workers whereas Figure-20 represents the dose distribution of MPF workers.

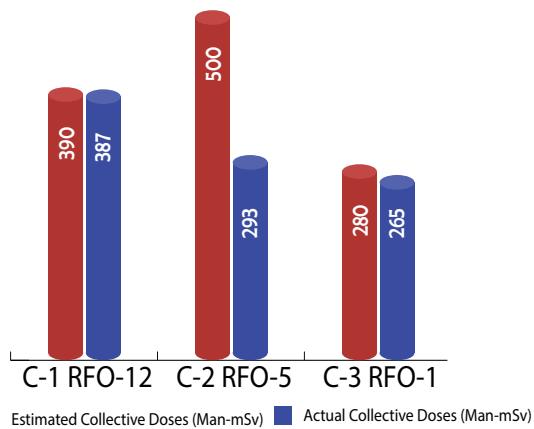


Figure-18 : Estimated and Actual Collective Doses during RFOs at C-Series NPPs

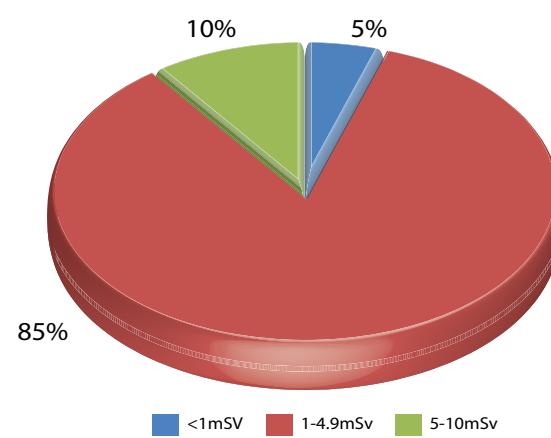


Figure-20 : Annual Radiation Doses to MPF Workers



4. Oversight of Radiation Facilities

Radiation sources (i.e. radioactive materials and radiation generators) are widely used in medical; industrial; agriculture; research and development sectors for the benefit of mankind. In medical sector, these sources are used for radiotherapy and diagnostic purposes; and in industry these sources are used in nuclear gauges and oil well logging. Use of radioactive sources for industrial radiography is also widespread for detecting defects in different materials. Radioactive sources are also used as irradiators for preservation of food items, sterilization of medical equipment and preservation of blood in blood banks. These sources are dangerous for human health, if appropriate safety measures are not taken during their use. PNRA regulates these facilities and activities to ensure protection of the workers, the public and the environment from harmful effects of ionizing radiation emitted by these sources.

In order to fulfill the regulatory obligations, PNRA has established a regulatory framework comprising of regulations and regulatory guides for safe use of radiation sources. The regulatory oversight process of PNRA comprises licensing of radiation facilities; authorization of practices and activities; review and assessment of licensing submissions; inspections of facilities and activities; maintenance and monitoring of records; and enforcement in case of non-compliance of regulatory requirements. This regulatory oversight is based on a graded approach according to safety significance and hazards associated with the facilities and activities.

4.1 Licensing and Authorization

PNRA grants licences and authorizations to

radiation facilities including service providers and manufacturers engaged in practices and activities involving radiation sources. These licences and authorizations are issued after ensuring that the applicant meets the regulatory requirements stipulated in PNRA regulations. This is verified through review and assessment of submissions; and inspections of premises, material and equipment involved. A licence is issued for a specific period of time and thereafter renewed based on consistent compliance of all applicable regulatory requirements.

Almost all the facilities and activities using radiation sources in the country are in PNRA's licensing network. However, there are some diagnostic X-ray facilities which are still out of the licensing network.

It is very encouraging that as a result of strenuous efforts, continuous pursuance and rigorous enforcement endeavors of PNRA, number of licensed facilities have significantly increased. PNRA believes that such efforts have contributed towards enhancement of the safety of the workers, the public and the environment from the operation of radiation facilities.

It is worth to mention that more than 570 new radiation facilities were licensed during the year 2018, thereby enabling PNRA to further expand its licensing net for radiation facilities.

By the end of year 2018, more than 5300 radiation facilities were in the licensing net of PNRA. The number of different types of licensed radiation facilities and registered radiation workers in such facilities is reflected in Table-5.

Table-5: Radiation Facilities under PNRA's Purview

Sr. No.	Type of Radiation Facility	Licensed Facilities	Registered Radiation Workers
1.	Nuclear Medicine, Radiotherapy, Cardiology and other Medical Facilities	87	2634
2.	Diagnostic X-ray Facilities including Dental Radiology	4668	7863
3.	Industrial Facilities including Industrial Radiography, Nuclear Gauges, Oil Well Logging, Irradiators, Analyzers, etc.	191	2104
4.	Educational and Research Institutes	71	405
5.	Importers of Radiation Generators and Sources	133	289
6.	Others (Scanners, Service Providers and Manufacturers)	183	709



PNRA Team Conducting Inspection and Survey at a Medical Cyclotron Facility

PNRA grants authorization for the import and export of radiation sources. For this purpose, PNRA has established collaboration with the Federal Board of Revenue to strictly control and prevent entry or exit of any consignment containing radiation sources unless the consigner obtains a “No Objection Certificate (NOC)” from PNRA. Only a valid licence holder is authorized to import or export radiation sources. The NOC is issued after verification of the intended end use and the technical specifications of the radiation source being imported or exported. A high activity sealed radioactive source (with initial activity of 100 GBq or more and half life greater than one year) can only be imported upon provision of undertaking by the supplier or manufacturer to accept its return at the end of its useful design life. PNRA also issues NOCs for the export of empty containers and disused sources. During 2018, PNRA issued 1388 NOCs for the import of new radiation sources; and 68 NOCs for export of empty containers and disused sources. Figure-21 reflects trend of NOC’s issued during last five years.

In some cases of import, the originating country requires a special permit from PNRA prior to procurement of a radiation source. PNRA issues such permit to facilitate the process of procurement. In 2018, PNRA issued 117 permits for procurement of radiation sources.

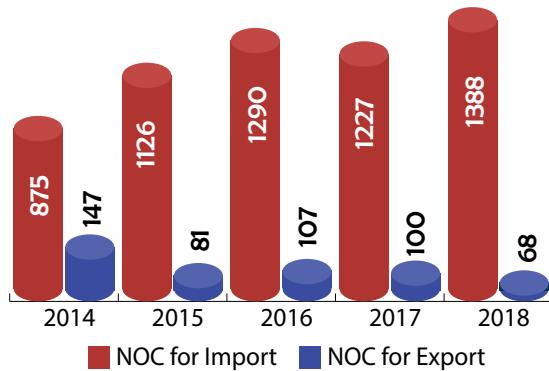
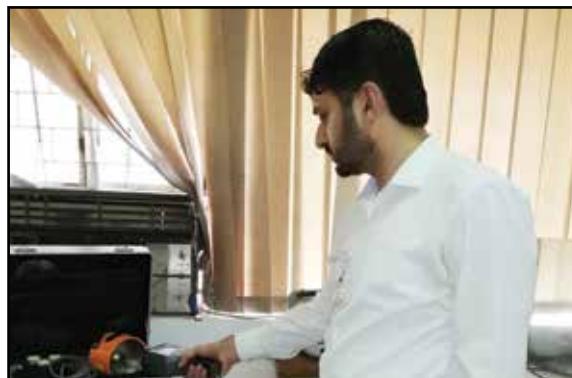


Figure-21: NOCs Issued for Import-Export of Radiation Sources



PNRA Official Conducting Physical Verification of Source at a Research Institute

PNRA maintains an inventory of sealed radioactive sources used in radiation facilities and activities in Pakistan. This inventory is maintained to ensure regulatory control on all such sources in the country from cradle-to-grave. Figure-22 presents an overview of sealed radioactive sources being used in different types of radiation facilities as per the inventory maintained at PNRA.

4.2 Review and Assessment

The applicants / licensees of radiation facilities are required to submit necessary documents such as programmes / plans for radiation protection, emergency preparedness, physical protection etc.; and training and qualification of personnel for licensing. PNRA follows a graded approach in requiring different levels of details in these documents that is commensurate with the potential hazard associated with the facility or an activity.

PNRA performs review and assessment of these submissions and communicates its position on whether the document is acceptable or gives recommendations for further improvement. Similarly, PNRA also performs review and assessment of submissions related to modifications in existing facilities for introduction of new practices. During 2018, PNRA reviewed a number of submissions from various radiation facilities.

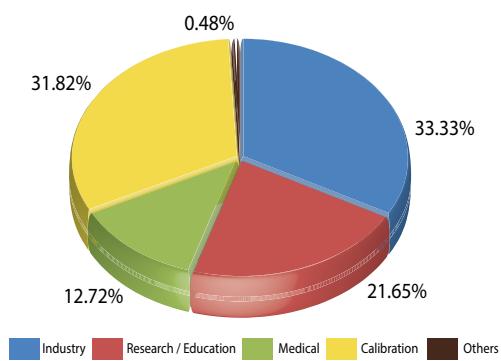


Figure-22: Sealed Radioactive Sources by Usage



PNRA Inspector Conducting Neutron Survey at an Industrial Facility

These included radiation protection programmes of nuclear medicine centres, radiotherapy facilities and industrial users; design and shielding calculations of linear accelerator and irradiator bunkers; commissioning plan and quality assurance programme for gamma camera installation; and safety reports of therapeutic / diagnostic procedures. PNRA also performs safety assessment of radiation facilities on the basis of performance objectives and criteria. In this regard, collection of input and subsequent safety assessment of radiation facilities remained in progress during 2018.

Furthermore, PNRA evaluated events reported from different international platforms highlighting lessons to enhance safety of radiation facilities in Pakistan. In this regard, reports on evaluation of events were prepared and shared with relevant stakeholders.

4.3 Inspection and Enforcement

Regulatory inspection is one of the core functions of PNRA and is a vital instrument for its regulatory oversight. Accordingly, PNRA conducts inspections of all facilities and activities using ionizing radiation. The purpose of these regulatory inspections is to witness the on-going activities; perform verification of documents and records; and conduct testing and measurements etc. to ensure compliance of regulatory requirements.

The inspections conducted by PNRA are of various types such as planned, unplanned, special and reactive inspections. All of these inspections can be announced or unannounced. These inspections are conducted prior to grant of initial licence to a radiation facility and after that on a pre-defined frequency during their routine operation.

In order to perform these regulatory inspections in an effective and efficient manner, PNRA has established regional directorates and inspectorates at different locations in the country. At present, PNRA has three regional directorates at Islamabad, Chashma and



DG Inspection & Enforcement Conducting Hearing of Defaulters at PNRA Inspectorate Multan

Karachi; and three regional inspectorates working under these directorates at Peshawar, Multan and Quetta respectively.

PNRA chalks out annual inspection plans for conducting these inspections as per defined frequency with graded approach depending upon the risk associated with the facility or activity.

PNRA has conducted more than 3100 inspections of radiation facilities and activities during 2018. The findings or gaps identified during these inspections and the corresponding recommendations are documented in the inspection reports which are communicated to the inspected facilities and are appropriately followed up for implementation of required corrective actions. Figure-23 reflects an overview of regulatory inspections of radiation facilities conducted during last five years.

PNRA takes enforcement actions against those licensees who do not comply with the regulatory requirements of PNRA Ordinance, regulations, directives or licence conditions. The enforcement actions include issuance of directives, show cause notices, offence reports and conduct of hearings. In severe circumstances, PNRA can also issue work stoppage notice, lock and seal the premises, or suspend / cancel an authorization / licence. During the year, a number of show cause notices and offence reports were issued by PNRA and accordingly

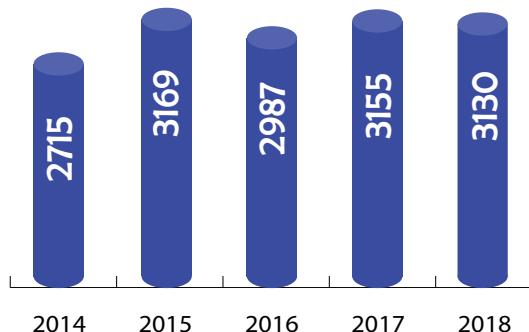


Figure-23: Regulatory Inspections of Radiation Facilities

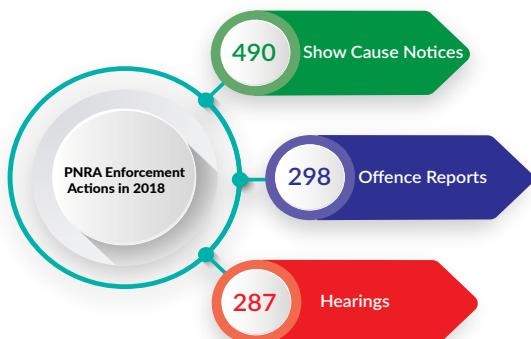


Figure-24: Enforcement Actions taken by PNRA

hearings were conducted. Significant improvement in compliance of regulatory requirements was observed through these enforcement actions. Figure-24 reflects the overall status of enforcement actions taken by PNRA during 2018.

