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PNRA

REPORT 2011

PAKISTAN NUCLEAR REGULATORY AUTHORITY

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Mr. Mahboob Ali

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Dr. Qazi Abdus Saboor

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FORMER

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Mr. Mohammad Shakilur Rahman

MESSAGE FROM THE CHAIRMAN

PNRA has been accomplishing success in discharging its responsibilities with vision in the last eleven years. It has brought about significant improvements in the regulation of civilian nuclear installations and radiation facilities. This has been made possible due to the rigorous and independent oversight and the commitment of PNRA staff to ensure safety. In the auspices of developing an efficient regulatory infrastructure, effective regulations, competency development in core functions, and stakeholders involvement, PNRA has established its credibility as a transparent, knowledge-based organization. Today, PNRA regulates a wide range of nuclear and radiation facilities such as power and research reactors, diagnostic radiology, radiation oncology, radiotherapy and use of radioisotopes in industrial, agriculture and research domains.

The accident at Fukushima Nuclear Power Plants in Japan has been a learning experience and an opportunity to draw lessons. PNRA imposed requirements to licensees of nuclear power plants to revisit and re-assess the design bases, design, management, emergency preparedness, procedures, and operators' training program to identify actions for improvements and complete the actions within an appropriate time frame. In addition, PNRA initiated a review of its regulations to identify areas where regulatory improvements are necessary based on Fukushima accident.

Efforts are underway to upgrade our Nuclear Security Training Centre into a Centre of Excellence, equipped with state-of-the-art laboratories to provide not only hands-on trainings at national level but also to serve as regional and international hub of knowledge.

Maintaining and elevating the competency, skill, qualification and number of PNRA staff members to meet the challenges of regulating the envisaged increase in the nuclear installations and radiation applications is of a high priority. Though pace for inducting new staff members remained slow this year because of budgetary constraints yet I am committed to fulfill the responsibility assigned by the nation to overcome the constraints through more effective and efficient working.

PNRA's contribution at international forums has been worthwhile. In 2011, PNRA officials assisted IAEA in fifteen international review missions and I am committed to enhance our contribution towards these efforts.

This all was only possible with the untiring efforts, dedication and commitment of our staff members as well as the cooperation of all the stakeholders. I pay homage to my staff members and all the stakeholders for their commendable endeavors. I would also like to thank international organizations like IAEA for extending cooperation towards enhancing nuclear safety and security regime in Pakistan.

In the end, I will emphasize that PNRA will continue to focus its efforts to constantly enhancing its regulatory effectiveness and efficiency so that the protection of workers, public and the environment attains highest levels which in-turn will benefit the society and the world.

(Mohammad Anwar Habib)

ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
Bq/m^3	Becquerel /cubic meter (3.7×10^{10} Bq = 1 Curie)
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
CNS	Centre for Nuclear Safety
DPP	Document Preparation Profile
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
KINPOE	KANUPP 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	Nuclear Security Action Plan
NSTC	Nuclear Security Training Centre
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
PSR	Periodic Safety Review
SAR	Safety Analysis Report
SAT	Self Assessment Tool
SNRS	School for Nuclear and Radiation Safety

Contents

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*

1 INTRODUCTION AND BACKGROUND

Under the Pakistan Nuclear Regulatory Authority Ordinance, 2001, the Pakistan Nuclear Regulatory Authority (PNRA) was established in 2001 as an independent regulatory body to regulate and supervise all matters related to the safety of nuclear and radiation facilities in the country. The main objective of PNRA is ensuring protection against risks arising from ionizing radiations, ensuring existence and implement-ability of appropriate emergency preparedness and physical protection measures for the facilities and fixing the extent of civil liability for nuclear damage resulting from any nuclear accident. In order to perform its functions, PNRA is empowered to formulate and implement regulations related to radiation protection, nuclear safety and physical protection, issue licences and authorizations for facilities and activities involving ionizing radiation, and carry out regulatory oversight to verify compliance with the regulations, conditions of the authorization and directives issued by the Authority.

Before the establishment of PNRA, nuclear and radiation regulatory activities were carried out by the Directorate of Nuclear Safety and Radiation Protection (DNSRP). The DNSRP had been established in 1984 within the Pakistan Atomic Energy Commission (PAEC) whose primary role is promoting nuclear energy. In 1994, the Government of Pakistan signed the Convention on Nuclear Safety, a key obligation under which is ensuring effective separation between the functions of the regulatory body and those of any other body or organization connected with the promotion or utilization of nuclear energy. As a first step to meet this obligation of independent regulation, the Government of Pakistan established the Pakistan Nuclear Regulatory Board in 1994. In 2001, Pakistan achieved full compliance with this aspect of the Convention on Nuclear Safety through the establishment of an independent nuclear regulatory authority—PNRA.

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

Major Activities in 2011

Major activities of PNRA during 2011 are summarized as follows:

1. Monitoring of activities at three operational NPPs (Karachi Nuclear Power Plant Unit 1, Chashma Nuclear Power Plant Unit 1 and Unit 2) and two under construction nuclear power plants (Chashma Nuclear Power Plant Unit 3 and Unit 4) continued. Releases to the environment from operating NPPs and radiation doses to workers remained well below the regulatory limits.
2. Monitored the seventh refuelling outage of Chashma Nuclear Power Plant Unit 1 (C-1). After completion of refuelling, C-1 started its operation in October 2011. Control point review and inspection activities at the plant were carried out during and after refuelling.
3. Site was registered for the construction of Chashma Nuclear Power Plant Unit 4 upon completion of the review of Site Evaluation Report (SER) and resolution of safety issues.
4. Conducted review of Preliminary Safety Analysis Report (PSAR) for Chashma Nuclear Power Plant; Unit 3 and Unit 4 and issued construction licenses.
5. Periodic Safety Review (PSR) of PARR-I was completed and the operating license was renewed upto 31st December 2012.
6. Enhanced the licensing net for diagnostic radiation facilities by 6.7 percent.
7. Approved Regulations on Safety of Nuclear Research Reactor(s) Operation (PAK/923).
8. Regulatory Guide on Format and Contents of Application for Modification in Technical Specifications/Operating Policies and Principles for Nuclear Power Plants (RG 913.03) was issued.
9. Conducted self assessment of regulatory activities using the IAEA SAT software

(version 2010).

10. Developed centralized database for national and international operating feedback.
11. Acquired Whole Body Counter (WBC) for NDCL at Karachi and Chashma.
12. Established a laboratory at Karachi for analysis of environmental samples under the NERSP project.
13. Headed Pakistan's delegation to the 5th meeting of the Contracting Parties to the Convention on Nuclear Safety and presented Pakistan's National Report during the meeting.
14. Headed Pakistan's delegation to the Ministerial Conference held in Vienna in response to the challenges posed by the accident at Fukushima Nuclear Power Plants in Japan.
15. Nineteen (19) professional training courses in nuclear safety, radiation protection and safety management were conducted in which a total of 408 officials from PNRA, PAEC and other stakeholder organizations participated.
16. Eighteen (18) training courses were conducted at PNRA in the area of nuclear security for the capacity building of first responders, emergency response personnel and front line officers. About 361 personnel from the law enforcement agencies and other organizations participated in these training courses.
17. 266 PNRA officials participated in 132 international events such as workshops, training courses, meetings and seminars organized by IAEA under the IAEA technical assistance programme.
18. PNRA officials assisted IAEA in fifteen (15) expert missions to other countries.

Targets for 2012

The targets set for 2012 are summed up as follows:

1. Continuously monitor licensees' activities to avoid major incidents, overexposure of workers, and releases to the environment beyond the permissible limits.
2. Enhance the licensing net for diagnostic radiation facilities by further 10 percent.
3. Issue "Regulations on Transaction of Business of Pakistan Nuclear Regulatory Authority" - (PAK/901).
4. Revision of the following regulations:
   a. Regulations on Licensing of Nuclear Installations in Pakistan - (PAK/909); and
   b. Regulations for the Safety of Nuclear Power Plant Design - (PAK/911).
5. Issue the following regulatory guides:
   a. Protection of Patients in Diagnostic Radiology (RG 904.01);
   b. Guidance for the Users of I-131 (RG 904.02);
   c. Radiation Safety in Industrial Radiography (RG 904.03); and
   d. Format and Contents of Application for Design Modification/Change Approvals for NPPs (RG 913.02).
6. Self assessment of regulatory activities using the revised IAEA Self Assessment Tool.
7. Preparation of short term strategic plan.
8. Preparation of Pakistan's national report for the extra-ordinary meeting of the Contracting Parties to the Convention on Nuclear Safety in response to accident at Fukushima Nuclear Power Plants in Japan and representing Pakistan in the meeting.
9. Conduct about 40 training courses on nuclear safety and security providing training to about 700 officials from PNRA and other stakeholders.
10. Make fully functional the NERSP laboratory at Karachi and start work on the establishment of laboratories at Islamabad.
11. Establish Interior Physical Protection Laboratories at PNRA.
12. Setup Whole Body Counting (WBC) Laboratories at Karachi and Chashma.
13. Formal closure of PSDP Project "Centre for Nuclear Safety" after successful completion.

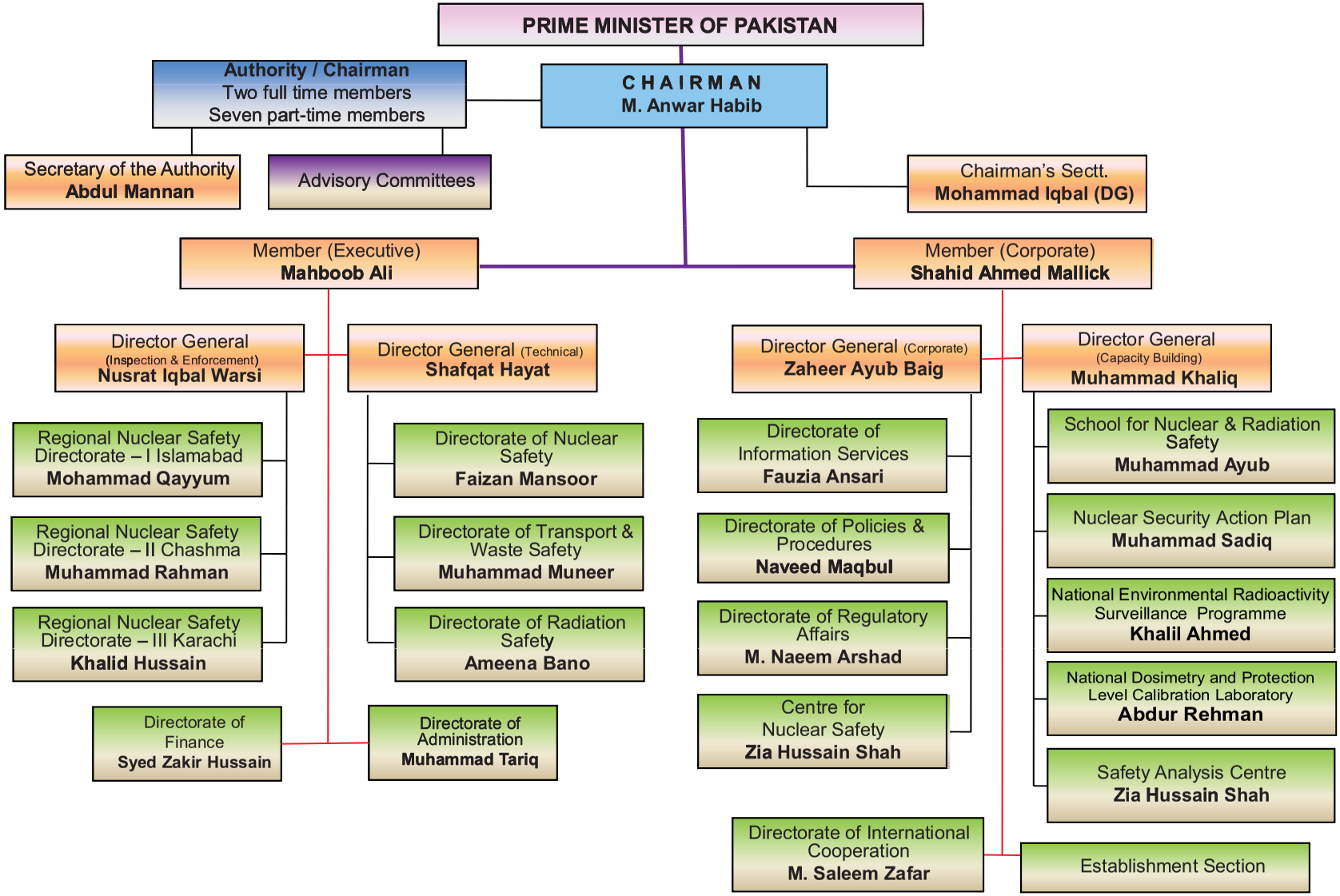


Figure 1: Organizational Structure of PNRA

2 REGULATORY FRAMEWORK

The Pakistan Nuclear Regulatory Authority Ordinance, 2001 empowers and mandates PNRA to regulate nuclear safety and radiation protection in Pakistan. To ensure the fulfilment of the obligations arising from the Ordinance, PNRA has established a regulatory framework for overseeing the safety of nuclear and radiation facilities in the country. This framework comprises of regulations and regulatory guides, which are developed in accordance with the provisions of the Ordinance. Compliance with the requirements of these regulations is verified by PNRA through review and assessment of the licensees' submissions and regulatory inspections. Non-compliance is controlled through enforcement actions, such as warning notices, suspensions, modification of licences or, in extreme cases, revocation of licences.

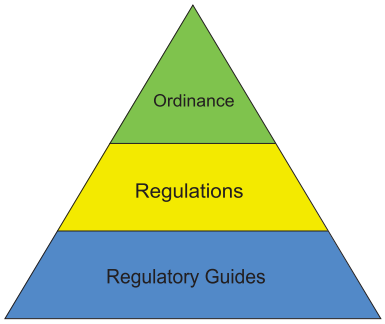


Figure 2: Regulatory Framework

The pyramid shown in Figure 2 depicts the regulatory framework of PNRA. At the highest level is the PNRA Ordinance. The aims and objectives of the Ordinance are translated for implementation into regulations, which provide specific regulatory requirements concerning different activities, and thus form the second tier in the regulatory pyramid. Compliance with these regulations is mandatory for licensees. The third level of the regulatory framework consists of regulatory guides, which describe acceptable methods for meeting the requirements of regulations. These guides are non-mandatory. If the applicant/licensee prefers to use some other method to meet the regulations, applicant/licensee is required to demonstrate that the proposed methods provide at least the same level of safety as would have been achieved if the methods described in the guides have been applied.

Regulations

Regulations provide the basis for PNRA to perform its functions of protecting radiation workers, the public and the environment from the harmful effects of radiation. PNRA follows an extensive process for development of these regulations. Each set of regulations undergoes rigorous internal review at different levels within PNRA, following which the opinions of all stakeholders, including licensees, the government, and the general public, is actively sought and incorporated. The entire process of developing a new set of regulations or revising existing regulations takes approximately two years. Figure 3 shows the different stages of the regulations development process.

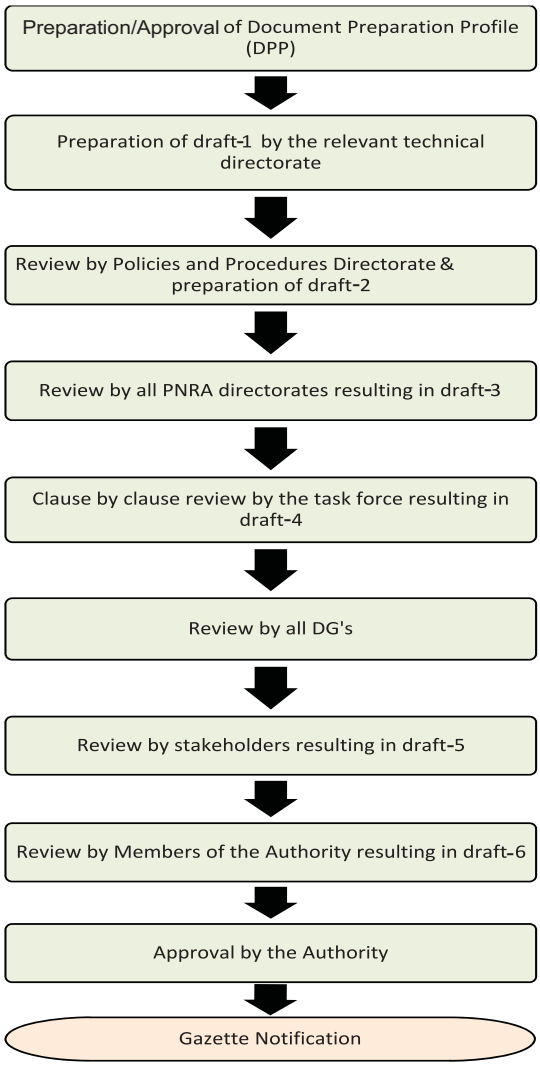


Figure 3: Regulations Development Process

Members of Pakistan Nuclear Regulatory Authority in 33rd Authority Meeting

PNRA's procedure for preparation, revision and adoption of regulations requires review of regulations every five years taking into account licensing and regulatory experience, feedback from stakeholders, and current international practices. Based on the outcome of review, a decision for revision of regulations is made. All the regulations that have so far been Gazette-notified are available on the PNRA website (www.pnra.org).

During 2011, Regulations for the Safe Operation of Research Reactor (PAK/923) were approved by the Authority. In addition, some amendments were made in "Regulations for Radiation Protection" (PAK/904) to include Radiation Protection Officer (RPO) criteria. Each Licensee of PNRA has to nominate RPO to operate the facility in a safe manner. Previously this criteria was missing in the regulations and the licensees were facing difficulties in identifying the RPOs.

