PNRA

REPORT 2013

PAKISTAN NUCLEAR REGULATORY AUTHORITY

MEMBERS OF PNRA

PRESENT

Mr. Mohammad Anwar Habib (Chairman)

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Mr. Mohammad Iqbal

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Mr. Asif Shuja Khan

Dr. Muhammad Nuruddin Qazi

Mr. Hussain Ahmad Siddiqui

Prof. Dr. Mustafa Kamal

Mr. Saeed Alam Siddiqi

FORMER

Mr. Jamshed Azim Hashmi (Chairman)

Dr. M. Younus Sheikh

Mr. Anwar Ali

Mr. Jawad Azim Hashimi

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Prof. Dr. Mohammad Ali Maud

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Mr. Mohammad Shakilur Rahman

Dr. Shahid Ahmed Mallick

MESSAGE FROM THE CHAIRMAN

With the grace of Almighty Allah and active support from my colleagues, I am honored to present the progress of PNRA in this annual report for the year 2013. As an independent nuclear regulatory body, we are in the fourteenth year of our journey with the aim to fulfill our mission and to transform our vision into reality. Although, the work of such an organization is not easily quantifiable, however, our progress in all regulatory domains has been remarkable in terms of development of a dynamic infrastructure, human resource development, education & training, formulation and implementation of regulations, and visible national/international recognition.

PNRA adopted proactive approach for ensuring safety of nuclear power plants in accordance with our national legislative system including consideration to international requirements and practices in the post Fukushima scenario. This is evident from improved performance of the operating nuclear power plants. Endeavors are being made for safety improvements in the radiation facilities resulting in considerable increase of radiation facilities in PNRA licensing net and their safe operation. However, by saying this, PNRA is not complacent about the situation and is committed to put proportionate efforts in this regard to bring every radiation facility in the licensing net.

Maintaining sufficient number of highly qualified, skilled and experienced professionals has been the cornerstone in PNRA functioning. Accordingly, PNRA has established training institutions with the objective to broaden the knowledge-base and professional skills of its staff. PNRA also arranges trainings of stakeholder's personnel who have important role in maintaining a high level of safety and security at nuclear installations and radiation facilities in the country.

Regarding development work, PNRA has completed the project of Nuclear Security Action Plan (NSAP) and transformed it into Directorate of Physical Protection and Nuclear Security (PPSD). The project of establishment of Safety Analysis Centre (SAC) to provide technical support in safety analysis for NPPs is progressing well. Laboratories under the projects of National Environmental Radioactivity Surveillance Program (NERSP) and National Dosimetry and Protection Level Calibration Laboratory (NDCL) have started functioning at Islamabad, Karachi and Chashma whereas, remaining work under these projects are being accomplished as per work plans.

At national level, PNRA is progressing steadily on developing and improving coordination with various national organizations including ministries, law enforcment agencies, autonomous bodies, educational institutions, etc., to discharge its obligations effectively. As part of its international obligations, PNRA prepared sixth national report on the Convention on Nuclear Safety and national report on Code of Conduct on Safety and Security of Radioactive Sources with input from all national stakeholders. PNRA has close liaison with the nuclear regulatory body of China. We are also working to strengthen coordination with the regulatory body of USA. As part of knowledge networking for the institutional strengthening and capacity building, PNRA is in close liaison with IAEA and is also providing its experts' support to IAEA in strengthening regulatory infrastructure and manpower development of regulatory bodies of other countries.

PNRA has progressed well on regulatory matters at national and international fronts. However, we realize that information sharing with public on regulatory activities needs more attention which is now being focussed.

A strong team with coherent approach and dedication to achieve the common objective of making PNRA an effective regulatory body is our achievement. PNRA is well aware of long term organizational needs in view of expansion of nuclear power program and radiation applications in the country which will be accomplished through implementation of five years strategic plan. With such a dedicated team and comprehensive planning, I am confident that PNRA would be able to meet current and future challenges in nuclear and radiation safety.

Mohammad Anwar Habib

VISION

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

MISSION

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

CORE VALUES

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

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

Contents

ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
Bq/m^3	Becquerel /cubic meter
C-1	Chashma Nuclear Power Plant Unit 1
C-2	Chashma Nuclear Power Plant Unit 2
C-3	Chashma Nuclear Power Plant Unit 3
C-4	Chashma Nuclear Power Plant Unit 4
CHASCENT	CHASNUPP Centre for Nuclear Training
CNPGS	Chashma Nuclear Power Generating Station
CNS	Centre for Nuclear Safety
DRLs	Derived Release Limits
DSRS	Disused Sealed Radioactive Sources
FSAR	Final Safety Analysis Report
GBq	Giga Becquerel (10^9 Becquerel)
IAEA	International Atomic Energy Agency
K-1	Karachi Nuclear Power Plant Unit 1
K-2	Karachi Nuclear Power Plant Unit 2
KINPOE	Karachi Institute of Nuclear Power Engineering
KWt	Kilowatt Thermal
MRML	Mobile Radiological Monitoring Laboratory
mSv	mili Sievert (unit of dose)
MWe	Megawatt Electrical
MWt	Megawatt Thermal
NDCL	National Dosimetry and Protection Level Calibration Laboratory
NERSP	National Environmental Radioactivity Surveillance Programme
NPP	Nuclear Power Plant
NRECC	National Radiation Emergency Coordination Centre
NSAP	National Nuclear Security Action Plan
NSTC	Nuclear Security Training Centre
NUML	National University of Modern Languages
NuSECC	Nuclear Security Emergency Coordination Centre
PAEC	Pakistan Atomic Energy Commission
PARR-I	Pakistan Research Reactor-I
PARR-II	Pakistan Research Reactor-II
PIEAS	Pakistan Institute of Engineering and Applied Sciences
PINSTECH	Pakistan Institute of Nuclear Science and Technology
PNRA	Pakistan Nuclear Regulatory Authority
PSAR	Preliminary Safety Analysis Report
PSDP	Public Sector Development Programme
RDE	Radiation Detection Equipment
RS	Radiation Sources
SAC	Safety Analysis Centre
SAR	Safety Analysis Report
SARIS	Self Assessment of Regulatory Infrastructure for Safety
SNRS	School for Nuclear and Radiation Safety
SPD	Strategic Plans Division

1 INTRODUCTION AND BACKGROUND

With the promulgation of Pakistan Nuclear Regulatory Authority Ordinance in January 2001, the Pakistan Nuclear Regulatory Authority was established as an independent nuclear regulatory body for regulation of nuclear safety and radiation protection in Pakistan. Since its inception, Pakistan Nuclear Regulatory Authority (PNRA) has been striving to fulfill its obligations for ensuring implementation of nuclear and radiation safety regime and supervision of all matters pertaining to safety of nuclear installations & radiation facilities in the country. During the first decade of its evolution, PNRA has made fabulous growth in enlargement of infrastructure essential for a nuclear regulatory body. Consequently, PNRA adopted all-around approach for the maturity of essential elements of a regulatory body. The first is the availability of legal basis for decision making, followed by development of competencies and necessary infrastructure for discharging its responsibilities. PNRA Ordinance empowers PNRA to devise, adopt and make regulations to guard workers, public and the environment against harmful effects of ionizing radiations. Development and promulgation of regulations was kept vibrant by seeking comments from the stakeholders and many regulations were revised on the basis of implementing experience feedback and considering technological advancement worldwide. Availability of legal basis for regulating nuclear and radiation facilities from cradle to grave has contributed towards effectiveness in discharging PNRA's responsibilities and implementing effective regulatory oversight process through competent staff. Now PNRA has legal basis for nuclear safety, radiation protection, emergency planning and preparedness, radioactive waste management, physical protection and enforcement. Availability of competent staff is ensured through qualification, training and retraining.

In addition to core responsibilities, instilling awareness among the concerned workers and general public about nuclear and radiation safety issues is a matter of great importance. PNRA maintains liaison with the relevant Governmental ministries and public administration bodies to improve implementation of safety measures in their domains in addition to collaboration with national institutions for research & development in nuclear & radiation safety.

All regulatory activities are carried out in accordance with the well established regimes that cater to national as well as international aspirations. As a forward-looking entity, PNRA lays great stress on enhancing its regulatory effectiveness and efficiency, particularly through capacity building and institutional strengthening measures, and on working in a manner that ensures the confidence of the licensees, the Government and the public.

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

Major Activities in 2013

Major activities of PNRA during 2013 are summarized as follows:

1. Monitoring of activities at three operational nuclear power plants (Karachi Nuclear Power Plant Unit-1, Chashma Nuclear Power Plants Units-1&2) and two under construction nuclear power plants (Chashma Nuclear Power Plant Units 3 & 4) continued. Releases to the environment from operating NPPs and radiation doses to workers remained well below the regulatory limits;
2. Monitored the first refueling outage of Chashma Nuclear Power Plant Unit-2 (C-2) and 8th refueling outage of Chashma Nuclear Power Plant Unit-1 (C-1). All activities under the scope were completed safely;

3. Enhanced the licensing net for diagnostic radiation facilities by more than 25 percent. 800 new facilities were registered during the reported period;
4. Issued two Regulatory Guides namely "Guidance for the Users of I- 131 in Nuclear Medicine Centres (RG-904.02)" and "Format and Contents of Application for Design Modification/Change Approvals for Nuclear Power Plants (RG-913.02)";
5. Completed baseline data of background radiation levels in the soil of the country;
6. Prepared Pakistan's Sixth National Report on the Convention on Nuclear Safety;
7. Successfully completed PSDP project "School for Nuclear and Radiation Safety" after formal approval of the Government. As a result, fifty five (55) personnel of the project were included as a part of permanent employees of PNRA;
8. Successfully completed PSDP project "National Nuclear Security Action Plan" after formal approval of the Government. As a result, eighty (80) personnel of the project were included as a part of permanent employees of PNRA;
9. Two PSDP projects "National Dosimetry and Protection Level Calibration Laboratory" and "National Environmental Radioactivity Surveillance Programme" were revised for another year;
10. Established Whole Body Counting (WBC) laboratory for assessment of internal contamination at Islamabad;
11. Established Environmental Monitoring (EM) laboratories for assessment of radio-nuclides in environment and in soil at Chashma site;
12. IAEA's Preparatory Mission for Integrated Regulatory Review Services (Pre-IRRS) visited PNRA to set the scope of IRRS mission to Pakistan;
13. PNRA conducted self-assessment which is a prerequisite for IRRS mission;
14. Under the IAEA-Pakistan Nuclear Security Cooperation Program, the security of three Nuclear Medicine Centres of PAEC was upgraded under the regulatory oversight of PNRA;
15. Conducted twenty seven (27) professional training courses in the areas of nuclear safety and radiation protection. About seven hundred (700) officials from PNRA, PAEC and other stakeholders/organizations were trained;
16. Conducted eleven (11) training courses in the areas of nuclear security for the capacity building of first responders, emergency response personnel, front line officers, etc. About two hundred and forty (240) personnel from PNRA, PAEC, law enforcement agencies and other related organizations participated;
17. Two hundred and seventy three (273) PNRA officials participated in two hundred & eight (208) international events such as workshops, training courses, meetings and seminars organized by IAEA under the Agencies' technical assistance program;
18. PNRA arranged five (05) training courses for RPOs and industrial radiographers. Ninety (90) RPOs and radiographers out of one hundred & twelve (112) were certified. In addition, three workshops on quality assurance and protection of patients in imaging and radiotherapy at medical centers were also arranged;
19. PNRA arranged ten (10) training courses for the Rescue-1122, Police, Bomb Disposal Squad, Civil Defense, Frontier Constabulary (FC), Special Brach, SPD, Counter Intelligence Team (CIT), Health Department;
20. PNRA officials assisted IAEA in fifty six (56) expert missions to other countries; and
21. PNRA in collaboration with IAEA arranged thirteen (13) workshops/training courses in Islamabad. More than three hundred (300) officials from PNRA, PAEC and other

stakeholders/organizations participated.

Targets for 2014

The targets set for 2014 are summed up as follows:

1. Continuous monitoring of licensees' activities to avoid major incidents, overexposure to workers, and releases to the environment;
2. Enhancing the licensing net for diagnostic radiation facilities by another 20 percent;
3. Issuance of "Regulations on Decommissioning of Facilities using Radioactive Material" (PAK/930); and revision of "Regulations for Licensing of Nuclear Safety Class Equipment and Component Manufacturers" (PAK/907);
4. Issuance of the following regulatory guides:
    a. Radiation Safety in Industrial Radiography (RG-904.03);
    b. Protection of Patients in Diagnostic Radiology (RG-904.05); and
    c. Format and Contents of Radiation Emergency Plans of Radiation Facilities and Activities (RG-914.02).
5. Development of advance reference material for IRRS mission and conduct of full scope IRRS mission to Pakistan;
6. Finalization of PNRA's Strategic Plan 2014-2018;
7. Revision of PNRA Management System Manual;
8. Establishment of National Institute of Safety and Security (NISAS);
9. Completion of PSA Level-1 Regulatory Model Development Project for Chashma Nuclear Power Plant Unit 1 (C-1); and
10. Conducting about 40 training courses on nuclear safety, security and radiation protection; providing training to about 700 officials from PNRA and other stakeholders.

Preparatory Meeting for Upcoming IRRS Mission in 2014

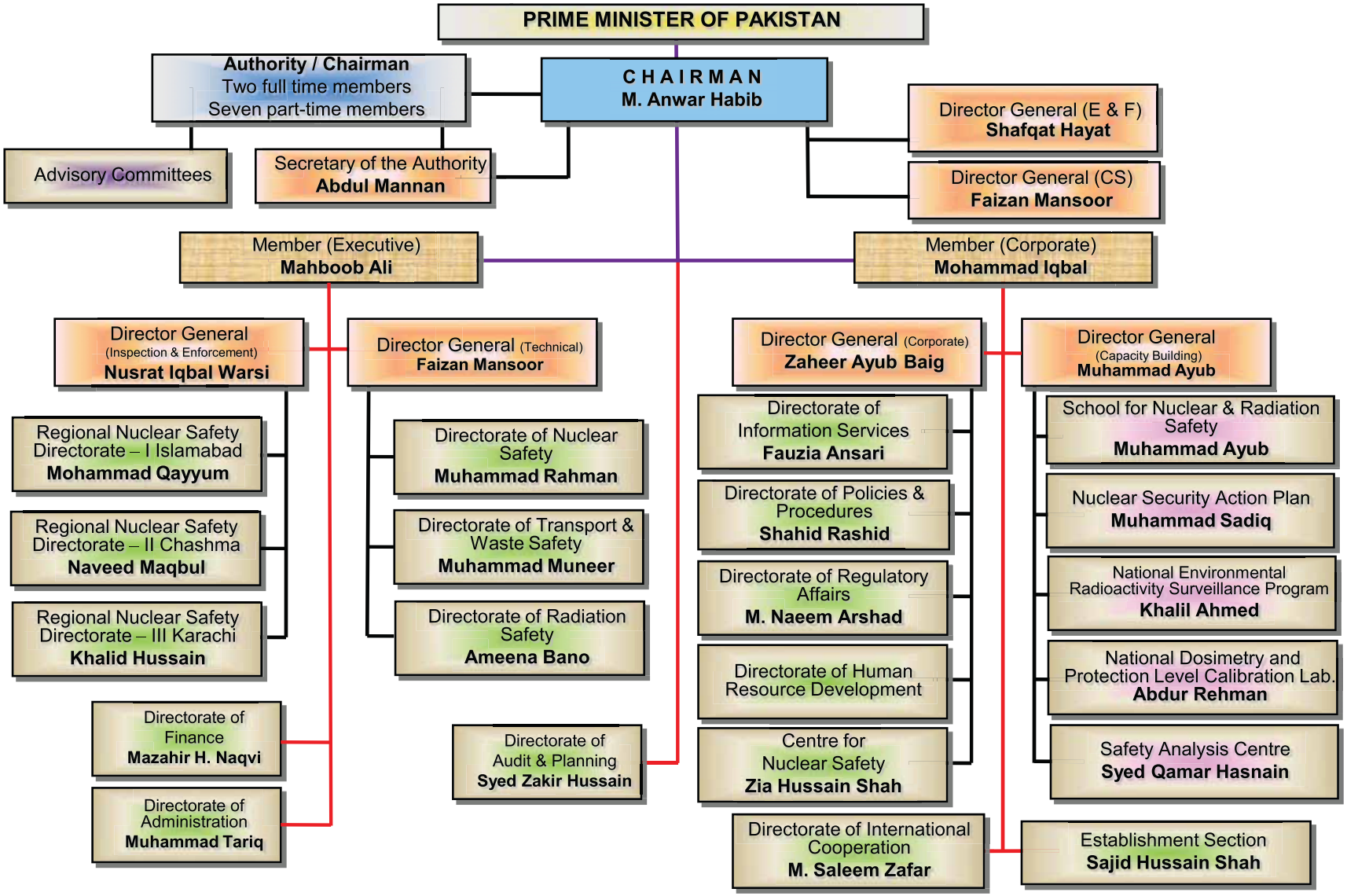


Figure 1: Organizational Structure of PNRA

2 REGULATORY FRAMEWORK

PNRA is maintaining its regulatory framework to ensure nuclear safety and radiation protection in the country. This regulatory framework comprises of three tiers as shown in the Figure 2. The first tier is PNRA Ordinance, followed by PNRA regulations and regulatory guides issued there-under in the subsequent tiers. The highest level document, PNRA Ordinance, describes the mandate, powers, functions and responsibilities of PNRA assigned by the Government of Pakistan. Under the Ordinance, PNRA is empowered to issue rules, regulations and policies in order to regulate safety of nuclear installations and protection against risks arising from ionizing radiations. The regulations are placed in the second tier of PNRA's regulatory pyramid. These regulations describe the requirements to be met by the applicants of nuclear installations and radiation facilities for issuance of authorizations or granting licences by PNRA. Before issuing an authorization or granting a licence, the applicant has to submit various documents along with the application. These documents are subjected to a comprehensive review and assessment at PNRA, based on the regulatory requirements addressed in PNRA regulations. Compliance to PNRA regulations is mandatory for the licensees throughout the lifetime of a nuclear or radiation facility and is verified through conducting regulatory inspections. In areas where PNRA regulations are not available, latest US Nuclear Regulatory Commission's regulations are applicable. Alternatively, the licensee may choose to follow the latest revisions of the applicable IAEA Safety and Security Standards. Non-compliance with the regulatory requirements is generally managed through persuasions. However, some cases are dealt with an enforcement process which is based on the policy that prosecution is used as a last resort when all other mechanisms such as persuasion and serving of notices do not result in any positive outcome. Development and revision of regulatory documents is a continuous process which includes publication of new requirements, revision/modification in previously issued requirements.