4.4 Occupational Exposures at Radiation Facilities

PNRA is maintaining a database of occupational exposure records of radiation workers at national level. This record is used to evaluate variations in occupational exposures. The database also ensures implementation and effectiveness of radiation protection programme in routine work practices. PNRA evaluates the dose record of the workers to monitor exposures and adherence to regulatory dose limits. As per regulatory requirements, the annual dose limit for a radiation worker is 20 mSv. However, in special circumstances, an effective dose of up to 50 mSv in a single year may be approved by PNRA provided that the average dose over five consecutive years does not exceed 20 mSv/year.

This database has two basic sources of input; records submitted by licensees and records provided

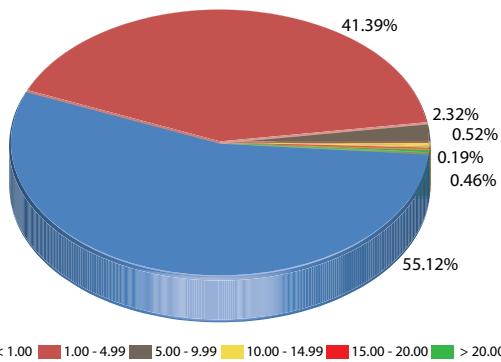


Figure-26: Dose Ranges (Millisieverts) of Workers in Radiation Facilities

by dosimetry service providers at national level. Currently, the database includes dose records of more than 14000 radiation workers. The distribution of radiation workers in various types of radiation facilities is shown in Figure-25.

As per this database, to date, doses to more than 96% of radiation workers remained less than 5 mSv in a year while more than 3% of the workers received doses between 5-20 mSv in a year. A small fraction (0.46%) of the workers received doses above 20 mSv in a year. The reason for such higher doses was thoroughly investigated and it was ensured that whenever such exposures are reported, the five year average annual dose of such workers is kept within the prescribed regulatory dose limit. During the year, 13 investigation reports of occupational over-exposure cases were reviewed and the licensees were advised to take corrective actions accordingly. Figure-26 reflects the overall occupational exposure of all radiation workers in different dose ranges.

Through these regulatory oversight activities, PNRA ensures that all radiation facilities and activities in the country are maintaining an acceptable level of safety by performing their activities in accordance with the applicable regulatory requirements.

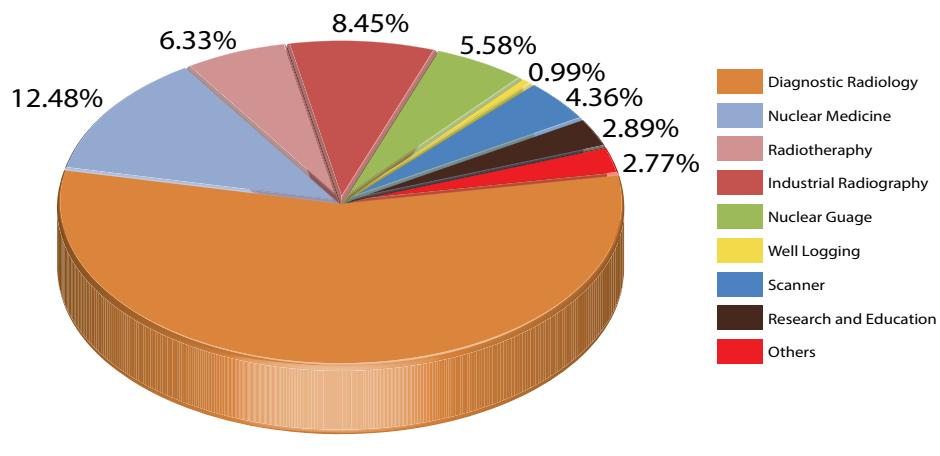


Figure-25: Distribution of Radiation Workers in Radiation Facilities



5. Oversight of Radioactive Waste, Spent Nuclear Fuel and Transport

Radioactive waste is generated at nuclear installations and radiation facilities during their operation. Similarly, Spent Nuclear Fuel (SNF) is also generated at nuclear installations. Moreover, radioactive materials are routinely transported in the country. All these activities involve ionizing radiation which may be dangerous for human health, if not properly managed. PNRA regulates all these activities to ensure that these are managed in accordance with the applicable national regulatory requirements and international standards and practices.

5.1 Radioactive Waste Management

PNRA pays high importance to the safe management of radioactive waste generated in the country to ensure safety of individuals and environment. It ensures safety through rigorous regulatory oversight of radioactive waste managed at nuclear installations and radiation facilities.

5.1.1 Radioactive Waste at Nuclear Power Plants

The regulatory framework requires the licensees of Nuclear Power Plants (NPPs) to keep the generation of radioactive waste to a minimum practicable. PNRA ensures that the licensees have appropriately managed the radioactive waste by taking suitable measures for its classification, segregation, treatment, conditioning and storage. Radioactive waste generated as a result of operation of NPPs is of two basic types: solid radioactive waste and radioactive effluents comprising liquids and gases. PNRA monitors the generation of solid radioactive

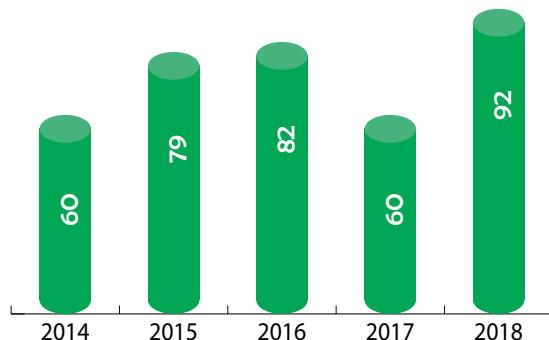


Figure-27: Number of Radioactive Waste Drums Generated at K-1

waste and radioactive effluents of NPPs to verify compliance with regulatory requirements. PNRA also assesses trend of waste generation to identify any adverse practice so that necessary corrective measures are taken well in advance by the licensees.

a) Solid Radioactive Waste

The operation of a NPP generates various types of solid radioactive waste which includes ventilation system filters, floor coverings, contaminated tools, small metallic or glass objects, rubbers, rags, clothing, etc. The radioactive waste, after necessary processing, is stored in the radioactive waste storage building at the plant sites in steel drums. PNRA ensures that NPPs manage solid radioactive waste in accordance with the applicable regulations and approved Radioactive Waste Management Programmes (RWMPs) through inspections and document verification. PNRA also maintains the inventory of radioactive waste drums generated at NPPs and ensures that volume of radioactive waste generated is kept within the approved annual limit. Figure-27 reflects the number of the solid radioactive waste drums generated at K-1 and Figure-28 shows number of radioactive waste drums generated at C-Series NPPs, during last five years.

b) Radioactive Effluents

Radioactive effluents are discharged from NPPs during normal operation in a controlled manner. PNRA keeps a strict oversight on discharge of radioactive effluents from these installations to ensure compliance of authorized limits in accordance with ALARA principle. During the year

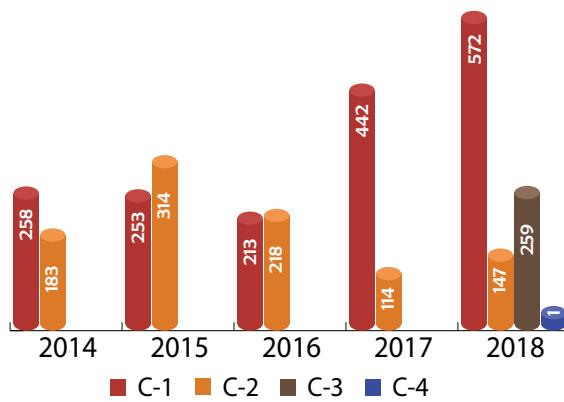


Figure-28: Number of Radioactive Waste Drums Generated at C-Series NPPs

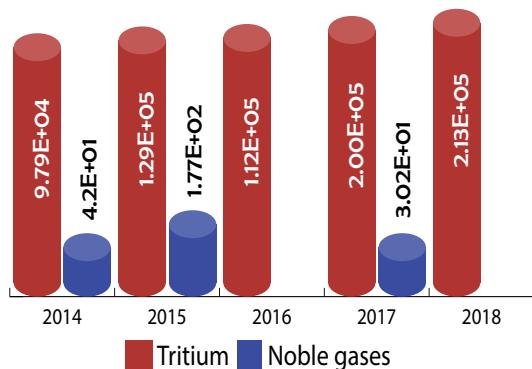


Figure-29: Gaseous Effluents (GBq/yr) from K-1

2018, the gaseous and liquid radioactive effluents discharged to the environment from operating NPPs remained within the authorized limits. Figure-29 and Figure-30 represent releases of gaseous and liquid radioactive effluents respectively from K-1; whereas Figure-31 and Figure-32 show releases of gaseous and liquid radioactive effluents respectively from C-Series NPPs during the last five years.

5.1.2 Radioactive Waste at Radiation Facilities

The application of radioactive materials in medical and industrial sectors is extremely important and its use is continuously increasing. The use of such materials generate radioactive waste including solid and liquid radioactive waste. Moreover, sealed radioactive sources, after completion of their useful life for the intended purpose, become radioactive waste and are termed as Disused Sealed Radioactive Sources (DSRS). PNRA ensures that radioactive waste generated from medical facilities and industrial applications including DSRS are appropriately managed as per applicable regulatory requirements.

Nuclear Medicine Centres (NMCs) generate radioactive waste containing short lived radionuclides. The solid radioactive waste at NMCs is stored prior to disposal as ordinary waste, until

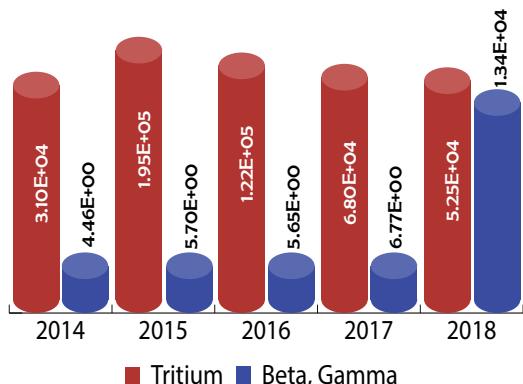


Figure-30: Liquid Effluents (GBq/yr) from K-1

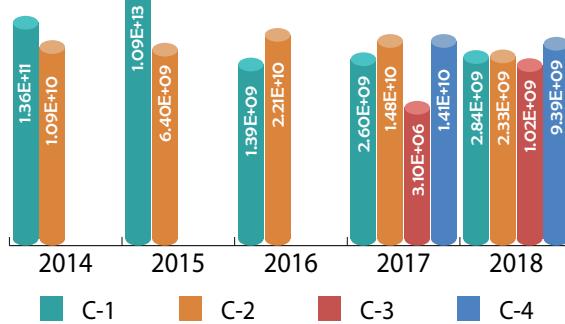


Figure-31: Gaseous Effluents (Bq/yr) from CNPGS

radioactivity decays up to the acceptable limits. The liquid radioactive waste is discharged directly or through delay tank, when it is below acceptable limits. PNRA ensures through inspections and record review that the management of radioactive waste is in accordance with regulations and approved RWMPs.

PNRA requires these centres to submit their radioactive waste management programmes for review and acceptance. During the year, 21 RWMPs were reviewed. Eight programmes were accepted while others were directed to further improve their programmes and submit updated versions to PNRA. During 2018, PNRA conducted a number of inspections of nuclear medicine centres and provided recommendations for further improvement in radioactive waste management practices.

Internationally, long lived high activity DSRS are returned to the supplier after completion of their useful life in order to reduce the accumulation of these sources in the country. Accordingly, PNRA requires that DSRS having a half life of more than 1 year and initial activity greater than 100 GBq are returned to the supplier. The DSRS which are not returned to the supplier, are stored at designated storage sites in the country and PNRA maintains inventory of all such sources. As per the inventory, the DSRS stored at these sites mainly include Co-

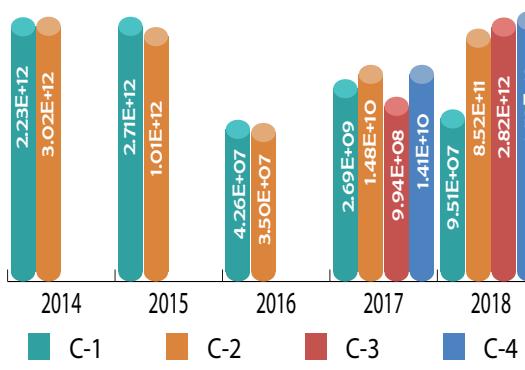


Figure-32: Liquid Effluents (Bq/yr) from CNPGS

60, Cs-137, Ir-192 and Ra-226. By the end of this year, 90.9% of DSRS in the country were safely stored at designated storage sites while 9.1% were returned to suppliers / manufacturers. Figure-33 shows the graphical representation of the status of DSRS.

a. Radioactive Waste Management Facilities

At present, two designated radioactive waste management facilities are established in the country. These include; Radioactive Waste Storage Area (RAWSA) at KANUPP, Karachi and PINSTECH Predisposal Radioactive Waste Management Facility (PPRWMF), Islamabad. These facilities store solid radioactive waste generated from nuclear power plants, research reactors and isotope production facilities in reinforced cement concrete barrels and mild steel drums, whereas, DSRS received from the radiation facilities are stored in shielded containers.