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

- Regulations for Licensing of Nuclear Safety Class Equipment and Component Manufacturers (PAK/907): Draft 2 of the Regulations has been circulated within PNRA for review and comments;
- Regulations for Licensing of Nuclear Installations in Pakistan (PAK/909): Draft 5 of the Regulations, incorporating the jointly agreed position of PNRA and the licensee, is being circulated among the Members of the Authority for review; and
- Regulations for the Safety of Nuclear Power Plant Design (PAK/911): Draft 4 of the Regulations is being finalized.

In addition, development of the following new regulations remained under way:

- Regulations on Transaction of Business of PNRA (PAK/901): Draft 4 of the regulations is being finalized;
- Regulations on Physical Protection of Nuclear Installations and Nuclear Material (PAK/925): Draft 2 has been circulated within PNRA for review and comments;
- Regulations on Decommissioning of Facilities Using Radioactive Material (PAK/930): Draft 5 of the regulations has been communicated to the stakeholders for review and comments; and
- Regulations for Security of Radioactive Sources: Draft 1 is under review.

Regulatory Guides

Regulatory guides are developed to facilitate the licensees in understanding and implementing the requirements of national regulations. In cases where PNRA regulatory guides are not available,

licensees are referred to the available international regulatory guides.

During 2011, the regulatory guide on "Format and Contents of Application for Modification in Technical Specifications/ Operating Policies and Principles for Nuclear Power Plants (RG 913.03)" was issued.

Work remained in progress on the development of the following new regulatory guides:

- Protection of Patients in Diagnostic Radiology (RG 904.01);
- Guidance for the Users of I - 131 (RG 904.02);
- Radiation Safety in Industrial Radiography (RG 904.03);
- Format and Contents of Application for Design Modification/Change Approvals for Nuclear Power Plants (RG 913.02); and
- Management of Radioactive Waste in Medicine, Industry, Agriculture, Research and Education.

Central Registry

PNRA maintains a Central Registry of all regulatory documents, including Regulations, Regulatory Guides, Policies and Procedures. In all, 14 Regulations, 8 Regulatory Guides, 5 Policies and 120 Working Procedures have been registered so far with the central registry (Figure 4).

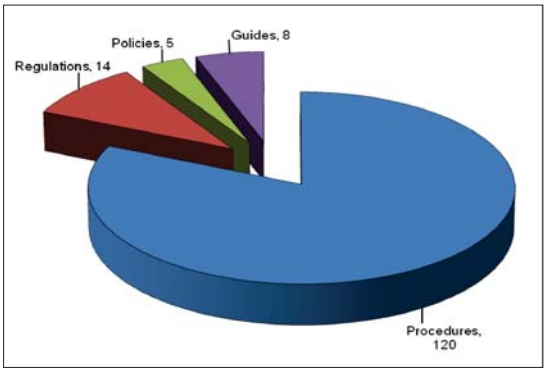


Figure 4: Status of PNRA Central Registry

PNRA Task Force Reviewing a Regulatory Guide

3 NUCLEAR SAFETY

All nuclear installations in the country are regulated by PNRA. The regulatory processes ensure that PNRA oversees the facilities' compliance with regulatory requirements, licence conditions and approved documents throughout their lives starting from site registration to decommissioning. The authorization and licensing of nuclear installations is a multi-stage process which includes Site Registration, Construction Licence, Fuel Load Permit, and Operating Licence. At each stage, the licensee is subjected to certain generic and specific conditions that are to be complied with during the authorized period. The licensee has to submit a number of documents at each stage of the licensing process. All these submissions are thoroughly reviewed and verified by PNRA in order to ensure that the requirements of relevant regulations and other regulatory commitments are fulfilled by the applicant/licensee.

At present, there are five operational nuclear installations in the country, including three nuclear power plants, namely, Karachi Nuclear Power Plant, Unit 1 (K-1), Chashma Nuclear Power Plant, Unit 1 (C-1), Chashma Nuclear Power Plant, Unit 2 (C-2), and two research reactors, i.e., Pakistan Research Reactors I and II (PARR-I and PARR-II). In addition, PNRA has granted Construction Licences to Chashma Nuclear Power Plant, Unit 3 (C-3) and Unit 4 (C-4), and the construction of these two units is in progress under regulatory oversight of PNRA. Details of nuclear facilities that are in operation or under construction in the country are summarised in Table 1.

PNRA also issues and renews the operating licences of personnel responsible for operating nuclear power plants and research reactors. A nuclear installation in the country is only permitted to operate if it is staffed with the minimum number of licensed operating personnel required by PNRA.

The review and assessment of licensees' submissions and regulatory inspections are carried out in accordance with the national regulations and applicable codes and standards to ensure that the licensees maintain an acceptable level of safety at nuclear installation. In case of degradation of safety, PNRA is empowered to take enforcement measures, ranging from issuance of directives for necessary corrective actions, curtailing activities and, in case of serious violations, suspension or revocation of authorization or licence.

PNRA conducts quarterly meetings with licensees of nuclear power plants for better coordination 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	Chashma Nuclear Power Plant Unit 1 (C-1)	In operation	Pressurized light water reactor	325 MWe	2000
3	Chashma Nuclear Power Plant Unit 2 (C-2)	In operation	Pressurized light water reactor	325 MWe	2011
4	Chashma Nuclear Power Plant Unit 3 (C-3)	Under Construction	Pressurized light water reactor	325 MWe	2016 (expected)
5	Chashma Nuclear Power Plant Unit 4 (C-4)	Under Construction	Pressurized light water reactor	325 MWe	2016 (expected)
6	Pakistan Research Reactor-I (PARR-I)	In operation	Swimming Pool	10 MWt	1965
7	Pakistan Research Reactor-II (PARR-II)	In operation	Tank-in-Pool	30 KWt	1991

communication; monitoring the safety performance of the plants and progress of necessary actions for safety improvements; identifying barriers, if any, in the implementation of necessary actions for safety improvements; and to decide on actions and the time frame for their completion. In addition, special meetings are arranged in response to significant safety matters requiring prompt attention.

Review and Assessment

Review and assessment of the submissions of applicants and licensees is a core function of PNRA. The submissions are made in support of applications for licensing; modifications in the structure, system and components important to safety; and such other activities where authorization is necessary. In addition, PNRA also reviews and assesses routine annual, biannual and monthly reports, as well as non-routine reports such as event reports submitted by licensees as per regulatory requirements.

The objective of review and assessment is to verify compliance of licensees' activities with national regulations, licence conditions, applicable codes and standards, and proven engineering practices. In case of non-compliance with regulatory requirements or a trend towards safety degradation, PNRA issues directives to the licensee to take necessary corrective actions in a defined time frame so that the health and safety of the workers, general public and environment remain uncompromised.

Operating Nuclear Power Plants

Karachi Nuclear Power Plant Unit 1 (K-1)

K-1 is a CANDU type nuclear power plant, operating since 1972. It completed its design life of 30 years in 2002. K-1 was allowed a life extension, with certain conditions, till 31st December, 2010 on completion of a number of actions required by PNRA regulations. The plant underwent long outage in October 2010 which continued till May 2011 for conducting necessary maintenance, modifications, in-service inspections and life re-assessment of main equipments, such as the steam generator tubes, fuel channel, etc. In compliance with one of its licence conditions, K-1 has established an Emergency Control Centre (ECC), to act as a hub for coordination with relevant off-site authorities for implementation of emergency response actions. After fulfilment of time-specific re-licensing conditions and satisfactory implementation of safety significant corrective actions, PNRA allowed K-1 to operate till April 2012. Decision on any further operation is subject to determining the remaining useful life of steam generators.

In October 2011, an event of heavy water leakage from one of the feeder pipes occurred at K-1 while the plant was in shutdown state for some maintenance activities. The event has been rated at level 1 on International Nuclear Event Scale (INES). PNRA reported this event to international community through Nuclear Event Web-based System (NEWS) and International Reporting System (IRS) of the IAEA. PNRA issued a directive to K-1 to analyse the event and seek permission from PNRA for plant start-up. Necessary actions were taken by the plant to control the leakage and isolate the leaked feeder pipe. During the event, no radioactivity was released to the environment and no increase in radioactivity level was observed. The radiation doses received by the plant personnel involved in the activities related to control of heavy water leakage were within the regulatory limits. Under the directive issued by PNRA, K-1 submitted a report on the root cause of the event, took necessary corrective actions to ensure prevention of recurrence of similar events, and took various other safety measures. After the detailed analysis of the report, PNRA granted permission for plant start-up.

Chashma Nuclear Power Plant Unit 1 (C-1)

C-1 completed its seventh cycle of operation in August 2011 and was shut down for refuelling. PNRA selected inspection points related to preventive maintenance and in-service inspection of safety equipment during the refuelling. About sixty-two control-point inspections and a number of general surveillances were conducted as a part of

C-1 RPV Head Installation After RFO-7

Physical Models of NPPs` Components

the refuelling outage inspection plan. PNRA conducted a review of various documents submitted by the licensee for criticality permission following the seventh refuelling. On completion of all necessary activities and based on the outcome of reviews and inspections, PNRA permitted C-1 to commence its eighth cycle of operation, after successful completion of criticality and low power tests as per regulatory requirements. Accordingly, C-1 started operation again in October 2011.

Chashma Nuclear Power Plant Unit 2 (C-2)

C-2 achieved its first criticality on 22nd February 2011 and grid connection was made on 15th March 2011. Requisite tests were conducted at low power, power ascension and full power to verify plant performance and response as per design intent. Some of the selected tests were also witnessed by PNRA. As per requirement of Regulation for Licensing of Nuclear Installation(s) in Pakistan (PAK/909), C-2 was required to submit application for Operating Licence within six months after first fuel load. In compliance, C-2 submitted its application along with submissions required under the regulations. Assessment of these submissions and verification of the fulfilment of commitments made by the licensee in response to review and assessment and inspections are being undertaken by PNRA. Operation Licence will be issued on satisfactory completion of these activities.

PNRA also issues directives to the licensees in case of non-compliance of safety requirements. During 2011, PNRA issued five directives to K-1; twenty-six to C-1; and six to C-2. K-1 has completed actions on four; C-1 on seventeen and C-2 on all six. PNRA is actively pursuing C-1 to implement the actions on the remaining nine directives. In addition, PNRA reviewed ten design modifications and two event reports submitted by K-1; four event reports by C-1 and ten event reports by C-2.

Nuclear Power Plants Under Construction

C-3 and C-4

The Site Evaluation Reports (SER) for construction of Chashma Nuclear Power Plant Units 3 and 4 (C-3 and C-4) were submitted in 2010 and reviewed in 2011 by PNRA. The site for C-3 was registered in February 2011. Site for C-4 was registered after completing review of the SER for C-4 in December, 2011.

PAEC applied for the issuance of Construction Licence of C-3 and C-4 along with the required documents including the plants' Preliminary Safety Analysis Report (PSAR), Probabilistic Safety Analysis (PSA) report and Overall Quality Assurance Programme (OQAP) in October, 2010. Detailed

Nuclear Island Before First Concrete Pouring of C-4

Chairman PNRA at C-4 First Concrete Pouring Ceremony

review of these documents was completed in 2011. PNRA granted special permission to C-3 to pour concrete in the foundation of the nuclear island in March 2011 and issued a construction licence on 28th May 2011 after resolution of all safety issues. The Construction Licence for C-4 was granted on 14th December, 2011.

PNRA continuously monitors the construction activities including equipment manufacturing. If any non-conformance is observed during monitoring or inspection, PNRA issues directives for taking necessary corrective actions. During 2011, PNRA issued nine such directives; the licensee was able to complete actions on six of these during the reported period. Remaining three directives are being followed-up by PNRA.

Figure 5 summarizes the review and assessment activities carried out by PNRA for the nuclear power plants during 2011.

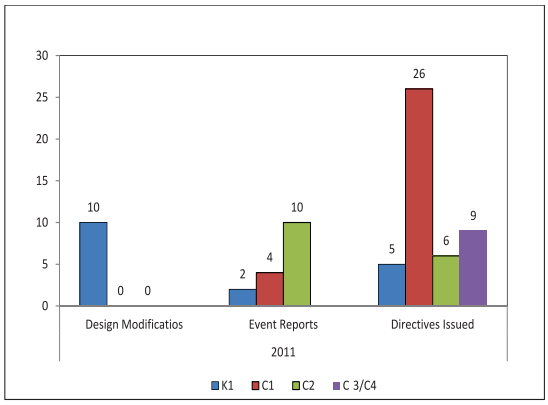


Figure 5: Review and Assessment of NPPs

Chairman PNRA Recording Comments on the Eve of First Concrete Pouring of C-4

Research Reactors

The Operating Licence (OL) of PARR-I was valid till 31st December 2010 and was then extended provisionally for one year. Under PNRA regulations (PAK/909), revalidation of the operating licence requires submission of the latest Periodic Safety Review (PSR) reports to PNRA. PARR-I submitted thirteen PSR reports with its application to extend its operating licence. Upon completion of the detailed review of PSR reports, PNRA granted PARR-I a licence to operate till 31st December 2012. The operating licence of PARR-II is renewed on annual basis.

Licensing of Operating Personnel

PNRA ensures that appropriately qualified and trained operating personnel remain available throughout the lifespan of each nuclear installation. According to national regulations (PAK/913), operating personnel including shift supervisors, shift engineers, and reactor operators require licence from PNRA. The licensing process for award of licences to operating personnel includes conducting oral examination, simulator test and walk-through examination. The operating personnel licences are renewed annually upon successful completion of retraining and performing mandatory shift duties.

During the reported period, three new personnel at K-1, three at C-1 and twenty-two at C-2 were granted operators' licences (Figure 6), whereas the

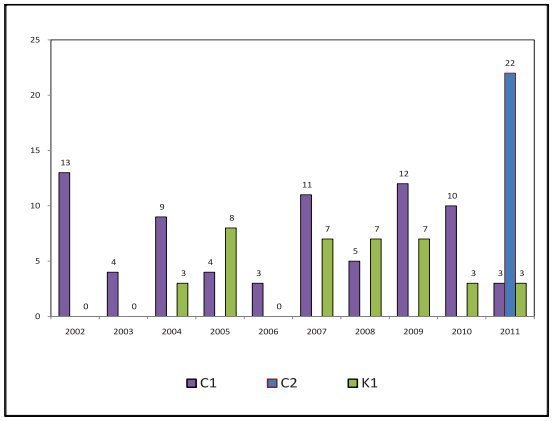


Figure 6: Issuance of New Operators' Licences for NPPs

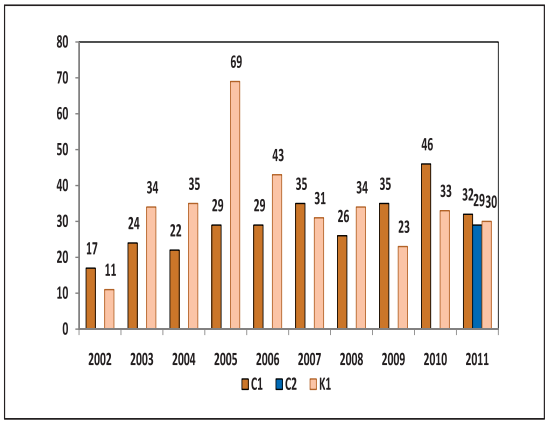


Figure 7: Renewal of Operators' Licences for NPPs

licences of thirty operating personnel at K-1, thirty two at C-1 and twenty nine at C-2 were renewed (Figure 7). At PARR-I and PARR-II, PNRA issued three new operators' licences and renewed nineteen licences of supervisors and operators (Figure 8).

Inspections of Nuclear Installations

PNRA conducts regulatory inspections during construction, commissioning and operation phases of nuclear installations. These inspections are carried out at plant site as well as at manufacturing and testing facilities outside the plant area. The main objective of these inspections is to ensure that the licensees are conducting their operations in accordance with national regulations, licence conditions and the directives issued from time to time. The inspections also verify that appropriate measures are being taken by the licensee to promote safety culture. The deficiencies observed during these inspections are communicated to the licensees in the form of inspection reports along with necessary 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. Resident inspectors have been posted at these Directorates. The RNSDs conduct regulatory inspections of nuclear and radiation facilities in their respective regions while the technical directorates located at PNRA

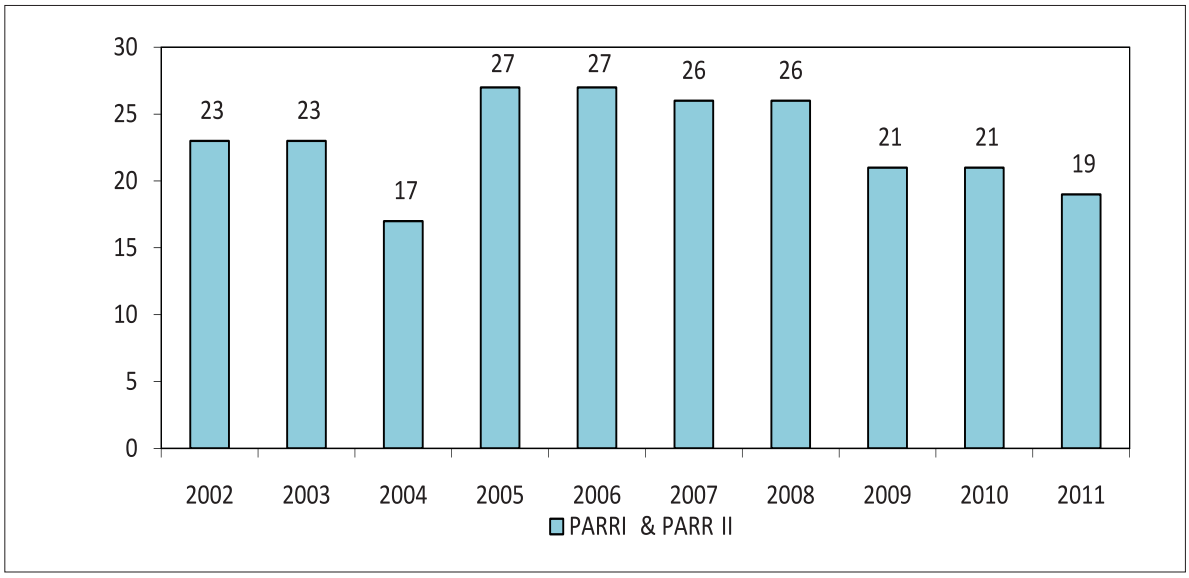


Figure 8: Renewal of Operators' Licences at PARR-I and PARR-II

Inspection of Civil Construction Activities at C-3 Site

PNRA Officials Visiting C-3 Site

Headquarters provide necessary technical assistance for conducting effective inspections.