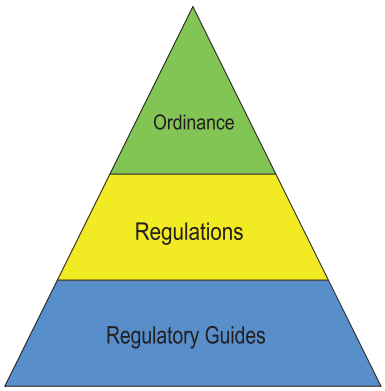


Figure 2: Regulatory Framework

The third level of regulatory framework composes of regulatory guides which describe acceptable methodology for implementing the requirements delineated by PNRA regulations. Since, these guides are non mandatory in nature therefore the licensee may choose other approaches to meet the regulatory requirements. In such a case, the licensee is required to demonstrate that the proposed approach provides at least the same level of safety as would have been achieved, if the methodology described in the guides had been applied.

Regulations

The regulations enable PNRA for realization of its mission of protecting the radiation workers, the general public and the environment from harmful effects of radiation. PNRA follows a comprehensive process for the development of its regulations including rigorous internal reviews at various levels within PNRA which is followed by inviting comments from all the stakeholders such as the licensees, the Government, and the general public. The entire process of developing a new set of regulations or revising existing regulations takes approximately three years.

The procedure for preparation and adoption of PNRA regulations requires review of regulations after every five years taking into account obligations of international conventions, feedback from licensing experience, feedback from stakeholders, and current international practices. The regulations

that have so far been published by PNRA are available at PNRA website (www.pnra.org).

Development of new and revision of existing regulations remained in progress during the year 2013. Work continued on the revision of the following regulations:

1. Regulations for Licensing of Nuclear Safety Class Equipment and Component Manufacturers – (PAK/907);
2. Regulations for the Licensing of Radiation Facilities other than Nuclear Installations – (PAK/908);
3. Regulations on the Safety of Nuclear Power Plants: Design – (PAK/911);
4. Regulations on Safety of Nuclear Power Plants: Operation – (PAK/913);
5. Regulations on Radioactive Waste Management – (PAK/915);
6. Regulations for the Safe Transport of Radioactive Material – (PAK/916); and
7. Regulations on the Safety of Nuclear Research Reactor(s) Operation – (PAK/923).

Following new regulations are being developed:

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

Regulatory Guides

Regulatory guides are non mandatory documents developed under the PNRA regulations to facilitate the licensees in the implementation of the requirements of PNRA regulations.

During 2013, following regulatory guides were issued:

1. Guidance for the Users of I- 131 in Nuclear Medicine Centres (RG-904.02); and
2. Format and Contents of Application for Design Modification/Change Approvals for Nuclear Power Plants (RG-913.02).

Development of the following regulatory guides remained in progress during 2013:

1. Radiation Safety in Industrial Radiography (RG-904.03);
2. Protection of Patient in Diagnostic Radiology (RG-904.05);
3. Radiation Protection and Safety in Radiotherapy (RG-904.06);
4. Format & Contents of Radiation Protection Program of Radiation Facilities/Practices (RG-904.07);
5. Guidelines for Medical Professionals on Transport, Diagnosis & Management of Overexposed & Contaminated Individuals in Radiological Emergency (RG-904.08);
6. Guidance for Preparation of License Applications of Radiation Facilities (RG-908.01); and

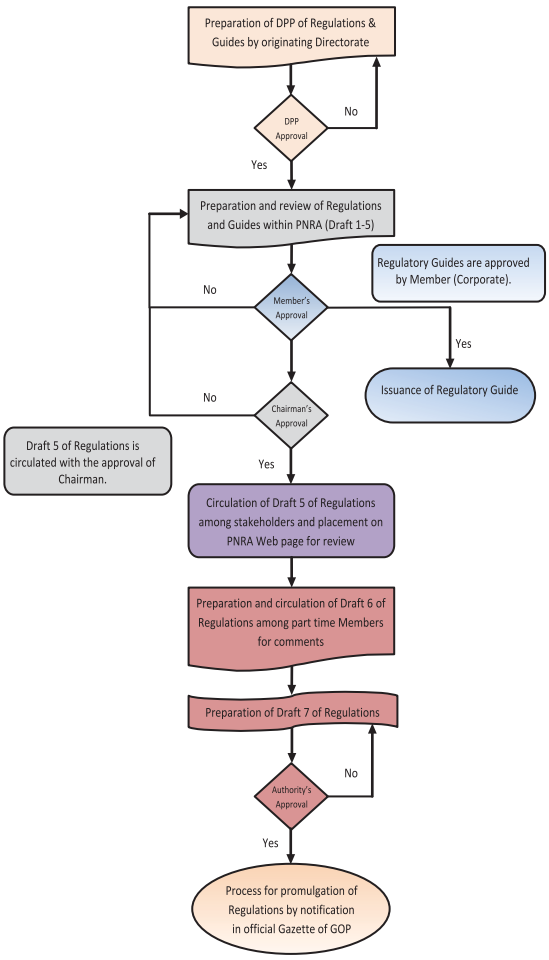


Figure 3: Development Process of Regulations and Regulatory Guides

7. Format and Contents of Emergency Plans of Radiation Facilities and Activities (RG-914.02).

Figure 3 shows different stages of the development process of PNRA regulations and regulatory guides.

Central Registry

PNRA maintains a central registry of all regulatory documents including regulations, regulatory guides, policies and internal working procedures. In all, 17 regulations, 8 regulatory guides, 7 policies, and 165 working procedures have been registered so far (Figure 4).

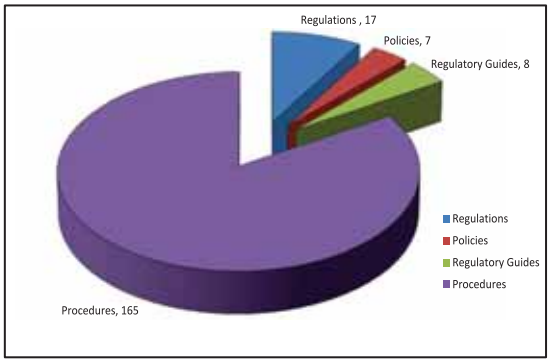


Figure 4: Status of PNRA Central Registry

PNRA Regulations

- Licensing Fee by Pakistan Nuclear Regulatory Authority - (PAK/900)
- Transaction of Business of Pakistan Nuclear Regulatory Authority - (PAK/901)
- Regulations on Radiation Protection - (PAK/904)
- Licensing of Nuclear Safety Class Equipment and Components Manufacturers - (PAK/907)
- Licensing of Radiation Facilities other than Nuclear Installations - (PAK/908)
- Licensing of Nuclear Installations - (PAK/909)
- Safety of Nuclear Installations – Site Evaluation - (PAK/910)
- Safety of Nuclear Power Plant Design - (PAK/911)
- Safety of Nuclear Power Plants-Quality Assurance - (PAK/912)
- Safety of Nuclear Power Plants Operation - (PAK/913)
- Management of a Nuclear or Radiological Emergency - (PAK/914)
- Radioactive Waste Management - (PAK/915)
- Safe Transport of Radioactive Material - (PAK/916)
- Safety of Nuclear Research Reactor(s) Operation - (PAK/923)
- Pakistan Nuclear Regulatory Authority Enforcement Regulation - (PAK/950)
- Pakistan Nuclear Safety and Radiation Protection Regulations, 1990
- Pakistan Nuclear Safety and Radiation Protection (Treatment of Food by Ionizing Radiation) Regulations, 1996

Review of PNRA Regulations

3
REGULATORY OVERSIGHT OF NUCLEAR INSTALLATIONS

Nuclear safety of all civilian nuclear installations in the country is regulated by PNRA. At present, there are five operational nuclear facilities in the country, which include three nuclear power plants and two research reactors. In addition, construction of two nuclear power plants is in progress upon issuance of construction licences by PNRA. Furthermore, PNRA registered a site near Karachi for construction of Unit-2 of Karachi Nuclear Power Plant (K-2) on February 28, 2013. Details of nuclear facilities that are in operation and under construction in the country are provided in Table 1.

The regulatory processes of PNRA ensure that all the nuclear installations remain under strict regulatory control and in compliance with PNRA regulations and the conditions attached to the licence throughout their life-time i.e. from siting to decommissioning and until the site is removed from regulatory control. The authorizations and licences issued during various stages of nuclear installations include site registration, construction licence, permission for commissioning, permission to load nuclear material, operating licence, decommissioning licence and authorization for removal of the site from regulatory control. In addition, the licensees are required to get permission from PNRA to make the reactor critical after refuelling outage and/or after a core alteration. PNRA also grants approval for the permanent design modifications and modifications in technical specification. All authorizations and licences are issued by PNRA upon completion of a thorough review & assessment and verification of the safety of the facility to ensure that the requirements of relevant regulations are fulfilled by the applicant/licensee. The licences and authorizations issued by PNRA are subject to fulfilment of certain generic and specific conditions that are attached with the issued authorization or licence.

PNRA also awards licences to personnel responsible for operating nuclear power plants and research reactors. No nuclear installation in the country is permitted to operate unless it is staffed with adequate number of licensed operating personnel.

The review and assessment of licensees' submissions and regulatory inspections are carried out in accordance with national regulations and applicable codes and standards to ensure that the licensees maintain an acceptable level of safety at their nuclear facilities. In case of degradation of safety, PNRA takes enforcement measures, ranging from issuance of directives, curtailing activities and,

Table 1: Nuclear Installations Under PNRA's Purview

S. No.	Installation	Status	Type	Capacity	Commercial Operation
1	Karachi Nuclear Power Plant Unit 1 (K-1)	In Operation	Pressurized Heavy Water Reactor	137 MWe	1972
2.	Karachi Nuclear Power Plant Unit 2 (K-2)	In Planning Phase	Pressurized light Water Reactor	1100 MWe	2019 (expected)
3.	Chashma Nuclear Power Plant Unit 1 (C-1)	In Operation	Pressurized light Water Reactor	325 MWe	2000
4.	Chashma Nuclear Power Plant Unit 2 (C-2)	In Operation	Pressurized light Water Reactor	330 MWe	2011
5.	Chashma Nuclear Power Plant Unit 3 (C-3)	Under Construction	Pressurized light Water Reactor	330 MWe	2016 (expected)
6.	Chashma Nuclear Power Plant Unit 4 (C-4)	Under Construction	Pressurized light Water Reactor	330 MWe	2016 (expected)
7.	Pakistan Research Reactor–I (PARR-I)	In Operation	Swimming Pool	10 MWt	1965
8.	Pakistan Research Reactor–II (PARR-II)	In Operation	Tank-in-Pool	30 KWt	1991

revokation of authorization or licence in case of serious violations.

Nuclear Power Plants

Operating Nuclear Power Plants

Karachi Nuclear Power Plant Unit 1 (K-1) is a pressurized heavy water reactor (CANDU type) with natural Uranium fuel and uses heavy water as reactor coolant and moderator. The design life of K-1 was completed in 2002 and upon completion of necessary safety up-gradation, the plant was allowed to operate beyond its design life.

During 2013, PNRA reviewed and approved twelve (12) design modifications. In addition, PNRA reviewed four (04) event reports and a number of routine submissions made by K-1 as per requirement of PNRA regulations and approved technical specifications to ensure that the plant is operating in compliance with the regulatory requirements.

Chashma Nuclear Power Plant Unit 1 (C-1) is a pressurized light water reactor with enriched Uranium fuel. It started commercial operation in 2000. C-1 completed its eighth cycle of operation in December 2012 and was shut down for refuelling, maintenance, testing and in-service inspections. PNRA selected about fifty five (55) inspection points of refuelling outage activities including fuelling, operation, maintenance, testing and in-service inspection of safety related equipment. PNRA also conducted a number of general surveillance inspections as part of refuelling outage inspection plan. PNRA conducted review of various documents submitted by the licensee for plant start-up following the eighth refuelling. On completion of all necessary activities and based on the outcome of reviews and inspections, PNRA permitted C-1 to make the reactor critical and commence its ninth cycle of operation. Accordingly, C-1 started operation again in February 2013.

During 2013, PNRA issued one (01) directive to C-1 which is being followed-up. PNRA reviewed and approved two (02) design modifications. In addition, C-1 submitted a number of routine submissions, as per requirement of PNRA regulations and approved technical specifications, which were reviewed and assessed to ensure compliance with regulatory requirements.

Chashma Nuclear Power Plant Unit 2 (C-2) is an improved version of C-1 with certain safety enhancements. C-2 completed its first cycle of operation in January 2013 and was shut down for first Refuelling Outage (RFO-1). PNRA selected seventy two (72) inspection points of refuelling outage activities including fuelling, operation, maintenance, testing and in-service inspection of safety related equipment. PNRA also performed a number of general surveillance inspections during the refuelling outage. PNRA conducted review of various documents submitted by the licensee for plant start-up following the first refuelling outage. On completion of all necessary activities and based on the outcome of reviews and inspections, PNRA allowed C-2 to commence its second cycle of operation. Accordingly, C-2 started operation again in April 2013.

During reported period, two (02) directives were issued to C-2 which are being followed-up by PNRA. During 2013, PNRA reviewed one (01) design modification submitted by C-2. PNRA also conducted review and assessment of routine submissions made by C-2 as per requirement of PNRA regulations and licence condition.

Under Construction Nuclear Power Plants

Construction of civil structures and manufacturing of equipment for Chashma Nuclear Power Plant Unit 3 and Unit 4 (C-3 and C-4) remained in progress under regulatory supervision of PNRA. During the reported period, dome of C-3 was successfully placed on the containment building.

Nuclear Power Plants in Planning Phase

Pakistan Atomic Energy Commission (PAEC) submitted its application along with necessary documents for the site registration of its new

C-3 Dome Placement

nuclear power plant "Karachi Nuclear Power Plant Unit 2 (K-2)". The documents submitted by PAEC included Site Evaluation Report, Management System during Siting and NOCs from the relevant federal and provincial Governments. After a thorough review of these documents and upon resolution of all the queries raised by PNRA during the review including agreement of time frame for certain actions, PNRA registered K-2 site on February 28, 2013. PNRA is expecting the application for Construction Licence of K-2 in near future.

Research Reactors

Pakistan Research Reactor-I (PARR-I) is a swimming pool type research reactor of 10 MWt which is in operation since 1965. Pakistan Research Reactor-II (PARR-II) is a tank in pool type research reactor of 30 KWt which is in operation since 1991. The Operation License (OL) of PARR-I and PARR-II is renewed on yearly basis.