PNRA keeps track of radioactive waste stored at these facilities and ensures that radioactive waste management at these facilities is performed in compliance with applicable regulatory requirements.

Figure-34 presents the number of compacted and cementized containers of radioactive waste stored at PPRWMF for the last five years.

5.2 Management of Spent Nuclear Fuel

The nuclear fuel, after its intended use for the operation of nuclear power plants and research reactors, is termed as Spent Nuclear Fuel (SNF). Being highly radioactive in nature, its safe management is necessary to avoid undue risk of radiation. Management of SNF involves removal of the fuel from the reactor core; and interim wet storage at the spent fuel pools at nuclear power plants or research reactors which is followed by dry storage in spent nuclear fuel casks.

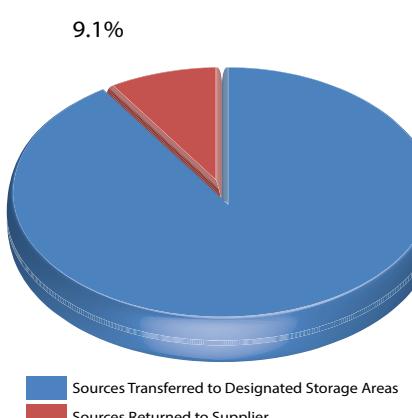


Figure-33: Status of Disused Sealed Radioactive Sources

Dry storage casks are cylindrical structures specially designed to provide radiation shielding to workers and members of the public. The dry storage of spent fuel, that has already been cooled in the spent fuel pool for a considerable period of time, provides an alternate means of its storage.

5.2.1 Spent Fuel Dry Storage Facilities

The KANUPP Spent Fuel Dry Storage Facility (KSFDSF) is being established under the operating licence issued to K-1. Moreover, in 2018, PNRA registered the site for establishment of CNPGS Spent Fuel Dry Storage Facility (CSFDSF) at Chashma, upon satisfactory completion of review of submissions. Construction licence of this facility will be issued after satisfactory review of the design in due course of time.

5.2.2 Design Certification of Spent Fuel Dry Storage Casks

PNRA performs design certification of the spent fuel storage cask after a thorough review and assessment of its design for the safe storage of spent fuel. HMC-3 has applied to PNRA for design certification of KANUPP Spent Nuclear Fuel Dry Storage Cask (SC-108), which is in progress. During 2018, PNRA witnessed all control points to verify the regulatory requirements during manufacturing and testing of prototype cask, which has been tested successfully. The design certification process of the cask is expected to be completed in 2019.

Furthermore, PAEC has shown its intention to design spent nuclear fuel dry storage cask for CNPGS. In this regard, list of codes and standards is agreed and safety analysis report of the cask is expected to be submitted soon to PNRA for review.

5.3 Management of Decommissioning

Decommissioning of a facility involves administrative and technical measures such as

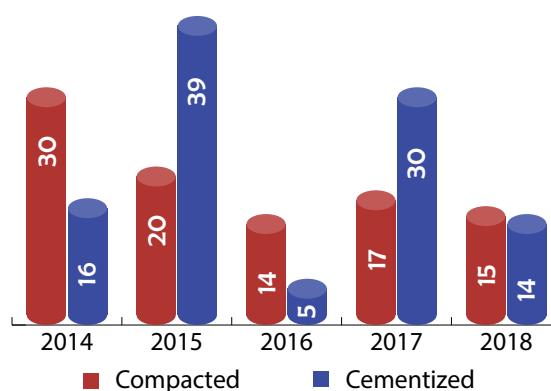


Figure-34: Radioactive Waste Containers at PPRWMF

decontamination; dismantling; transportation of plant equipment; and storage or disposal of waste generated. The process of decommissioning starts after the permanent shutdown of the facility and termination of its operation licence. The objective of decommissioning is to achieve a state where the site no longer possesses radiation risks for the public and the environment. Upon successful completion of the decommissioning activity and meeting the specific regulatory criteria, the facility can be removed from further regulatory supervision after acquiring such authorization from PNRA.

Planning for decommissioning starts right from the design stage of an installation or a facility. PNRA requires licensees to submit the Initial Decommissioning Plan (IDP) prior to start of operation of nuclear installation and specified radiation facilities. IDPs of nuclear installations in operation are reviewed periodically after every five years until it becomes Final Decommissioning Plan (FDP) that is required to be submitted at least three years before termination of the Operating Licence.

During this year, IDP of PARR-1 was approved, whereas IDPs of K-2 and K-3 were reviewed and regulatory position communicated accordingly. Furthermore, review of the K-1 FDP remained in progress which will be completed in due course of time.

5.4 Management of Transport of Radioactive Materials

PNRA regulates safe transport of radioactive materials in the country covering all modes of transport i.e. by land, sea, and air. For the purpose of safety, radioactive materials are transported in containers / packages having capability to withstand

anticipated transport scenarios. PNRA also regulates design and manufacturing of such transport containers / packages; and shipment of radioactive materials in the country by granting certifications and authorizations. PNRA reviews transport plans of the licensees and conducts regulatory inspections to verify the safety and security requirements for transport of radioactive materials.

Licensees are required to notify PNRA about any movement of radioactive materials. During the year 2018, more than 700 shipments of radio-pharmaceuticals and SRS were notified to PNRA. Relevant submissions including transport plans and shipping documents were reviewed and verified by PNRA to assess measures for safe transport of radioactive materials. Furthermore, PNRA issued a regulatory order No. 562(I)/2018 regarding prohibition of use of a foreign manufactured transport container in the country that ceased to have valid design certification from the country of origin.

5.4.1 Certification of Transport Packages

PNRA performs regulatory oversight during design and manufacturing of the transport packages. PNRA also issues design approval certificates to type B (U) transport package designed and manufactured in Pakistan. This package is required to be capable to bear accidents thereby preventing any damage to the radioactive materials. A few such packages have been designed by Pakistan Institute of Nuclear Science and Technology (PINSTECH) and are being manufactured by HMC-3 for the transport of radio-pharmaceuticals. During 2018, PNRA conducted a number of control point inspections during manufacturing of three Type B(U) transport packages at HMC-3.



Participants of Workshop held at PNRA HQs. on Spent Nuclear Fuel Dry Storage Facility



6. Emergency Preparedness and Response

PNRA has been assigned with the responsibility to ensure and regulate emergency preparedness and response arrangements at nuclear installations and radiation facilities to cater potential nuclear or radiological emergencies. Nuclear installations and radiation facilities with significant potential hazards are required to document relevant on-site and off-site emergency response plans and periodically test these plans by conducting emergency drills and exercises. PNRA reviews and approves the emergency preparedness and response plans. PNRA also witnesses the conduct of emergency exercises and drills to assess the effectiveness of these plans.

Pakistan is a State Party to two international conventions related to nuclear accidents and radiological emergency. These are "Convention on Early Notification of a Nuclear Accident" and "Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency". PNRA is responsible to ensure continuous fulfillment of international obligations under these conventions.

6.1 Emergency Response Plans

The radiation emergency response plans and subsequent procedures are required to cover arrangements for management of emergency including identification of potential emergency situations; mechanisms and channels for emergency notifications; warnings and activation of response actions; and measures for mitigation of potential consequences. These plans are also required to describe arrangements for managing the medical response, countermeasures to prevent ingestion of contaminated items and long term protective actions in off-site areas.

The licensees describe emergency response arrangements for protection of plant personnel in on-site emergency response plans. These plans are required to be submitted by nuclear installations and radiation facilities with significant potential hazards and are approved by PNRA.

The emergency response arrangements for the protection of public are described in off-site emergency response plans. All nuclear installations are required to prepare the off-site emergency response plans in consultation with relevant off-site response organizations. These plans are reviewed by PNRA and are approved by the Government at appropriate levels.

During the year 2018, PNRA reviewed emergency response plans of three nuclear installations and 56 radiation facilities including hospitals, industries, irradiators, industrial radiography practices, etc.

6.2 Emergency Response Exercises of Licensees

Nuclear installations and major radiation facilities periodically conduct emergency exercises as per frequency and time-line agreed by PNRA. Nuclear installations conduct partial emergency exercises to test the adequacy of selected elements of on-site or off-site response plans while integrated emergency exercises are conducted to simultaneously test both the plans.

In the year 2018, PNRA witnessed and evaluated integrated emergency exercise of K-1; and partial emergency exercises of CNPGS (off-site) and PARR-1 (on-site). Furthermore, PNRA also evaluated the emergency exercises conducted by some of the major radiation facilities during 2018.

6.3 National Radiation Emergency Coordination Centre

Pakistan acceded to conventions on early notification and assistance as a State Party in 1989. Under these Conventions, the State Parties are required to designate a national competent authority and continuously make available a national warning point, authorized to make and receive notifications and requests for assistance in case of nuclear accidents or radiological emergencies.

On behalf of the Government of Pakistan, PNRA is the designated National Competent Authority under these Conventions. Accordingly, a National Radiation Emergency Coordination Centre (NRECC) is operational at PNRA as Pakistan's designated national warning point to fulfill the national obligations under these conventions.

NRECC functions round-the-clock and is responsible for assessing the emergency situations. It provides assistance / advice to licensees, response organizations, other government organizations and Member States under the Assistance Convention.

A designated team of trained professionals is deputed at NRECC. It also has access to on-call specialists, as members of its technical support team, having expertise and experience in areas of nuclear

safety, radiation protection, physical protection, accident analysis, environmental analysis and dose assessment. Radiation Monitoring Teams (RMTs) are posted in all regional offices of PNRA located in six different cities across the country. These teams are equipped with radiation monitoring, personal protection and communication equipment. These teams also have Mobile Radiological Monitoring Laboratories (MRMLs) for performing radiological assessment, independent of the assessments made by the licensee. These teams are also capable and responsible to support national mechanism for response to nuclear and radiological emergencies.

6.3.1 Emergency Exercises Conducted by NRECC

For its operational readiness, NRECC conducts different types of emergency exercises. The Communication Test Exercise (COMTEX) is conducted to test the availability of dedicated communication channels of PNRA HQs, regional directorates and inspectorates of PNRA, licensed nuclear installations and other relevant national response organizations. MRML field exercises are conducted to test the response capabilities of PNRA's RMTs. During 2018, three COMTEX, and five MRML field exercises were conducted.

6.3.2 Participation in International Emergency Exercises

IAEA conducts various exercises under the international conventions. These exercises are called Convention Exercises (ConvEx). These exercises are open to all Member States' party to these conventions. Various ConvEx exercises are conducted by IAEA with the objectives to test the international communication channels and the capability of State Parties to evaluate and respond to different radiological accident scenarios. Some of the ConvEx exercises are focused to test the State's capabilities for response to a nuclear or radiological emergency at national level. While some exercises focus on management of trans-



NRECC Team Preparing for Emergency Response Field Exercise at PNRA HQs.

boundary consequences; and provision and request of international assistance under the Assistance Convention. NRECC participates in these exercises regularly. During the year 2018, NRECC participated in five ConvEx exercises namely ConvEx-1a, ConvEx-2a, ConvEx-1b, ConvEx-2b and ConvEx-2c.

6.4 IAEA's Response and Assistance Network

IAEA has established a Response and Assistance Network (RANET) to meet obligations under the Assistance Convention. RANET is intended, inter alia, to strengthen the worldwide capability to provide assistance and advice; and to coordinate the requests and provision of assistance under the convention for nuclear accidents and radiological emergencies.

Pakistan is member of RANET since 2008. PNRA is the identified National Assistance Coordinator for RANET activities in the country and is responsible to coordinate activities related to RANET with other stakeholders in Pakistan as well as with the IAEA.

During 2018, Pakistan updated its National Assistance Capabilities (NACs) for RANET in four areas already registered in RANET while three more areas are included this year. These NAC's include radiological assessment and advice; source search and recovery; radiation survey; medical support; dose assessment; environmental sampling and analysis; and nuclear installation assessment and advice. This year, PNRA conducted a national workshop to test the operational arrangements and timely provision of such assistance through RANET.

IAEA also tests the global mechanisms for NAC's registered in RANET during conduct of ConvEx exercises. During 2018, PNRA participated in ConvEx-2b exercise conducted by IAEA to test national mechanism for provision of assistance under RANET.