Regulatory inspections of nuclear installations are carried out in accordance with the PNRA inspection programme. PNRA performs planned as well as unplanned (reactive) inspections in response to some events or special circumstances. In addition, control point inspection (Hold, Witness and Record Points) are carried out during construction, commissioning and refuelling of NPPs. Control point inspections are selected from the licensees' workplan submitted to PNRA.

In 2011, PNRA conducted a total of 45 inspections at K-1, 130 at C-1, and 113 at C-2 as per the annual inspection plans (Figure 9). In addition, 62 control point inspections were conducted at C-1, 27 at C-2, 214 at C-3/C-4 and 37 at K-1. Routine plant inspections are carried out on daily basis.

PNRA also performs inspections during equipment manufacturing of C-3/C-4. These inspections are managed by the Nuclear Safety Directorate at the PNRA Headquarters. In 2011, PNRA conducted four inspections during equipment manufacturing, whereas, one inspection of the management system of main contractor and manufacturers of main equipment, was also conducted.

Five safety inspections were conducted at PARR-I and one 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 10).

Equipment Manufacturer

Heavy Mechanical Complex-3 was licensed to manufacture Nuclear Safety Class (NSC) 2 and 3 equipment in 2005. The licence was later revalidated until 2015. The Complex has now submitted a request to upgrade its licence to allow

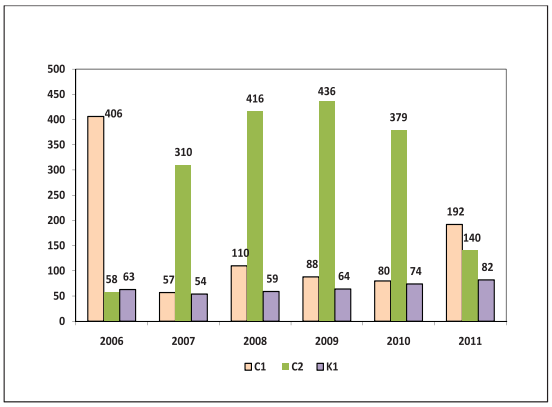


Figure 9: Regulatory Inspections of C-1, C-2 and K-1

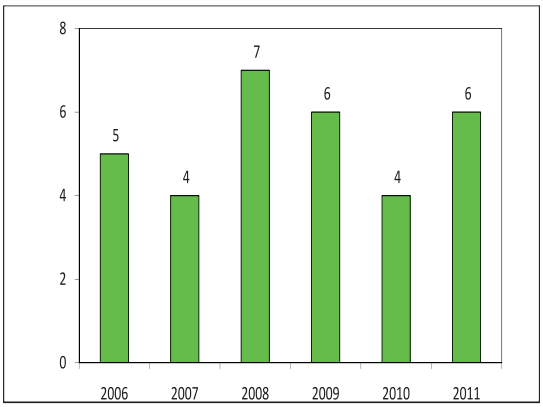


Figure 10: Regulatory Inspections of PARR-I and PARR-II

Inspection of Boric Acid Hold-up Tank

Inspections of Cement Grouting During Construction of C-3 NPP

manufacturing of Safety Class-1 equipment, along with the documents required under regulations PAK/907. PNRA has completed the review of these documents. However, the Complex is required to demonstrate its manufacturing capabilities by preparing a mock-up to demonstrate its competence for carrying out necessary processes for manufacturing Safety Class-1 equipment. The decision about licence upgradation will be made only after assessment of the Complex capabilities to the satisfaction of PNRA during mock-up preparation.

PNRA is also carrying out inspections. In 2011, ninety-three (93) control point inspections were conducted during mock-up preparation for verifying the Complex capabilities for manufacturing Safety Class-1 equipment. The Complex is also manufacturing safety class 2 and 3 equipment for C-3/C-4 under the manufacturing licence issued by PNRA. PNRA conducted one hundred and seventeen control point inspections during equipment manufacturing for C-3/C-4.

Safety Review of NPPs Documents

4
RADIATION SAFETY

Under the PNRA Ordinance, PNRA is authorized to control, supervise and regulate all matters related to radiation safety in Pakistan. To effectively discharge its regulatory obligations, PNRA develops and enforces regulations for radiation safety and executes comprehensive programmes for the protection of life, health and the environment from harmful effects of ionizing radiation. In addition to the nuclear installations, PNRA also regulates radiation safety aspects of diagnostic radiology including X-rays, radiotherapy centres, nuclear medicine facilities; irradiators; use of radioactive sources in industry, research and industrial radiography. The regulatory tools employed by PNRA to fulfil its obligations in this sphere include review and assessment, inspections, and, where necessary, enforcement actions.

Review and Assessment

Review and assessment of licensee's submissions is a major regulatory activity to ensure compliance of regulatory requirements for radiation safety set forth in national regulations. Radiation protection programs of various nuclear and radiation facilities were reviewed during the reporting period. Similarly certain radiation safety implementation procedures and ALARA plans of facilities were also evaluated. Dosimetry program and dose results were assessed. Evaluation and trending of ambient radiation levels around the nuclear power plants is continuously performed at PNRA. A summary of activities related to radiation safety at nuclear and radiation facilities during the reported period is presented below.

Radiation Safety at Nuclear Installations

Karachi Nuclear Power Plant Unit 1 (K-1)

Radiation safety at K-1 is assured through review and assessment of plant submissions. Annual safety report of K-1 for the previous year and monthly technical reports were reviewed in detail. Assessment of radiation exposures to plant workers was performed and these were found to be largely within the prescribed regulatory limit of 20 milli Sieverts (mSv) per year. The annual dose received by 65.03 percent of workers was less than 1 mSv, while 17.9 percent received doses in the range 1 – 5 mSv. The dose received by a small fraction (1.74 percent) of workers was in 20–30 mSv range during the reported year. In such cases, where the regulatory limit of 20 mSv per year is exceeded for a specific worker, it is required that the 5-year average dose limit of that worker be maintained below 20 mSv. It was found that all of the 1.74 percent of workers who received a 20-30 mSv dose during 2011 had received a total dose of less than 100 mSv over the last five years. The dose distribution of workers at K-1 is detailed in Figure 11.

Ambient radiation levels at K-1 and in the nearby city of Karachi are continuously monitored and assessed. Over the last four years, ambient radiation levels at K-1 were found to be generally at the same level as the natural background in the city (Figure 12).

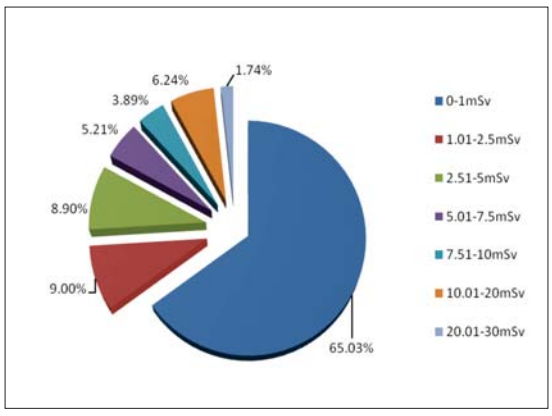


Figure 11: Annual Radiation Doses to K-1 Workers

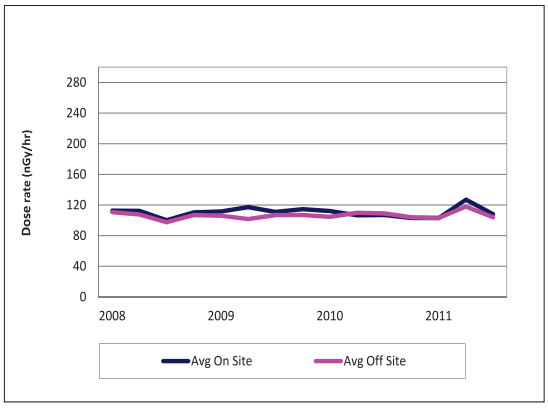


Figure 12: K-1 Onsite and Offsite Average Ambient Dose Level Trend

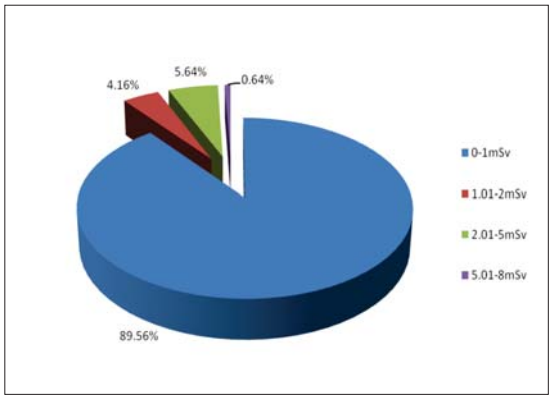


Figure 13: Annual Radiation Doses to C-1 Workers

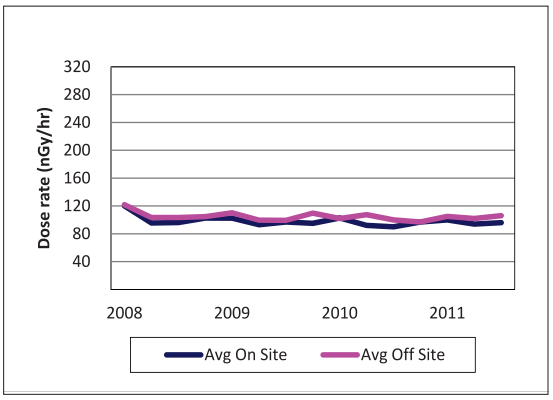


Figure 14: C-1 Onsite and Offsite Average Ambient Dose Level Trend

Chashma Nuclear Power Plant Unit 1 (C-1)

Radiation safety at C-1 is also ensured through review and assessment of the plant's submissions. The annual dose report of C-1 for the previous year was reviewed in detail and radiation exposures to plant workers were assessed. Radiation exposure of all plant workers was found to be well below the prescribed regulatory limits; doses to about 90 percent of workers remained below 1 mSv while dose received by a small fraction (0.64 percent) of workers was in 5–8 mSv range during the reported year (Figure 13).

Ambient radiation levels at C-1 are monitored continuously and compared with the natural background of surrounding cities. Assessment of the past four years' records reveal that ambient dose levels at C-1 are generally at the level of the natural background of surrounding cities (Figure 14).

C-1 performed its seventh refuelling during the reported period. All activities of the refuelling outage (RFO) were closely monitored and evaluated. Dose estimates and ALARA plans were reviewed and verified against previous experiences, actual results and performance. The collective dose received by 1393 radiation workers during this RFO was 483.5 man-mSv against the estimated collective dose of 500 man-mSv. The maximum dose received by an individual during the seventh RFO was 9.169 mSv, which was less than the estimated maximum individual dose of 10 mSv. A

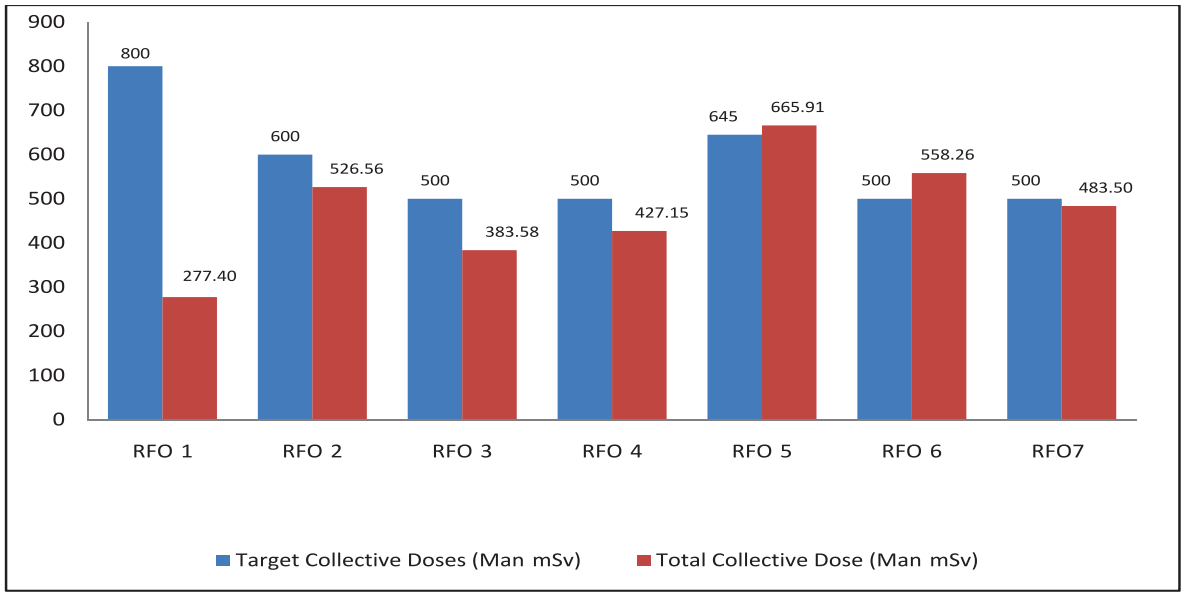
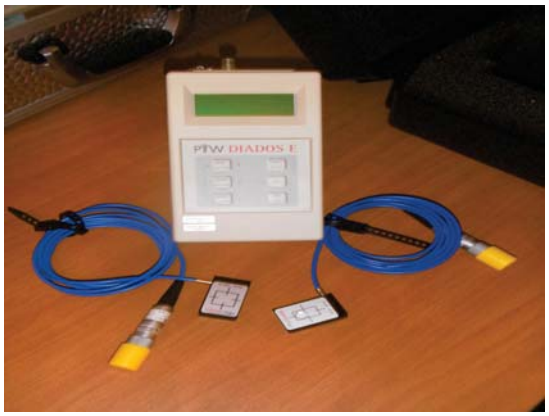


Figure 15: Estimated and Actual Individual Doses During C-1's RFOs

Diagnosis by Gamma Camera at NORI Hospital, Islamabad



Semiconductor Dosimeter for Patient Dosimetry

comparison of the estimated and actual doses received by workers is detailed in Figure 15.

Radiation Safety at Radiation Facilities

It is the responsibility of PNRA to assure that all radiation facilities in the country operate safely so that workers and the public do not face undue risk of radiation exposure and the doses they receive remain within the regulatory limits. The radiation facilities being monitored by PNRA include diagnostic radiology and radiotherapy centres; nuclear medicine centres; industrial radiography services; blood, food and material irradiators; oil well logging units; educational and research institutes using radioactive sources including agricultural research centres, etc.

Licensing of Radiation Facilities

Radiation facilities in the country are authorized to operate only after getting a licence from PNRA. Licences 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. The licences issued to radiation facilities are renewed annually.

All radiation facilities in the country have been licensed by PNRA, except for diagnostic X-ray facilities, a significant number of which still remain outside the licensing net. Appropriate steps are being taken to bring these radiation facilities within the licensing net.

It has also been observed that a number of previously licensed X-ray facilities are not renewing their licences: the default rate among X-Ray licence holders is increasing. By the end of 2011, more than 2190 radiation facilities came into the licensing net.

PNRA Experts with Participants of Training Course at Agha Khan Medical University & Hospital, Karachi

Participants of Training Course Arranged by PNRA for the Users of Nuclear Gauges at Karachi University

Out of these, more than 490 had defaulted by 2011, leaving about 1701 valid licensees. To deal with this increasing trend of defaults, enforcement regulations have been Gazette-notified and enforcement procedure has been prepared. Efforts are now underway to start legal proceedings against defaulters.

During the reported period, 123 new facilities were licensed while 1701 licences were renewed by the three regional directorates of PNRA. Facilities that have ever been licensed during the last eleven years include 61 large medical centres, 145 industrial users, 66 research institutes, 92 importers, 1763 diagnostic X-ray facilities, and 66 other facilities.

Occupational Exposure at Radiation Facilities

PNRA has developed a database of occupational exposure records of workers of the radiation facilities. Radiation facilities are required to submit radiation exposure data of workers involved in radiation work on annual basis. Currently, the database includes dose records of around 7023 radiation workers including 1544 workers in the radiotherapy/nuclear medicine, 1434 workers in the industrial sector, 461 workers in research and education, 3392 in diagnostic radiology and 192 other workers (Figure 16).

The database helps in assessing compliance with regulatory dose limits, control of itinerant workers, and ALARA implementation. According to the record available to date, doses to 95.11 percent of workers remained less than 5 mSv while 4.27 percent of workers received doses between 5-20 mSv. A small fraction (0.61 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

Radiological protection of patients is an integral part of radiation protection at medical facilities. While the concept of dose limitation is not applied in medical exposure, every medical practice involving ionizing radiation is regulated by optimization techniques that balance the patient dose and clinical output. One of the optimization strategies is the evaluation and development of Dose Guidance Levels (DGLs) in diagnostic radiology.