Ground Breaking Ceremony of K-2

During 2013, PNRA conducted planned inspections of research reactors in the area of Environmental Monitoring, Waste Management, Operations, Radiation Protection, Emergency Preparedness, etc. In addition, PNRA also reviewed a number of reports submitted by the licensee as per requirements of regulations and licence conditions.

Licensing of Operating Personnel

PNRA ensures that appropriately qualified and trained operating personnel remain available throughout the operating lifespan of each nuclear installation. As per requirement of PNRA regulations (PAK/913), operating personnel working as shift supervisors, shift engineers, and reactor operators require licence from PNRA. In this context, PNRA conducts licensing examinations for award of licences to these operating personnel. The licensees are required to get their operators' licences renewed annually.

During the reported period, one (01) person at K-1, five (05) at C-1 and three (03) at C-2 were granted operators' licences (Figure 5), whereas the licences of thirty nine (39) operating personnel at K-1, thirty five (35) at C-1 and thirty one (31) at C-2 were renewed (Figure 6).

PNRA renewed twenty (20) licences of shift supervisors and operators at PARR-I and PARR-II, during the reported year (Figure 7).

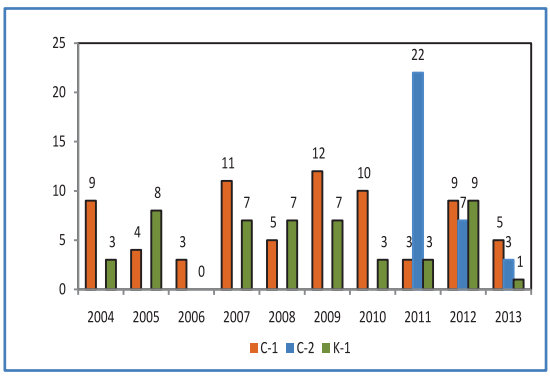


Figure 5: Issuance of New Operators' Licences for NPPs

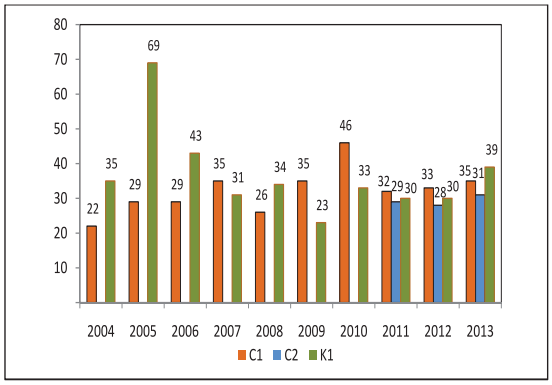


Figure 6: Renewal of Operators' Licences for NPPs

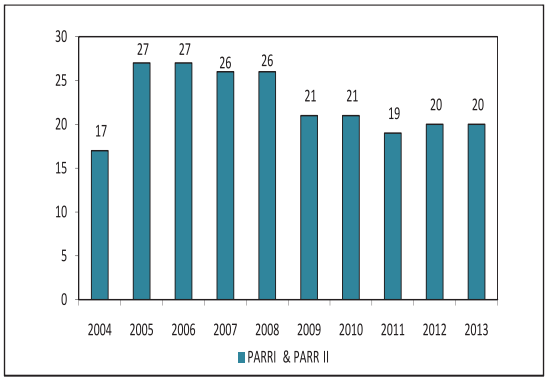


Figure 7: Renewal of Operators' Licences at PARR-I and PARR-II

Inspections of Nuclear Installations

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

To carry out inspection activities, PNRA has established three Regional Nuclear Safety Directorates (RNSDs) in Islamabad, Kundian and Karachi, namely, RNSD-I, RNSD-II and RNSD-III respectively, where resident inspectors have been posted permanently. The RNSDs conduct regulatory inspections of nuclear installations in their respective regions. The directorates located at PNRA Headquarters provide support during the inspections if needed by the regional directorates.

Various routine and planned inspections of nuclear installations are carried out in accordance with the PNRA inspection programme. In addition, control point inspections (Hold, Witness and Record Points) are carried out during construction, commissioning and operation of NPPs. In hold point inspections, the licensee requires explicit permission of PNRA for proceeding beyond this point. Other inspections of nuclear installations, like unplanned and reactive inspection, are carried out as and when required.

In 2013, PNRA conducted a total of ninety four (94) inspections at K-1, one hundred and sixty (160) at C-1 and one hundred and eighty two (182) at C-2 as per the annual inspection plans. In addition, PNRA conducted one hundred and eighty two (182) control point inspections at C-3 and one hundred and seventy nine (179) at C-4 (Figure 8).

C-3 Steam Generator Hydrostatic Test at China

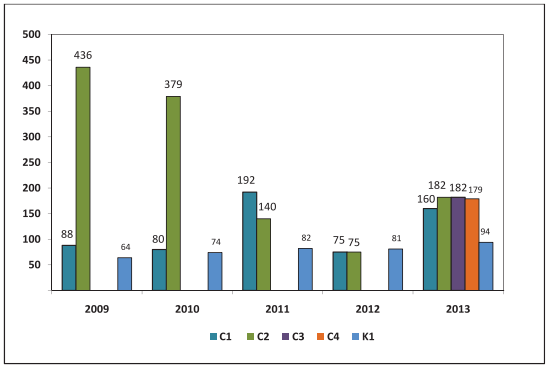


Figure 8: Regulatory Inspections of K-1, C-1, C-2, C-3 and C-4

These inspections were in addition to daily, routine inspections and general surveillance of different plant areas.

PNRA also performs inspections during equipment manufacturing of C-3 & C-4. These inspections are managed by the Directorate of Nuclear Safety at PNRA Headquarters. In 2013, PNRA conducted twenty six (26) inspections during equipment manufacturing in China.

For research reactors, twelve (12) safety inspections were conducted at PARR-I and four (04) at PARR-II to check compliance with regulations in the areas of operation, safety systems, radiation protection, radioactive waste, fire protection and environmental monitoring (Figure 9).

Radiation Safety at Nuclear Installations

Karachi Nuclear Power Plant Unit 1 (K-1)

In 2013, the annual safety report submitted by K-1 for the year 2012 was reviewed in detail. Revised radiation protection program of K-1 was also reviewed and approved during 2013. Assessment of radiation exposures to plant workers in 2012 found that the doses received by the workers were mostly within the prescribed regulatory limit of 20 mSv per year. Detailed dose records of any worker who approaches 20 mSv annual dose in any year are evaluated at PNRA to ensure the compliance of regulatory requirements. It was verified that few workers who received more than 20 mSv dose during 2013, had received a total dose of less than

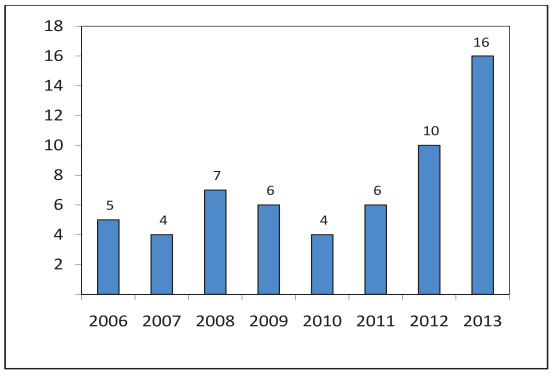


Figure 9: Regulatory Inspections of PARR-I and PARR-II

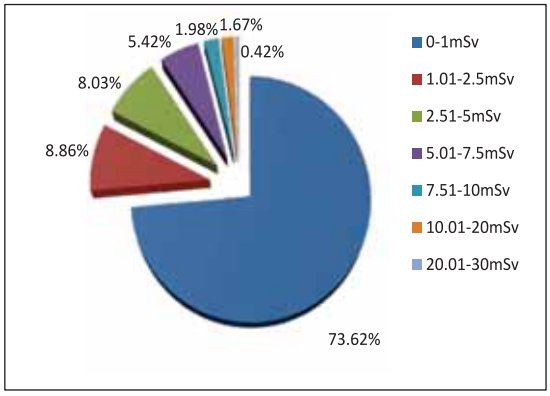


Figure 10: Annual Radiation Doses to K-1 Workers

100 mSv over the last five years. The dose distribution of workers at K-1 is detailed in Figure 10.

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

In 2013, the annual dose reports submitted by C-1 and C-2 for the year 2012 were reviewed in detail. Radiation exposures to plant workers at C-1 and C-2 provided in annual report of 2012 submitted in 2013 were assessed and found to be well below the prescribed regulatory limits. The dose distribution of workers at C-1 is detailed in Figure 11, whereas dose distribution of all workers at C-2 was less than 1 mSv.

C-1 initiated its eighth Refuelling Outage (RFO-8) while C-2 initiated its first Refuelling Outage (RFO-1) during the reported period. All activities of the C-1 RFO-8 and C-2 RFO-1 were closely monitored and evaluated. Dose estimates for all activities of the refueling outage were reviewed and verified against

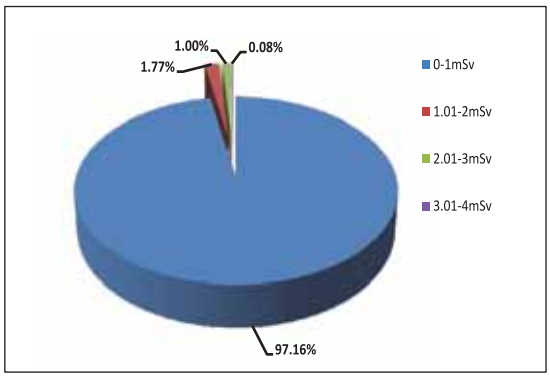


Figure 11: Annual Radiation Doses to C-1 Workers

previous experiences, actual results and performance. The actual collective dose received by 1301 radiation workers and trainees at C-1 and 1501 at C-2 was 537.47 man-mSv and 570.06 man-mSv respectively against the estimated collective dose of 450 man-mSv and 375 man-mSv respectively. The maximum dose received by an individual at C-1 and C-2 was 7.558 mSv and 6.483 mSv respectively. A comparison of the estimated and actual collective doses received by workers and persons who visited C-1 during the different RFOs is detailed in Figure 12, whereas estimated and actual collective doses received by workers and persons who visited C-2 during RFO-1 is detailed in Figure 13 .

Radiation safety at research reactors PARR-I & PARR-II is ensured through, inter alia, review and assessment of the licensee's submissions. The annual dose records of research reactors for 2012 and 2013 were reviewed in detail during reported period and radiation exposures to radiation workers were assessed. Radiation exposure of all the workers was found well below the regulatory limits. Doses to about 30% of workers remained below 1 mSv while 55% workers received doses in range of 1.01-4 mSv. Dose received by 15% of workers was between 4.01-8 mSv. (Figure 14).

Equipment Manufacturer

Heavy Mechanical Complex (HMC-3) was licensed to manufacture nuclear safety class-1 equipment in 2012 by PNRA whereas licence to manufacture safety class 2 and 3 equipment was issued a few

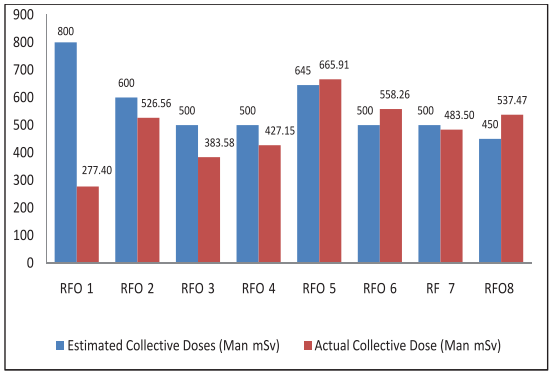


Figure 12: Estimated and Actual Collective Doses during C-1 RFOs

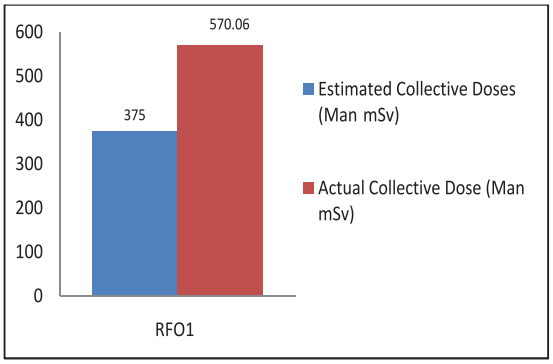


Figure 13: Estimated and Actual Collective Doses during C-2 RFO-1

years back. Under the license, HMC-3 has manufactured a number of safety class equipments for C-3 & C-4 projects. During manufacturing activities, PNRA inspectors performed thirty five (35) inspections to confirm compliance with the regulatory requirements.

During the reported period, PNRA also performed inspection to verify effectiveness of Quality Assurance Administrative of HMC-3. The objective of this inspection was to verify effectiveness of the implementation of Quality Assurance Manual of HMC-3.

During the reported period, two (02) directives were issued to HMC-3. PNRA is actively pursuing to implement the actions on these directives.

Manufacturing of Transport Containment for Radioactive Material i.e. B (U) type package was initiated by HMC-3 under the regulatory supervision of PNRA. During the current year, a prototype has been manufactured and its functional testing is in progress.

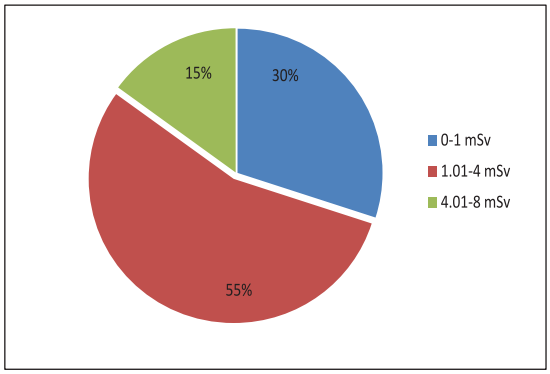


Figure 14: Annual Radiation Doses to Research Reactor Workers

4
REGULATORY OVERSIGHT OF RADIATION FACILITIES

Applications of radiation in everyday life for the benefit of society has been greatly increasing round the globe in the past few decades. Same is the case for Pakistan where the use of ionizing radiation in various industrial and medical applications is on the rise. These include diagnostic radiology practices (including X-rays), radiotherapy centers, nuclear medicine facilities, irradiators, practices involving use of radioactive sources in industry, research and industrial radiography, etc. Since any radiation exposure from these radiation facilities presumably involves some potential risk to workers, public and the environment, PNRA has been mandated to regulate such facilities. PNRA regulations form the basis for regulatory oversight whereas regulatory processes of review and assessment of licensees' submissions, licensing and inspection of radiation facilities are utilized to verify compliance with regulatory requirements and where necessary enforcement actions are taken to rectify non-compliances.

Under the PNRA Ordinance, it is essential for radiation facilities in the country to operate only after obtaining a license from PNRA. PNRA requires these facilities to submit various documents as part of licensing application and during the lifetime of the facility in order to ascertain that the facility is working safely and in compliance with the regulatory requirements.

The review and assessment is a continuous process in which activities of different nature and volume are performed. A summary of activities related to radiation safety at radiation facilities during the reported period is presented below.

Radiation Safety at Radiation Facilities

A large number of radiation facilities are operating in Pakistan. PNRA is obliged to ensure that appropriate regulatory control is in place for the safe operation of these facilities. The radiation facilities being monitored by PNRA include:

- Medical applications (radiology, radiotherapy and nuclear medicine);
- Industrial applications (industrial radiography, nuclear gauges, scanning, irradiation, etc.); and
- Research (universities, research centers, etc.).

During the reported period, radiation protection programs of 30 radiation facilities were reviewed and a number of them were approved. In 2013, PNRA continued the program to arrange training courses for industrial radiographers. This year, PNRA conducted one course for radiographers in which 24 radiographers participated out of which 21 successfully completed the course. During this year, PNRA also conducted four certification courses for Radiation Protection Officers (RPOs) of radiation facilities from different medical centres, irradiation facilities and industries. A total of 88 RPOs from different medical centers, industries and irradiators participated in this course out of which 69 successfully completed it. Conduct of such courses will continue in the coming years.

Licensing of Radiation Facilities

The procedure of issuance of license requires the applicant to fulfill all the applicable regulatory requirements prior to issuance of license. Licenses to radiation facilities are issued after detailed review and assessment of the applicants' submissions specified under the national regulations and inspection of the site and equipment. Periodic inspections of radiation facilities are performed to monitor continued compliance with safety provisions.

All the radiation facilities using radioactive material in the country are licensed by PNRA including all radiotherapy centers, nuclear medicine facilities, irradiators, and practices involving use of radioactive sources in industry, research and industrial radiography, etc. However, a number of medical X-ray facilities are still outside the licensing net. During the reported period, strong persuasions continued to bring the unlicensed X-ray facilities in the licensing net which has resulted in an appreciable increase in licensed X-ray facilities this year.

