PNRA

REPORT 2009

PAKISTAN NUCLEAR REGULATORY AUTHORITY

MEMBERS OF PNRA

PRESENT

Mr. M. Anwar Habib (Chairman)

Mr. Mohammad Shakilur Rahman

Dr. Shahid Ahmed Mallick

Lt. Gen.(R) Khalid Ahmed Kidwai

Dr. Inam-ur- Rahman

Dr. Qazi Abdus Saboor

Mr. Asif Shuja Khan

Prof. Dr. Mohammad Ali Maud

Mr. Zia-ul-Hassan Siddiqui

Prof. Dr. Inayat Shah Roghani

FORMER

Mr. Jamshed Azim Hashmi (Chairman)

Mr. Jawad Azim Hashimi

Syed Badshah Husain

Mr. Anwar Ali

Dr. Younus Sheikh

MESSAGE FROM THE CHAIRMAN

It is a great pleasure for me to present this report for the first time as Chairman, PNRA. I must thank Mr Jamshed Azim Hashmi, the first Chairman of PNRA for establishing the organization on firm footing. His vision and untiring efforts have made PNRA a robust public sector organization dedicated to ensuring safety of the workers, public and the environment from harmful effects of radiation and won accolades from the national and international nuclear community.

I would like to assure my colleagues that I will carry forward the traditions set by my predecessor and focus on consolidating the organization for meeting the future challenges.

One of the challenges that I foresee is to bring all radiation facilities in the country under the PNRA licensing net. During the past eight years our focus has been nuclear safety and we have achieved remarkable progress in ensuring safety and security of nuclear installations by implementing our national regulations. I would like to mention that our national regulations are at par with the international standards.

The same cannot be said of all radiation facilities especially the X-ray facilities. PNRA has not been able to bring all X-ray facilities in the licensing net and in fact some of the X-ray facilities previously under the licensing net have started defaulting during the previous years. I feel that although PNRA has been using persuasions but has refrained to invoke the provisions of prosecution in the court of law which is encouraging many licensees to default. I assure you, that we will use all means of persuasion and enforcement and would be able to bring all the radiation facilities of the country in the licensing net.

My other challenge is to nurture a skilled and competent workforce. We aim to double our technical workforce by 2015 to meet the challenges of providing regulatory oversight to the energy security plan envisaged by the Government of Pakistan which contemplates a twenty fold increase in nuclear generation capacity by 2030 and for providing oversight to all radiation facilities in the country. Addition of such a large fresh work force requires rigorous training and competency building of this work force in a short span of time.

My focus therefore will be on enhancing the capacity of PNRA School for Nuclear and Radiation Safety and National Nuclear Security Training Centre so that these training centres can build the required competency of the next generation of regulators not only for Pakistan but also for other countries.

(Mohammad Anwar Habib)