A programme to assess the radiation doses received by patients during diagnostic procedures (radiography, interventional radiology, mammography, cardiac interventions and computed tomography) was initiated in mid-2010

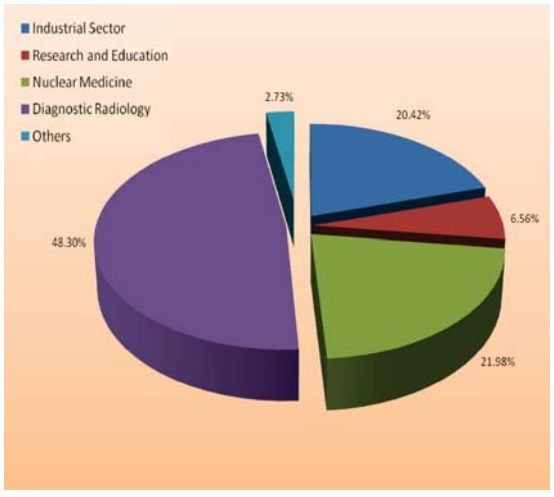


Figure 16: Radiation Workers in Different Activity Types

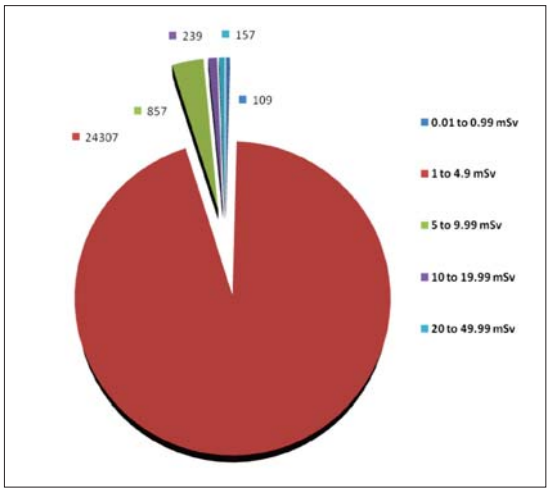


Figure 17: Radiation Workers in Different Dose Ranges

and remained in progress during the reported year. The main objective of the programme was to evaluate the guidance levels, as described in the Regulations on Radiation Protection (PAK/904), for diagnostic medical procedures and to prepare guidelines for optimization of diagnostic and radio-therapeutic procedures. The plan is to be executed in several phases. The first phase involved the procurement of related equipment for experimental work. The next phase is the collection of data from interventional (angiography and angioplasty) and mammographic procedures at different medical facilities in major cities of Pakistan. By the end of the reported period, the equipment had been received and the next phase of the plan, collection of data, was being initiated.

Keeping in view the international trend in incident occurrence in industrial radiography and local working conditions in Pakistani industry, PNRA has undertaken an initiative to certify all radiation workers in industrial radiography. For this purpose, PNRA initiated a programme to arrange training courses for radiographers having Level-1 certificate in Industrial Radiography. By the end of the reporting year, PNRA had conducted eight courses in which around 172 radiographers participated, out of which 115 successfully completed the course.

Inspections of Radiation Facilities

Regulatory inspections of radiation facilities are carried out by PNRA to verify compliance with requirements and provisions of the PNRA Ordinance, regulations made thereunder, and any other conditions imposed by the Authority from time to time.

Periodic inspections of all radiation facilities are incorporated in the Authority's annual inspection programme, and there are provisions for special inspections where required. In accordance with the annual inspection plan for 2011, 2035 inspections of different type of radiation facilities in the medical, industrial, agricultural, research and educational spheres 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 18. Recommendations for improvement and compliance with regulations were communicated to the inspected facilities in inspection reports and these were appropriately followed up for compliance. This regulatory

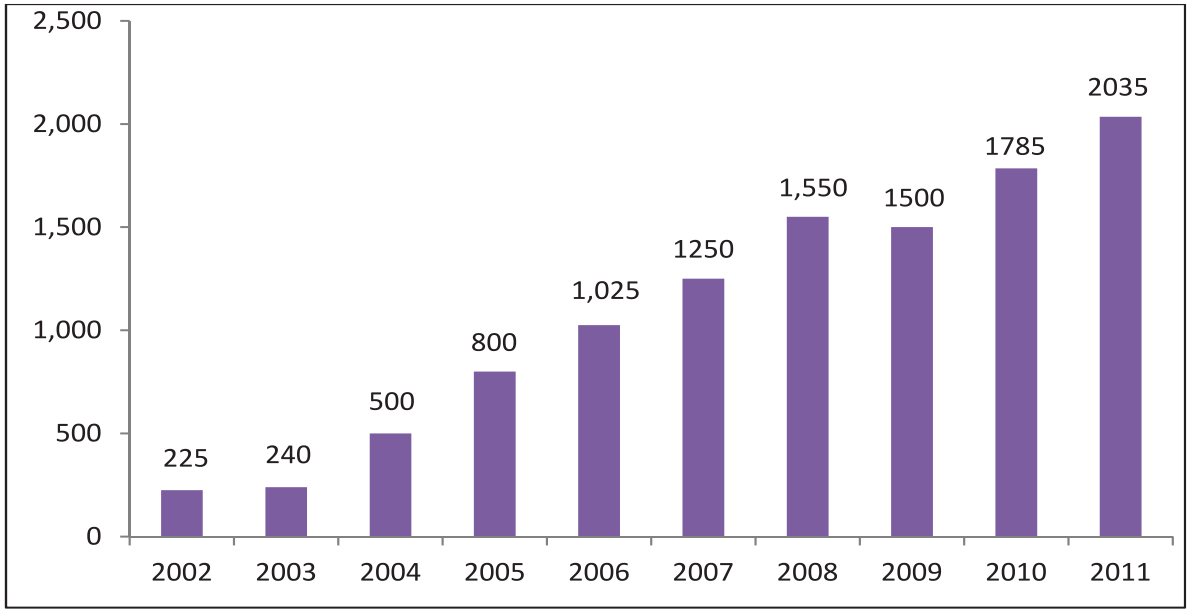


Figure 18: Regulatory Inspections of Radiation Facilities

Teletherapy by LINAC at NORI, Islamabad

Interventional Radiology at Agha Khan University Hospital, Karachi

surveillance led to improvements in the safety of radiation practices.

In addition to the facility design, functioning, work practices and ALARA implementation, adequacy of security measures being taken by licensees during use, transportation and storage of the sources are also assessed by PNRA.

Authorization of Import and Export of Radiation Sources and Generators

National regulations require that all import and export of radioactive sources or generators be authorized by PNRA through a "No Objection Certificate" (NOC). This NOC is issued after verification of the intended end use and the technical specifications of the radiation source or generator to be imported or exported. During the reported period, PNRA issued 701 NOCs. A comparison of NOCs issued during 2011 with those issued during the previous years is given in Figure 19.

Maintaining cradle-to-grave track of all radioactive sources used in the country is also a regulatory obligation of PNRA. Use of sources in different categories is shown in Figure 20.

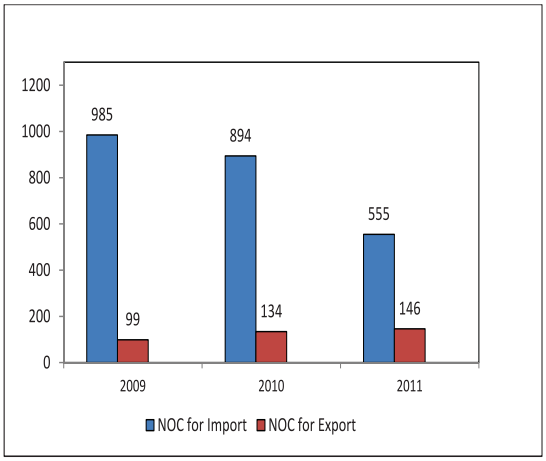


Figure 19: Issuance of NOCs for Import-Export of Radiation Sources and Equipment

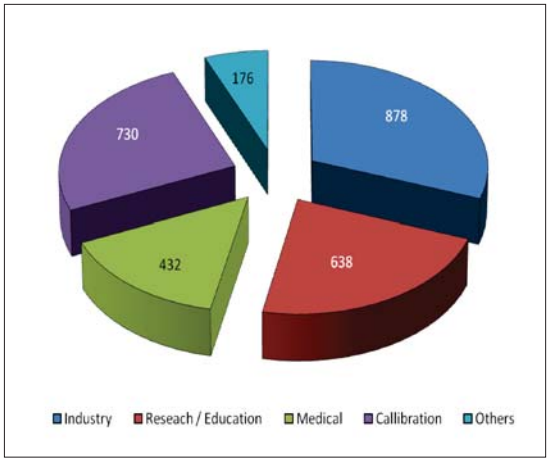


Figure 20: Distribution of Sealed Radiation Sources by Usage

5
WASTE AND TRANSPORT SAFETY

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 thus poses a long-term hazard to human health and the environment. The safe management of radioactive waste is therefore essential to protect the public and the environment from its harmful effects. The long-term safety of radioactive waste cannot be ensured until it has been emplaced in a secure facility.

Regulating the safe management of radioactive waste and safe transportation of radioactive material is 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, inspections and authorization processes.

Radioactive Waste Safety at Nuclear Installations

In Pakistan, the main generators or sources of radioactive waste include the nuclear installations such as C-1, C-2, K-1, and PINSTECH, which houses PARR-I and PARR-II. PNRA ensures that both the activity and the volume of radioactive waste generated at nuclear installations is minimized through suitable design, operation and other measures, and the discharge of radioactivity is kept as low as reasonably achievable so that doses to the public and the environment remain minimal. PNRA also ensures that the operator maintains round-the-clock monitoring of gaseous and liquid effluent.

Karachi Nuclear Power Plant Unit 1

PNRA ensures that K-1 maintains continuous monitoring of gaseous effluents such as tritium, radioiodine, radioactive noble gases and radioactive particulates released through stack, as well as of the liquid effluents discharged to the sea. To keep discharges to the environment within acceptable levels, Derived Release Limits (DRLs) for liquid and gaseous effluents have been established for K-1 and PNRA ensures that the plant's discharges remain well below these limits. The established DRLs are based on 30 percent of the public dose limit (1 mSv) as required under regulations. DRLs for liquid effluent are: tritium, 1.60×10^{9} GBq/year; and beta-gamma, 2.80×10^{3} GBq/year. For gaseous releases, the DRLs are: tritium, 3.0×10^{7} GBq/year; noble gases, 1.40×10^{6} GBq/year; iodine, 4.10×10^{2} GBq/year; and particulates, 2.30×10^{2} GBq/year.

Both the radioactive effluents, i.e., gaseous emissions to the atmosphere and liquid discharges to the sea, remained well below the DRLs during 2011 (Figures 21 and 22).

Solid radioactive waste generated during the

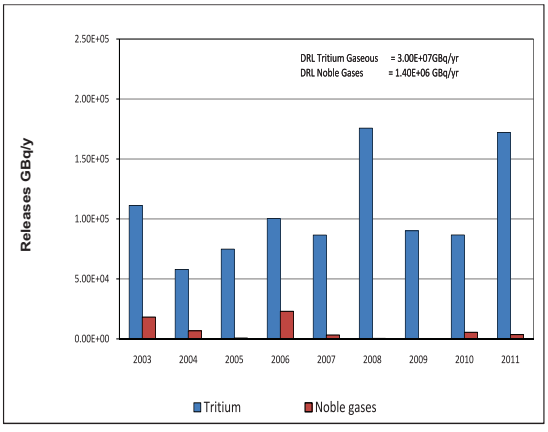


Figure 21: Gaseous Effluents from K-1

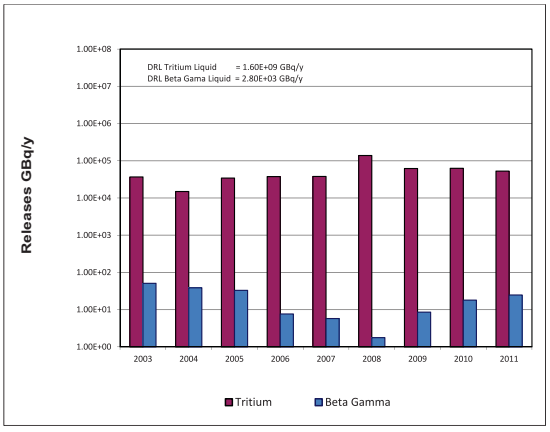


Figure 22: Liquid Effluents from K-1

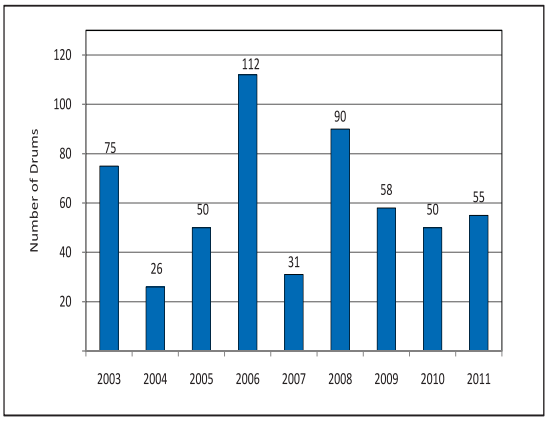


Figure 23: Compacted Solid Waste Generated at K-1

operation of K-1 is stored in compacted drums at K-1. Currently, radioactive waste for about 40 years of operation is stored at K-1, the safety and security of which is ensured by PNRA. On the Authority's directives, K-1 has compiled an inventory of all radioactive waste generated since the start of its operation and provided the data to PNRA.

The number of waste-containing drums added every year at K-1 is shown in Figure 23, while the waste generated during 2011 has not yet been compacted, it is expected that it will fill about 55 drums.

K-1 is in the process of establishing an additional radioactive waste storage facility at its site to increase the available capacity. During the reported period, K-1 also shared its intention to establish a Spent Fuel Dry Storage Facility (SFDSF). Discussions remained under way on the issue of licensing the planned SFDSF and qualification requirements for its concrete cask.

Chashma Nuclear Power Plant Unit 1

PNRA ensures that radioactive waste management at C-1 is in accordance with the Radioactive Waste Management Programme (RWMP) established by C-1 under national regulations.

PNRA routinely monitors the discharges of C-1 and analyses them to ensure that they remain below the limits defined in the plant's technical specifications. Gaseous waste treatment at C-1 includes pressurized storage of the radioactive hydrogenated effluents in hold-up tanks for 60 days until they decay down to a value acceptable for discharge to the environment. Discharge of gaseous waste is allowed to continue if the radioactivity level is less than 10 GBq/m^3. Figure 24 provides the total activity released in gaseous effluents from C-1 since 2001. The discharges remained well below the technical specification limit in 2011 and no abnormal discharges were reported.

The plant's liquid waste is discharged to the river Indus, downstream of Chashma barrage through an eleven kilometers long channel, if its radioactivity level is less than 3.7E05Bq/m^3 (370 KBq/m^3). If radioactivity exceeds this limit, the wastes are collected in three different, independent collecting tanks depending upon their radioactivity level and the nature of their source till the time they decay to the permissible limit. Figure 25 provides the total

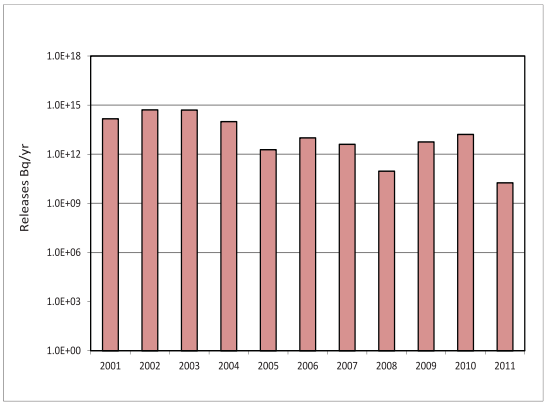


Figure 24: Gaseous Effluents from C-1

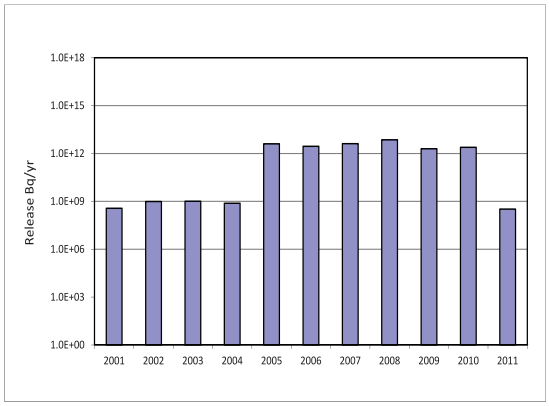


Figure 25: Liquid Effluents from C-1

activity released in liquid effluents by C-1 since 2001. The discharges remained well below the technical specification limits in 2011.

The solid wastes generated at C-1 are compacted and stored in drums in a radioactive waste storage building at the plant. The design capacity of the storage building is for 10 years, corresponding to 1,700 drums for storage of compacted waste and 7,268 drums for storage of solidified waste. The accumulated number of solidified waste storage drums against the available capacity at C-1 is shown in Figure 26.

Availability of sufficient waste storage capacity at NPPs is continuously monitored by PNRA. At the end of 2011, the remaining capacity of compacted drums at C-1 had been reduced to 198 drums only. Under the Operation Licence Condition imposed by PNRA, C-1 plans to establish a Nuclear Power Waste Centre at the Chashma site to provide additional capacity for the storage of radioactive waste to be generated from the operation of C-1, C-2 and future NPPs to be established at the site.