It has been noted in previous years that quite a number of facilities were not renewing their licenses after its expiry. During the reported period, PNRA continued its efforts to bring the number of such defaulters to minimum and as a result, a number of such defaulters further decreased during 2013 as compared to previous year. By the end of 2013, the total licensing net of PNRA consisted of 3501 radiation facilities. Out of these, 362 had defaulted by 2013, leaving about 3139 valid licensees. Legal proceedings are being initiated against these defaulters as per enforcement regulations and enforcement procedure.

During the reported period, 800 new facilities were licensed while 2339 licenses were renewed by the three regional directorates of PNRA. The number of facilities that have ever been licensed during the last thirteen years include 69 large medical centers, 146 industrial users, 63 research institutes, 92 importers, 3040 X-ray facilities, and 91 other facilities.

Inspections of Radiation Facilities

Regulatory inspections of radiation facilities are one of the core activities of PNRA. These inspections are carried out to verify that provisions of the PNRA Ordinance, regulatory requirements, license conditions and other directives of PNRA are complied by the licensee. To carry out inspection activities, PNRA has established three Regional Nuclear Safety Directorates (RNSDs) at Islamabad, Kundian and Karachi, namely, RNSD-I, RNSD-II and RNSD-III, respectively and three Regional Nuclear Safety Inspectorates (RNSIs) at Peshawar, Multan and Quetta where resident inspectors have been posted permanently. The RNSDs and RNSIs conduct regulatory inspections of radiation facilities in their respective regions. The directorates located at PNRA Headquarters provide support during the inspections if needed by the regional directorates and inspectorates.

An annual inspection program to conduct periodic inspections of radiation facilities is prepared each year with the provisions for special inspections where required. In accordance with the annual inspection plan for the reported period, 2509 inspections of different types of radiation facilities were performed. A comparison of the regulatory inspections performed during the reported year with the inspections performed during the previous years is shown in (Figure 15). These inspections are focussed on verification of the facility design, functioning, work practices, As Low As Reasonable Achievable (ALARA) implementation and adequacy of security measures being taken by licensees during use, transportation and storage of the sources. Directives and recommendations for improvement and compliance with regulations are communicated to the inspected facilities in inspection reports and these are appropriately followed up for compliance.

Occupational Exposure at Radiation Facilities

Radiation facilities are required to submit radiation

Radiation Survey in Gamma Camera Room

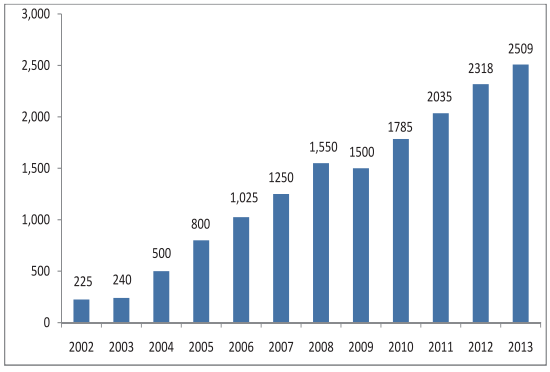


Figure 15: Regulatory Inspections of Radiation Facilities

exposure records of workers involved in radiation work on annual basis. PNRA also obtains the occupational exposure records from service providers. These records are maintained in database of occupational exposures at PNRA. Currently, the database includes dose records of 7932 radiation workers including 1773 workers in the radiotherapy/nuclear medicine, 1239 workers in the industrial sector, 406 workers in research and education, 3857 in diagnostic radiology and 657 other workers. Distribution of radiation workers in various sectors is shown in Figure 16.

According to the record available to date, doses to 95.64 percent of workers remained less than 5 mSv while 3.92 percent of workers received doses between 5-20 mSv. A small fraction (0.44 percent) of workers received doses above 20 mSv. Although the five-year average annual dose of these workers remained within the regulatory limit of 20 mSv, the licensees were advised to investigate the cause of the high doses and to take corrective actions. A representation of radiation workers in different dose ranges is given in Figure 17.

Radiological Protection of Patients

The largest source of radiation dose to the population is considered to be the medical applications involving ionizing radiations. Therefore, considerable efforts are being employed to reduce the radiation dose to the human beings without compromising the quality of diagnosis or treatment. Radiological protection of patients is therefore one of the core activities of PNRA involving development of regulatory guides, training of medical community personnel, and a program to assess radiation doses received by patients in various radiological procedures. In 2013, a leaflet was prepared on "Iodine (I-131) Therapy: Precautions for Out-Patients" for the awareness of the patients. The leaflet guides the patients to take practical measures to reduce the radiation dose to their family members and caretakers. During the reported period, PNRA conducted three educational workshops on quality assurance and protection of patients in imaging and radiotherapy at medical centers in Lahore and Karachi. A total of seventy one (71) professionals from medical community participated in these workshops.

The project on "Radiological Protection of Patients in Diagnostic Radiology" remained in progress during the reported year. The main objectives of the project are: 1) assessment of the patient doses in radiography; 2) comparison of radiation dose results with the national and international dose guidance levels; and 3) determination of good radiography practices. The national dose guidance levels are prescribed in regulations issued by PNRA. During 2013, analysis of data collected during the clinical attachment of PNRA officials with different hospitals during the previous year was conducted and a consolidated internal report was issued. In this study, doses of 1179 patients undergoing common radiological examinations (chest, cervical

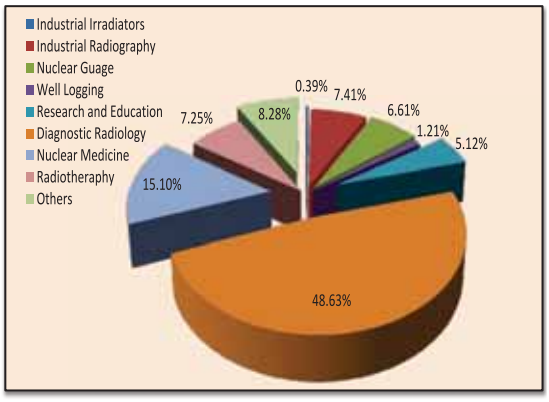


Figure 16: Radiation Workers in Different Radiation Facilities

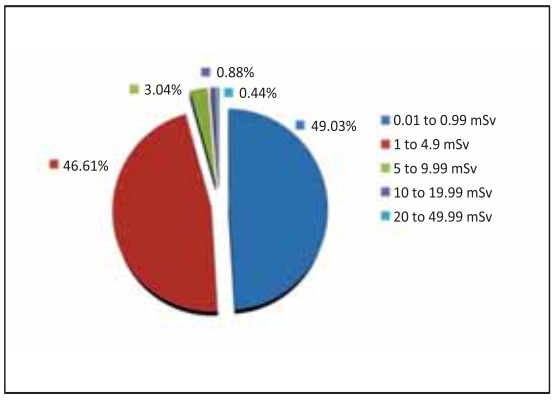


Figure 17: Radiation Workers in Different Dose Ranges

spine, lumbar spine, abdomen and pelvis) at different hospitals were assessed. It was observed that the doses received by the patients during these examinations vary at different hospitals; however, the average dose values for all examinations were in good agreement with the national Dose Guidance Levels (DGLs).

As next phase of the project, studies are in progress for interventional cardiology procedures. The data regarding the patient doses is being collected from some interventional cardiology hospitals.

Authorization of Import and Export of Radiation Sources and Generators

PNRA maintains cradle-to-grave track of all radiation sources / generators used in the country. Any person or facility which intends to acquire or use radiation sources or generators is required to be licensed with PNRA. A "No Objection Certificate" (NOC) from PNRA is mandatory for Custom clearance of radiation sources / generators when imported into Pakistan. NOCs are issued only to the licensed facilities. Facilities can purchase the high activity sources after getting the undertaking from supplier / manufacturer to accept the return of these sources at the end of their useful life as a part of purchase contract. An export NOC is required from PNRA for shifting the sources to other countries.

Issuance of NOC is based on regulatory verification of the intended end user and fulfillment of technical requirements according to specifications of the radiation sources and generators to be imported or exported. PNRA issued 998 NOCs for import of new radiation sources or generators into the country and 171 NOCs for export of disused radiation sources and generators/empty containers during the reported period. Data of NOCs issued during 2013 and previous years is given in Figure 18 whereas use of sources in different categories is shown in Figure 19.

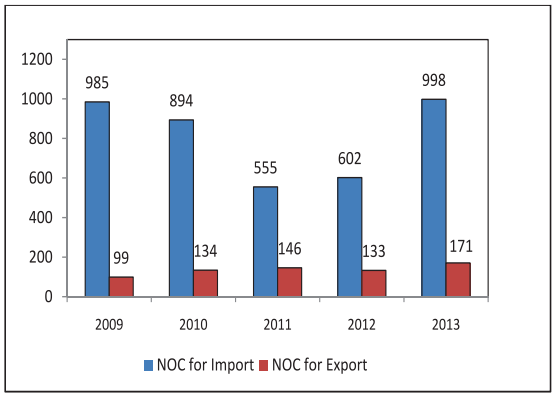


Figure 18: Issuance of Permits for Export–Import of Radiation Sources and Equipment

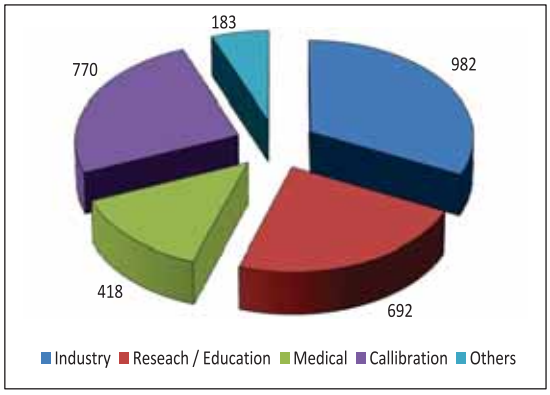


Figure 19: Distribution of Sealed Radiation Sources by Usage

5
RADIOACTIVE WASTE AND TRANSPORT SAFETY

Every human activity generates some kind of waste. The same is true for nuclear and radiation facilities. Radioactive waste is generated as a result of operation of nuclear installations and application of radio-nuclides in various industries, medical facilities, research activities, etc. Such waste contains materials that emit ionizing radiation and, if not handled properly, may have potential for hazard to human health and the environment. The safe management of radioactive waste is therefore, essential to protect the workers, public and the environment from its harmful effects. The long-term safety of radioactive waste can only be ensured if it is emplaced in a safe and secure facility.

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

Regulating the safe management of radioactive waste and safe transportation of radioactive material is an essential part of PNRA's mandate under the Pakistan Nuclear Regulatory Authority Ordinance, 2001. The Authority has issued national regulations on Radioactive Waste Management (PAK/915) and Safe Transport of Radioactive Material (PAK/916) and ensures their implementation through review and assessment, authorization and inspection processes.

PNRA also emphasizes on the training of its licensees on management of radioactive wastes. During the reported year, a three (03) days workshop on "Safety of Radioactive Waste Management" was organized by PNRA. The workshop mainly focused on the provision of a common platform for understanding of regulations and international standards to the operator and regulator and enhancement of their capabilities in the area of waste safety so that they can implement the regulatory requirements effectively.

Radioactive Waste Safety at Nuclear Installations

PNRA regulates radioactive waste management activities of all nuclear installations in the country. At present, there are five main generators of radioactive waste in the country, which include three nuclear power plants (K-1, C-1 and C-2) and two research reactors (PARR-I and PARR-II). PNRA ensures that both the radioactivity and the volume of radioactive waste generated at nuclear installations is minimized through suitable design,

IAEA-PNRA Workshop on Development of Dose Constraints and Radioactive Effluent Release Limits For Normal Operation of NPPs

operation and other measures, and the discharges are kept minimum so that doses to the public and the environment remain well below the authorized limits. PNRA also ensures that the operator maintains continuous monitoring of gaseous and liquid effluents.

Pakistan is in the process of revising its effluent release/discharge limits on the basis of dose constraint and international practices. Accordingly, PNRA in collaboration with International Atomic Energy Agency (IAEA) organized a workshop on "Development of Radiation Dose Constraints and Radioactive Effluent Release Limits" for the purpose of setting the regulatory criteria during the normal operation of Nuclear Power Plants (NPPs).

Karachi Nuclear Power Plant Unit 1 (K-1)

K-1 is a CANDU type Nuclear Power Plant, operating since 1972. PNRA ensures, through document review and inspection process that K-1 keeps its radioactive discharges to the environment within acceptable levels. For this purpose, Derived Release Limits (DRLs) for gaseous and liquid effluents have been established by K-1 which have been approved by PNRA. During the year 2013, both the radioactive effluents i.e. gaseous and liquid remained well below DRLs which are shown in Figure 20 & 21 respectively.

Solid radioactive waste generated by K-1 during the reported year has been compacted and stored in MS drums at K-1. Figure 22 shows the graphical

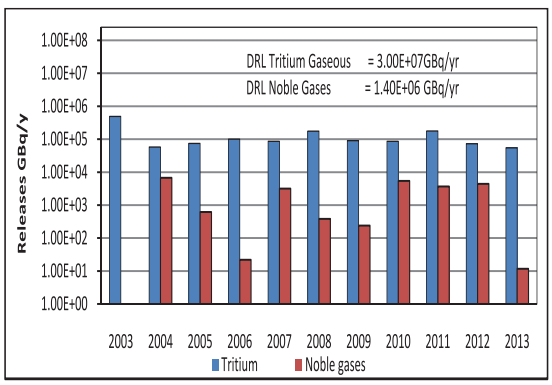


Figure 20: Gaseous Effluents from K-1

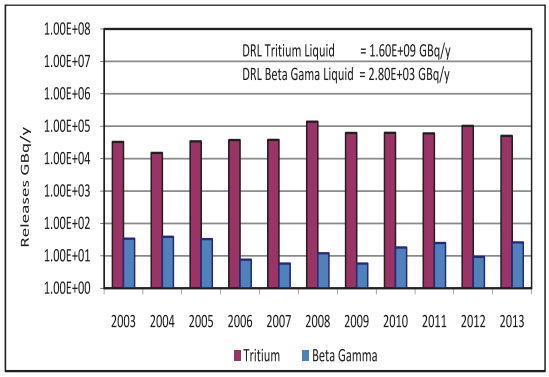


Figure 21: Liquid Effluents from K-1

representation of the solid waste generation at K-1 during the previous years.

Radioactive Waste Storage Area at K-1

K-1 is in the process of establishing an additional Radioactive Waste Storage Area (RAWSA) to increase the available storage capacity. In this regard, K-1 submitted the Safety Analysis Report (SAR) to PNRA which is under review.

Chashma Nuclear Power Plant Unit 1 & Unit 2

Radioactive waste management at C-1 and C-2 is ensured through review and assessment of the licensee's submissions and regulatory inspections. PNRA ensures that the releases of radioactive effluents from C-1 & C-2 to the environment are kept at minimum possible level and that radioactive waste management is in accordance with the Radioactive Waste Management Program (RWMP) established by Chashma Nuclear Power Generating Station (CNPGS) under national regulations.

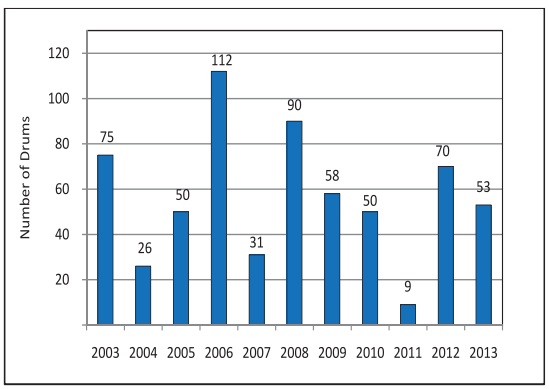


Figure 22: Compacted Solid Waste Generated at K-1

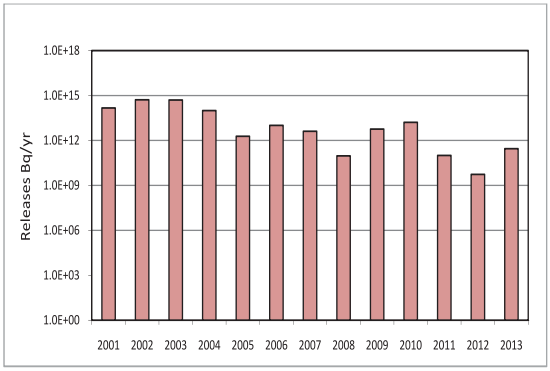


Figure 23: Gaseous Effluents from C-1

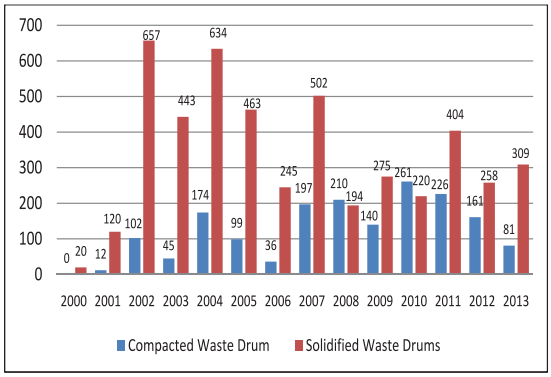


Figure 25: Compacted and Solidified Waste Drums at C-1

PNRA regulates C-1 & C-2 to ensure that the discharges remain well below the authorized limits. The total activity released in gaseous and liquid effluents from C-1 & C-2 during the reported year remained less than 1% of the authorized limits. The radioactive effluents released in the form of gaseous and liquid effluents are shown in Figures 23 & 24 respectively.