Field Exercise for Radiological Emergency Response in Quetta



7. Competence Development

Effective regulatory control over nuclear installations and radiation facilities requires the services of dedicated, highly qualified and professional personnel in the relevant areas. PNRA believes that well educated and experienced manpower contributes more effectively towards meeting the organizational objectives and goals. It is recognized at organizational levels that investment in the competence development of the personnel always contributes in enhancing productivity and achieving the organizational goals effectively. Competency development of regulatory officials in the required areas is considered a key for performing the assigned regulatory duties in an effective and efficient manner. PNRA utilizes various means for capacity building of its employees to keep them abreast with the latest technological advancements in the areas of nuclear safety, nuclear security and radiation protection. The efforts made in this regard ultimately contribute towards the improvement in regulatory oversight of nuclear installations, radiation facilities and associated activities in the country.

PNRA has in place a systematic approach to identify the existing and desired competencies for its employees. On the basis of identified gaps,

plans are developed and implemented to achieve the desired competencies in its employees. PNRA has adopted a three pronged approach for the competence development of its employees. This includes competence development through in-house training facility of PNRA as well as through national and international institutions. The competence development matrix of PNRA is depicted in Figure-35.

7.1 Competence Development through In-House Resources

PNRA emphasizes on in-house capacity building of its employees in the areas of regulatory interest. In this regard, National Institute of Safety and Security (NISAS), knowledge sharing programme and leadership development programme are used as in-house resources for competence development of PNRA officials.

7.1.1 National Institute of Safety and Security

The NISAS possesses highly qualified faculty members and provides trainings to PNRA officials in regulatory perspectives. NISAS also seeks

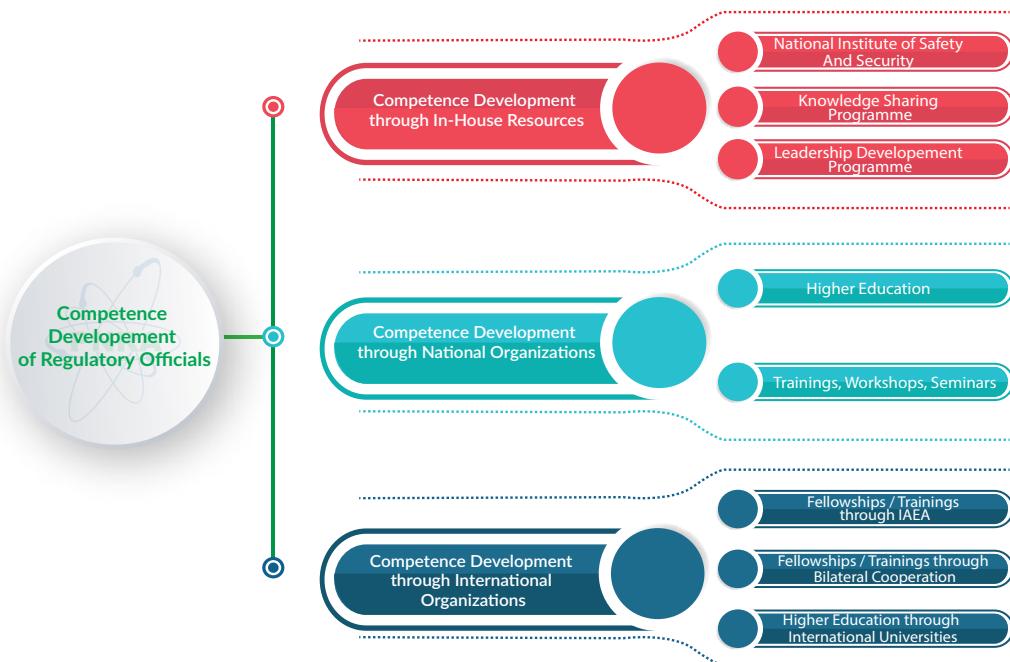
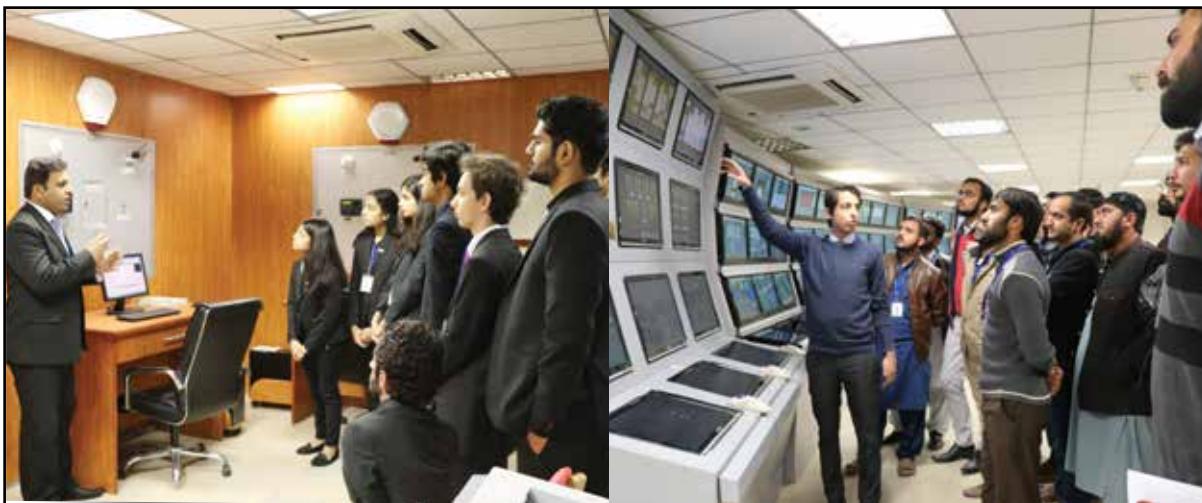


Figure-35: Elements of Competence Development Matrix of PNRA



Briefing on NISAS Training Laboratories to Visitors from Educational Institutions

expert services of officials from different PNRA departments in specialized areas as resource persons. The institute also provides trainings to officials of other national and international organizations. NISAS is equipped with state of the art training facilities. These facilities include scaled down models of NPP equipment; non-destructive testing and materials laboratory; radiation detection equipment laboratory; physical protection interior laboratory; and physical protection exterior laboratory. In addition, a soft panel training simulator available at NISAS is utilized to provide training to PNRA inspectors on regulatory aspects of plant operation during normal or accident situations. During this year, NISAS was re-certified on latest ISO Standards 9001-2015.

NISAS develops annual training calendar in collaboration with PNRA departments that fulfills the necessary training requirements. The training calendar also caters the specific needs of freshly

recruited officials as well as middle and senior level professionals. The PNRA's "Basic Professional Training Course Level-I" and "Professional Training Course Level-II" are mandatory courses for all technical officers.

During the year 2018, PNRA conducted 38 training courses at NISAS in the areas related to nuclear safety, nuclear security and radiation protection. More than 410 professionals from PNRA and 460 professionals from other organizations participated in these training courses. The detail of training courses conducted along with participants attending these courses during the last five years is presented in Figure-36.

7.1.2 Knowledge Sharing and Mentoring Programme

The management and sharing of knowledge plays a vital role in enhancing organizational competence.



ISO 9001-2015 Recertification of NISAS

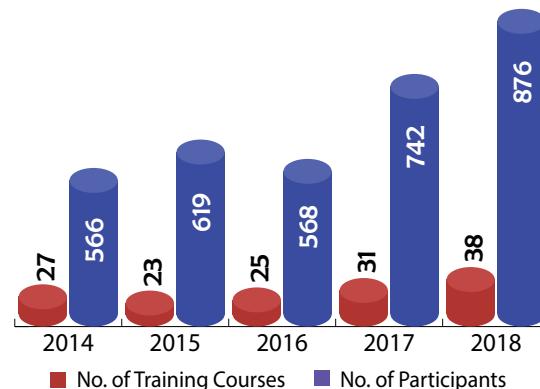


Figure-36: Trend of Training Courses Conducted by PNRA



Member Executive PNRA Delivering Lecture to Regulatory Officials During a Training Course at NISAS

Being the national nuclear regulator, PNRA has taken various initiatives for the management of knowledge. In this regard, PNRA considers that knowledge sharing sessions are an effective tool for the transfer of tacit knowledge into the explicit knowledge.

PNRA regularly organizes the knowledge sharing sessions where experts from within and outside the organization share their experiences with PNRA employees in order to improve knowledge of participants. During the year 2018, a number of knowledge sharing sessions were organized at PNRA where prominent and seasoned professionals shared their thoughts with PNRA employees.

7.1.3 Leadership Development Programme

Leadership is considered as an important function of management that provides direction and guidance regarding achievement of organizational

goals in an effective and efficient manner. PNRA launched a Leadership Development Programme (LDP) in 2007, for developing and enhancing the leadership capabilities of regulatory officials. Under this programme, PNRA has successfully trained two batches while training of 3rd batch of officers is in progress.

In order to further improve the existing leadership development programme, PNRA leadership team initiated internal evaluation of the programme in 2018. The team proposed restructuring of the programme which remained under consideration by the end of year.

7.2 Competence Development through National Organizations

The education and training institutions available in Pakistan provide good opportunity to PNRA for enhancing qualification, knowledge and skills of its employees. PNRA nominates its officials in education and training activities arranged at reputed national institutes.

7.2.1 Higher Education at National Institutions and Universities

PNRA is a learning organization and always encourages its employees to improve their academic qualification, professional knowledge and working skills through reputed national universities/institutes and facilitates them to study in the fields relevant to PNRA activities. In this regard, two approaches are followed for higher studies. In the first case, young recruits are awarded fellowships for higher studies at Karachi Institute of Nuclear Power Engineering



PNRA Officials Attending Training Course on Advance PSA at Stockholm, Sweden



IAEA Experts, PNRA Management and Participants of Workshop held at PNRA HQs. on Nuclear Safety Culture

(KINPOE) or Pakistan Institute of Engineering and Applied Sciences (PIEAS) for Master's degree in the areas of nuclear power engineering, nuclear engineering, systems engineering and medical physics. In the second case, the employees are facilitated for higher studies through self finance arrangements at various national universities and institutions.

During this year, 11 fellows have joined PNRA after successful completion of their master degree programmes from PIEAS in different fields while 9 fellows are pursuing their masters degree programmes who are expected to complete their studies in 2019.

Furthermore, under the self finance arrangements, 11 PNRA employees are currently pursuing their postgraduate and doctoral degree programmes in various national universities in technical as well as managerial disciplines.

7.2.2 Trainings at National Organizations

There are a number of national training institutes / organizations which conduct training courses in various disciplines for capacity building in the fields relevant to PNRA. The most prominent among these organizations include Pakistan Welding Institute (PWI); National Centre for Non-Destructive Testing (NCNDT); Pakistan Manpower Institute (PMI); Secretariat Training Institute (STI); and National University of Science & Technology (NUST). PNRA regularly nominates officials in different training courses for competence development.

During the year 2018, PNRA nominated around

126 officials in 59 training courses held in 21 different national institutes in various technical and managerial fields.

Figure-37 shows participation of PNRA employees in the training courses organized by these training institutes during the last five years.

7.3 Competence Development through International Organizations

PNRA gives due importance to the advancements in the nuclear field at international level and utilizes it as one of the important factors for the competence development of PNRA regulatory officials. In this regard, PNRA benefits from the opportunities offered by international institutions. These include competence development through International Atomic Energy Agency (IAEA); arrangements under the bilateral cooperation agreements; and higher education through international universities.

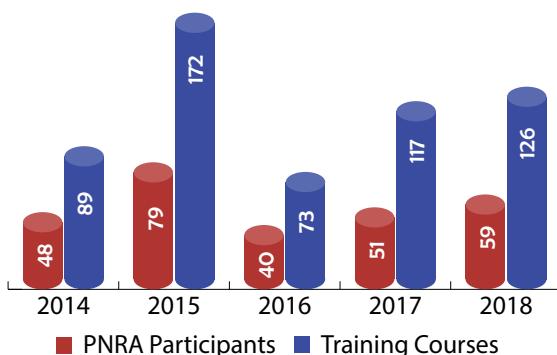


Figure-37: Participation of PNRA Officials in Training Opportunities at Various National Institutions

7.3.1 Competence Development through International Atomic Energy Agency

IAEA regularly organizes events including workshops, training courses, fellowships and scientific visits for capacity building of personnel from its Member States. These events cover the fields of nuclear, radiation, radioactive waste and transport safety as well as emergency preparedness, physical protection and nuclear security. During the year 2018, PNRA nominated a number of its officials to participate in these events.

Furthermore, PNRA acquires assistance of IAEA for the capacity building of its employees in the specific areas of interest through fellowship programme. During the year 2018, a number of PNRA officials successfully completed fellowships in various technical areas related to regulatory domain at various IAEA Member States including Austria, China, Czech Republic, France, Italy and Turkey.

7.3.2 Competence Development under Bilateral Cooperation

PNRA has bilateral agreements of cooperation with National Nuclear Safety Administration (NNSA); Nuclear Safety Centre (NSC) and China Nuclear Power Operation Technology Corporation, Ltd. (CNPO) of the Peoples Republic of China. Under these agreements PNRA avails training opportunities for its employees in specific technical areas. These organizations also conduct various trainings, workshops at PNRA.