During 2011, C-1 announced its plan to introduce a facility for the treatment of spent resin in its radioactive waste management system and submitted the case for modifications in its system. After review of the proposed modification, comments have been communicated to C-1.

Pakistan Institute of Nuclear Science and Technology (PINSTECH)

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

PNRA ensures that national requirements regarding waste minimization are also met at PINSTECH. Waste management activities at the Institute are

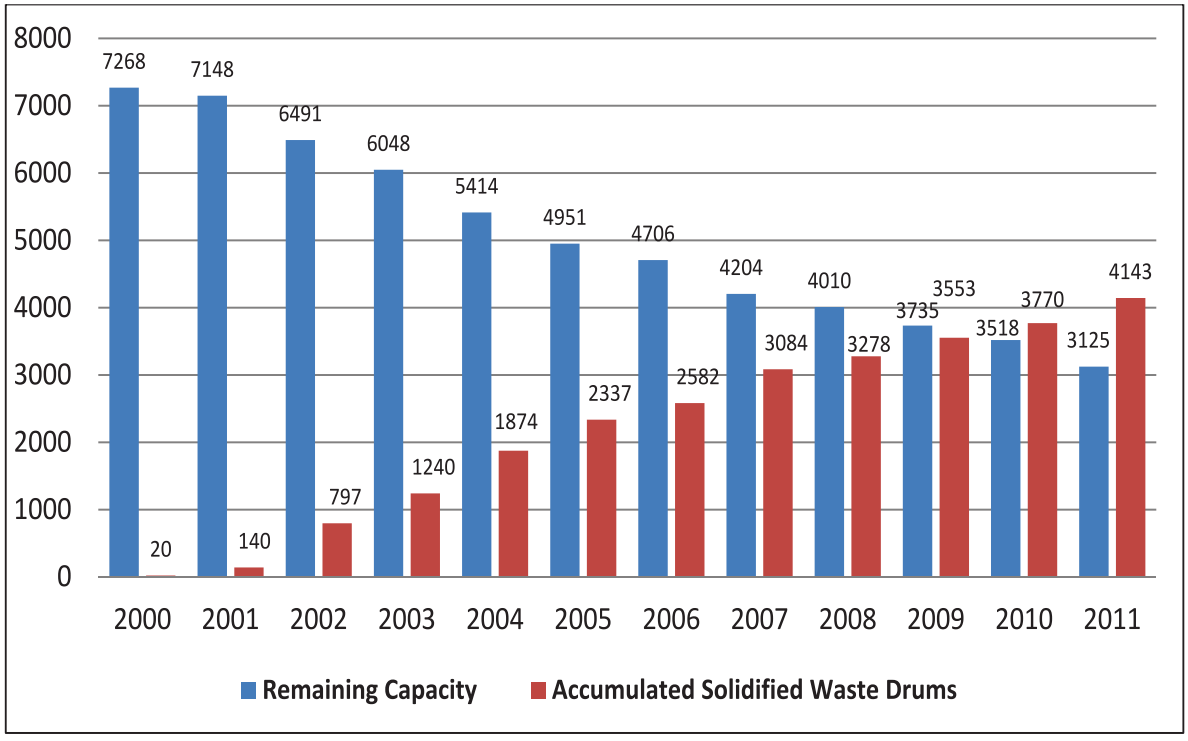


Figure 26: Accumulated Solidified Waste Drums Vs Capacity at C-1

regularly monitored. No deviation from the requirements of national regulations and international standards was observed during the reporting year.

The volume of Low Level Waste (LLW) collected at PINSTECH has varied from year to year. Figure 27 shows the number of cementized and compacted containers of waste produced at PINSTECH during the last nine years.

Government of Pakistan approved a national policy on control and safe management of radioactive waste in February 2011, wherein Pakistan Atomic Energy Commission (PAEC) has been assigned the responsibility for safe disposal of radioactive waste generated as a result of operarion of radiation facilities in the country. PAEC has declared PINSTECH as one of the facility for collection of waste from the northern part of the country and K-1 from the southern part. As a result, PINSTECH has to expand its facilities for radioactive waste.

During 2011, PINSTECH submitted its intention to obtain a separate licence for its existing facility for the pre-disposal management of radioactive waste. PNRA provided guidance on the codes and standards as well as contents and format to be followed in the preparation of the safety analysis report. PINSTECH has prepared the safety analysis report and submitted to PNRA for review and assessment.

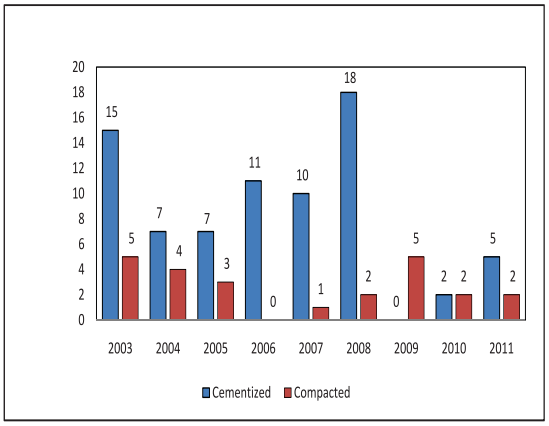


Figure 27: Cementized and Compacted Containers at PINSTECH

Inspections in the Area of Waste Management

In addition to routine inspections, PNRA conducts special inspections of the facilities to verify compliance with regulatory requirements concerning radioactive waste management and with the waste management programme established by the operator. These inspections mainly focus on storage facilities to assess the safety of waste collection, classification, treatment, conditioning and storage.

During the reported period, two such inspections were conducted, one at C-1 and the other at K-1. PNRA found that radioactive waste management processes are being performed safely and in compliance with national regulations. PNRA appreciated the good practices of the licensees. Recommendations were also issued to the operators for further improvement in the implementation of their radioactive waste management programmes.

Management of Disused Sealed Radioactive Sources

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) should only be purchased with an undertaking from the manufacturers or suppliers to accept the return of the sources when they are no longer 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 of 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.

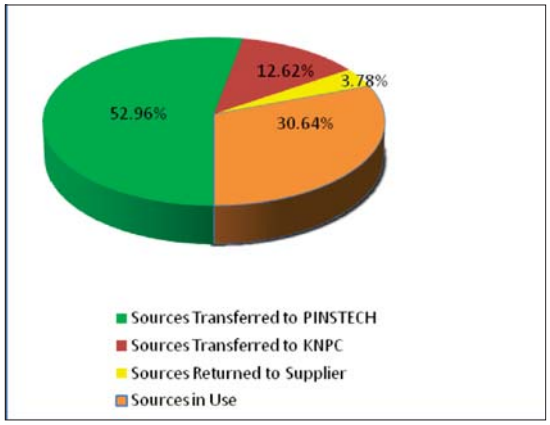


Figure 28: Status of Imported SRS

Figure 28 presents the status of SRS in the country. Out of the total SRS imported into Pakistan, 52.96 percent have been transferred to PINSTECH after the completion of their useful life for storage, 12.62 percent to K-1, and 3.78 percent have been returned to the concerned supplier. The remaining 30.64 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 radionuclides. The respective percentages of different radionuclides in the DSRS stored at PINSTECH and K-1 are shown in Figure 29.

Decommissioning of Nuclear Installations

After a nuclear power plant has completed its productive life, it needs to be decommissioned, i.e., the plant and its systems need to be dismantled and its site decontaminated to a state no longer requiring protection from radiation for the general public and environment. During 2011, specific national regulations on decommissioning (PAK/930) were drafted and circulated to stakeholders for their comments.

K-1 has completed its design life and is now operating under a life extension programme. Its eventual decommissioning is therefore an important concern for PNRA, especially because, as with the decommissioning of all NPPs, it will entail significant monetary resources. K-1 has established a financial mechanism to cope with decommissioning activities, and has revised its decommissioning plan to meet the requirements identified by PNRA.

In line with the approach of planning ahead for the challenges entailed in decommissioning, PNRA has also initiated discussions with C-1 and C-2

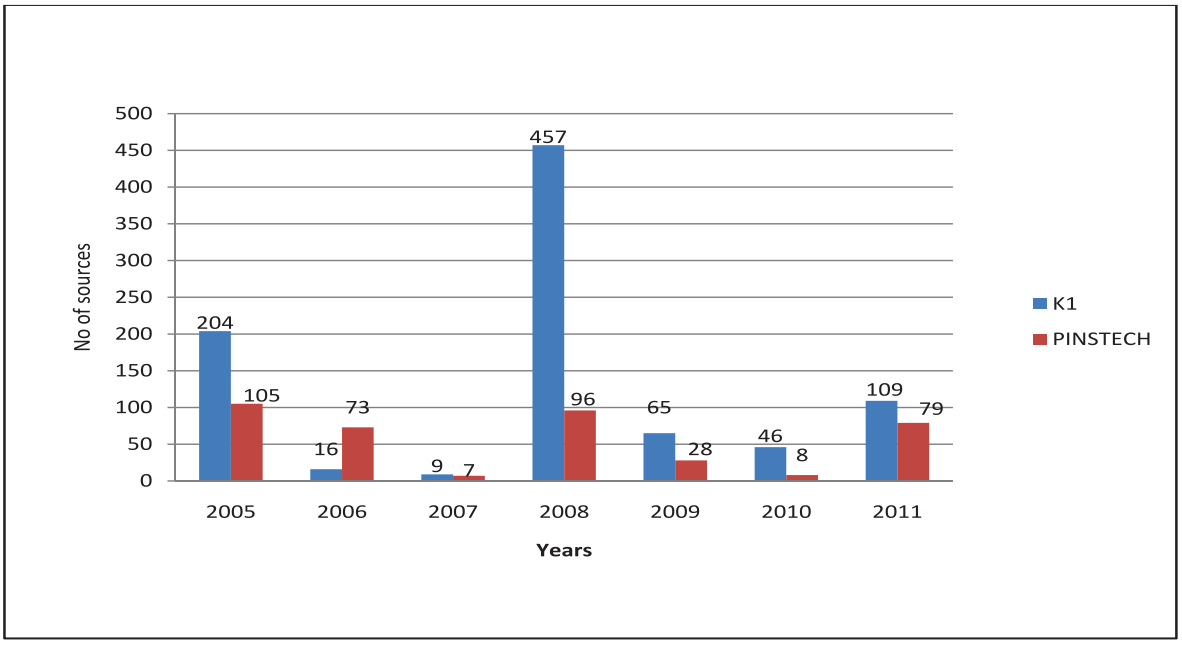


Figure 29: Number of Disused Sources in the Country

regarding their initial decommissioning plans, even though these plants are relatively young.

Safe Transport of Radioactive Materials

In addition to the other nuclear and radiation safety related activities, PNRA also regulates the transportation of radioactive material to protect the public and the environment from the associated hazards. The national regulations on transport of radioactive material are in line with the international requirements. Based on national requirements, technical guidance is provided to various establishments dealing with transportation of radioactive material or radioactive sources, specifically regarding matters such as the transport index, United Nations (UN) number, categorization of packages, content limiting of packages, etc.

PNRA ensures that consignors and carriers fulfill their obligations and comply with the national requirements for safe transportation of radioactive sources within the country. The Authority's regional directorates conduct routine and periodic inspections, some of which are unannounced, to verify that users' activities comply with regulatory requirements. 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.

During 2011, PINSTECH expressed its intention to design and manufacture type B (U) transport packaging for the purpose of transporting Molybdenum-99 (Mo-99) within as well as out of the country. In this regard, PNRA identified and prepared list of codes and standards to be followed, and format & contents, for the preparation of the Safety Analysis Report (SAR) before undertaking the proposed project. PINSTECH, submitted initial information for the design of the proposed packaging. The information is being reviewed by PNRA.

Chairman PNRA and IAEA Experts with the Participants of Training Course on Safety & Security of Nuclear & Radioactive Materials

6 EMERGENCY PREPAREDNESS

Nuclear and radiation facilities are designed and operated by maintaining a very high level of safety with advanced engineered safety features to prevent accidents. Strict regulatory control is exercised throughout the life of such facilities. Nevertheless, the probability of accidents, although quite low as compared to conventional industries, cannot be entirely ruled out. This necessitates preparedness to respond to and mitigate the consequences of any incident that might occur at nuclear or radiation facilities affecting workers, the public or the environment.

PNRA is obliged under the Pakistan Nuclear Regulatory Authority Ordinance, 2001 to ensure preparation and implementation of emergency plans for actions to be taken by the relevant onsite and offsite authorities following a nuclear or radiological emergency.

In this regard, the Authority has issued regulations on management of a nuclear or radiological emergency (PAK/914) which require licensees to have in place emergency plans, the necessary work force, equipment and mechanism for responding to any such eventuality. Licensees are also required to maintain capacity for coordination with offsite response organizations concerned with mitigating the consequences of a nuclear or radiological emergency.

Emergency Plans and Exercises

PNRA reviews and approves the emergency plans of the facilities under its purview to assure that the plans are commensurate with regulatory requirements and executable. PNRA also requires licensees to conduct regular exercises and drills to ensure that their emergency plans are effective and implementable. The frequency of these exercises and drills is agreed upon in the approved emergency plans and they are witnessed by PNRA to assess the licensees' preparedness for executing them as and when required. PNRA also invites representatives from relevant government departments and ministries to witness some of these exercises or drills at nuclear installations.

During the reported period, PNRA reviewed the revised onsite emergency plans of C-1 and C-2, and recommended some modifications in these plans. PNRA also reviewed the Radiological Emergency Plan for PARR-I at PINSTECH and offsite recovery plan of K-1. PNRA witnessed K-1 and PARR-I annual emergency exercises to verify the implementation of their emergency plans and procedures.

PNRA has developed and issued guidelines for preparation of emergency and radiation protection plans for facilities using nuclear gauges. PNRA has also reviewed emergency plans of a number of radiation facilities, including radiotherapy and nuclear medicine centres, various industries and research institutes, and recommended improvements. Emergency drills of some industries using radioactive sources were also witnessed during the reported year.

National Radiation Emergency Coordination Centre (NRECC)

The National Radiation Emergency Coordination Centre, based at the PNRA Headquarters in Islamabad, is responsible for coordinating the response to nuclear accidents or radiological emergencies and functions round-the-clock. NRECC is equipped with the necessary communication facilities, Mobile Radiological Monitoring Laboratory (MRML), and various types of radiation detection and personal protective equipment. During the reported year, the capabilities of NRECC were enhanced by equipping it with advanced radiation monitoring equipment procured with the assistance of IAEA.

NRECC is Pakistan's designated National Warning Point (NWP) under the IAEA Conventions on "Early Notification of a Nuclear Accident" and "Assistance in the Case of a Nuclear Accident or Radiological Emergency". In this role, it is responsible for notifying the competent authorities, both domestic and foreign, including the IAEA, about any nuclear accident or radiological emergency in the country,

Ms Anita Nillson from IAEA Observing the Field Exercise on Source Search and Recovery

PNRA Technical Support Meeting During Emergency Exercise

and for receiving and responding to similar information about nuclear accidents in other countries. Moreover, NRECC is the national contact point under the Response Assistance Network (RANET) established by IAEA under the International Convention on Assistance in case of Nuclear Accident or Radiological Emergency. RANET is an integrated system in which Member States register and pool their capabilities to detect, measure, respond to or mitigate radiological emergencies and, when required, any Member State can request or offer assistance. Pakistan registered its National Assistance Capabilities (NACs) in different areas of response in 2008. In 2011, the RANET scope and areas of assistance were revised by IAEA. In response, NRECC has also revised its offer for assistance to the Member states. During the reported year, PNRA participated in a RANET meeting in Vienna for the preparation of a field manual to be used by RANET field assistance teams.

NRECC conducts different types of emergency exercises, including the Communication Test Exercise (COMTEX), in which the availability of communication channels with licensees and regional directorates of PNRA is verified; the MRML exercise, which tests the capability to respond to a request for assistance in an event involving radiation monitoring; and field exercises. During the reported period, NRECC conducted three COMTEX exercises and two MRML exercises.

NRECC also participates in exercises and drills conducted by licensees, as well as Convention Exercises (ConvEx) conducted by IAEA under international conventions. The ConvEx exercises focus on verification of international communication channels and the capability of Member States to evaluate and respond to different radiological accidents. NRECC participated in two Convention exercises in 2011.

IAEA conducts Emergency Preparedness Review (EPREV) missions to appraise emergency preparedness of Member States, including onsite, offsite and national response arrangements. On PNRA's request, IAEA conducted emergency preparedness review of NRECC during 2011. The mission comprised experts from IAEA, Slovakia and Hungary. The experts highlighted gray areas in emergency preparedness and response arrangements for further improvements.

Response to Nuclear Accident in Japan

On 11 March 2011, an earthquake measuring 9.0 in the Pacific Ocean generated a tsunami that was 14-15 meters high when it hit eastern Japan. As a result of the earthquake and tsunami, Fukushima Nuclear Power Station (NPS) lost all power sources resulting in a nuclear accident and subsequent release of radioactivity into the environment.

In response to this accident, NRECC was activated and manned round-the-clock to maintain a close watch on the evolving situation in Fukushima and study its possible consequences. NRECC received frequent updates from IAEA as well as associated

websites of Japanese and other international organizations and was continuously analyzed. With the consent of the Government of Pakistan, PNRA offered assistance to Japan through RANET in the areas of radiation monitoring, search and recovery of radiation sources, environmental measurements and assessment, and advice on emergency response.