Two types of solid waste generated at C-1 & C-2 i.e. solidified and compacted, are stored in drums in the radioactive waste storage building at the plant site. A comparison of total number of solidified and compacted drums generated during 2013 with those generated during previous years at C-1 is shown in Figure 25.

Pakistan Institute of Nuclear Science and Technology (PINSTECH)

The Pakistan Institute of Nuclear Science and Technology (PINSTECH) is a multidisciplinary research facility of PAEC which houses the country's two research reactors, PARR-I and PARR-II. In addition, the institute is one of the designated sites for storage of waste generated from other radiation facilities in Pakistan. The radioactive waste generated from Research and Development (R&D) activities at the institute are stored in Reinforced Cement Concrete (RCC) barrels at PINSTECH.

The number of cementized and compacted containers of radioactive waste produced at PINSTECH from 2003 to 2013 is shown in Figure 26.

PINSTECH submitted the Safety Analysis Report (SAR) for its Pre-disposal Radioactive Waste Management Facility. A task force comprising various technical officers of PNRA was constituted to review the SAR, which is in progress.

National Waste Policy

Government of Pakistan approved a national policy on control and safe management of radioactive

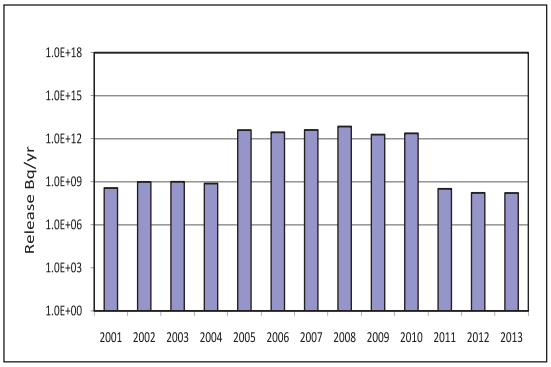


Figure 24: Liquid Effluents from C-1

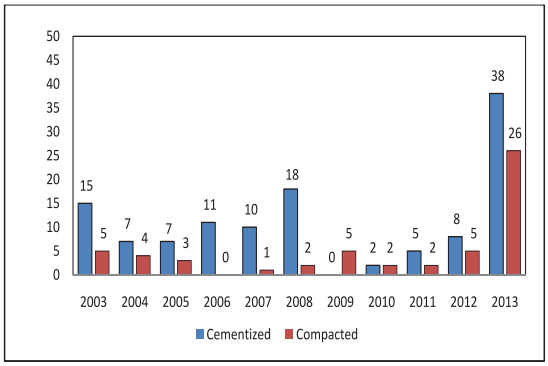


Figure 26: Cementized and Compacted Containers at PINSTECH

waste, wherein Pakistan Atomic Energy Commission (PAEC) has been assigned the responsibility for safe disposal of radioactive waste generated as a result of operation of radiation facilities in the country. PAEC has declared Pakistan Institute of Nuclear Science and Technology (PINSTECH) as one of the facilities for collection of waste from the northern part of the country and Karachi Nuclear Power Plant (K-1) from the southern part. PAEC has also prepared a Strategy for safe management of radioactive waste in the light of national waste policy and submitted to PNRA in March, 2013. PNRA reviewed the document and communicated its observations to PAEC for improvement of the strategy.

Management of Disused Sealed Radioactive Sources (DSRS)

Under the national regulations on radioactive waste management, Sealed Radioactive Sources (SRS) containing long lived radio-nuclides (having half lives of more than one year with initial activity of 100 GBq or more) shall only be procured with an undertaking from the manufacturers or suppliers to accept the return of the sources when they are no more useful.

The disused radioactive sources in possession of the licensees prior to the promulgation of the above mentioned regulations and those not covered in the national regulations need to be disposed off in a safe manner. As mentioned earlier, under the national policy on the control and safe management of radioactive waste, PINSTECH in Islamabad and K-1 in Karachi are responsible for receiving DSRS for safe storage.

Figure 27 presents the status of SRS in the country. Out of the total SRS imported into Pakistan, 51.15 percent have been transferred to PINSTECH after the completion of their useful life for storage, 12.96 percent to K-1, and 4.85 percent have been returned to the concerned supplier. The remaining 31.04 percent are in use by licensees.

The DSRS stored at PINSTECH and K-1 contains Cobolt-60, Cesium-137, Irradium-192, Radium-226, among other radio-nuclides. The number of DSRS stored at PINSTECH and K-1 are shown in Figure 28.

Inspections in the Area of Waste Management

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

During the reported period, three such inspections were conducted, one each at C-1, K-1 and PINSTECH. Directives were issued to the operators for further improvement in the implementation of

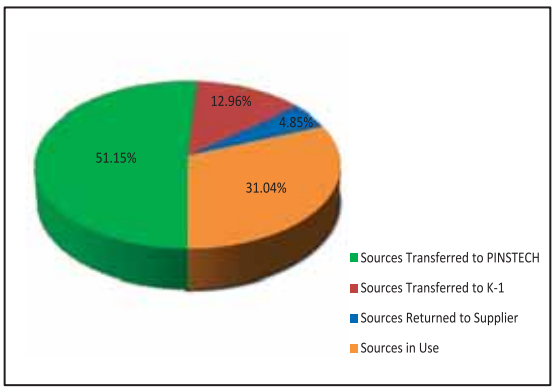


Figure 27: Status of Imported SRS

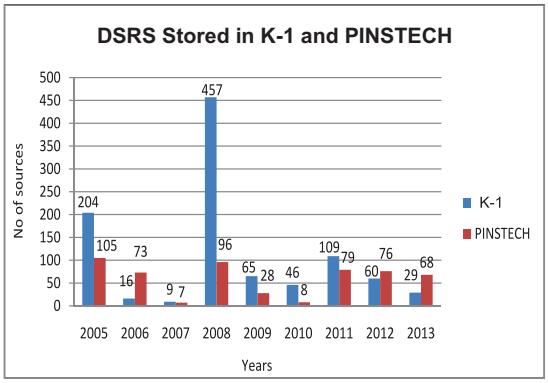


Figure 28: Disused Sources in the Country

their radioactive waste management programs.

Safe Transport of Radioactive Materials

PNRA ensures safe and secure transportation of radioactive material in the country. National regulations on transport of radioactive material are in line with the international requirements. PNRA ensures that consignors and carriers fulfill their obligations and comply with the national requirements for safe transportation of radioactive material/sources within the country. All radioactive consignments imported into the country and exported under contract are duly authorized by PNRA. The shipping documents of such consignments are evaluated and permissions granted after confirming that the shipments meet national and international requirements for transportation. Regional directorates of PNRA conduct periodic inspections, some of which are unannounced, to verify compliance with regulatory requirements. During the reported period, PNRA also provided technical guidance to various establishments dealing with transportation of radioactive materials or radioactive sources.

Certification of Type B (U) Packaging

PINSTECH formally communicated its intention to design and manufacture type B(U) transport packaging in 2011 for transportation of Mo-99. In this regards, detailed review of SAR of type B (U) packaging was completed during this year and the queries thus generated were communicated to PAEC for explanation/clarification. Certification will be granted after satisfactory response from the applicant.

PNRA inspectors witnessed the functional testing on Type B(U) Package (Leakage, Penetration & Drop) conducted in compliance with National Regulations PAK/916. PNRA also witnessed dose mapping on the container after drop test. The inspection reports including findings were communicated to PAEC.

Several meetings were held with PINSTECH to discuss the results of function test performed on the prototype of Type B(U) packaging. Subsequently, PNRA has performed independent analysis to verify the results submitted by the applicant.

During the reported period, PNRA in collaboration with IAEA organized workshop on "Certification and Recertification of Type B(U) Packaging" for the manpower development and competency enhancement of the regulators as well as the operators in area of transport safety.

IAEA-PNRA Workshop on Certification and Recertification of Type B(U) Packaging

6
EMERGENCY PREPAREDNESS AND RESPONSE

Nuclear installations and radiation facilities are designed and operated to a very high level of safety with advanced engineered safety features to prevent accidents. Strict regulatory control is exercised throughout the life of installations and facilities. Nevertheless, the possibility of accidents cannot be ruled out, even though it is quite low compared to other conventional industries. However, there is always a need for preparedness to respond to incidents or accidents and mitigate their consequences that might occur at a nuclear installation or radiation facility having potential to affect workers, public and the environment.

PNRA is obliged under the Ordinance to ensure preparation and implementation of emergency plans for actions to be taken by the relevant plant management and offsite authorities following a radiological emergency.

Regulations issued by PNRA on the management of a nuclear accident or radiological emergency (PAK/914) require licensees to have in place emergency plans, the necessary workforce, equipment and mechanism for responding to any such eventuality. The licensees are also required to maintain capacity for coordination with offsite response organizations involved in mitigating the consequences of radiation emergency.

Emergency Plans and Drills

PNRA reviews and approves emergency plans of the facilities under its purview, as part of its licensing process, to ensure that the plans are commensurate with regulatory requirements and are executable. PNRA also requires licensees to conduct exercises and drills on regular basis to ensure that their emergency plans are effective and workable. The frequency of exercises and drills is agreed in the approved emergency plans and they are witnessed by PNRA inspectors to assess the licensees' preparedness for executing them, if required. During this year, PNRA evaluated site emergency exercise at K-1 and integrated emergency exercise at CNPGS for C-1 and C-2. During the conduct of CNPGS integrated emergency exercise, off-site protective measures (e.g. distribution of prophylactic, sheltering, evacuation, access control, off-site area & public monitoring, establishment of evacuee centers, etc.) were demonstrated as per off-site emergency plan. The emergency exercise at PARR-I was conducted in December, 2013.

During the reporting period, PNRA has completed review of revised on-site emergency plans of K-1 and PARR-I. The onsite plans describe actions to be taken by the licensee to mitigate consequences of a nuclear or radiological emergency at the site. The offsite emergency plan of CNPGS, which describes actions to be taken by the District Government Mianwali, to implement protective measures in offsite area, has also been reviewed and approved by PNRA during this year. PNRA has also reviewed emergency plans of a number of radiation facilities,

Technical Support Personnel in NRECC during Emergency Exercise

including radiotherapy and nuclear medicine centers, industries and research centers and communicated recommendations to licensees for improvements. Emergency drills of certain industries using radioactive sources were also conducted during the reported year.

National Radiation Emergency Coordination Centre (NRECC)

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

NRECC is equipped with necessary communication facilities, Mobile Radiological Monitoring Laboratories (MRMLs) and various types of radiation detection and personal protective equipments. During the reported year, capabilities of NRECC were enhanced by equipping it with advanced radiation monitoring instruments, procured with the assistance of IAEA. The Centre conducts different types of emergency exercises, including the Communication Test Exercise (COMTEX) and MRML exercises to evaluate its readiness to respond to any emergency. The availability of communication channels with licensees and regional directorates of PNRA is verified during COMTEX while MRML exercise tests the capability to respond to an event involving radiation monitoring; and field exercises. During the reported period, NRECC conducted three COMTEX exercises and one MRML exercise.

NRECC also participates in exercises and drills conducted by licensees, as well as in Conventional Exercises (ConvEx) conducted by IAEA under international conventions. The ConvEx exercises focus on verification of international communication channels and the capability of member states to evaluate and respond to different radiological accidents. NRECC participated in four (04) ConvEx exercises in 2013.

Sharing of Information Related to Radiation Incidents and Emergencies

PNRA receives information of radiation incidents and emergencies, through IAEA, occurring worldwide. These events are usually related to overexposure of workers/member of public, lost/stolen radioactive sources, contamination/spill of radioactive material, malfunction of equipment, etc. PNRA analyzes the information received and implement lessons learnt from such information for improvement of radiation safety. PNRA shares the

MRML Emergency Response Exercise

information of radiation incidents occurring in the world with its licensees.

Training of Operators, Regulators and First Responders on Response to Nuclear and Radiological Emergencies

PNRA arranged a three days training course on emergency preparedness and response for operators of nuclear installations for implementation of regulatory requirements related to emergency preparedness and response and to improve interaction among operators and regulators. The course was attended by personnel dealing with matters related to nuclear or radiological emergencies at C-1, C-2, K-1 and PINSTECH.

Training of those responding within the first few hours of a radiological emergency (first responders) is very important to avoid spread of contamination and overexposure to radiations. It is also important for initial response, assessment and management of incident scene for the collection of radiologically contaminated samples for detailed analysis. In 2013, PNRA arranged ten (10) training courses for the Rescue-1122, Police, Bomb Disposal Squad, Civil Defense, Frontier Constabulary (FC), Special Brach, SPD, Counter Intelligence Team (CIT), Health Department and CENAR, PAEC Quetta. A total of 234 personnel of these organizations have been trained in this area.

IAEA Response and Assistance Network (RANET)

The Response and Assistance Network (RANET) is an integrated system established by IAEA under International Convention on Assistance in case of Nuclear Accident or Radiological Emergency. Under this network, member states register and pool their capabilities to detect, measure, respond or mitigate radiological emergencies and when required, any member state can request or offer assistance under this network. PNRA is the national contact point under this network. In 2008, Pakistan registered its assistance capabilities in different areas of response. In year 2010, RANET scope and areas of assistance were revised by IAEA. A RANET team within Pakistan has been constituted by identifying experts from PNRA, PAEC and KRL. An operational manual for activation of RANET setup at PNRA has been prepared and is presently under review. Representatives from PNRA have also participated in an IAEA RANET Workshop at Fukushima, Japan. The workshop also included the field exercise conducted in the periphery of Fukushima NPPs site. A national RANET workshop was conducted in December, 2013 hosted by PNRA. RANET members from PNRA, PAEC and KRL Hospital participated in the workshop. The basic aim of the workshop was to get RANET team members familiarized with recent developments in RANET and to exercise deployment of resources and capabilities registered with RANET.

Debriefing Session of IAEA Emergency Exercise ConvEx-3

7 HUMAN RESOURCE DEVELOPMENT

In-House Education and Training

Maintaining sufficient number of highly skilled professionals, with appropriate qualification and experience is of prime importance for any organization. Accordingly, PNRA gives high priority to training of its employees. For this purpose, PNRA established two training institutes namely: (1) School for Nuclear and Radiation Safety (SNRS); and (2) Nuclear Security Training Centre (NSTC) for the training of PNRA personnel as well as stakeholders in the fields of nuclear and radiation safety, physical protection and nuclear security. These training centres were established as special projects under the Public Sector Development Programme (PSDP) of the Government of Pakistan. These institutes organize training and retraing for PNRA employees and its stakeholders having a role in maintaining radiation safety and security of radiation sources in the country and whose professional training is important. Necessary modern gadgets are available in the classrooms of SNRS and NSTC. Laboratories are equipped with sufficient tools, a soft-panel training simulator and physical models of various components of a Nuclear Power Plant (NPP). A limited scale Non-Destructive Testing (NDT) laboratory has been established for providing training to PNRA inspectors in various NDT techniques.

Figure 29 provides information about the number of training courses arranged in SNRS since 2006 in various areas of nuclear safety & radiation protection and the number of participants of the courses. During 2013, SNRS conducted 27 training courses related to Nuclear & Radiation Safety in which a total of 698 participants from PNRA, PAEC and other stakeholder organizations participated.