During 2018, a number of PNRA officers successfully completed trainings at these institutions. In addition, trainings, workshops were also organized by CNPO and NSC at PNRA.

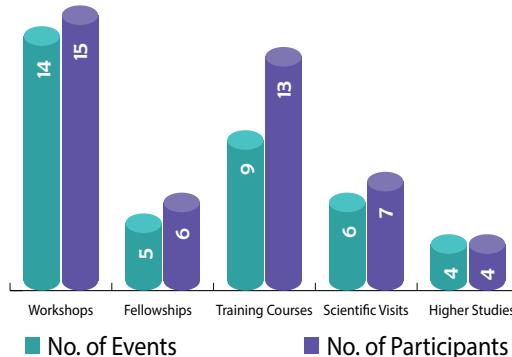


Figure-38: Competence Development through International Organizations and Institutions

7.3.3 Competence Development through International Universities

PNRA encourages its officials to enhance their qualification by allowing them to undertake higher education from international universities. During 2018, four regulatory officials joined PNRA after successful completion of post graduation, master and PhD programmes from Korea and Malaysia. Furthermore, four PNRA employees got admissions in international universities. Among these, one official is enrolled in Korea Advanced Institute of Science and Technology to pursue masters degree in the field of nuclear and radiation safety; while three are pursuing higher studies leading to PhD degree in the field of nuclear engineering and electrical engineering at different universities of China, Korea and USA.

Figure-38 shows detail of competence development activities of PNRA employees through international organizations during 2018.



Participants of the Delegation of Pakistan at International Conference on Security of Radioactive Materials at IAEA HQs.



8. National and International Cooperation

PNRA maintains strong liaison with national as well as international organizations to execute its functions and responsibilities effectively. This cooperation and coordination aims to strengthen national and global safety and security regimes as well as to enhance confidence of public, government and other stakeholders. The mechanisms used for this purpose include sharing of regulatory decisions and perspectives; providing experience feedback; education and training; and research and development activities.

8.1 National Cooperation

National cooperation is an effective instrument for continuous improvement of regulatory processes; effective regulatory control of the nuclear installations and radiation facilities; and enhancing public confidence on regulatory body. Under these cooperation arrangements, strong communication links are maintained with licensees and national stakeholders for information sharing and regulatory decision making. PNRA also reaches out to public for sharing regulatory decisions and enhancing awareness about risks and protection from radiation hazards.

8.1.1 Coordination with Government Organizations

PNRA has close collaboration and working interfaces with several government organizations

including Strategic Plans Division (SPD), Ministry of Foreign Affairs (MoFA), Planning Commission, Ministry of Finance, law enforcement agencies and other organizations.

PNRA periodically shares the safety status of nuclear power plants in the country with the relevant governmental organizations. During the year 2018, PNRA issued four quarterly reports summarizing general performance and updated progress in the areas of regulatory oversight of nuclear and radiation safety. PNRA has also established coordination with relevant government organizations for acquiring meteorological data for assessment of radiological consequences in case of a nuclear accident or radiological emergency. In addition, senior officials from various government organizations and PNRA officials held several meetings to discuss matters of mutual interest and cooperation.

National legislation has entrusted PNRA to maintain its capabilities for coordination and assessment of potential nuclear accidents and radiological emergencies. These also include provision of advice to the Federal Government and other concerned entities regarding implementation of necessary safety and protective measures. PNRA also maintains proportional preparedness for provision of technical assistance to national organizations in emergency response functions. A strong coordination is maintained with relevant national stakeholders for effective fulfillment of



Visit of DG IAEA to PNRA HQs



Top Management of PNRA and Pakistan Atomic Energy Commission During a Corporate Meeting at PNRA HQs.

responsibilities under PNRA Ordinance. PNRA is also a support organization under the Nuclear Emergency Management System (NEMS) which is operated at national level for response to nuclear accidents, radiological emergencies or nuclear security events.

8.1.2 Interaction with Licensees

PNRA keeps a strong liaison with its licensees for ensuring nuclear safety and radiation protection in the country. In this regard, PNRA organizes periodic coordination meetings with PAEC, being the major licensee, at corporate level and management level at nuclear installations. These meetings are held to discuss various safety issues and ongoing measures to enhance safety.

During the year 2018, PNRA held one corporate level meeting and 11 coordination meetings with officials of operating and under construction NPPs. PNRA also held four coordination meetings with the management of other nuclear installations and associated activities i.e. PARR-1, PARR-2, MPF; and safety class equipment manufacturers.

PNRA has established a mechanism for obtaining feedback from its licensees for improvement in its regulatory performance. During the year 2018, PNRA sent a questionnaire to nuclear installations and associated activities; and prepared an evaluation report in the light of the feedback. Improvement in areas identified in this evaluation is expected to enhance the performance of PNRA. Furthermore, revision of questionnaire for acquiring the feedback of radiation facilities remained in progress.

PNRA invites its licensees and other relevant national stakeholders in training courses and workshops in the areas of nuclear safety, security and radiation protection. During the year 2018, PNRA provided trainings to more than 460 officials from the licensees of nuclear installations, radiation facilities and other relevant national stakeholders.

8.1.3 Public Awareness Programme

PNRA started public awareness programme almost a decade ago and is continuously working on this programme to enhance public awareness on the applications of radiation in everyday life; associated hazards; and protection from these hazards. Under this programme, PNRA conducts seminars at universities, colleges, schools, hospitals and other organizations across the country.

During 2018, PNRA conducted 31 seminars in various educational institutions and hospitals in all four provinces of Pakistan. More than 4200 personnel participated in these seminars. Figure-39 shows a graphical representation of public awareness seminars conducted and participation trend in these sessions over the past five years.

8.2 International Cooperation

PNRA maintains close cooperation at several international forums. This includes cooperation with the International Atomic Energy Agency (IAEA); fulfillment of Pakistan's obligations under international conventions; and Pakistan's involvement in the activities of United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). It also includes bilateral cooperation with nuclear regulator and technical support organizations of Peoples Republic of China.

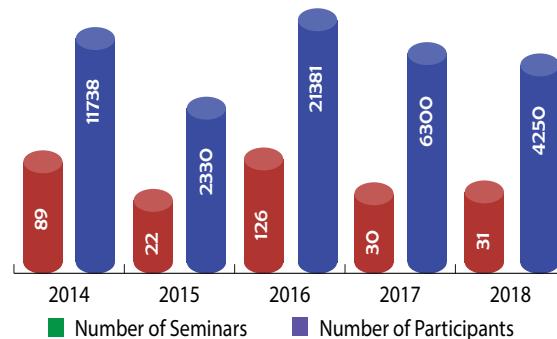


Figure-39: Summary of Public Awareness Campaign



PNRA Official Conducting Public Awareness Seminar at an Educational Institution

8.2.1 Cooperation with the International Atomic Energy Agency

PNRA has a strong liaison with IAEA for cooperation in diverse domains such as nuclear safety, nuclear security, radiation protection and emergency preparedness and response.

a) IAEA General Conference

PNRA actively participated in the proceedings of the 62nd Regular Session of the IAEA General Conference as part of Pakistan delegation in 2018. PNRA provided support to the delegation to formulate national position on various technical issues. PNRA also participated in a wide range of other side events such as meeting of senior regulators; meetings with delegates from China, France and Jordan; and representatives of nuclear energy, nuclear security and technical cooperation departments of IAEA. PNRA also attended deliberations from Korea on education programmes and from Sweden on safety culture self assessment.

b) IAEA Forums and Committees

The IAEA has established various committees of senior representatives of Member States. These forums and committees provide guidance and recommendations for international safety standards; and on activities to support the application of these standards. Furthermore, IAEA has established an International Reporting System for operating experience (IRS) for Member States to exchange experience to improve the safety of nuclear power plants by submitting event reports on unusual events. Similarly, International Generic Ageing Lessons Learned (IGALL) is the IAEA programme to develop and maintain documents and a database to provide technical basis and practical guidance on managing ageing of nuclear power plants. PNRA, as designated representative of Pakistan, is actively engaged in the activities of different IAEA committees and forums.

During 2018, Chairman PNRA participated in 43rd meeting of the Commission on Safety Standards (CSS). Furthermore, PNRA officials represented Pakistan in 43rd steering committee meeting of Regulatory Cooperation Forum (RCF), 45th meeting of the Nuclear Safety Standards Committee (NUSSC); 45th meeting of the Waste Safety Standards Committee (WASSC); 6th meeting of the Emergency Preparedness and Response Standards Committee (EPReSC); 45th meeting of the Radiation Safety Standards Committee (RASSC); 37th meeting of the Transport Safety Standards Committee (TRANSSC); 12th meeting of the steering committee of the Global Nuclear Safety and Security Network (GNSSN) and meeting of the Implementation and Assessment Group (IAG) of the Global Initiative to Combat Nuclear Terrorism (GICNT).

Furthermore, PNRA IRS representative contributed in the development of document related to NPP operating experiences and participated in technical meetings for sharing operating experience. PNRA officials also participated in meetings of phase-4 of IGALL in different working groups during 2018.

c) IAEA Missions, Consultancies and Meetings

PNRA contributes towards the global efforts in enhancing nuclear safety worldwide. PNRA supports IAEA in the conduct of international missions and consultancies. PNRA also participates and contributes in other IAEA activities such as workshops, seminars, conferences and meetings. PNRA also provides its services to IAEA for developing different IAEA technical documents and the training material, specifically designed to strengthen regulatory infrastructure and enhance the competence of the regulatory personnel and its implementation through workshops in various embarking countries.

During 2018, PNRA officials contributed / participated in a number of Integrated Regulatory Review Service (IRRS) Missions and Follow-

up Missions; Nuclear Security Self Assessment Missions; national training courses; regional workshops; and consultancy and technical meetings. Figure-40 represents PNRA's contribution / participation in IAEA activities during 2018.

d) IAEA Technical Cooperation; Regional Asia and Research Projects

IAEA provides support to its member states for the capacity building and strengthening the infrastructure through different technical cooperation projects, regional projects and coordinated research activities. PNRA actively participates in these activities.

Presently, PNRA is participating in IAEA comprehensive national technical cooperation project namely "National Technical Cooperation Project PAK-2007: Strengthening and Enhancing Capabilities of Pakistan's National Institutions to Support a Safe, Reliable and Sustainable Nuclear Power Programme". This project aims to develop the capacities of the national institutions involved in the nuclear power programme. As a sole national regulator, PNRA is benefiting from IAEA support to enhance its capacity to perform core regulatory functions related to licensing and oversight of nuclear installations. Through this project, PNRA is developing its capabilities in the area of safety assessment such as risk informed decision making; internal and external hazard assessment; ageing management of NPPs, emergency preparedness and response; safety of nuclear fuel fabrication facilities; waste safety and decommissioning; and improving understanding in other emerging technologies such as use of passive safety features and digital instrumentation & control in new designs of NPPs.

In 2018, PNRA organized seven national workshops and one training course under this project. 24 eminent international experts conducted these events in Pakistan in the field of nuclear safety, security and radiation protection. PNRA also enhanced the capabilities of its officials through six scientific visits and two fellowships under this technical cooperation project. Pakistan hosted IAEA regional

workshops and trainings in the area of nuclear safety and officials of different IAEA member states participated in these events. In addition, PNRA is also procuring equipment through this technical cooperation project for its laboratories.

During 2018, Nigerian Nuclear Regulatory Authority (NNRA) approached PNRA through IAEA for PNRA's technical support for establishing regulatory infrastructure and capacity building of its regulatory officials in the areas of nuclear safety and radiation protection under IAEA technical cooperation. A delegation led by Chairman PNRA, participated in a meeting between IAEA, NNRA and PNRA to discuss the initial modalities of the Memorandum of Understanding (MoU). This collaboration and support will include exchange of technical expertise and information by conducting workshops at NNRA and placement of NNRA fellows at PNRA. The MoU is expected to be signed during the 1st quarter of 2019.

PNRA also benefits from IAEA's Regional Asia (RAS) projects. In 2018, PNRA officials attended five regional workshops held under RAS projects in the areas of nuclear safety and radiation protection.

PNRA is also member of working group of IAEA coordinated research project "Improved Assessment of Initial Alarms for Radiation Detection Instruments" and participated in 2nd research coordination meeting held under this project in 2018.

e) Pakistan - IAEA Nuclear Security Cooperation Programme

Pakistan and IAEA are working on nuclear security cooperation programme since 2005 for establishing, maintaining and sustaining effective nuclear security regime in the country. IAEA has been assisting Pakistan in its efforts for the establishment of an effective nuclear security administration in the country. Under this programme, PNRA is the designated focal point and is responsible for coordination with all national stakeholders for effective implementation of the programme.

During the year 2018, activities related to the physical protection upgrades at K-1 were carried out as per schedule. Furthermore, physical protection upgrades at nuclear medicine centres are also part of the programme. In 2018, physical protection upgrades at three centres were completed while upgrades at other centres remained in progress.