In order to assess any buildup in natural background radioactivity levels in Pakistan due to the Fukushima accident, PNRA started air sampling at different locations including Islamabad, Karachi, Lahore, Kundian, Peshawar, Bahawalpur and Quetta. However, no abnormality was observed. To further ensure public protection, PNRA coordinated with Pakistan Customs and recommended a restriction on import of bulk amounts of edible goods from Japan without monitoring.

In addition, PNRA directed its licensees to re-evaluate and strengthen emergency preparedness and response arrangements by considering a scenario of severe disaster conditions leading to unavailability of necessary infrastructure, such as (bridges, roads, communication means, etc. Licensees were asked to demonstrate implementation of emergency plans, especially the evacuation aspects by involving the public in their exercises.

Furthermore, PNRA directed its licensees to re-evaluate the adequacy of the Emergency Planning Zones (EPZs) around their installations. A committee was also formulated at PNRA to study the adequacy of existing EPZs.

Training of First Responders to a Radiological Emergency

The training of those responding within the first few hours of a radiological emergency is very important to avoid the spread of contamination and overexposure to radiations. In 2011, PNRA in coordination with Rescue 1122, arranged eight training sessions at Rescue 1122 Rawalpindi Station and Police College, Sihala. More than 2,600 first responders participated in these training sessions. The main training topics concerned awareness about radiological emergencies, potential sources of radiological emergency, radiation identification processes, response concepts, response strategies, personal and public protection, etc.

Training of Medical Professionals in Handling of Radiation Injuries

A medical professional may be the first person to diagnose a radiation induced injury. Yet, the medical community is seldom aware of the precautions necessary for the management of exposed or contaminated persons. To address this issue, PNRA formulated a committee consisting of representatives from PNRA, PAEC and other related organizations in 2005 to develop national capabilities for handling and management of overexposed and contaminated individuals. The committee focuses special attention on training of medical professionals in the management of overexposed and contaminated individuals following radiation accidents. During 2011, special seminars on the treatment and management of contaminated or overexposed individuals were conducted by PNRA at government and private hospitals in Islamabad, Rawalpindi, Lahore, Multan, Bahawalpur, Hyderabad and Karachi. More than a thousand medical doctors and paramedical staff participated in these seminars.

Participants of Training Course by PNRA on Radiation Emergency Management Including Contamination, Treatment, etc. in Civil Hospital Karachi

7
PUBLIC SECTOR DEVELOPMENT PROJECTS

The Government of Pakistan approved six Public Sector Development Programme (PSDP)–funded projects for the capacity building and strengthening of PNRA. A summary of these projects is given below:

S. No.	Name of Project/Approval Status	Total Cost (PKR million)	Duration
1	Institutional Strengthening and Capacity Building of PNRA Regarding Regulatory Activities Related to Licensing of NPPs (Centre for Nuclear Safety)	480.00	2005–2011
2	Capacity Building of PNRA to Implement National Nuclear Security Action Plan (NSAP)	497.00	2006–2013
3	PNRA's School for Nuclear and Radiation Safety (SNRS)	413.00	2006–2012
4	Establishment of National Dosimetry and Protection Level Calibration Laboratory (NDCL)	292.00	2007–2013
5	National Programme on Environmental Radioactivity Surveillance: Islamabad, Kundian, Karachi (NERSP)	263.00	2007–2013
6	Safety Analysis Centre (SAC) to Provide Regulatory Support and for Indigenization of NPP in Pakistan	463.00	2010–2015

These projects are briefly discussed in the following sections.

Centre for Nuclear Safety (CNS)

PNRA initiated the Institutional Strengthening and Capacity Building Project in June 2005; this was completed in mid-2011. Under this project, PNRA established a Technical Support Organization (TSO), called the "Centre for Nuclear Safety" (CNS), in order to provide technical support to PNRA in safety assessments of licensee submissions and inspections for the C-2 project in particular and future NPP projects in general. The project has not only accomplished its primary task regarding technical support to C-2 licencing , but also played a vital role in strengthening PNRA by supplying it with skilled and trained professionals for present as well as future needs.

CNS has recruited and trained 55 professionals who are responsible for the review and assessment of NPPs' safety reports, such as safety analysis reports, periodic safety review reports, design modifications, etc. CNS officers are also responsible for safety research and development in the areas of deterministic and probabilistic safety analysis, stress analysis, structural analysis, materials science, accident analysis, radiological hazard analysis, etc., which form the basis of regulatory decisions. CNS is providing technical support to PNRA's technical directorates in the review and assessment of various submissions of licensee and inspections of nuclear facilities and activities within the country and abroad during manufacturing of safety equipment. CNS is thus an important element of PNRA's indigenous capability for effectively and efficiently regulating the country's nuclear industry. The growing role of CNS signifies that PNRA has substantially decreased its reliance on experts of foreign countries in the assessment of NPP safety.

The performance of CNS is continuously monitored by the Planning and Development Division of the Government of Pakistan. The Planning Division has expressed appreciation of the initiatives and achievements of CNS against various milestones, and termed CNS a "model project".

During the reporting period, CNS independently performed the review and assessment of the Preliminary Safety Analysis Report (PSAR) for C-3 and C-4. In addition to this major activity, the following tasks were performed during 2011:

Chairman, Members and Senior Officials on PNRA's 10 Years Celebration Day

- Safety review of dry cask spent fuel storage facility planned to be built at K-1;
- Determination of radiological consequences of C-1 in collaboration with Pakistan Institute of Engineering and Applied Sciences (PIEAS), Islamabad and Nuclear Institute for Agriculture and Biology (NIAB), Faisalabad;
- Stress analysis of C-2 containment;
- Steady state analysis of C-3/C-4 fuel rod performance analyses;
- Analysis of severe accident scenarios in the wake of Fukushima accident;
- Steady-state thermal hydraulic analysis of PARR-I;
- Steady-state and transient analyses of PARR-I;
- Analysis of fuel failure under severe loss of coolant accident;
- Started to develop independent regulator's Level-1 Probabilistic Safety Assessment (PSA) Model for C-1;

A View of the Audience during the Closing Ceremony of CNS

- Training of PIEAS faculty members in the use of PCTRAN and MACCS computer codes;
- Development of a database for events at NPPs in Pakistan;
- Verification of atmospheric dispersion at Chashma site;
- Re-evaluation of emergency planning zones; and
- Testing of Soft Panel Simulator.

This project was completed in June 2011. PC-IV of this project has been submitted to the Planning Commission of Pakistan for evaluation. Subsequently, the manpower of this project will be absorbed in PNRA and CNS will become a regular directorate of PNRA.

Nuclear Security Action Plan (NSAP)

The "Implementation of Nuclear Security Action Plan (NSAP)" project was initiated in 2006 to develop a sustainable system of prevention, detection and response to incidents related to nuclear security. The project was originally planned for over five years, and this period was completed in mid-2011. Most of the activities planned under the project have been completed. However, a few major activities could not be completed due to the release of insufficient funds from the Government of Pakistan. Therefore, the project had to be extended for a further period of two years, i.e., until June 2013.

The main focus areas of NSAP, and the progress achieved are outlined in the following sections:

Chairman PNRA Addressing the Participants of National Train the Trainers Course on Security of Radioactive Sources

Nuclear Security Training Centre

The Nuclear Security Training Centre (NSTC) is currently housed at PNRA Headquarters. Construction of the NSTC building has been completed and furnishing is in progress. NSTC is expected to shift to its own building in early 2012.

NSTC has been conducting training courses in the areas of nuclear security, i.e., prevention, detection and response, since 2006. About 361 officials from different organizations were trained through eighteen training courses in 2011 (Figure 30). To enhance the capacity of Pakistan Customs for combating illicit trafficking of nuclear and other radioactive materials, five training courses were organized, under which 102 officers were trained.

In addition to training services, NSTC is also gearing to provide various laboratory services required for the efficient and sustainable maintenance of nuclear security. In this regard, the following laboratories are being established within the NSTC:

- **Radiation Detection Equipment Laboratory:** State-of-the-art Radiation Detection Equipment (RDE) laboratory has been established at NSTC for training as well as providing support in the field of nuclear security. A Mobile Expert Support Team (MEST) has also been developed to support Front Line Officers (FLOs) at the country's borders and PNRA's regional offices in operation and maintenance of equipment already supplied by NSAP during the previous years.

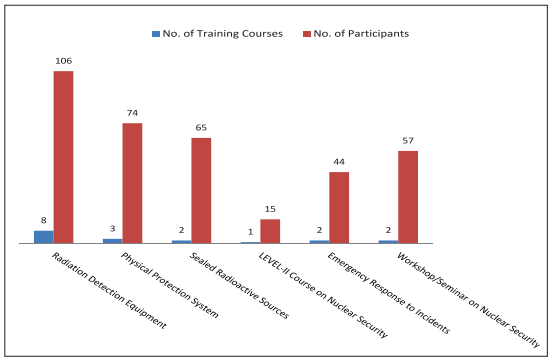


Figure 30: Training Courses Conducted by NSTC During 2011

- **Repair and Maintenance Laboratory:** A repair and maintenance laboratory has been established for preventive maintenance of radiation detection equipment so it can be used sustainably at the national level.
- **Physical Protection Laboratories:** The physical protection laboratory contains intrusion detection system, access control system, close circuit TV display centre, physical barriers test bed, and a fences test bed. This laboratory will be used for providing training to the officials responsible for security of various installations.

Based on the broad spectrum of NSTC training courses and state-of-the-art laboratories in the area of nuclear security, this centre will ultimately become a Center of Excellence for providing services at national, regional and global level for sharing knowledge and expertise.

Nuclear Security Emergency Coordination Centre (NuSECC)

The Nuclear Security Emergency Coordination Centre (NuSECC) has been established under the NSAP project to facilitate coordination among government agencies and respond to different incidents and emergencies pertaining to nuclear security. NuSECC also provides training to front line officers, first responders and law enforcement agencies to enhance their ability and build their confidence to take appropriate measures to protect themselves and the public while managing an emergency that involves radioactive materials or radiation. A round-the-clock, toll free emergency telephone helpline **(0800 777 66)** is being maintained for this purpose.

NuSECC maintains emergency mobile laboratories in PNRA's regional directorates and inspectorates in Islamabad, Kundian, Karachi, Peshawar, Quetta and Multan. These facilities have the capacity and capability for radiation assessment, identification and recovery of radioactive materials, and contamination monitoring of public and workers at the scene.

During 2011, NuSECC and NRECC participated in an International Nuclear Emergency Exercise (INEX-4) conducted by Nuclear Energy Agency (NEA), Organization for Economic Cooperation and Development (OECD), France. Key objectives of the exercise were to test and investigate the adequacy of national and international arrangements for, and issues in, consequence management and transition to recovery in response to a malicious act involving a radiological dispersion device in an urban environment; identify good practices; share information on different approaches; and provide a basis for improvements in the emergency management system. As per the format of the exercise, a national level table-top exercise was conducted by PNRA and representatives from different organizations, including the National Disaster Management Authority, Strategic Plans Division, Ministry of Foreign Affairs, Pakistan Atomic Energy Commission, Pakistan Institute of Medical Sciences, Directorate of Emergency Disaster Management, Capital Development Authority, Islamabad Local Police, Islamabad Traffic Police, Emergency Services Rescue 1122 participated in this exercise. The exercise evaluation questionnaire and lessons learned were shared with NEA, OECD.

Locating and Securing of Orphan Sources

Lost, abandoned, or stolen radioactive sources for which the owner cannot be identified are called orphan sources. These sources may pose a threat to the public and the environment by falling into the unsafe and insecure hands. One of the objectives of NSAP is to provide the public an environment free of orphan sources. To achieve this objective, NSAP has developed processes for locating and securing orphan sources. Countrywide physical and non-physical searches for orphan sources are being conducted. The search for orphan sources is a long-term and continuous process. During the reporting period, fifty five physical searches were conducted. However no orphan source was identified or recovered during the reported period.

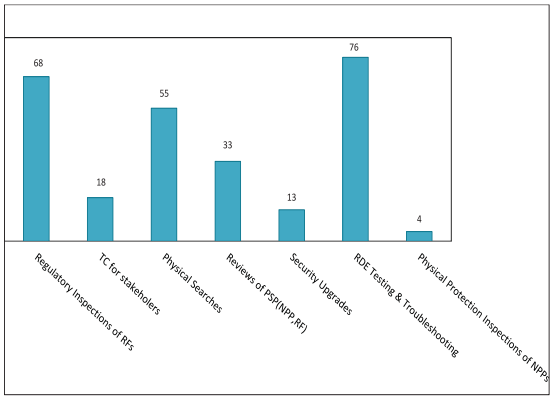


Figure 31: NSAP Activities in 2011

Installation of Radiation Portal Monitors

With the assistance of IAEA, PNRA has initiated a plan for installation of a Radiation Portal Monitor (RPM) at PNRA Headquarters for training purposes. One such monitor is also being installed at the Islamabad Dry Port for monitoring the import and export of goods.

Major activities performed during the reported period include the following:

- Regional Nuclear Security Inspectorate-II was established at Multan;
- The regional directorates and inspectorates conducted sixty eight (68) inspections to assess and evaluate the security measures of radiation facilities using high-activity SRS;
- The physical security plans of thirty three (33) radiation facilities using SRS in category 1-3 were reviewed, and feedback was provided through the respective regional directorates; and
- Security upgrades of the PNRA Headquarters building were initiated and completed.

Key activities conducted under NSAP in 2011 are summarized in Figure 31.

PNRA School for Nuclear and Radiation Safety (SNRS)

The licensing and supervision of nuclear power plants, research reactors, and radiation facilities is a

Physical Protection Systems Used for Training

Lecture on Radiation Safety at Lotte PPTA, Karachi.

critical and challenging task for the regulatory body in any country. Among the key issues is maintaining a sufficient number of highly skilled professionals, with appropriate academic qualifications and adequate experience, for regulatory supervision. The PNRA School for Nuclear and Radiation Safety (SNRS) project is aimed at developing the indigenous work force required for regulatory activities. This project was initiated in 2006 and was expected to be completed in June 2010. However to conduct the activities which could not be completed due to scarcity of resources, this project has been extended until June 2012.

The school imparts knowledge and skills to newly recruited officers and conducts refresher courses for existing staff. SNRS has also initiated training for other stakeholders who have a role in maintaining radiation safety in the country and whose professional training is therefore important. All modern gadgets are available in the classrooms of SNRS. The laboratories are equipped with the necessary tools, a soft-panel training simulator, physical models of nuclear power plant equipment, and various computer softwares to assess the safety of nuclear installations. A non-destructive testing (NDT) laboratory has been established where PNRA inspectors can learn about NDT activities at NPPs and manufacturing facilities.

SNRS conducted nineteen (19) training courses along with twenty four (24) special lectures during 2011. A total of 2821 participants from PNRA, PAEC and other stakeholder organizations, along with students from different universities, participated in these events (Figure 32 and 33).

During the reported period, SNRS is in the process of developing virtual 3D modelling of NPP equipments. Virtual modelling is a powerful tool for training: it enables trainees to "see" three-dimensional views of the parts, cross-sections, cladding, assemblies, etc. of NPP components and therefore enables them to develop a clearer and

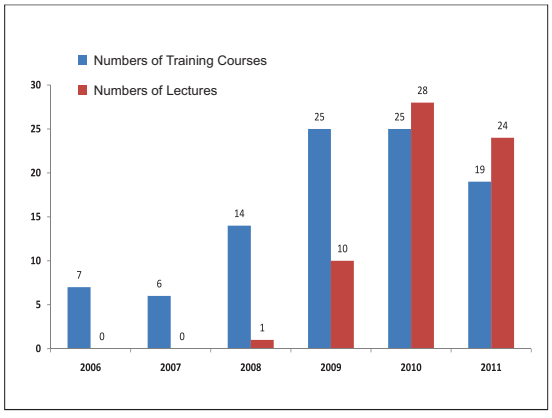


Figure 32: Training Courses and Lectures Conducted by SNRS

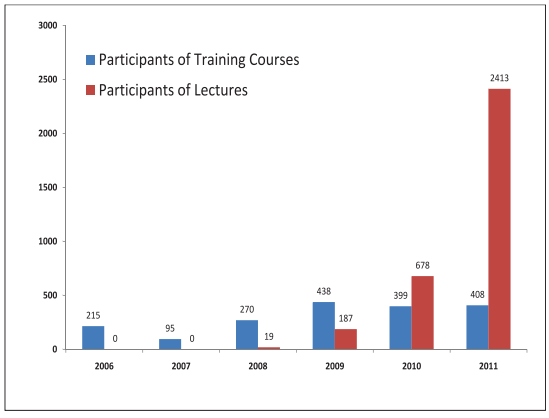


Figure 33: Summary of Participants in Training Courses and Lectures

deeper understanding of the major equipments and systems. The Pro-E Wildfire 4.0 software is employed for 3D modelling, assemblies and animations.

In addition, physical cut-away models of the main equipments of PWR were designed and developed at reduced scale through the China Nuclear Power Operation Technology Corporation (CNPO). This tool was developed for use in trainings to increase participants' understanding of the internal structures, functions and working of major mechanical components of the Reactor Coolant System.

SNRS has focused special attention on research and development (R&D) work along with teaching and training. During 2011, the following research papers were presented in various international conferences:

- "Seismic analysis of reactor building including the soil structure interaction" – presented at the International Conference on Earthquake Engineering and Seismology held at National University of Sciences and Technology (NUST), Islamabad; and
- "Assessment of Knowledge Domains of PNRA for their Maturity and Criticality: A Case Study" – submitted for presentation at the First (IEEE) International Conference on Engineering Management (ICEM 2012), Challenges and Opportunities in Engineering Management, to be held at NUST, Islamabad in 2012.