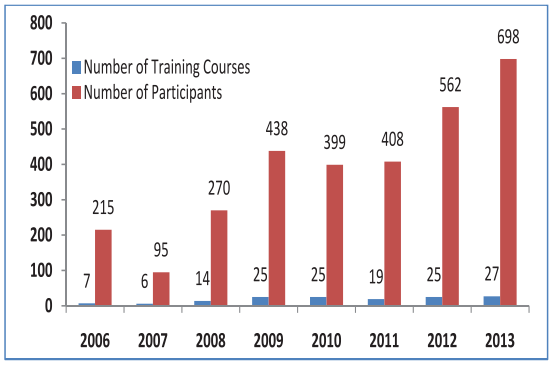


Figure 29: Training Courses Conducted by SNRS

A limited scope soft panel training simulator is available at SNRS for training of technical officers who are involved in review & assessment, inspection and enforcement activities of NPPs as well as those officers who are engaged in research and development related to deterministic and probabilistic safety analysis. The soft panel training simulator covers the normal, abnormal and accident states of plant operation.

Physical scaled cut-away models of main equipments of PWR are available at SNRS to train regulatory body staff for developing good understanding of internal structures and working principles of main equipment of reactor coolant system of PWR.

Virtual Modeling is a powerful support system for training and in-depth understanding of major equipments and systems of a nuclear power plant. Virtual Modeling can be used for personnel training to have a better and clear understanding of the parts, cross sections, assemblies and arrangements of NPP components and structures in 3D views. SNRS is using different software packages for 3D modeling, assemblies and animations.

As explained in the previous section, the other training centre is the Nuclear Security Training Centre (NSTC) which is responsible for trainings in the field of Nuclear Security and Physical Protection. The Centre is equipped with state-of-the-art nuclear

Soft Panel Training Simulator at SNRS

Participants and Resource Persons of the 1st Certification Course for Radiation Protection Officers of Industrial Radiation Facilities

Inauguration of Training Course on MEST Capabilities in Nuclear Security Applications

Physical Models of NPP Equipments

Certificate Distribution of IAEA-PNRA Workshop on Type B(U) Packaging

security laboratories for training and research purposes. These include physical protection labs (Interior and exterior), radiation detection equipment lab and equipment repair & maintenance lab.

Since 2006, the center has arranged around 113 training courses and have trained over 2250 personnel from various organizations like designers and users of physical protection systems, Front Line Officers (FLOs), First Responders (FRs), emergency response personnel, officials from intelligence agencies, Law Enforcing Authorities (LEA), trainers, nuclear regulators and policy makers. Figure 30 shows an overview of total number of nuclear security training courses and number of participants.

In 2013, the institute continued to enhance the competence of national nuclear security among stakeholders through trainings, workshops, seminars and field exercises in physical protection, detection and response areas.

PNRA, in collaboration with PIEAS, initiated nuclear security education programme in 2009 by introducing two (02) subjects in MS Nuclear Engineering extending over a full semester. PNRA provides assistance in conducting these courses. Introduction of two more courses i.e. (a) nuclear material accountancy and inventory control and (b) nuclear forensics and attributions are in progress. This year fourth (4th) batch of nuclear security professionals graduated under this program.

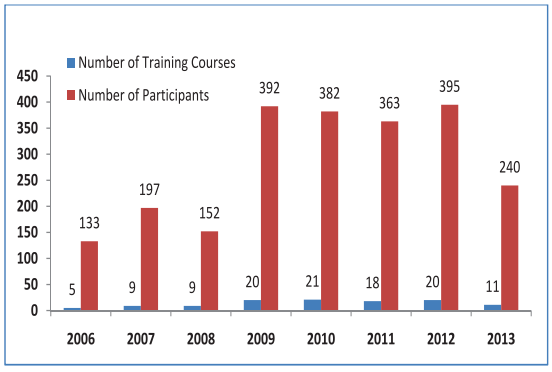


Figure 30: Overview of Nuclear Security Training Courses

Capacity Building at National Institutions

PNRA collaborates with various national institutes for knowledge enhancement of its regulatory staff. For this purpose, PNRA holds agreements with the Pakistan Institute of Engineering and Applied Sciences (PIEAS) and Karachi Institute of Nuclear Power Engineering (KINPOE) for MS programs and CHASNUPP Centre for Nuclear Training (CHASCENT) for Post Graduate Training Program (PGTP). In addition, officials from PNRA regularly participate in short training courses at various national academic institutes.

Guests & Participants of the Training Course on International Law

Detection Equipment in Nuclear Security Laboratory

Seminar on Response at Quetta

A collaborative research project with the involvement of experts from PNRA, Pakistan Institute of Engineering and Applied Sciences (PIEAS) and National Institutute of Agriculture and Biotechnology (NIAB) was initiated on the development of nuclear power plant ingestion model. The scope of the collaborative research project is to conduct experimental work for determining the Soil-Plant and Plant-Animal transfer functions by considering actual site related parameters. In this perspective, the soil samples were collected from the vicinity of NPP site for analysis. The experimental work is near completion and the results are being analyzed for comparison with the validated Ingestion Model as a reference.

In 2013, twelve (12) officers were awarded fellowships for MS degrees in nuclear engineering at PIEAS and KINPOE. In addition, 117 PNRA officials participated in 51 courses at different national institutes. A year-wise comparison of training courses arranged in different national institutes is provided in Figure 31.

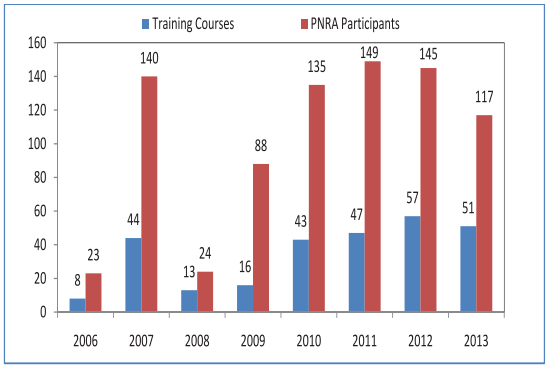


Figure 31: Training Courses and Participants in Various National Institutes

Resource Persons and Participants of IAEA-PNRA Basic Management Course

8
NATIONAL & INTERNATIONAL COOPERATION

PNRA recognizes the importance of cooperation with national and international organizations and institutions for enhancement of its performance and for keeping abreast of the latest knowledge and skills in the area of nuclear safety & security and radiation protection.

At the national level, PNRA has close interaction with national regulators such as, Oil and Gas Regulatory Authority (OGRA), Pakistan Telecommunications Authority (PTA), Public Procurement Regulatory Authority (PPRA), Civil Aviation Authority (CAA), National Electric Power Regulatory Authority (NEPRA), Pakistan Environmental Protection Agency (PEPA), National Disaster Management Authority (NDMA), Planning Division, and other governmental organizations. in safety and regulatory activities. PNRA links are maintained with national institutes and universities to keep abreast with latest national and international research and developmental and training activities.

At the international level, PNRA interacts with various institutions and organizations under bilateral and multilateral cooperation programmes to place its staff for higher studies and technical support to perform regulatory functions. PNRA provides assistance to the Government of Pakistan in execution of its obligations under the four international conventions to which Pakistan is a signatory. In addition, IAEA assists PNRA under various technical cooperation programmes for capacity building. PNRA provides experts to IAEA for international regulatory missions, conduct training courses in other countries and development of IAEA documents and training material. PNRA is also developing a Centre of Excellence for providing services and training on nuclear security at national and international level for sharing knowledge and expertise.

National Cooperation

Relations with Licensee

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

As a regular practice, PNRA involves all the stakeholders including licensees and the general public in the review process of its national regulations. The drafts of the regulations are sent to the licensees for their feedback; and their comments are incorporated, if found appropriate.

PNRA holds regular meetings with its licensees and conducts training courses for their staff to develop an understanding on the implementation of relevant regulatory requirements. In 2013, PNRA arranged one course for radiographers and four certification courses for radiation protection officers (RPOs) of radiation facilities. A number of radiographers and RPOs from different X-ray facilities, medical centers, industries and irradiators successfully completed the courses. Furthermore, more than nine hundred (900) personnel from nuclear installations, radiation facilities and other stakeholder organizations participated in various related trainings arranged by PNRA.

Collaboration with National Institutes

PNRA is continuously striving for improvement in its regulatory performance. For this purpose, PNRA is collaborating with distinguished institutes to provide education and training to PNRA staff in technical and management areas of interest. PNRA holds agreements with Pakistan Institute of Engineering and Applied Sciences (PIEAS), Karachi Institute of Nuclear Power Engineering (KINPOE) and Chashma Centre for Nuclear Training (CHASCENT) for MS programs, PGTP and sharing of facilities and resource persons. In addition, PNRA arranges trainings at National Centre for Non-Destructive techniques (NC-NDT), Pakistan Welding

Institute (PWI), Pakistan Institute of Management (PIM), Secretariat Training Institute (STI), Pakistan Manpower Institute (PMI), National Centre for Physics (NCP), and others.

Relations with the Public

PNRA communicates with the public through lectures, brochures, booklets and timely press releases regarding hazards from undue radiation exposure, protective measures in case of nuclear emergency and significant events at nuclear installations and radiation facilities. PNRA updates general public about its activities through its website (www.pnra.org). Draft regulations are also placed on its website for feedback from the general public.

In order to create awareness among the general public and workers, PNRA delivers lectures in hospitals, medical centers, schools and universities on benefits, harmful effects and protection against radiation; radiation protection in radiology; nuclear medicine and radiotherapy; radiological accidents; their consequences; and protection against radiation releases. During 2013, PNRA organized thirty three (33) lectures/seminars in Islamabad, Faisalabad, Lahore, Multan, Bahawalpur, DG Khan, Abbottabad and Peshawar in which thirty eight hundred (3800) personnel participated. Statistics of public awareness program is detailed in Figure 32.

PNRA is now considering to utilize press and electronic media for a wider coverage of its campaign to create awareness among general public about safety from harmful effects of nuclear radiations.

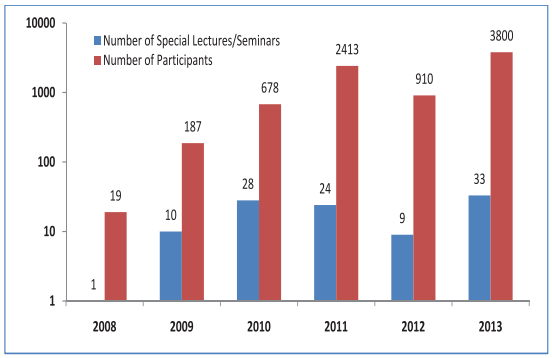


Figure 32: Summary of Special Lectures/Seminars and Participants

International Cooperation

Nuclear safety is a global issue and international cooperation in relation to nuclear safety is essential to the development of a global safety regime. PNRA has close cooperation with various international institutes and organizations to improve its regulatory functions and to enhance competence of its staff. PNRA also offers assistance to countries embarking for the development of regulatory infrastructure in their countries for nuclear power program.

Fulfillment of Obligations

PNRA represents the country to fulfill its international obligations under four international conventions to which it is a signatory. These include Convention on Nuclear Safety; Convention on Early Notification of a Nuclear Accident; Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; and Convention on Physical Protection of Nuclear Materials. Pakistan also follows the Code of Conduct on Safety and Security of Radioactive Sources.

During the reported period, PNRA, in collaboration with PAEC and other stakeholders, prepared 6th national report on the Convention on Nuclear Safety and submitted to IAEA for review. PNRA also reviewed the national reports of other countries. Furthermore, PNRA participated in various meetings held under the Convention on Nuclear

Lecture on Ionizing Radiation Delivered at Agriculture University, Faisalabad

Safety addressing the safety measures after Fukushima accident. Following the Fukushima accident, IAEA established an Action Plan to be implemented in the coming years to address the underlying nuclear safety issues. PNRA is participating in the working group meetings to address various challenges related to the operation of NPPs and nuclear safety.

Bilateral and Multilateral Cooperation

In a changing world, bilateral and multilateral cooperation agreements play an important role for the sustain-ability of state-of-the-art knowledge, management and utilization of resources for strengthening regulatory effectiveness, safe and secure development of nuclear industry and for the capacity building of young professionals worldwide in the area of nuclear and radiation safety.

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

Under the protocol with National Nuclear Safety Administration (NNSA), China and agreements with North China Regional Office (NCRO) of NNSA, two (02) PNRA officials have completed Chinese Language Course at Beijing Languages and Cultural University and have completed their on-the-job training at North China Regional Office (NCRO). During 2013, two (02) more officers have been deputed for language course and placement at NCRO under the same arrangement. Three (03) officials have been attached with Nuclear Power Operation Technology Corporation (CNPO), China for study on safety analysis of new NPPs. PNRA and NNSA also jointly organized a workshop at PNRA HQs on "Post Fukushima Actions by NNSA" and "Review Experience of New Nuclear Power Plants in China".

PNRA also interacts with United States Nuclear Regulatory Commission (USNRC) for the institutional strengthening and capacity building related to nuclear safety. Both organizations have an understanding to exchange information on issues such as development of severe accident management guidelines, licensing and inspection of fuel cycle facilities and accident analysis. In this connection, two (02) PNRA officials have completed training and two (02) more will be sent to USNRC in near future.

Collaboration with IAEA

PNRA has been actively participating and contributing towards the IAEA efforts to promote nuclear radiation, transport and waste safety. These efforts include implementation of IAEA Codes and Standards, participation in its various committees and networks related to nuclear safety and security. During 2013, PNRA continued to share expertise, technical information, regulatory experiences and good practices with other international regulators through IAEA. PNRA is keen to extend support to the countries embarking upon nuclear technology in establishing regulatory infrastructure and developing legislation/regulations through different IAEA forums with an objective to strengthen nuclear safety internationally.

PNRA provided assistance to IAEA by developing exemplary training material. This training material will be used by the IAEA for the workshops designed for countries embarking on nuclear power. IAEA has appreciated PNRA for providing

this valuable assistance. PNRA has also hosted two (02) fellows from Indonesia under the IAEA fellowship programme for a period of three months each in the areas of site evaluation for nuclear power plants and licensing of nuclear installations. Six PNRA officials are providing services to IAEA on deputation basis.

PNRA hosted a number of expert missions during this year. In addition, two (02) senior IAEA officials Mr. Ali Boussaha, Director Technical Cooperation and Mr. Minh-Long Nguyen, Section Head, Soil Crop and Water Management visited Pakistan to discuss technical cooperation.

PNRA participated in the exhibition "Colors of Pakistan" during the 57th Session of IAEA General Conference and highlighted the achievements after the establishment of PNRA. PNRA is participating in various IAEA activities such as Technical Cooperation Projects, and Regional Asia Projects. PNRA officials are members of many IAEA committees and they also participate in numerous other forums such as seminars, meetings, training courses, expert missions, etc.

a. IAEA Committees and other Forums

PNRA is a member of various IAEA committees and other related forums/networks working to promote nuclear safety and security. These include Nuclear Safety Standards Committee (NUSSC), Transport Safety Standards Committee (TRANSSC), Waste Safety Standards Committee (WASSC), Radiation Safety Standards Committee (RASSC), Committee on Safety Standards (CSS), Nuclear Security Guidance Committee (NSGC), Advisory Group on Nuclear Security and Global Nuclear Safety and Security Network (GNSSN). In addition, PNRA participates as national coordinator in the activities of International Nuclear Event Scale (INES) and International Reporting System (IRS).

PNRA also represents Pakistan and contributes in the activities of United Nations Scientific Committee on the Effects of Atomic Radiations (UNSCEAR) and is committed to contribute in the objective of this committee through sharing necessary information and expertise. During the reported period, PNRA participated in 60th session of UNSCEAR.

During 2013, experts from PNRA participated in various consultancy meetings such as Global Nuclear Safety and Security Network (GNSSN) and Development of International Regulators Network (RegNet), Consultancy Meeting on Establishing, Developing and Maintaining Capacity Building in Member States, Consultancy Meeting to prepare

"Colors of Pakistan" during the 57th Session of IAEA General Conference

the IRS training course for delivery to new or recently appointed IRS National Coordinators and Consultancy Meeting on Safety Guide on Regulatory Functions and Processes, etc.

PNRA also participated in the activities of Regulatory Cooperation Forum (RCF) of IAEA, to improve collaboration and coordination for regulatory capacity building among member states with established nuclear power programme and those considering the introduction or expansion of such programme.

Moreover, PNRA contributed in the activities related to Technical and Scientific Support Organization Forums (TSOF). TSOF activities are focused on the enhancement of nuclear and radiation safety and security and related infrastructure development.