During the year 2018, several project coordination meetings and progress review meetings were held between Pakistan and IAEA to discuss progress of the ongoing projects and to further extend the scope. Under this programme, PNRA also arranged

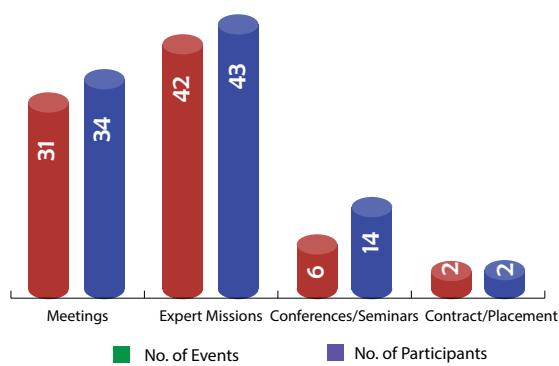


Figure-40: Contribution / Participation in International Events

training and provided radiation detection equipment to national organizations including Pakistan Customs to enhance their capability to deter illicit trafficking of nuclear or other radioactive materials.

❖ International Conventions

PNRA, as representative of Government of Pakistan, acts as a national contact point for the implementation of obligations arising from international conventions related to nuclear safety; physical protection; and nuclear and radiological emergencies. These include Convention on Early Notification of a Nuclear Accident; Convention on Assistance in the case of a Nuclear Accident or Radiological Emergency; Convention on Nuclear Safety; and Convention on Physical Protection of Nuclear Materials. PNRA also assists Government of Pakistan to implement and fulfill obligations of Code of Conduct on Safety and Security of Radioactive Sources.

During the year 2018, PNRA represented Pakistan in the 9th meeting of the competent authorities identified under the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the case of a Nuclear Accident or a Radiological Emergency to discuss improvement in national and international emergency preparedness and response arrangements.

PNRA also initiated preparation of National Report, to be submitted in 2019, for 8th Review Meeting of the Convention on Nuclear Safety. A national work plan was chalked out in coordination with relevant stakeholders for implementation of activities to ensure compliance of obligations under the convention. Meetings of PNRA, PAEC, SPD and MoFA were held during 2018 to identify the activities, time-lines and responsibilities of national stakeholders as per the agreed work plan.

In 2018, PNRA incorporated technical requirements of amended Convention on Physical Protection of Nuclear Materials in its draft regulations on “Physical Protection of Nuclear Material(s) and Nuclear Installation(s)-PAK/925”.

8.2.2 United Nations Scientific Committee on the Effects of Atomic Radiation

Since 2011, Pakistan is a permanent member of the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). PNRA represents Pakistan in the committee and actively participates in proceedings of the annual sessions of UNSCEAR.

During 2018, PNRA participated in 65th session of UNSCEAR and contributed in finalization of several technical documents during the session.



Signing of MoU Between PNRA and Nuclear Safety and Radiation Protection Centre of China

PNRA also analyzed and contributed simplified national data for UNSCEAR's global survey on medical exposures.

8.2.3 Bilateral Cooperation with Peoples Republic of China

Pakistan has strong bilateral ties with the Peoples Republic of China in several technical domains including nuclear safety.

PNRA has maintained, over the years, cooperation arrangements with nuclear regulator of China i.e. National Nuclear Safety Administration (NNSA). PNRA also has working relationship with China Nuclear Power Operations Technology Co., Ltd. (CNPO) to enhance the capabilities of its personnel for effective oversight of NPPs. PNRA has established liaison with Nuclear Safety and Radiation Protection Centre (NSC), a Technical Support Organization (TSO) of Ministry of Environmental Protection of China, to strengthen PNRA's internal TSO.

The 10th steering committee meeting between PNRA and NNSA was held in Islamabad during 2018. The committee reviewed the progress of implementation of activities agreed under the bilateral cooperation arrangements and identified areas for future cooperation. A delegation, lead by Vice President of CNPO, also visited PNRA to discuss areas of mutual cooperation and provision of technical assistance in the areas of nuclear safety and radiation protection. In 2018, two PNRA officials successfully completed fellowships in the area of emergency preparedness and response from Nuclear and Emergency Support Centre (NESC) of NNSA.

A delegation from Pakistan led by Chairman, PNRA participated in 5th Asia-Europe Meeting (ASEM) Seminar on Nuclear Safety held in Beijing, China. The theme of the seminar was “Translating Commitments into Actions-Addressing Nuclear Safety Challenges in the 21st Century”. Chairman, PNRA also co-chaired a session of the seminar.



9. TSO, Laboratories and Development Projects

Safety review and assessment of submissions received from licensees is an important part of the authorization and licensing process of nuclear installations and radiation facilities. This process is augmented by evaluation and analysis of scientific and technical data; and regulatory position on the existing and emerging safety issues. It is a common practice worldwide among the regulatory bodies to get required support from technical support organizations. These technical support organizations possess sufficient qualified manpower with adequate in-depth technical knowledge, competence, and skills required to perform the review, evaluation and analysis of different technical areas and provide effective support in the licensing and regulatory decision-making.

PNRA has established an internal Technical Support Organization (TSO) with highly trained and experienced personnel in specialized areas to perform review & assessment of technical documents submitted by the licensees. This TSO also performs deterministic and probabilistic safety analysis by using analytical computer codes to support review and assessment process.

In addition, PNRA has established radiation detection and measurement laboratories in Pakistan which can provide technical support for independent assessment and verification of the environmental monitoring data and occupational exposure.

Moreover, to further strengthen and enhance the technical capabilities required for effective regulatory oversight of nuclear installations and radiation facilities in the country, PNRA has

undertaken four Public Sector Development Programme (PSDP) projects. Progress of activities related to TSO, laboratories, and PSDP projects during the year 2018 is presented below:

9.1 Technical Support Organization

PNRA's internal TSO comprises two support centres, namely Centre for Nuclear Safety (CNS) and Safety Analysis Centre (SAC). This TSO serves various departments of PNRA by providing technical and scientific support through its pool of technical experts. The experts have been adequately trained to be capable of performing independent review and assessment of technical information; and audit calculations of safety analysis submitted by the licensees for acquiring a licence or an authorization. It also carries out research and development activities related to current and emerging safety issues pertaining to nuclear installations and radiation facilities.

9.1.1 Centre for Nuclear Safety

During the year 2018, CNS provided technical support to a number of departments by performing regulatory review of more than 100 submissions from licensees of different nuclear installations which mainly include the following:

- i. Low power and shutdown probabilistic safety assessment reports of C-1 and C-2;
- ii. Revised final safety analysis reports of MPF and PARR-1;



Meeting of PNRA and NNSA at PNRA HQs.

- iii. Revised final safety analysis report of C-4;
- iv. Probabilistic seismic hazard analysis report of Chashma site; and
- v. Modifications in design and technical specifications of operating NPPs.

CNS also performed different activities related to audit calculations and safety research and development to support regulatory decision-making process. During this year, main analytical tasks performed are as follows:

- i. Estimation of doses at exclusion area boundary and low population zone of C-3;
- ii. Analysis of flooding of Chashma site due to postulated Kalabagh dam break;
- iii. Tsunami hazard analysis of K-1 site due to Makran subduction zone;
- iv. Analysis of aircraft impact on K-2 containment building; and
- v Seismic hazard assessment of Muzaffargarh site.

9.1.2 Safety Analysis Centre

During the year 2018, following major analytical tasks were performed by SAC:

- i. Development of independent regulator's full power level-I PSA model of K-2 and K-3;
- ii. Shielding calculations of K-1 spent fuel dry storage cask;
- iii. Fatigue analysis of reactor pressure vessel head of K-2 and K-3;
- iv. Flow induced vibration analysis of C-2 lower

- reactor internals;
- v. Sensitivity analysis of reactor coolant system of K-2 and K-3; and
- vi. Thermal hydraulic analysis of various events of K-2 and K-3.

Furthermore, SAC also provided support to regional directorate at Karachi in inspections of construction and installation activities of K-2 and K-3.

9.2 PNRA Laboratories

PNRA has established two laboratories, namely National Dosimetry and Protection Level Calibration Laboratory (NDCL) and National Environmental Monitoring Programme (NEMP) to monitor personnel radiation doses of radiation workers and environmental radioactivity levels in the country, respectively. Besides this, these laboratories are also used for cross verification of occupational exposure and environmental monitoring data provided by the licensees.

9.2.1 National Dosimetry and Protection Level Calibration Laboratory

PNRA has established National Dosimetry and Protection Level Calibration Laboratories at its headquarters and regional offices for independent monitoring and cross verification of radiation exposure of the workers. These laboratories are also used to provide radiation dose monitoring services to the workers of response organizations and law enforcement agencies who may be involved to respond to any nuclear or radiological emergency. Furthermore, these laboratories perform independent assessment of worker's radiation dose record submitted by the licensees.

NDCL has both internal and external dosimetry equipment to monitor exposure to radiation workers. During the year 2018, whole body monitoring



Briefing on Whole Body Contamination Monitoring System to Visitors from Educational Institute

of more than 700 personnel was performed for internal dose assessment by using whole body counting systems. The monitoring included nuclear power plants workers, IAEA inspectors / officials, contractor's workers and visitors. NDCL also provided external dosimetry services to several licensed radiation facilities for measuring external exposure to radiation workers.

Furthermore, Protection Level Calibration setup installed at NDCL is used for calibration of radiation detection equipment. During the year 2018, calibration of more than 100 radiation detection equipment was performed.

9.2.2 National Environmental Monitoring Programme

PNRA has established an environmental monitoring laboratory at Islamabad which is equipped with state of the art radiation detection and measurement equipment to conduct environmental radioactivity surveillance around nuclear installations and to establish background radiation levels all around the country.

NEMP also performs radiation surveys in the industries utilizing Naturally Occurring Radioactive Material (NORM) to monitor the associated radiation hazards. Besides, NEMP performs radiometric analysis of various samples of food and other materials to be exported from Pakistan based on the requirements of importing countries to ensure that the radioactivity levels are within prescribed limits.

During the year 2018, NEMP collected around 1850 samples of soil and water from 645 locations of Punjab, Khyber Pakhtunkhwa and Sindh. The

processing and analysis of these samples remained in progress during the year 2018.

NEMP also made an assessment of NORM in coal samples based on surveys conducted at coal mining sites to assess radiation hazards. The analysis revealed that no significant radiation hazard is associated with these sites. In addition, a number of food and other samples received from exporters were analyzed at NEMP.

9.3 Public Sector Development Programme Projects

Several projects under the Government's Public Sector Development Programme (PSDP) are currently being executed by PNRA. These include National Radiological Emergency Coordination Centre (NRECC); PNRA Residential Colony Chashma (PRC); Design Assessment and Analysis of NPPs (DAAP); and Cyber Security and Digital Safety (CSDS).

9.3.1 National Radiological Emergency Coordination Centre

This project is aimed to upgrade the existing setup of NRECC of PNRA. The objective of project is to strengthen PNRA's capabilities for advising Government and relevant organizations to implement protective measures in case of nuclear accident or radiological emergency. The project will enable PNRA to assess the plant conditions at all times by making available the critical parameters of nuclear power plants, meteorological data and environmental radiation levels at PNRA HQs. The following major activities were carried out during the year 2018:



Meeting of Chairman PNRA with Commandant Pakistan Centre of Excellence in Nuclear Security at PNRA HQs.

- i. Approval of NRECC building design from Capital Development Authority (CDA) and award of contract for construction of NRECC building;
- ii. Initiated construction of building;
- iii. Procured radiation consequence assessment software and training of PNRA officials on the software; and
- iv. Signed Memorandum of Understanding (MoU) with Pakistan Meteorological Department (PMD) for acquiring meteorological data required for radiological assessment.

9.3.2 PNRA Residential Colony Chashma

PNRA started construction of colony project at 34 kanal of land in 2015 with the aim to facilitate PNRA officials posted at Chashma site by providing them a safe and secure accommodation. The project has been successfully completed during the year 2018 by constructing and making fully functional 48 apartments to accommodate officers and supporting staff.

9.3.3 Design Assessment and Analysis of NPPs

The objective of Design Assessment and Analysis of NPPs (DAAP) project is to further strengthen PNRA's capabilities for design assessment and analysis through capacity building and training of officials. The prime focus is to enhance existing capabilities in assessment and analysis, acquire new software, fulfill future training needs and update the available analytical tools.

During the year 2018, DAAP organized a number of trainings at national and international level to enhance the capabilities in the required areas. Furthermore, different analytical softwares and latest design & construction codes were procured under this project. In addition, DAAP is also working to explore further areas of capacity building for PNRA officials with the cooperation of China Nuclear Power Operations Technology Co., Ltd. (CNPO).

DAAP procured a number of software during 2018, which include software for soil-structure interaction analysis; structural behaviour analysis; residual life assessment of nuclear power plant components; and up-gradation of soft panel training simulator. Furthermore, a number of design codes were procured during 2018.