During the reported period, commissioning of the limited scope soft panel training simulator, developed with the help of CNS and PAEC, remained in progress. This simulator would be used to train manpower and to carry out safety analysis.

National Dosimetry and Protection Level Calibration Laboratory (NDCL)

Presently, nuclear power plants provide radiation exposure assessment (dosimetry) services to their own workers while PINSTECH in Islamabad and the Karachi Institute of Radiotherapy and Nuclear Medicine (KIRN) provide this service to their own workers as well as other radiation workers in the private sector. As the number of radiation workers in the country is increasing with greater use of radiation sources and equipment, the currently available dosimetry services are insufficient. To help meet the rising demand, a project for the establishment of a National Dosimetry and Protection Level Calibration Laboratory (NDCL) was approved in 2007. This facility will provide internal and external dosimetry services as well as protection level calibration services to radiation facilities and radiation workers in the country.

NDCL laboratories are currently being established in Karachi, Islamabad and Kundian. Construction of the laboratory in Karachi has been completed and equipment is being installed. Land has been acquired for the laboratories in Islamabad and Kundian, and their construction plans are being finalized. However, due to paucity of releases, the construction work could not be started at Islamabad and Kundian.

During the reported year, testing and calibration of equipment at Karachi remained in progress. It is expected that the laboratory at Karachi will be made functional by the end of 2012.

National Environmental Radioactivity Surveillance Programme (NERSP)

PNRA has the responsibility to ensure that the

Gamma Spectrometry System

Collection of Soil Sample

Collection of Air Sample

public is protected from any build up of environmental radioactivity in the country. The National Environmental Radioactivity Surveillance Programme (NERSP) is aimed at enhancing PNRA's capabilities for monitoring environmental radioactivity, evaluating any buildups of radiation, assessing the doses being received by the public, and verifying the environmental data provided by NPPs. The programme is being implemented by PNRA and entails systematic measurement of radioactivity in soil, air, water, flora and fauna throughout the country.

Under this project, three laboratories will be established at Islamabad, Karachi and Kundian. During the reported period, two main equipments Gamma Spectrometry System (GSS) and Liquid Scintillation Analyzer (LSA) have been installed in the laboratory at Karachi and it is expected that it would be made functional during next year. A GSS and LSA have been installed at PNRA HQs Islamabad on temporary basis to analyze low-volume air samplers.

PNRA has started to collect soil samples from around the country to establish the baseline background activity level. During the reported period, seventy three (73) soil samples from 19 districts, forty two (42) soil samples from sites around the nuclear power plants and thirty eight (38) samples of soil, sediments, water and oil from five OGDCL sites were collected for analysis.

Safety Analysis Centre (SAC)

Safety Analysis Centre is a Technical Support Organization (TSO) to provide technical support in safety analyses for NPPs to both regulators and operators without compromising regulatory independence. The project is under the Public Sector Development Programme of the government which was approved in September 2009; however, actual work on the project was initiated in 2010 due to delayed release of funds. The major areas of work of SAC include deterministic and probabilistic safety analyses, structural and seismic analysis, etc. Significant activities performed at SAC during the reported period are as follows:

(i) Preparation of databases engineering handbook required for safety analysis;
(ii) Performed background thermal hydraulic analysis for development of Symptom Based Emergency Operating Procedures (SEOPs) for Design Basis Accident (DBA) and Beyond Design Basis Accident (BDBA);
(iii) Developed severe accident model for development of Severe Accident Management Guidelines (SAMGs);
(iv) Performed containment analyses of NPPs;
(v) Developed analytical capabilities for pressurized thermal shock analysis;
(vi) Developed PNRA desktop simulator; and
(vii) Established quality management system for SAC.

8
NATIONAL AND INTERNATIONAL COOPERATION

PNRA recognizes the importance of cooperating with national and international stakeholders in the performance of its regulatory functions, and in the capacity development of all stakeholders to ensure safe operation of nuclear and radiation facilities.

At the national level, PNRA interacts closely with the Pakistan Atomic Energy Commission, and with other national regulators, including Oil and Gas Regulatory Authority (OGRA), Pakistan Telecommunications Authority (PTA), Public Procurement Regulatory Authority (PPRA), Civil Aviation Authority (CAA), and the National Electric Power Regulatory Authority (NEPRA), in safety and regulatory activities in the country. In addition, linkages are maintained with national universities and academic institutes of international repute to keep abreast with current national and international research and development activities.

At the international level, PNRA works with various institutions under bilateral and multilateral cooperation programmes. PNRA assists the Government of Pakistan in fulfilling all of its obligations under the four international conventions pertaining to nuclear and radiation safety to which Pakistan is a signatory. In addition, the Authority continues to avail technical capacity building opportunities with IAEA, actively extends cooperation for international peer reviews, and provides experts for international regulatory missions when requested by IAEA.

National Linkages

Relations with Licensees in International Affairs

PNRA maintains a relationship of mutual respect and trust with all its stakeholders, including its licensees. A dedicated Advisory Committee on Improving Utility-Regulatory Interface (ACIURI) exists to resolve issues arising due to any reason.

In 2011, apart from routine regulatory activities, PNRA remained involved in many public awareness and education and training activities for licensees. One hundred and thirty three PAEC officers and one hundred thirty five officials from other stakeholder organizations participated in training courses conducted by PNRA's School for Nuclear and Radiation Safety.

Collaboration with National Academic Institutions

PNRA strives for continuous improvement of its regulatory performance and, in this regard, has initiated a number of collaborative programmes with prestigious national academic institutions.

PNRA is in an agreement with Chashma Centre for Nuclear Training (CHASCENT) for the sharing of resources such as training facilities, expertise, training materials, research and development, etc. The PNRA School for Nuclear and Radiation Safety shares resource persons with the Pakistan Institute of Engineering and Applied Sciences (PIEAS) for various training courses and the MS programme.

Under another cooperative initiative, a limited-scope soft-panel training simulator was developed with technical support from PAEC and installed at PNRA. Testing and commissioning of this simulator is being conducted jointly by PNRA and PAEC.

Seven officers were awarded fellowships for MS degrees in nuclear engineering at PIEAS and KINPOE this year. Nine (9) officers were allowed to undertake higher studies leading to MS and Ph. D degrees in national and international universities

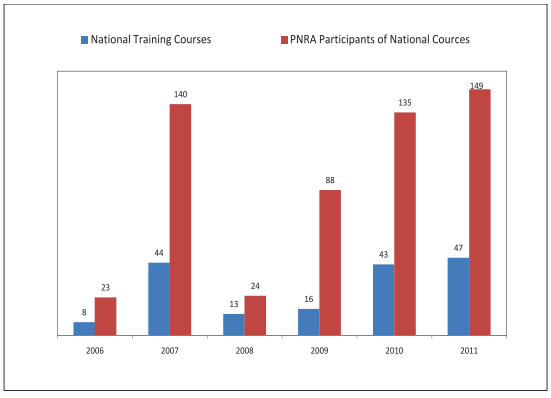


Figure 34: Training Courses and Participants in Various National Institutes

other than PIEAS and KINPOE. In addition, 149 PNRA officials participated in 47 courses at different national institutes. A year-wise comparison of training courses arranged in different national institutes is provided in Figure 34.

Relations with the Public

As a general practice, PNRA keeps the public informed about its activities. Its website, www.pnra.org, serves as a continuous source of updated information for the public.

In addition, PNRA ensures that the facts of any significant event at nuclear and radiation facilities are communicated to the public through timely press releases. Various means are used to educate the public regarding the most relevant aspects of nuclear and radiation safety.

For the awareness and instructions of first responders to a radiological emergency, as well as the guidance of the general public, PNRA has prepared information materials, including brochures and booklets, regarding rescue activities, control of contamination spread, and protection during response to a radiological emergency. These materials are provided to participants and may also be distributed during an emergency.

Various lectures on the use of radiation for diagnostic and treatment purposes, consequences of over exposure to radiation and preventive measures are delivered at institutes and hospitals to create awareness of the general public and workers.

SNRS arranges lectures at universities and other educational institutions in order to make them aware of the applications of ionizing radiations in everyday life, associated hazards, and means of protection. Since March 2011, the school has delivered numerous lectures on the accident at Fukushima Daiichi Nuclear Power Stations, Japan, to apprise various universities and other concerned institutions of the nature of the accident and its radiological consequences.

International Cooperation

Fulfilment of Obligations

PNRA ensures that Pakistan fulfils its international obligations under the four international conventions to which it is a signatory, including the Convention on Nuclear Safety, Convention on Early Notification of a Nuclear Accident, Convention on Assistance in Case of Nuclear Accident or a Radiological Emergency, and Convention on Physical Protection of Nuclear Materials, as well as the Code of Conduct on the Safety and Security of Radioactive Sources. In this connection, PNRA represents the country at related international forums.

During the reported period, Pakistan, along with other member states, submitted its fifth national report on nuclear safety to IAEA under the Convention on Nuclear Safety (CNS). Under the IAEA review mechanism, these reports are reviewed by member states. On behalf of Pakistan, PNRA and PAEC reviewed the national reports of various countries, and responded to the questions raised by member states on Pakistan's report. PNRA led the Pakistan delegation in the Fifth Review Meeting of CNS.

Bilateral and Multilateral Cooperation

It is widely recognized that international cooperation and networking among nuclear regulatory bodies and other concerned organizations is essential for the safe and secure development of the nuclear industry and for the capacity building of young engineers and scientists worldwide in the field of nuclear safety. The PNRA Ordinance empowers the Authority to enter into bilateral cooperation agreements with other national regulators and international organizations in peaceful uses of nuclear technology.

Cooperation with China

PNRA has established strong bilateral relations with reputed Chinese institutes in the field of nuclear

safety. Agreements have been signed with the National Nuclear Safety Administration (NNSA), the China Nuclear Power Operation Technology Corporation (CNPO), and Nuclear Safety Centre (NSC) of China. These institutions assist PNRA in review and assessment and inspections of NPPs.

Nuclear Safety Centre is a technical support organization of NNSA, in the same manner as the Centre for Nuclear Safety (CNS) serves as a TSO to PNRA. In 2011, CNS and NSC signed an agreement for exchange and cooperation in the field of nuclear safety and radiation protection. Both the parties agreed to exchange technical consultation and services related to review and inspection.

The Northern Regional Office (NRO) is the inspection organization of NNSA, responsible for inspections to ensure safety and radiation protection of civil nuclear installations, especially in manufacturing of nuclear safety equipment. PNRA also signed an agreement with NRO for exchange of technical consultation and services to strengthen inspection methodologies in the field of nuclear safety and radiation protection.

Cooperation with Other Countries

The VUJE is a technical support organization of the nuclear regulatory authority of Slovakia. It is specialized in nuclear power plant technology, safety and environmental issues. During the reporting period, VUJE and Centre for Nuclear Safety of PNRA renewed their agreement, which had expired in November 2010. In the past, VUJE has provided training to PNRA staff in nuclear safety, especially in safety review and inspection of pressurized water reactor components. Under this agreement, VUJE also agreed to assist PNRA in the field of safety reviews and inspections of PWRs.

PNRA also interacts with the United States Nuclear Regulatory Commission (USNRC) for institutional strengthening and capacity building related to nuclear safety. An understanding exists between the two organizations 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 PNRA officials are on contract placement at USNRC in different areas of reactor safety.

PNRA also has a close relationship with the Henry L. Stimson Centre in Washington D.C. In 2011, one officer of PNRA was awarded fellowship of Stimson Centre.

PNRA is working to explore possibilities of bilateral and multilateral cooperation with the national regulators of Korea, the United Arab Emirates (UAE) and Jordan.

Pakistan is also a member of the Network of Regulators of Countries with Small Nuclear Programmes (NERS) and maintains its website (www.ners.co). PNRA participated in the annual meeting of NERS, held at Cape Town, South Africa, in February 2011.

Technical Cooperation with IAEA

PNRA works closely with the International Atomic Energy Agency for the capacity building of its young scientists and engineers in nuclear safety and security, and to provide technical support to other member states in these areas. PNRA is participating in a number of IAEA Technical Cooperation Projects and Regional Asia Projects that are aimed at strengthening the regulatory framework of member states. PNRA and IAEA are also cooperating under a special programme to improve

PNRA Participants of a Workshop on Safety Class Component Life Assessment in Collaboration with IAEA

Signing of PNRA-IAEA Extension in Technical Cooperation Programme

PNRA Participants and Experts in IAEA Workshop on Performance Assessment

nuclear security in Pakistan. In addition, PNRA participates in a host of events and missions organized by IAEA.

Technical Cooperation Projects

Presently, two Technical Cooperation Projects, "Further Strengthening of Regulatory Performance for the Pakistan Nuclear Regulatory Authority (PAK/9/028)" and "Strengthening Infrastructure for Radiation, Transport and Waste Safety (PAK/9/034)", are in progress. Various activities, such as workshops, training courses, fellowships, scientific visits, and procurement of equipment have been carried out under these projects.

During the reported year, five fellowships and one scientific visits were awarded by IAEA in the area of safety analysis and assessment, radiation protection, and waste safety.

PNRA arranged the following workshops in Austria and China in collaboration with the IAEA:

- Qualification of electrical and instrumentation & control (I&C) equipment in NPPs, Beijing, China;
- Verification/Calculation of residual life of safety class NPP components, Beijing, China;
- Regulatory oversight regarding NPP inspections optimization, Vienna, Austria;
- Implementation of management system to develop safety culture in regulatory bodies, Vienna, Austria;
- Development of performance indicators to monitor and evaluate performance of regulatory body, Vienna, Austria;
- PSA regarding postulated initiating events (PIE) selection methods, success and modelling techniques, Vienna, Austria;
- Public information and media communication during nuclear or radiological emergency, Vienna, Austria;
- Radiological monitoring during an emergency and decision-making of protective measures, Beijing, China;
- Preparing, conducting and evaluating an emergency response exercise, Beijing, China; and
- Safety assessment as support to licensing of radioactive waste management solutions, Vienna, Austria.

IAEA also provided various software to PNRA for safety analysis. Further, IAEA supported PNRA in procuring equipment for its laboratories, including a portable gamma dose rate meter, liquid scintillation counters, automatic Thermo Luminescence Dosimeter (TLD) Card Reader, TLD cards along with dose calculation algorithm for dosimeter configuration, nitrogen generator, simulated radiation meters, charcoal filters for air sampler, etc.

Regional Asia Projects

PNRA is currently participating in nine Regional Asia (RAS) projects of IAEA. These focus mainly on strengthening national regulatory infrastructure for control of radiation sources; protection of public and the environment from radiation practices;

strengthening nuclear regulatory authorities in the Asia and the Pacific region; supporting education and training in radiation protection; development of human resources in nuclear security, education and training in support of radiation protection infrastructure etc. In 2011, under these projects, personnel from PNRA participated in various training courses organized by IAEA.

Expert Missions

Under the aegis of IAEA, expert missions are conducted for member states to explore the effectiveness, efficiency, and consistency of their existing regulatory system and its implementation. These missions serve to identify gaps and inconsistencies to be addressed, opportunities for improvement, as well as good practices.

The PNRA team comprises of experts in various technical and management areas of nuclear safety. These officials contributed as IAEA experts in a number of important international activities. They delivered lectures on a wide range of topics concerning nuclear safety and security, such as regulatory inspection, nuclear power infrastructure, development of regulatory framework, management system, licensing process in all phases of nuclear installation, emergency preparedness, physical protection, regulatory control, capacity building, strengthening nuclear safety and security institutions etc.

During 2011, various IAEA experts visited PNRA to assist in specific activities, such as Installation of TLD readers, training in security of radioactive sources, project development, and evaluation of security up-gradation of PNRA Headquarters.

Chairman PNRA Addressing on Regulatory Oversight Framework in International Symposium at Amman, Jordan

Participation of PNRA Officials in International Events

In addition to the participation in the above activities, PNRA officials participate in other international events. During 2011, altogether, 250 officials participated in 122 such events. These events include workshops, training courses, meetings and seminars. Details of these activities are shown in Figure 35.

Miscellaneous Activities

PNRA is an active member of various IAEA committees, including the Nuclear Safety Standard Committee (NUSSC), Transport Safety Standards Committee (TRANSSC), Waste Safety Standard Committee (WASSC), Radiation Safety Standards Committee (RASSC), and Committee on Safety Standards (CSS). PNRA also participates as the national coordinator in the activities of the International Nuclear Event Scale (INES) and Incident Reporting System (IRS) forums of IAEA. Chairman PNRA participated in 21st meeting of the Advisory Committee on Nuclear Security (AdSec) and 30th meeting of Commission on Safety Standard (CSS) in Vienna in November, 2011.

Chairman PNRA participated in the meeting of

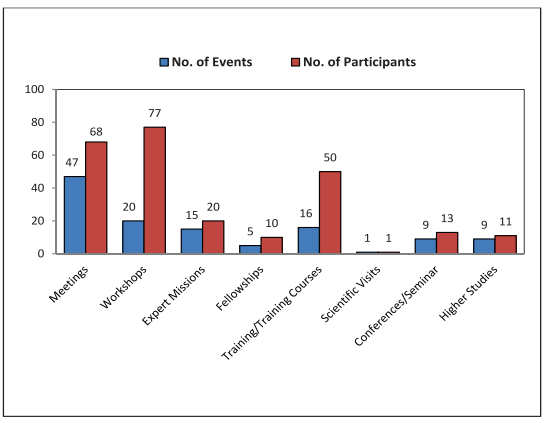


Figure 35: International Training Activities During 2011

Participants of Training Course by PNRA on Safety and Security of SRS in Industry, Karachi.