PNRA participated in following international conferences and shared regulatory experience with the Member States:

- 25th Annual Regulatory Information Conference – USA;
- Effective Nuclear Regulatory System: Transforming Experience into Regulatory Improvement –Canada;
- MENA NUCLEAR Industry Congress – Turkey;
- Nuclear Safety and Security of Radioactive Sources: Enhancing Global Efforts – Austria;
- Safety and Security of Radioactive Sources – UAE; and
- 2013 New Nuclear International Conference – UAE.

b. IAEA Technical Cooperation Projects

PNRA is participating in two (2) technical cooperation projects "PAK/9/035: Further Strengthening of Regulatory Performance for the Pakistan Nuclear Regulatory Authority" and "PAK/9/037: Strengthening Infrastructure for Radiation, Transport and Waste Safety". Under these projects, various activities such as workshops/training courses, fellowships, scientific visits, etc. have been carried out.

During the reported year, following four major activities were carried out by IAEA and international experts under these projects:

- Review of Probabilistic Safety Assessment (PSA) Regulatory Model, developed by PNRA with the support of international experts;
- Preparatory Integrated Review Services Mission (Pre-IRRS) visited PNRA to set the scope of full scope IRRS mission to Pakistan in the second quarter of 2014;
- Education and Training (EduTa) Mission; and
- Education and Training Review Service (ETRES) Mission.

Furthermore, during the reported period, PNRA in collaboration with IAEA conducted workshops and training courses in the following areas under the umbrella of these projects:

I. Safety Culture Self Assessment;
ii. Safety Assessment of Mechanical Components against Different Degradation Mechanisms;
iii. Fuel Safety, Safety Criteria and Changes in Fuel Design Characteristics during Operation;
iv. Certification and Recertification of Type B(U) Packages;
v. Effective and Sustainable Regulatory Control of Radiation Sources; and
vi. Dose Constraints and Radioactive Effluents Release Limits for the Purpose of Setting Regulatory Criteria.

c. IAEA Regional Asia (RAS) Projects

PNRA is participating in the activities of twelve (12) Regional Asia (RAS) projects mainly in the areas of nuclear education and training, strengthening regional nuclear regulatory authorities and safety culture, promoting and maintaining regulatory infrastructure for the control of radiation sources, providing legislative assistance, transfer of experience related to occupational radiation protection of the nuclear industry and other applications involving ionizing radiation, radiation

protection of patients during medical exposure, building competence in radiation safety, strengthening compliance assurance regime in transport of radioactive material, national capabilities for response to nuclear and radiological emergencies, radiation protection of public and environment in line with the international safety standards, human resource development in nuclear security and establishing a radioactive waste management infrastructure. Under these projects, officials from PNRA participated in various activities such as workshops and training courses organized by IAEA.

d. IAEA Coordinated Research Projects

PNRA is also participating in Coordinated Research Projects (CRPs) titled "Development of Methodology for Risk Assessment and State Management of Nuclear Security Regime", and "Development and Implementation of National Nuclear Security Support Centre (NNSSC) in Pakistan" and "Structural Analysis of NPPs".

e. Expert Missions

Under the auspices of Agency, expert missions are carried out for the member states to strengthen regulatory regime; identify gaps and challenges, capacity building and opportunities for their improvements in the light of international experiences and adopting good practices. Presently, experts from PNRA are contributing towards various programmes of agency and sharing the experience with international community in the area of nuclear safety and security. During the reported year, sixty (60) officials from PNRA participated in fifty six (56) international activities as trainers, consultants or experts and shared knowledge and expertise in the areas of regulatory importance such as safety & security, legal and regulatory framework, IRRS missions, IRS, physical protection, emergency preparedness, etc.

f. IAEA - Pakistan Nuclear Security Cooperation Program

IAEA is assisting PNRA under a special program to strengthen nuclear security regime in Pakistan. The program is focused to support PNRA in capacity building through training of its personnel and stakeholders in nuclear security related areas. IAEA arranged training courses and workshops for PNRA and its stakeholders in the areas of project management, security of radioactive sources, intrusion detection sensors and monitoring systems, MEST capabilities in nuclear security applications, and trainer course on radiation detection techniques for Front Line Officers.

FNRBA Regional Workshop on Capacity Building in Douala, Cameroon

Participation of PNRA Officials in Other International Events

PNRA continues to participate in several international activities/events with an objective to strengthen regulatory infrastructure, share experiences, exchange information and promote nuclear safety worldwide. In this connection, two hundred and seventy three (273) PNRA officials participated in two hundred and eight (208) international events such as conferences, technical meetings, workshops, training courses, seminars, consultancy meetings, fellowships and expert missions, etc. Moreover, seven (07) officers from PNRA are on higher studies in Korean and Australian universities. Detail of these events is shown in Figure 33.

Research and Analysis in International Affairs

PNRA continues to monitor and analyze international political and technical developments taking place in the nuclear domain that influences nuclear safety and security in the country and regulatory decision making. For this purpose, PNRA has created special cadre of International Relations Analysts/Officers (IRAs). They are responsible to carry out research on international strategic issues that influences regulatory activities and review and analysis of international conventions, treaties and IAEA documents. Moreover, to expand outreach of PNRA at national and international level, they have maintained close liaison with national and international research institutes and think tanks. During the reported year, they regularly attended and participated in the seminars, conferences and lectures organized by South Asia Strategic Stability Institute (SASSI), Institute of Strategic Studies Islamabad (ISSI), Institute of Policy Studies (IPS), and Center for International Strategic Studies (CISS). They have also participated in the Workshop on Research Methods organized by School of Politics and International Relations of Quaid-I-Azam University, Islamabad.

During 2013, two (02) PNRA officials were awarded scholarships by Civilian Research and Development Foundation (CRDF) Global in Monterey Institute of International Studies (MIIS) Visiting Fellow Program. In addition, IAEA also awarded two (02) fellowships to PNRA for the capacity building in research and analysis in the field of Nuclear & Radiation Safety and Nuclear Security at the Stockholm International Peace Research Institute (SIPRI), Sweden. During these fellowships, they produced papers in the areas of Nuclear Safety & Security, Safeguards, Illicit Trafficking of Nuclear and other Radioactive Materials and Nuclear Forensics.

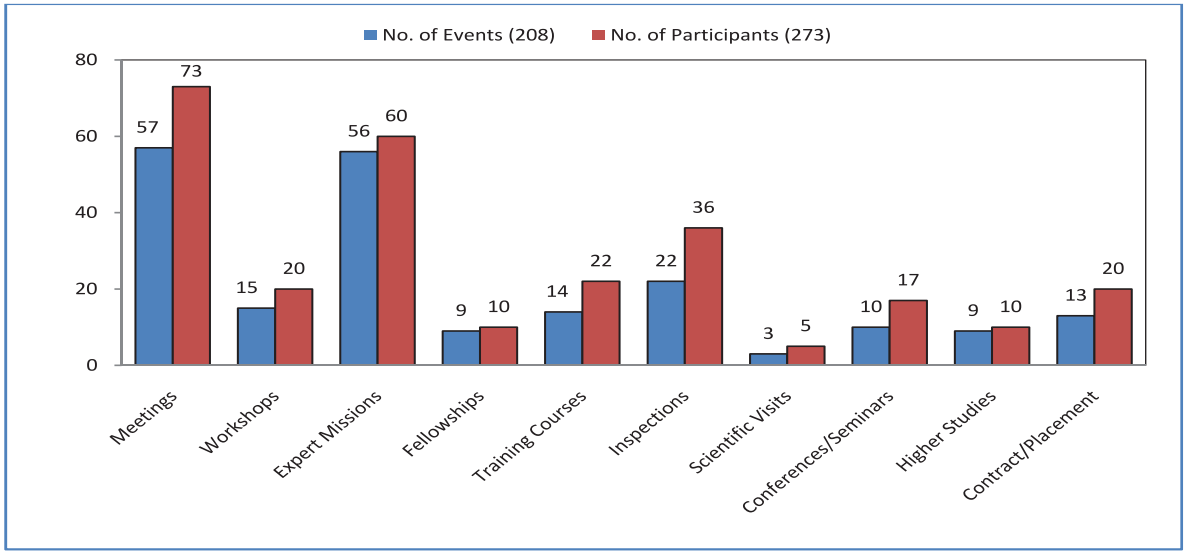


Figure 33: International Trainings/Activities During 2013

9
PUBLIC SECTOR DEVELOPMENT PROJECTS

PNRA has been working on different Public Sector Development Programme (PSDP) projects since 2005. Some of these projects have become regular elements of PNRA after their completion while remaining are in progress. The overall objective of these projects is capacity building and institutional strengthening in response to the emerging needs of nuclear and radiological safety and security. During 2013, PNRA continued working on four (4) such projects. A summary of these projects is tabulated below:

S. No	Name of PSDP	Total Cost (PKR Millions)	Duration
1	Capacity Building of PNRA to implement National Nuclear Security Action Plan (NSAP)	571.50	2006-2013
2	Establishment of National Dosimetry and Protection Level Calibration Laboratory (NDCL)	364.45	2007-2014
3	National Program on Environmental Monitoring Radioactivity Surveillance (NERSP): Islamabad, Kundian, Karachi	263.00	2007-2014
4	Safety Analysis Centre (SAC) to provide regulatory support for indigenization of NPPs in Pakistan	463.00	2010-2015

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

National Nuclear Security Action Plan (NSAP)

Effective national system for nuclear security is vital for peaceful uses of nuclear energy. PNRA has made efforts to strengthen physical protection measures at nuclear and radiation facilities through NSAP project. The main objective of this project is to prevent, detect and respond to theft, sabotage or other unauthorized acts involving nuclear or radioactive material through provision of trainings, technical assistance, deploying of radiation detection equipment, enhancing regulatory vigilance and issuing guidance on improving nuclear security in the country. The activities on the five focus areas during 2013 are described in the following paragraphs:

Security of Radioactive Sources:

In order to enhance the regulatory vigilance over the radioactive sources, NSAP performed a number of inspections to assess the security measures at radiation facilities using high activity radiation sources in collaboration with Regional Nuclear Safety Directorates (RNSDs). NSAP indigenously prepared "Nuclear Inspector's Tool for Security of Sealed Radiation Sources (SRS)" and assessed the security levels of various radiation facilities. Physical Security Plans (PSPs) of some radiation facilities were also reviewed to upgrade these plans as per PNRA requirements. Under the IAEA-Pakistan Nuclear Security Cooperation Program, the security of three (3) Nuclear Medicine Centers of PAEC at Islamabad, Abbottabad and Peshawar has been upgraded under the regulatory oversight of PNRA. Physical security up-gradation plan of another twelve (12) medical centres is under way.

Nuclear Security Emergency Coordination Centre (NuSECC):

An effective and efficient response mechanism to deal with the nuclear security related emergencies is essential. In this regard, Nuclear Security Emergency Coordination Centre (NuSECC) is established at PNRA Headquarters, having a network of mobile emergency labs at five regional offices of PNRA. The center is equipped with state-of-the-art response equipment and capabilities to

manage radiological emergencies.

The centre, with the assistance of IAEA, equipped first responders (law enforcement agencies, Rescue 1122 and fire brigade) with radiation detection equipment for early detection and effective management of a radiological incident. During 2013, the equipment has been procured through IAEA. In addition, NuSECC has established liaison with National Police Academy (NPA), as part of its outreach program, to create awareness in law enforcement agencies about nuclear security events.

Combating Illicit Trafficking of Nuclear Material:

One of the important pillars of NSAP project is to help enable Custom authorities to combat illicit trafficking of nuclear material across the international borders. In this regard, eight major entry/exit points of the country have been equipped with radiation detection equipment. A Mobile Expert Support Team (MEST) has also been established to provide technical assistance to Custom authorities. During 2013, MEST continued to provide support to Custom officials on operation and maintenance of radiation detection equipment.

Orphan Source Search & Recovery:

PNRA has developed a strategy to regain control over orphan radioactive sources. During 2013, NSAP performed physical searches various targeted locations like dry ports, scrap yards, junk yards, and steel mills for implementation of the strategy.

Physical Protection of Nuclear Material and Facilities:

PNRA has been delegated the responsibility to ensure that appropriate measures are being taken by the licensees for physical protection of nuclear material and installations. NSAP conducted regulatory inspection of licensed nuclear installations in collaboration with regional directorates and provided its technical opinion regarding physical protection of these installations. As a result, work on up-gradation of its physical protection systems has been initiated by the installations as per the requirements of PNRA.

National Dosimetry and Protection Level Calibration Laboratory (NDCL)

One of the main objectives of PNRA is to ensure the protection of radiation workers, the general public and the environment from the harmful effects of ionizing radiations. In this regard, monitoring of radiation exposure is a fundamental mechanism to ensure the safety of occupational workers. In order to provide personal dose monitoring services to the radiation workers throughout the country, PNRA had launched a project for establishment of "National Dosimetry and Protection Level Calibration Laboratories (NDCL)" at Islamabad,

Briefing about Working of NDCL Laboratories

Inauguration of NDCL Laboratories by Chairman PNRA

Visit of Ex-Member (PNRA) to NDCL Lab

Visit of Pakistan Ambassador at Austria to NDCL Lab

Visit of Chairman PNRA to NDCL Internal Dosimetry Lab

Radiation Worker in WBC Chamber for Whole Body Counting

NDCL Team and Experts during the Installation of WBC System

Kundian and Karachi. According to its original schedule, this project was to be completed by June, 2013. However, due to some constraints, it could not be completed on time and the project was revised. Now this project is expected to be completed by June, 2014. After that, PNRA would be able to provide dosimetry services not only to nuclear and radiation facilities but also to the first responders in the event of a radiological emergency in Pakistan. These laboratories will also be helpful to ensure the implementation and compliance of annual regulatory dose limits at the nuclear & radiation facilities in the country.

Further, taking into consideration the expansion of Pakistan's nuclear power programme, and based on the regulatory importance of verification of the reliability of the radiation equipment being used at NPPs, a setup of protection level calibration laboratory is also being established under the NDCL project. During the year 2013, the following major targets of NDCL project were successfully achieved:

Establishment of External Dosimetry Labs at Islamabad and Karachi:

The external Dosimetry laboratories at Islamabad and Karachi which are equipped with automatic and manual Thermo-Luminescent Dosimeter (TLD) Readers have the capability to readout the different types of TLD cards for whole body doses as well as for extremity doses. The laboratories at Islamabad and Karachi are providing external dosimetry services to some of the licensed radiation facilities in the country. NDCL is in process to establish a Film Badge Dosimetry Laboratory for provision of external dose monitoring services to radiation workers on the large scale. In this regard, the procurement of required equipment is in process and it is expected that these laboratories will become fully functional in 2014.

Establishment of Internal Dosimetry Labs at Islamabad, Kundian and Karachi:

In the reported year, NDCL has successfully established three internal dosimetry laboratories at Islamabad, Karachi and Kundian. These laboratories have been equipped with the Whole Body Counting (WBC) Systems imported with the assistance of IAEA. The two laboratories at Karachi and Kundian are equipped with Stand-up type Whole Body Counting Systems for measurement of minute amount of radioactivity inside human body. The third lab at Islamabad is equipped with Bed-type Whole Body Counting System. This system can be used for whole body counting as well as for organ counting. It consists of low background shielding room.

Establishment of Calibration Labs at Kundian and Karachi:

One of the main objective of NDCL project is to establish two protection level calibration laboratories at Kundian and Karachi aiming to verify the reliability of radiation measuring instruments

being used at radiation facilities and nuclear power plants. For this purpose, the construction of lab buildings including gamma irradiator bunkers are near to completion while the procurement of lab equipment is under process in co-ordination with IAEA. It is expected that these labs will become operational within the defined period of the project.

National Environmental Radioactivity Surveillance Program (NERSP)

PNRA has the responsibility to ensure that the public is protected from any buildup of environmental radioactivity in the country. The NERSP is aimed at enhancing PNRA's capabilities for monitoring environmental radioactivity, evaluating any build up of radiation, assessing the doses being received by the public, and verifying the environmental data provided by NPPs. The program is being implemented by PNRA and entails systematic measurements of radioactivity in soil, air, water, flora and fauna, etc., throughout the country.

Establishment of Environmental Monitoring (EM) Labs:

Environmental Monitoring (EM) laboratory at Karachi: This lab is fully operational. Soil samples from all districts of Baluchistan, and soil and air samples around Karachi Nuclear Power Plant site have been collected and analyzed at the laboratory. Tritium measurements in water samples are also analyzed. In addition, food samples received at RNSD-III are also being analyzed for the issuance of radiation free certificates.

Environmental Monitoring (EM) laboratory at Chashma: Construction work of this lab has been completed in the reporting year. Environmental radiation measuring equipment e.g. Gamma Spectrometry System (GSS), Liquid Scintillation Analyzer (LSA), high and low volume air samplers, and radon monitors have been installed and made operational. Other necessary equipment required for sample collection and processing have also been placed in these laboratories. Collection of soil and water samples in the area has been started for the establishment of the natural background. The laboratory was inaugurated on 30th September, 2013.