9.3.4 Cyber Security and Digital Safety

The PSDP project Cyber Security and Digital Safety (CSDS) was approved by the Planning Commission in 2018 and initiated accordingly by PNRA. The aim of this project is to strengthen the PNRA capabilities to cope with the innovations and technological advancements taking place in the design of newly constructed nuclear power plants. The analogue Instrumentation and Control (I&C) systems are now being replaced by digitalized systems. This digitalization, however, may initiate an event during plant operation with vital consequences for safety due to vulnerabilities inherent in the digitalized systems. The primary focus of this project is to upgrade the regulatory capacity of PNRA, thereby enabling it to licence the digitalized nuclear power plants and manufacturing facilities for safety class digital I&C systems within the country.



Chairman PNRA Unveiling the Plaque at Inauguration of PNRA Residential Colony Chashma



10. Performance Review

PNRA regularly reviews and monitors its performance for achieving continuous improvement in fulfillment of its responsibilities. For this purpose, PNRA has adopted various internal and external mechanisms. One of these is the performance review of PNRA's annual progress against predefined indicators.

PNRA has devised 12 "Strategic Performance Indicators (SPIs)" with downstream "Specific Performance Elements (SPEs)" to assess its performance and evaluate effectiveness of its regulatory processes.

Performance of activities and achievement of targets against defined performance elements contribute in the assessment of each indicator on defined rating scale. This rating scale includes five steps i.e. Satisfactory, Minimally Acceptable, Needs Improvement, Unsatisfactory and Not Acceptable.

10.1 Assessment of Strategic Performance Indicators

The performance review of PNRA for the year 2018 against each strategic performance indicator is reflected in the following paragraphs.

Strategic Performance Indicator 1:

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

The SPI-1 has three contributing performance elements related to regulatory processes of review and assessment; inspection and enforcement; and reporting of events.

During the year 2018, PNRA received a number of submissions of nuclear installations and radiation facilities. All these submissions were reviewed as planned; and where required, findings were communicated to the respective licensees. There was no delay in the scheduled reviews or pending disputes on resolution of review queries during 2018.

Details of review and assessment activities are presented in Chapters 3, 4, 5 and 9 of this report.

Each year, various directorates and inspectorates of PNRA, which have been assigned with the

responsibility for inspections, develop plans for conducting these inspections. These plans outline schedule of inspections of nuclear power plants; research reactors; molybdenum production facility; equipment manufacturers; service providers and radiation facilities.

During 2018, PNRA conducted regulatory inspections in line with scheduled plans and issued inspection reports accordingly. Where required, directives were issued to initiate corrective actions, which were followed-up.

PNRA activities related to inspections and enforcement are detailed in Chapters 3 and 4 of this report.

PNRA inspectors also witnessed the emergency exercises of various nuclear installations and radiation facilities conducted during 2018.

Highlights of these activities are reported in Chapter 6 of this report.

PNRA ensures that all reportable events are timely reported as per relevant regulatory requirements. A number of events were reported by licensed installations during this year. All these events were level zero events as per International Nuclear Event Scale (INES).

PNRA critically assessed the submitted reports to verify compliance of regulatory requirements and implementation of corrective actions.

Details of these activities are reflected in Chapter 3.

Through these activities, PNRA ensured that its licensees are maintaining an acceptable level of safety by performing their activities in accordance with the regulatory requirements.

Accordingly, PNRA performance for the year 2018 against this indicator has been rated as "Satisfactory".

Strategic Performance Indicator 2:

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

The "availability of updated regulations and guides"; and "licensee's perception & understanding

of regulations” constitute the specific performance elements for evaluation of SPI-2.

PNRA planned the issuance of one new regulation and revision of two existing regulations during 2018. Similarly, issuance of two new regulatory guides were intended for this year.

PNRA promulgated three regulations during 2018. In addition to these, one regulatory order and a national policy was also gazette notified.

PNRA also issued one new regulatory guide during the year. Furthermore, development / revision of several other regulations and regulatory guides remained in progress at PNRA in various stages of development during 2018.

Although, PNRA surpassed the target number of issuance of regulations this year, it was noted that two of the three identified regulations, stipulated to be issued this year, were in final stages of approval by the end of year. Similarly, one regulatory guide was also in final stages of approval. The details of these activities are presented in Chapter 2 of this report.

The perception and understanding of licensees about PNRA regulations is assessed through involvement of licensees in the regulation's development process; and licensee's feedback received on implementation of regulations. PNRA stakeholders are given due opportunity to provide comments during the development of regulations.

During 2018, PNRA shared a number of draft regulations, a national policy and a regulatory order with its licensee's for comments.

The feedback of licensee's on PNRA regulatory framework obtained through various mechanisms did not indicate any adverse opinion related to the licensees perception and understanding of the regulations.

Furthermore, PNRA organized several training courses and lectures for developing and enhancing the understanding of its stakeholders regarding PNRA regulatory framework.

Detailed description of PNRA activities in this regard are presented in Chapters 2, 7 and 8 of this report.

In view of the identified delay in promulgation of two regulations and one regulatory guide stipulated for this year; and considering that PNRA surpassed the target number of issuance of regulatory documents in 2018; PNRA's performance against this indicator is rated as “**Minimally Acceptable**”.

Strategic Performance Indicator 3:

“Strives for continuous improvement of its performance”

PNRA assesses the SPI-3 with respect to its efforts to bring improvement in regulatory processes based on its various mechanisms of performance monitoring.

The mechanisms adopted by PNRA which contribute to the assessment of this indicator include internal audit, self assessments, opinion of stakeholders and international feedback.

During 2018, PNRA scheduled the conduct of 4th internal regulatory audit of all its organizational units. Teams comprising independent technical experts completed the conduct of audit as planned and issued individual audit reports to each department and an integrated audit report for management.

Quarterly performance evaluation of all departments was also conducted as scheduled during 2018, whereas, various PNRA departments also conducted their self assessments.

The feedback from various stakeholders including national organizations and licensees for improvement in regulatory processes and activities is obtained through different mechanisms.

During 2018, PNRA shared several draft regulatory documents; had several mutual interactions; and a number of formal correspondences were exchanged with different stakeholders.

PNRA continued implementation of recommendations and suggestions of the International Regulatory Review Service (IRRS) Mission to Pakistan. Accordingly, periodic progress reports were issued.

All efforts were made to translate the insights and feedback acquired through these mechanisms for improvement in processes and activities of PNRA.

Accordingly, corrective action plans were made and several improvement actions in identified areas were initiated which included modifications in practices and revision of procedures.

Chapter 2 of this report presents detail of monitoring and evaluation activities, all of which are aimed at continuous improvement of PNRA's performance.

Considering that all activities contributing to evaluation of this indicator scheduled during 2018 were conducted effectively and efficiently as intended, performance of PNRA for this indicator is rated as “**Satisfactory**”.

Strategic Performance Indicator 4:

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

PNRA assesses SPI-4 based on its activities to prevent degradation of safety and promote safety improvements in the light of periodic safety assessment of licensees; implementation of necessary design modifications; and international experience feedback.

During the year 2018, PNRA performed operational safety trend analysis and integrated safety assessment of various nuclear installations. PNRA also reviewed and accepted "scope and strategy" for periodic safety reports of two nuclear power plants.

Development of format and contents of identified Chapter of Safety Analysis Report was completed in 2018. However, safety assessment of dry storage cask for CNPGS spent nuclear fuel scheduled for this year could not be completed. Similarly, safety assessment of radiation facilities could not be completed as scheduled during 2018.

Chapters 3 and 4 reflect details of these activities.

During the year 2018, PNRA evaluated experience feedback from different international platforms highlighting lessons to enhance safety of nuclear installations and radiation facilities in Pakistan.

In this regard, reports on international operating experience feedback and evaluation of events reported through IAEA and other nuclear regulators were prepared and shared with relevant stakeholders.

Details of these activities are reflected in Chapters 3 and 4 of this report.

A number of modifications in design and technical specifications of various nuclear installations submitted by the licensees were assessed at PNRA during 2018. Several of them were approved while assessment of a few was ongoing by the end of the year.

Details of these activities are presented in Chapter 3 of this report.

Considering that most of scheduled activities contributing for this indicator were completed during this year; while keeping in view the extension in time-line for preparation of guidance document for periodic safety review; and delay in safety assessment of radiation facilities; the performance of PNRA is rated as "**Minimally Acceptable**" this year.

Strategic Performance Indicator 5:

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

The performance elements which contribute to assessment of SPI-5 are planning for human resources; competency and training needs assessment; and training of regulatory officials in relevant domains.

In line with "Human Resource Strategic Plan 2025", PNRA continued systematic induction of manpower for continued performance of regulatory activities. During this year, a number of engineers and scientists joined PNRA. These professionals were inducted after the successful completion of PNRA sponsored MS programmes in nuclear engineering, medical physics and other relevant fields from reputable institutions.

PNRA also recruited a number of administrative and other support professionals during 2018. A number of PNRA officers also continued perusing graduate, post-graduate, master's and doctorate degree programmes in reputed national and international universities.

PNRA completed the exercise for rationalization of human resources for its departments during 2018. Based on the experience feedback and task analysis of various departments, tasks and functions assigned to PNRA departments were updated and issued for the period 2019-2021.

PNRA conducted a number of in-house training courses for all levels of regulatory officials in various regulatory domains in line with the identified training and competence needs.

In addition, a number of PNRA officials were sent to various national and international organizations and institutes to participate in different training courses, workshops, fellowships and scientific visits.

Information about human resource planning; identification of competence needs and training activities is shared in Chapter 7 of this report.

In view of the continued efforts for human resource and competence development, performance against this indicator is rated as "**Satisfactory**".

Strategic Performance Indicator 6:

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

The SPI-6 correlates with the performance of PNRA

in the enforcement regime. Its assessment is based on the performance elements related to availability of enforcement mechanism; serving of notices to ensure compliance; and actions taken against violators.

PNRA has a well established enforcement mechanism based on Enforcement Regulations - PAK/950; associated process outlined in its management system; and internal working procedure describing details of various enforcement steps, actions and responsibilities.

All radiation facilities and related activities in the country require licence from PNRA to operate. However, a number of medical diagnostic X-ray facilities across Pakistan are still out of licensing net. With this exception, all other radiation facilities and related activities are already licensed or registered with PNRA.

PNRA identified a number of non-compliances of regulatory requirements by different licensees during 2018.

Accordingly, a number of directives, show cause notices and offence reports were issued to relevant violators and followed up for compliance. PNRA also conducted several hearing proceedings in 2018.

Chapters 3 and 4 of this report reflect details of these activities.

In consideration of the fact that a number of medical diagnostic X-ray facilities are still out of licensing net while noting the on-going efforts of PNRA to implement its enforcement regime, performance of PNRA against this indicator is rated as "**Minimally Acceptable**".

Strategic Performance Indicator 7:

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

The SPI-7 is evaluated against performance elements related to defining and meeting targets; executing all assigned activities; and optimization of resources.

PNRA continued effective regulatory oversight of all nuclear installations and radiation facilities in the country. Work plans identifying targets and resources were prepared for various regulatory activities in all territorial jurisdictions.

Efforts were made to meet the targets while accommodating unplanned activities encountered during performance of regulatory business. PNRA

completed all scheduled licensing, authorization, review, assessment, inspection and enforcement activities as planned.

All major targets and milestones for the year 2018 were achieved while effectively utilizing allocated resources.

PNRA also completed planned activities regarding development or revision of regulatory and management system documents, processes and procedures.

Furthermore, PNRA successfully completed scheduled activities under PSDP Projects as per approved cash and work plans.

Chapters 2, 3, 4, 5, 6 and 9 of this report present details of these activities.

Considering the efforts made by PNRA for timely and cost effective accomplishment of scheduled activities, the performance of PNRA against this indicator is rated as "**Satisfactory**".

Strategic Performance Indicator 8:

"Ensures that a well established quality management system exists"

The SPI-8 relates to the establishment of management system; its understanding by regulatory officials; and its implementation within PNRA.

PNRA has established a well-defined management system in line with relevant international standards. This is documented in Management System Manual (MSM). The MSM systematically describes organizational responsibilities and all regulatory and organizational processes and functions.

In 2018, PNRA completed an awareness campaign among its regulatory staff for enhancing the understanding of the Management System Manual.

PNRA has also established a mechanism for monitoring effective implementation of management system. In general, all elements of PNRA MSM were noted to be effectively implemented while actions were initiated for improvement in areas highlighted in various monitoring and evaluation activities conducted during 2018.

Chapter 2 of this report reflects details of these activities.

Considering the continuous efforts of PNRA for maintenance and effective implementation of management system, the performance of this indicator is rated as "**Satisfactory**".

Strategic Performance Indicator 9:

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

This indicator is assessed on the basis of performance elements related to financial & human resources; and functioning of technical support centre(s) of PNRA.

Based on the human resource rationalization, efforts were made to ensure availability of identified human resources for all organizational units of PNRA. During the year 2018, efforts were made for approval of necessary budget from Government.