Participants of a Workshop on Qualification of Electrical and I&C Equipment in Beijing, China, Arranged in Collaboration with IAEA

Regional Cooperation Forum (RCF) held in Vienna. The objective of the forum is to help in developing regulatory infrastructure in new countries embarking on nuclear power programme by sharing nuclear knowledge and training of personnel in core functions of the regulatory body.

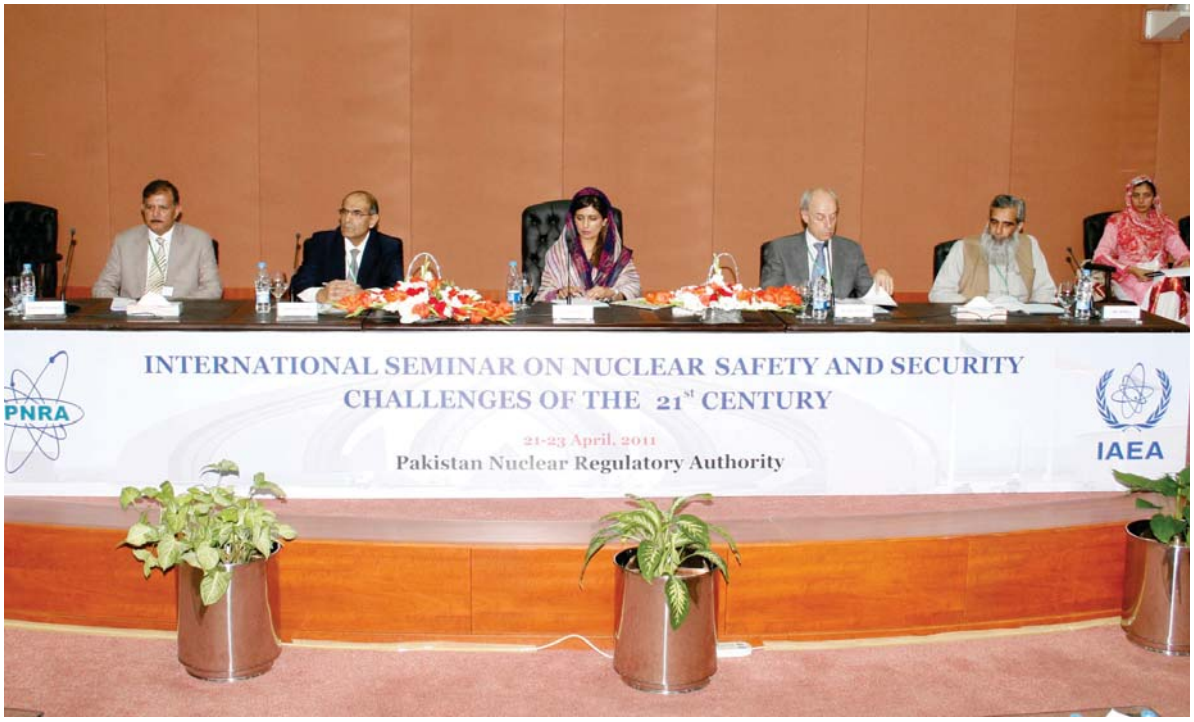
On the invitation of Jordanian Nuclear Regulatory Authority Commission, Chairman PNRA, participated in the "4th International Symposium on Nuclear Energy", jointly organized by Al-Balqa Applied University, Jordan and delivered lecture. Chairman PNRA was invited as a keynote speaker at the Nuclear Power World MENA 2011 Conference in Dubai and Nuclear Energy Asia 2011 Conference in Hong Kong.

On the invitation of PNRA, Mr. Denis Flory, Deputy Director General, Department of safety & Security IAEA; visited Islamabad for key note presentation in the "International Seminar on Nuclear Safety and Security: Challenges of the 21st Century" arranged by PNRA in collaboration with IAEA. Mr. Christopher Price, Deputy Director HSE, UK; Mr. Antonio Madonna, Director, ITER-Consult, Italy and Mr. Tomislav Bajs, Director, ENONET, Croatia delivered lectures on various topics related to safety and security.

International Seminar on Safety and Security: Challenges of the 21st Century

In collaboration with IAEA, PNRA conducted an international seminar on "Nuclear Safety and Security: Challenges of the 21st Century", which was held in Islamabad from 21–23 April 2011. The

Chairman PNRA Presenting a Sovenier to Mr. Denis Flory, Deputy Director General, IAEA



International Seminar on Nuclear Safety and Security: Challenges of the 21st Century, Organized by PNRA in Collaboration with IAEA

Foreign Minister Addressing the International Seminar on Nuclear Safety and Security

Posters Displayed by PNRA During International Seminar

Foreign Guests at PNRA Exhibition During the International Seminar

objective of this seminar was to highlight the significance of nuclear safety and security in the regulation of NPPs in the current world scenario. Participants shared the national and global experience and best practices related to regulatory oversight for assessment of safety and security of NPPs taking into account the challenges and technological advancements of the twenty-first century. The seminar included valuable papers, oral and poster presentations by foreign as well as PNRA experts during the plenary sessions on the following topical areas:

- Current nuclear regulatory challenges;
- Regulatory assessment of NPPs;
- Long-term/Beyond design life operation of NPPs;
- Regulatory aspect of innovative/modern design of NPPs; and
- Physical protection practices in regulating NPPs

Research and Analysis in International Affairs

PNRA has started an International Relations Analysts (IRAs) programme jointly with Strategic Plans Division (SPD) and PAEC to cater to the special needs of regulatory work that has an international dimension. Activities being carried out under this programme include research on international strategic issues that influence regulatory activities. This entails review and analysis of conventions, treaties and protocols related to nuclear safety, security and physical protection, as well as research in the areas of regulatory and strategic importance.

As a part of a programme to expand the outreach of PNRA to national think-tanks, International Relations Analysts (IRAs) have maintained close liaison with the South Asian Strategic Stability Institute (SASSI), Institute of Strategic Studies Islamabad (ISSI), Islamabad Policy Research Institute (IPRI) and other research institutions, and regularly participate in their seminars, conferences and lectures. This effort not only broadens the horizons of the PNRA mission but also facilitates a synergic approach in dealing with affairs of nuclear regulatory and strategic importance.

Chairman PNRA, Member PNRA & Mr. Denis Flory During the International Seminar

Chairman PNRA Addressing the International Seminar

Foreign Minister Visiting the Exhibition During the International Seminar on Nuclear Safety and Security

Mr. Denis Flory, DDG, IAEA Giving the Keynote Address During the International Seminar

9
PERFORMANCE REVIEW

Assessment of Performance

PNRA has been monitoring and evaluating its effectiveness and continuously striving to improve its performance since its inception. An annual report is prepared and submitted regularly to the government at the end of each calendar year, and also made available for the public on PNRA website to enable all stakeholders to keep abreast with developments in the regulations of nuclear and radiation facilities in the country.

PNRA has set 12 strategic performance indicators to monitor its performance. A rating scale of five levels – Not Acceptable (pink), Unsatisfactory (red), Needs Improvement (yellow), Minimally Acceptable (white), and Satisfactory (green) – is used to assess performance against each indicator. Regulatory performance is evaluated qualitatively against pre-defined targets and goals. Non-conformances and weak areas are identified and preventive and corrective actions are taken for improvement. The result of the assessment for year 2011 is summarized in Figure 36 and discussed below.

Indicator 1 (*Ensures that acceptable level of safety is being maintained by licensees)*: Although an acceptable level of safety is maintained by licensees at all nuclear installations and many radiation facilities, improvement in safety at existing licensed X-ray facilities is still required. Further, all the X-ray facilities in the country are not inside the licensing net. PNRA has to struggle hard to accomplish this target. PNRA also needs to focus on education and training of X-ray machine operators and their certification. Keeping in view the above facts, PNRA has rated its performance during 2011 as still **"Needs Improvement"**.

Indicator 2 *(Ensures that regulations and procedures are in position and understood by licensees)*: During 2011, the new "Regulations for the Safe Operation of Research Reactor" and amendment in "Regulations for Radiation Protection" were approved. The new regulations on "Transaction of Business of PNRA ", "Decommissioning of Facilities Using Radioactive Material", "Physical Protection of Nuclear Installations and Nuclear Material and Security of Radioactive Sources" are being developed. Various regulations are under revision process based on licensees' and international feedback. Therefore, it is assessed that PNRA's performance remained **"Satisfactory"** during the reporting year.

Indicator 3 *(Strives for continuous improvement of its performance)*: PNRA is committed to enhancing its regulatory effectiveness and efficiency. During the reporting period, PNRA conducted self assessment of core areas using the IAEA Self Assessment Tool (SAT). IAEA has now upgraded the tool and the exercise of self assessment will be repeated using the revised tool during the next year. PNRA has requested IAEA for an Integrated Regulatory Review Service (IRRS) mission to strengthen and enhance the effectiveness of the regulatory infrastructure. The results of the self assessment will form one of the basis of the review by IRRS mission. The mission is expected by the end of 2012.

Directorate of Regulatory Affairs is conducting performance assessment of each Directorate and Project based on their annual plans on quarterly basis. Three quarterly performance evaluation reports were issued during the reported period. PNRA participated in national workshops arranged by IAEA on development of specific indicators for performance assessment and management system.

IAEA has appreciated PNRA's efforts in striving for improvement in its processes, procedures and performance programmes. Hence, PNRA is considered to have maintained a **"Satisfactory"** rating on this indicator.

Indicator 4 *(Takes appropriate actions to prevent degradation of safety and to promote safety improvements):* PNRA continued the review and assessment of various safety related documents and modifications and inspection of nuclear installations, in operation and under construction throughout the year and issued directives for compliance of regulatory requirements. A significant number of inspections of different type of radiation facilities in the medical, industrial, research, educational and agricultural spheres was also conducted during the reported year. PNRA also conducted training courses for radiographers on radiation protection to ensure that their

Figure-:36 Assessment of PNRA's Performance in 2011

(Indicator 1) Ensures that acceptable level of safety is being maintained by licensees	(Indicator 2) Ensures that regulations and procedures 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 adequate legal provisions exist for enforcement, e.g., dealing with non-compliance or licence violations
(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

familiarization and understanding of radiation protection requirements and practices is up to the mark. This regulatory surveillance and training of the radiographers led to improvements in the safety and security status of radiation practices. However despite intensive persuasion, PNRA remained unable to bring all the X-ray facilities in the country in the licensing net. Furthermore, legal proceedings could not be initiated against the defaulters/offenders. Therefore, assessment on this performance indicator has been rated in the category of **"Needs Improvement"**.

Indicator 5 *(Takes appropriate steps for human resource development and has competent and certified regulatory staff)*: PNRA pays attention not only to enhance technical capabilities of existing staff but also has to increase its technically competent officers' strength keeping in view the anticipated workload during the coming years. Seven (07) new officers joined PNRA during 2011 after completion of their MS studies at PIEAS and KINPOE whereas seven (07) officers were awarded new fellowships for MS degree in nuclear engineering at PIEAS and KINPOE. Nine (09) officers were allowed for MS and Ph. D studies in other institutes in Pakistan and abroad. Nineteen (19) technical training courses were arranged at PNRA and 408 officers participated in these courses. More than 2400 persons participated in twenty four (24) lectures conducted at PNRA/national institutes/ centres/ universities. Therefore PNRA's performance against this indicator remained **"Satisfactory"** during this year as well.

Indicator 6 (*Ensures that adequate legal provisions exist for enforcement, i.e., dealing with non-compliance or licence violations*):, Although Pakistan Nuclear Regulatory Authority Enforcement Regulations (PAK/950) have been Gazette-notified, and the related procedures have been developed, legal setup still needs to be established in PNRA. Efforts are now underway to establish such a setup as early as possible. Keeping in view these aspects, the performance of PNRA on this indicator is judged as **"Needs Improvement"** as was done in the previous year.

Indicator 7 *(Performs its functions in a timely and cost-effective manner)*: PNRA has performed all of its regulatory activities and achieved targets set for the year 2011 within the allocated budget and schedules. PNRA has carried out the review of PSAR of C-3 & C-4 and PSR of PARR-I, performed all inspections at nuclear and radiation facilities, completed all reviews and assessment of licensees submissions and conducted meetings with utilities as planned. All the licences were issued and renewed after necessary verification well in time. Hence PNRA maintained its **"Satisfactory"** rating on this indicator

Indicator 8 *(Ensures that a well established quality management system exists)*: PNRA has prepared the management system manual, performed regulatory audit of the regional directorates, conducted in-house training and participated in workshop on implementation of management system in collaboration with IAEA. However, PNRA needs to ensure effective implementation of the manual and identify further documents to be developed to fulfil the requirements of management system. Therefore, PNRA has retained this indicator to **"Minimally Acceptable"** level as was done during the previous year.

Indicator 9 *(Ensures that adequate resources are available for performing its functions and technical support centre is available for specialist assistance when required)*: PNRA has established a technical support centre in the name of Centre for Nuclear Safety (CNS) through the financial support of Public Sector Development Programme (PSDP) of the Government of Pakistan. CNS provided support in review and assessment of the licensees' submissions related to C-1, C-2, C-3, C-4 and K-1 during the reported period. Another technical support centre in the name of Safety Analysis Centre (SAC) is also being developed at Karachi through PSDP funding. However, the releases of funds from the Government of Pakistan were not smooth during the year. PNRA has to face a number of problems due to shortage of funds. Therefore, the performance rating for this indicator has been lowered one step from "Needs Improvement" to **"Unsatisfactory"** due to lack of adequate funds (resources).

Indicator 10 *(Performs its functions in a manner that ensures confidence of the operating organization)*: PNRA conducts meetings with its licensees of nuclear power plants on quarterly basis with the objectives to improve interfaces and communication; to monitor the safety performance of the plants and progress of necessary actions for safety improvements; and to identify barriers if any that hinder implementation of necessary actions for safety improvements. For some safety significant matters, special meetings are also arranged for their resolution. PNRA's performance rating on this indicator has remained **"Satisfactory"** during this year.

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. Special activities and any significant event at radiation facilities are also reported through timely press releases. Any query raised by public and media is promptly responded to. Information material is prepared and published for the general public. PNRA conducted lecture at various educational institutes/universities to instil awareness, education and training of the public. Hence this indicator has neither improved nor deteriorated during the reporting period and has remained **"Minimally Acceptable"**.

Indicator 12 *(Performs its functions in a manner that ensures confidence of the Government)*: PNRA continued to fulfil Pakistan's international obligations under the conventions related to nuclear and radiation safety. PNRA coordinated with various governmental organizations to prepare action plan for ministerial conference in Vienna. Various governmental organizations were invited to lectures on nuclear disaster in Japan. While interacting with PNRA, the Governmental agencies and Ministries give high regard to PNRA's advice and proposed actions. Moreover, PNRA's point of view is seriously considered by the Government. This is also evident from the Government's policy to allowing PNRA to represent the Government of Pakistan at various international forums. PNRA judges its performance on this indicator as **"Satisfactory"** for the reported period.

Overall Performance

Based on the evaluation of all the twelve performance indicators, PNRA assesses its overall performance, against a rating scale of five levels i.e. Not Acceptable (pink), Unsatisfactory (red), Needs Improvement (yellow), Minimally Acceptable (white), and Satisfactory (green). A comparison of its overall performance since its inception is given in Figure 37.

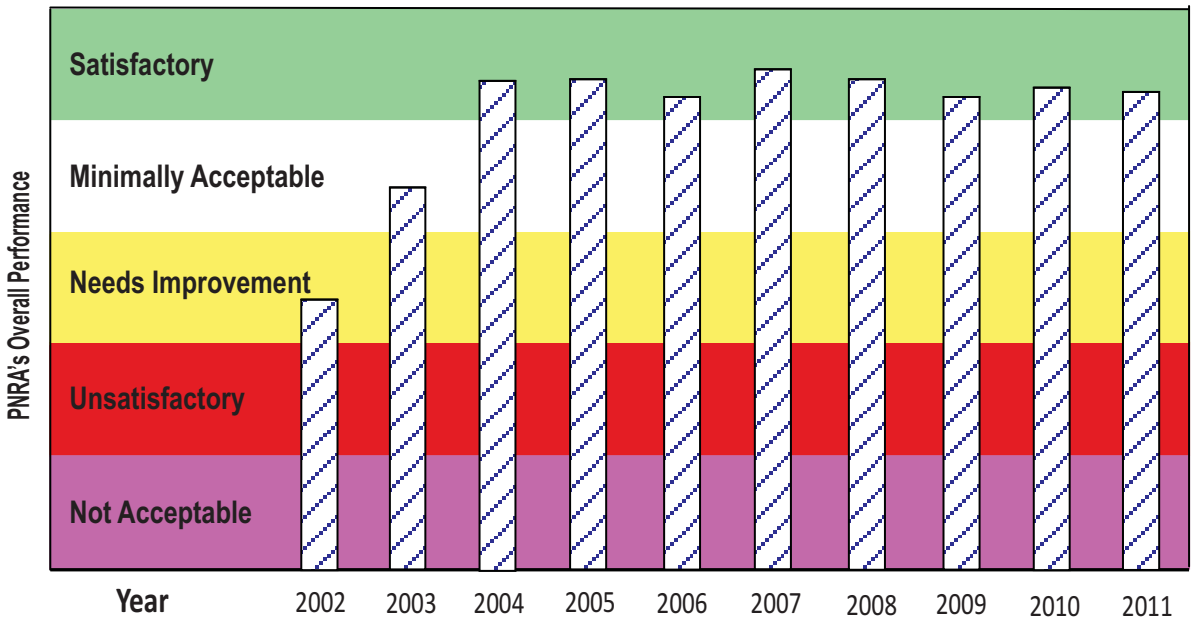


Figure 37: Overall Performance of PNRA Since 2002