Environmental Monitoring (EM) laboratory at Islamabad: This lab is currently functioning at PNRA Headquarters while the specified location is expected to complete in 2014.

During the reported year, gamma spectrometric analysis of soil samples collected from various districts of Baluchistan and KPK provinces have been completed. Gamma spectrometric analysis results of Punjab, Sindh, KPK and Baluchistan have been compiled in a report entitled "Distribution of Gamma Emitting Radionuclides and Associated Radiological Hazards in Soil of Pakistan" in order to establish base line data of background radiation levels of gamma emitting radio-nuclides in the

Gamma Spectrometry System

Radiochemical Laboratory

Liquid Scintillation Analyzer Lab

whole country. In this report, specific activities of naturally occurring (238U, 232Th and 40K) and anthropogenic radionuclide (137Cs) and associated absorbed gamma doses have been calculated. Fifteen (15) samples of soil, crude oil and water from different oil & gas sites were also analyzed at EM lab, Islamabad. Different samples of food and other materials received from RNSDs were also analyzed at EM lab, Islamabad, for issuance of radiation-free certificates.

One (01) Gamma Spectrometry System, one (01) Liquid Scintillation Analyzer and three (03) Alpha Spectrometry Systems are in procurement phase through IAEA. All necessary equipment required for sample processing lab and radiochemical lab prior to gamma and beta analysis has been procured locally for EM labs at three locations.

EM Lab, Kundian

Safety Analysis Centre (SAC)

Safety Analysis Centre is a Technical Support Organization (TSO) to provide technical support in safety analysis for NPPs. The major areas of work of SAC include deterministic and probabilistic safety analyses, structural and seismic analysis, etc. Besides analysis, development work for simulation of nuclear power plant systems and equipment are also part of SAC activities.

SAC plans, develops, and executes comprehensive safety analyses and studies to support PNRA's mission towards safe operation of nuclear power plants. A consistent learning environment is established at SAC through technical discussions and presentations.

SAC has strengthened its computing facility by procuring latest licensed software like ETAP-12

Inauguration Ceremony of EM lab Chashma, Kundian

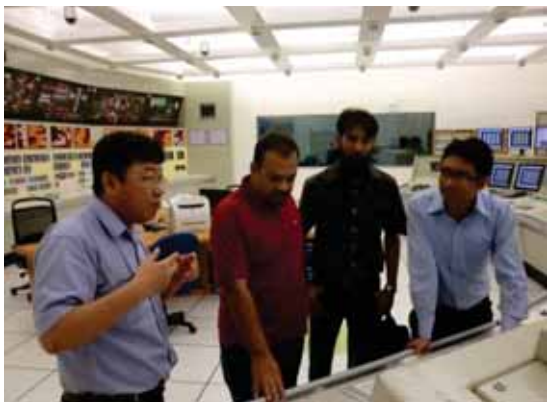
(Nuclear), MATLAB 2013, SAP 2000, 3Ds MAX Design 2014, Visual Studio 2012, and Enterprise Architect.

SAC is developing a Desktop Simulator in Visual Basic 6.0 for a 3-Loop PWR. The development team has finalized steady state file along with power maneuvering capability. At present, SAC researchers are engaged in the nuclear power plant controls development for simulation of normal transients like reactor trip, turbine trip etc. Simulation & analysis laboratory has been established at the centre which will be used for the training & development of desktop simulator as well as for review of analysis performed by computer codes.

During 2013, following significant activities were performed:

- Qualification of the RELAP input deck generated from generic 1000 MWe engineering handbook;
- 15 design bases accident analyses from generic 1000MWe model;
- Tuning of 3-Loop 1000 MWe PWR steady state file for MELCOR model;
- Containment modeling and analysis for severe accidents using MELCOR;
- Fatigue analysis of upper closure head of RPV, stress analysis of main feed water pipe for normal and abnormal conditions, and stress analysis of inlet nozzle of RPV for design conditions;
- Modeling of NPP systems and station controllers in RELAP for the background analysis of Symptom Based Emergency Operating Procedures (SEOPs);
- Draft-1 for the development of regulatory guide on "Format and Contents of Safety Analysis Report (SAR) for Light Water Reactors (LWRs)";
- Modeling & simulation of CHASNUPP 300 MWe systems (i.e. component cooling water system, steam dump system, and reactor point kinetics model) using MATLAB & SIMULINK;
- Comparative study of latest ASME code with RCCM; and
- Start-up of PSA group and initial analyses for radiological consequences of accidents.

Simulation and Analysis Lab



Batch-1 at Full Scope Training Simulator, CNPO, China

10
PERFORMANCE REVIEW

As part of its management system, PNRA monitors and evaluates its performance against pre-defined twelve strategic performance indicators to identify the weak areas and to enhance its regulatory effectiveness. These indicators cover areas of responsibilities and functions of PNRA. A rating scale of five levels – Not Acceptable, Unsatisfactory, Needs Improvement, Minimally Acceptable, and Satisfactory – is used to assess performance against each indicator. Monitoring and Evaluation (M&E) remained an ongoing activity during the reporting period. The result of the assessment for January–December 2013 is discussed below and summarized in Figure 34 .

Indicator 1 *(Ensures that acceptable level of safety is being maintained by licensees):* PNRA inspectors carried out regulatory inspections of nuclear installations and radiation facilities as per plan of year 2013 and perceived safety level acceptable. A significant number of new radiation facilities, especially X-rays facilities that were not registered with PNRA, were brought into the licensing net during the reported period. PNRA conducted one course for industrial radiographers and four certification courses for radiation protection officers of radiation facilities from different medical centres, irradiation facilities and industries. PNRA also witnessed and participated in onsite/offsite emergency exercises conducted by the licensees and international exercises conducted by the IAEA. Review and assessment of licensees' submissions remained in progress. Based on these facts, the performance of PNRA is improved from *"Minimally Acceptable"* to *"Satisfactory"*.

Indicator 2 *(Ensures that regulations and guides are in position and understood by licensees):* During 2013, two (02) regulations (i) Licensing of Nuclear Safety Class Equipment and Component Manufacturers (PAK/907) and (ii) Decommissioning of Facilities using Radioactive Material (PAK/930) were planned to be finalized and issued, however, these are still under preparation. Revision of six regulations are also under process. Similarly, two regulatory guides, (i) Guidance for the Users of I-131 in Nuclear Medicine Centres (RG-904.02) and (ii) Format and Contents of Application for Design Modification/Change Approvals for Nuclear Power Plants (RG-913.02), were finalized and issued. Seven regulatory guides remained under the development process. Keeping in view these facts, the performance of PNRA has lowered from *"Minimally Acceptable"* to *"Needs Improvement"*.

Indicator 3 *(Strives for continuous improvement of its performance):* PNRA has performed a number of activities for its improvement. Directorate of Regulatory Affairs (RAD) conducted regulatory audit of all directorates and projects and issued audit reports. RAD also carried out performance assessment of each directorate and project on quarterly basis and performance evaluation reports of fourth quarter of 2012 and first three quarters of 2013 were issued. During the reported period, various directorates and projects conducted their self-assessment for the year 2012. Regarding the long outstanding IAEA IRRS review mission to Pakistan, a preparatory mission visited Pakistan in March 2013 to finalize the scope of IRRS review. The full scope IRRS mission is expected in the second quarter of 2014. PNRA is preparing advance reference material for this mission. Self-Assessment of PNRA using IAEA SARIS database has been completed. PNRA invited its licensees for participation in various training courses and obtained their feedback on regulatory processes and activities for improvement. Based on these facts, PNRA considers that it has maintained this indicator as "*Satisfactory*".

Indicator 4 *(Takes appropriate actions to prevent degradation of safety and to promote safety improvements):* PNRA reviewed various safety related modifications; technical and periodic safety analysis reports; event reports and other safety related documents submitted by nuclear

Figure 34: Assessment of PNRA's Performance in 2013

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

Rating Scale

Green	Satisfactory
White	Minimally acceptable
Yellow	Needs improvement
Red	Unsatisfactory
Pink	Not acceptable

installations and radiation facilities. PNRA also ensured that appropriately qualified and trained operating personnel remain available throughout the operating lifespan of nuclear installations. PNRA conducted one course for radiographers and four certification courses for radiation protection officers of radiation facilities. Ninety (90) out of one hundred & twelve (112) participants successfully completed these courses. In addition, PNRA also conducted three workshops on quality assurance and protection of patients in imaging and radiotherapy at medical centres in Lahore and Karachi. Based on the steps taken by PNRA to prevent degradation of safety at nuclear installations and radiation facilities, the performance of PNRA has improved from *"Minimally Acceptable"* to *"Satisfactory".*

Indicator 5 *(Takes appropriate steps for human resource development and has competent and certified regulatory staff):* PNRA is taking appropriate steps to increase the number of its technical staff as well as to enhance the technical competency of the existing staff keeping in view the future expansion of nuclear program in the country. Maintaining a sufficient number of highly skilled professionals, with appropriate academic qualifications and adequate experience, for regulatory supervision is one of the key future issues for PNRA. PNRA established School for Nuclear and Radiation Safety (SNRS) and Nuclear Security Training Center (NSTC), to impart knowledge and skills to newly recruited officers as well as for existing staff. During 2013, SNRS conducted twenty seven (27) training courses & thirty three (33) lectures/seminars and NSTC conducted eleven (11) training courses. Officials from PNRA, PAEC, law enforcement agencies and other stakeholder organizations participated in these events. In addition, PNRA officials also participated in fifty one (51) courses at different national institutes. Fellowships for MS degrees in nuclear engineering at Pakistan Institute of Engineering and Applied Sciences (PIEAS) and the Karachi Institute of Nuclear Power Engineering (KINPOE) continued. Fellows from passing out batch joined PNRA after completion of studies at PIEAS and KINPOE. Therefore, it is considered that PNRA has maintained its performance against this indicator as *"Satisfactory"*.

Indicator 6 *(Ensures that legal actions are taken in case of violations of regulatory requirements):* During the reported period, PNRA strongly pursued enforcement actions and issued notices to defaulters that were in violation of regulatory requirements. In response to these legal actions, a number of defaulters and violators were registered with PNRA. Although, with the inclusion of these facilities, the licensing net of PNRA has substantially increased, however, efforts are being made to bring all the defaulters and facilities in licensing net. Keeping in view the efforts and progress made under this indicator, the performance of PNRA has improved from *"Needs Improvement"* to *"Minimally Acceptable"*.

Indicator 7 *(Performs its functions in a timely and cost-effective manner):* PNRA has achieved most of the targets set for the year 2013 within estimated resources. PNRA continuously monitored the implementation of regulations through regulatory surveillance, inspections and review & assessment of the licensees' documents. PNRA has developed the PSA regulatory model for PWR two loops plant. However, it will be finalized, to utilize it in the assessment of nuclear installations, in the next year. Therefore, this indicator has been retained as *"Satisfactory"* this year as was done during the previous year.

Indicator 8 *(Ensures that a well established quality management system exists):* The Management System Manual (MSM) had been developed and started its implementation from 2010. Based on the feedback from the users, its

revision is now in progress. During the reported period, PNRA arranged two training courses on Safety Culture Self Assessment (SCSA) with the assistance of IAEA. The in-house safety culture self assessment is in progress and is expected to be completed in 2014. Afterwards, safety culture statement and attributes for PNRA will be finalized. Based on the existing MSM, internal audit of all PNRA directorates and projects was conducted. Action plans have been developed on audit recommendations and are being implemented. The revision of MSM was expected to be completed by June, 2013. However, this task could not be completed in time. therefore, the performance of PNRA against this indicator is maintained at *"Minimally Acceptable"*.

Indicator 9 *(Ensures that adequate resources are available for performing its functions and technical support centre is available for specialist assistance when required):* Despite financial constraints, being faced by all sectors of Government, to which PNRA is no exception, PNRA has achieved most of its objectives and targets set during the reporting period. The project, Nuclear Security Action Plan (NSAP), established to develop a national sustainable system in nuclear security, has successfully been completed during the reported period. The technical support organization of PNRA, Centre for Nuclear Safety (CNS), developed PSA regulatory model, conducted research and development in the areas of accident analysis and stress analysis of NPPs, reviewed and assessed various licensees' safety related documents. The other technical support organization of PNRA, Safety Analysis Centre (SAC), continued to develop expertise in deterministic and probabilistic safety analyses. Keeping in view the above, PNRA maintained its performance against this indicator as *"Minimally Acceptable"*.

Indicator 10 *(Performs its functions in a manner that ensures confidence of the operating organization):* PNRA conducted coordination meetings with the licensees of NPPs, as planned, to discuss the progress of the safety activities being performed at the plants and to check the performance of the regulatory staff responsible for regulatory inspections. Personnel from NPPs participated in various training courses arranged by PNRA and vice versa. PNRA shared the draft regulations with the NPP licensees for their feedback and shared the international feedback on safety related issues. PNRA also arranged certification courses for RPOs and industrial workers. In addition, PNRA invited various stakeholders for participation in training courses on safety and security, RS detection techniques, emergency responses, etc. In view of the above, the PNRA's performance has improved from *"Minimally Acceptable"* to *"Satisfactory"*.

Indicator 11 *(Performs its functions in a manner that ensures confidence of the general public):* PNRA keeps the general public informed about its activities through its annual report and by placing relevant information at PNRA web page (www.pnra.org). Radiation protection information was prepared and published in the form of booklets and pamphlets for the general public. PNRA also arranged seminars & special lectures for general public as well as medical professionals in order to aware them about the application of ionizing radiations in everyday life & medical field, hazards associated with them & means of protection. However, a mechanism to widen the involvement of stakeholders in authorization process of nuclear installations and development and implementation of public awareness strategy still needs to be developed. Keeping the above in view, PNRA's performance against this indicator has lowered from *"Needs Improvement"* to *"Unsatisfactory"*.

Indicator 12 *(Performs its functions in a manner that ensures confidence of the Government):* PNRA provides quarterly report on the safe

operation of nuclear installations to the Government, conducts meetings with related Government departments to inform them about the status of public & environmental safety and to seek their support for further enhancement of regulatory regime for nuclear safety and security in the country to match the highest international standards. Therefore, PNRA judges its performance against this indicator as *"Satisfactory"* for the reported period.

Overall Performance

Based on the evaluation of all the twelve performance indicators, PNRA has rated its overall performance for the reported period as satisfactory. A comparison of its overall performance during the last ten years is given in Figure 35.

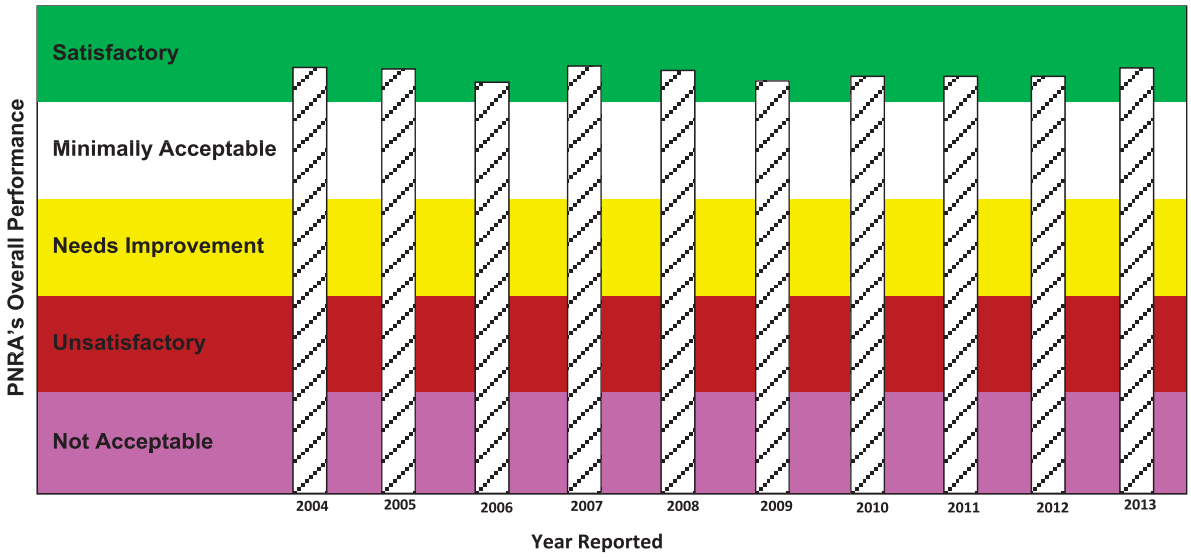


Figure 35: Overall Performance of PNRA since 2004

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