However, allocated budget was less than the proposed budget. Nevertheless, PNRA made efforts for timely release of allocated funds and subsequent effective utilization of the released funds for accomplishment of organizational goals and targets.

PNRA has two operational technical support centres in the northern and southern part of the country. These centres strengthen and enhance the existing capabilities of PNRA in order to efficiently and effectively discharge its regulatory responsibilities.

In 2018, these centres provided technical support in review and assessment of various licensing submissions; and provided analysis based input for licensing and regulatory decision making.

Details of these activities are reflected in Chapter 9 of this report.

Keeping in view the availability of resources and technical support to PNRA during 2018; while considering the restrained allocation of finances; the performance of this indicator is rated as "**Minimally Acceptable**" this year.

Strategic Performance Indicator 10:

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

Performance elements related to acquisition of direct feedback of licensees; and participation of licensees and regulator in each other's activities contribute in assessment of this indicator.

PNRA has developed a mechanism for obtaining feedback of its licensees through a questionnaire on effectiveness of regulatory processes and professionalism of regulatory officials.

During this year, PNRA shared the questionnaire with nuclear installations and evaluated the feedback received.

During the year 2018, PNRA arranged a number of training courses, seminars, workshops which were attended by a considerable number of participants from licensees including the radiation workers. Some of these events were exclusively organized for licensees.

Similarly, regulatory officials also attended events organized by different licensees across the country. PNRA also conducted a number of periodic coordination meetings at different levels with representatives of major nuclear installations during 2018.

Chapters 2, 7 and 8 of this report present details of these activities.

In view of the efforts for acquiring direct feedback and interaction with licensees; PNRA's performance against this indicator is rated as "**Satisfactory**".

Strategic Performance Indicator 11:

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

PNRA assesses this indicator with respect to performance elements related to public awareness programme; sharing of information with public; and involvement of public in preparation of regulatory documents.

PNRA is implementing a continuous public awareness programme for enhancing awareness about ionizing radiation, associated hazards and mechanisms of protection.

During the year 2018, a number of lectures and seminars were organized across the country in different cities. Information about these activities are reflected in Chapter 8 of this report.

PNRA website (www.pnra.org) is also used to share information about major regulatory decisions and activities with the public. Information about all activities performed during the year are also reflected in detail in PNRA Annual Report.

During 2018, PNRA's website was regularly updated with recent information and Annual Report was widely circulated within and outside the country.

PNRA encourages public involvement in the development of its regulations. During 2018, public comments were invited on a number of regulatory documents and comments received were addressed after due consideration.

However, revision of mechanism to include public involvement in preparation of regulatory guides remained in progress.

Furthermore, it was felt that PNRA also needs to update its processes to further enhance outreach that ensures active involvement of public in the development of regulatory documents.

Details of these activities are reflected in Chapters 2 and 8 of this report.

In view of the ongoing revision of process for preparation of regulatory guides and identified need to update processes to ensure more active involvement of public in the development of regulatory documents, the performance of this indicator is rated as “**Needs Improvement**”.

Strategic Performance Indicator 12:

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

The relevant performance elements of SPI-12 are information sharing, reporting and communication of decisions to the Government; and provision of support to Government in fulfillment of obligations under international conventions.

During 2018, PNRA continued to maintain effective liaison with Government regarding execution of its national obligations. Regulatory decisions taken during 2018 were appropriately communicated to relevant government organizations.

Progress reports on implementation of IRRS Report Action Plan were shared with Government during 2018. PNRA also continued to share quarterly summary reports on status of nuclear power plants with relevant government organizations.

PNRA continued to play its role and supported the Government in fulfillment of Pakistan’s obligations under relevant international conventions pertaining to nuclear safety, radiological emergencies and physical protection. In this regard, PNRA remained actively engaged in activities related to national obligations under the international conventions to support the Government of Pakistan.

Chapters 8 of this report provide information about these activities in detail.

In view of the above, the performance of PNRA against this indicator is rated as “**Satisfactory**”.

10.2 Overall Performance

Performance of activities and achievement of targets during 2018 against each of the 12 Strategic Performance Indicators contribute in the overall integrated assessment of PNRA’s performance.

Considering the evaluation presented in preceding paragraphs, PNRA rated its performance as “**Satisfactory**” for the year 2018. Figure-41 presents the rating scale and associated color codes used for reflecting the assessment of PNRA’s performance against 12 SPIs as indicated in Figure-42.

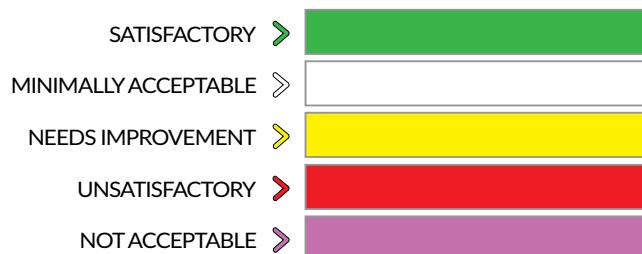


Figure-41: Rating Scale and Colour Codes



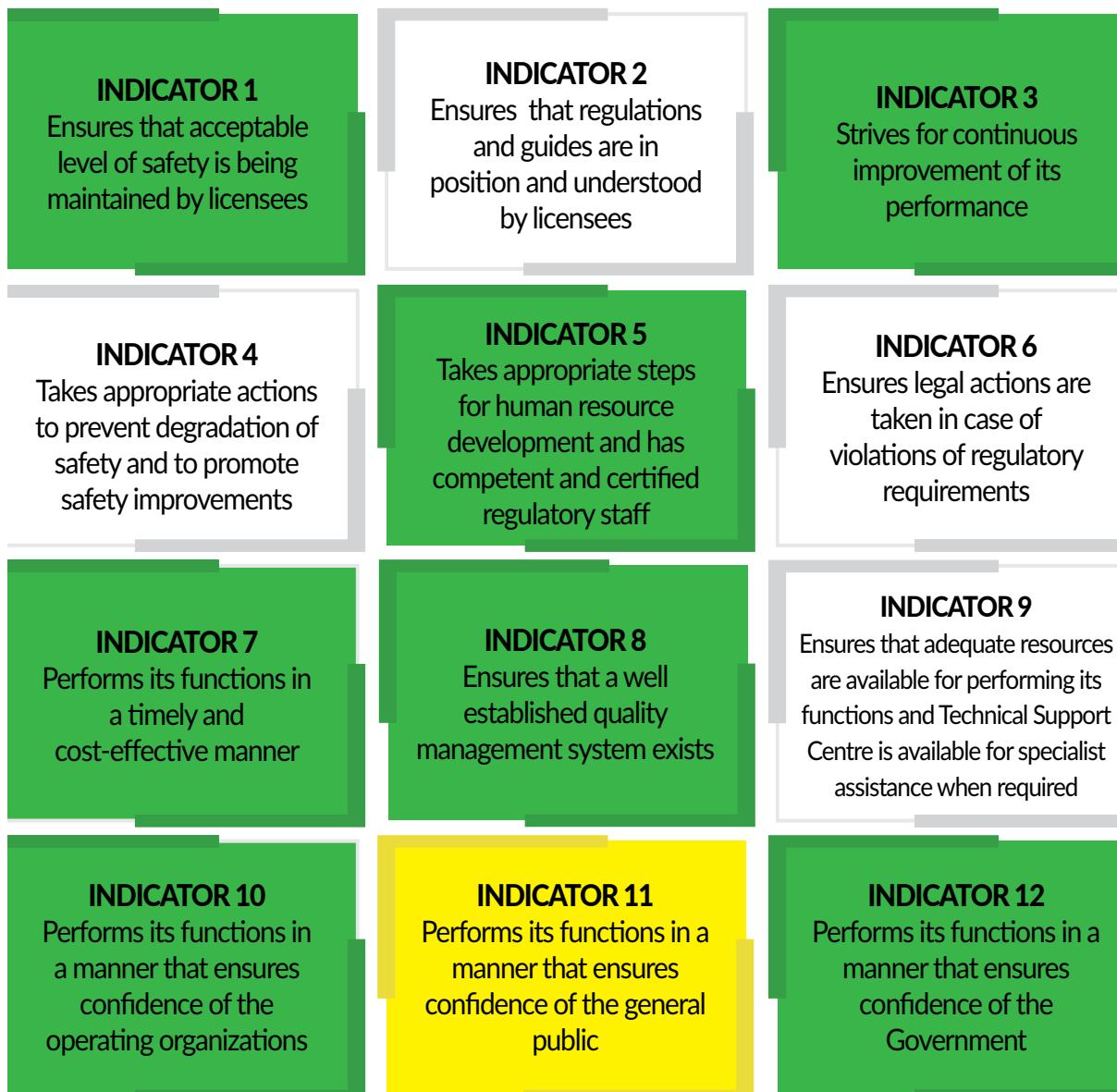
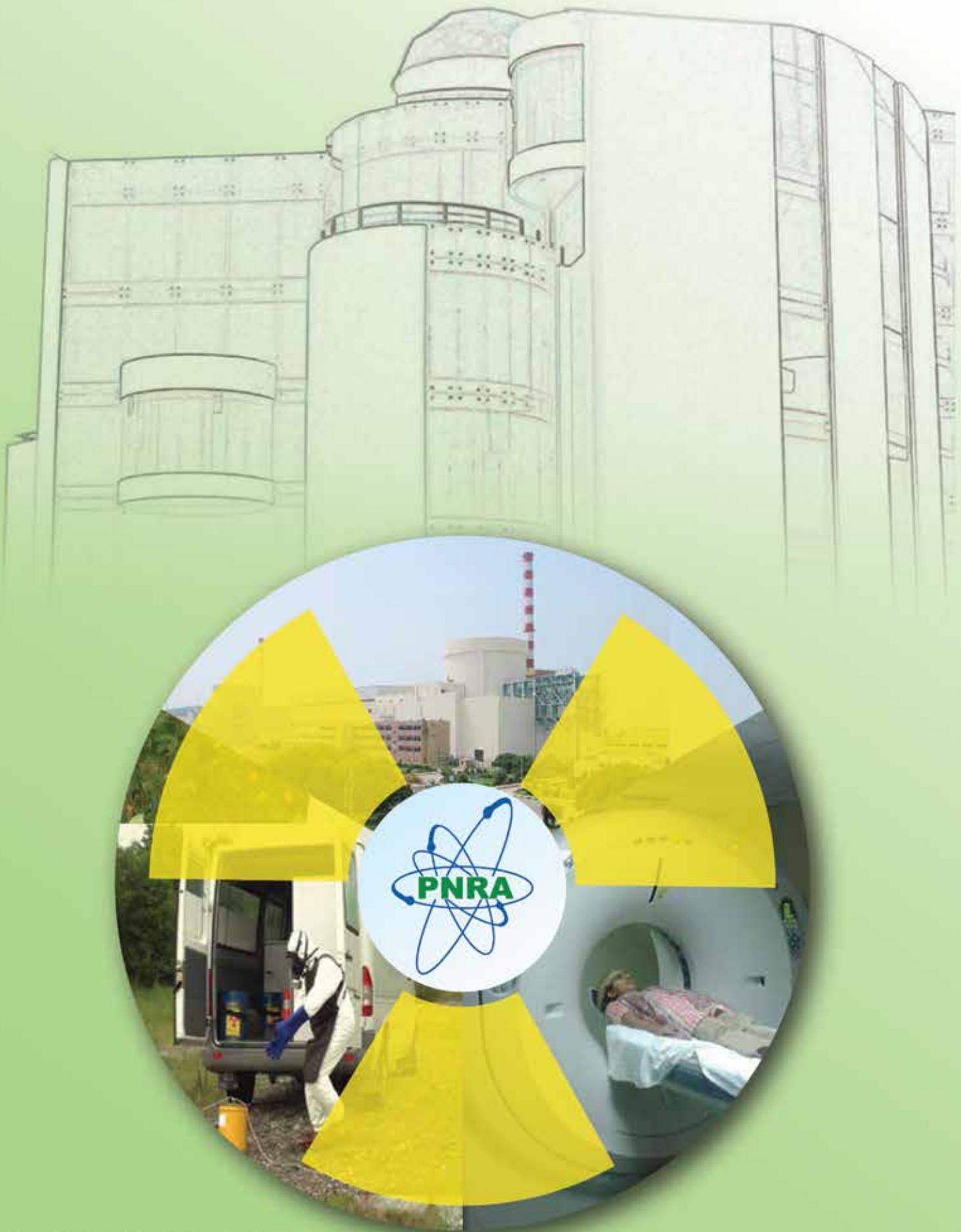


Figure-42: Assessment of PNRA's Performance in 2018



Pakistan Nuclear Regulatory Authority

G-8/1 Mauve Area
Islamabad, 44000 Pakistan

Tel: +92 (51) 926 3001-6

Fax: +92 (51) 926 3007

Email: officialmail@pnra.org

www.pnra.org