ABBREVIATIONS

ACIURI	*Advisory Committee on Improving Utility-Regulatory Interface, PNRA*
ALARA	*As Low As Reasonably Achievable*
C-1	*Chashma Nuclear Power Plant Unit 1 (CHASNUPP-1)*
C-2	*Chashma Nuclear Power Plant Unit 2 (under construction)*
C-3	*Chashma Nuclear Power Plant Unit 3 (planned)*
C-4	*Chashma Nuclear Power Plant Unit 4 (planned)*
CAA	*Civil Aviation Authority*
CNPO	*China Nuclear Power Operation Technology Corporation Ltd.*
CNS	*Centre for Nuclear Safety, PNRA*
COMTEX	*Communication Test Exercise*
ConvEx	*Conventional Exercise*
DNSRP	*Directorate of Nuclear Safety and Radiation Protection*
HMC	*Heavy Mechanical Complex*
IAEA	*International Atomic Energy Agency*
JTS	*PNRA-PAEC Joint Technical Study Programme*
K-1	*Karachi Nuclear Power Plant, Unit 1 (KANUPP-1)*
K-2	*Karachi Nuclear Power Plant, Unit 2 (planned)*
KINPOE	*Karachi Nuclear Power Plant Institute of Nuclear Power Engineering*
LTOK	*Long Term Operation of K-1*
LUMS	*Lahore University of Management Sciences*
MRML	*Mobile Radiological Monitoring Laboratory*
MWe	*Megawatt-electric*
NDCL	*National Dosimetry and Protection Level Calibration Laboratory*
NEPRA	*National Electric Power Regulatory Authority*
NERS	*Network of Regulators of Countries with Small Nuclear Programmes*
NERSP	*National Environmental Radioactivity Surveillance Programme*
NNSA	*National Nuclear Safety Administration, China*
NOC	*No Objection Certificate*
NRECC	*National Radiation Emergency Coordination Centre, PNRA*
NuSECC	*Nuclear Security Emergency Coordination Centre, PNRA*
OGRA	*Oil and Gas Regulatory Authority*
PAEC	*Pakistan Atomic Energy Commission*
PARR	*Pakistan Research Reactor*
PC-1	*Project Control Form 1*
PHWR	*Pressurized Heavy Water Reactor*
PIEAS	*Pakistan Institute of Engineering and Applied Sciences*
PINSTECH	*Pakistan Institute of Nuclear Science and Technology*
PNRA	*Pakistan Nuclear Regulatory Authority*
PPRA	*Public Procurement Regulatory Authority*
PSDP	*Public Sector Development Programme*
PTA	*Pakistan Telecommunication Authority*
PWR	*Pressurized Water Reactor*
RANET	*Response Assistance Network, IAEA*
RNSD	*Regional Nuclear Safety Directorate, PNRA*
RSD	*Directorate for Radiation Safety, PNRA*
SNRS	*School for Nuclear and Radiation Safety, PNRA*
SRS	*Sealed Radioactive Sources*
TRANSSC	*Transport Safety Standards Committee, IAEA*
UNSCEAR	*United Nations Scientific Committee on Effects of Atomic Radiations*
WSD	*Directorate of Transport and Waste Safety, PNRA*

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 and 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

With the promulgation of the Pakistan Nuclear Regulatory Authority Ordinance in January 2001, the Pakistan Nuclear Regulatory Authority (PNRA) was established as an independent Regulatory Body to implement nuclear and radiation safety regime and supervise all matters pertaining to safety of nuclear installations and radiation facilities in the country.

The predecessor of PNRA was the Directorate of Nuclear Safety and Radiation Protection (DNSRP) which was established in 1984 pursuant to Pakistan Nuclear Safety and Radiation Protection Ordinance-1984. DNSRP carried out the nuclear regulatory activities in the country as a part of the Pakistan Atomic Energy Commission (PAEC). Thus PAEC was performing the functions of promoters and regulators of nuclear energy simultaneously. In 1994 the Government of Pakistan signed the international Convention on Nuclear Safety. One of the obligations under the Convention was to effectively separate the functioning of regulators and promoters of nuclear energy in the country, to ensure priority to safety over production. As a first step towards this direction, Pakistan Nuclear Regulatory Board (PNRB) was established in 1994. PNRB was a quasi-independent body. The Board comprised of nine Members, four out of which were from within the PAEC and the remaining five from other organizations. The Chairman PAEC was the ex-officio Chairman of PNRB. In 2001 Pakistan fully complied with the obligations of the Nuclear Safety Convention by establishing a fully independent nuclear regulatory authority in the name of PNRA. The Authority consists of a Chairman, two full time Members and seven part-time Members. PAEC is represented by only one part-time Member in the Authority.

In the short span of eight years since its inception in 2001, PNRA has proven its capacity to undertake its supervisory role as a national nuclear regulator, confronting new challenges posed by the nuclear technology and current international practices. PNRA has developed close liaison activities at national and international level which help in meeting the challenges of the Global Safety Regime.

The overall functions of PNRA are to regulate the safety of nuclear installations in the country, provide protection against risks arising from ionizing radiation, establish the extent of insurance to be carried by a licensee against the risk of nuclear damage to the public, fix the extent of civil liability for nuclear damage resulting from any nuclear incident and for matters ancillary thereto or connected therewith.

In order to perform its functions, PNRA has been given the powers to formulate and implement Regulations related to nuclear safety and radiation protection, issue licences and authorizations for facilities and activities involving ionizing radiation, carry out inspections to verify the compliance of Regulations and directives issued by the Authority and to prosecute the violators in the court of law.

The prime task of PNRA is to regulate nuclear safety and radiation protection in Pakistan. PNRA also ensures that adequate emergency preparedness programmes exist at all the nuclear facilities and the radiation facilities using high risk radiation sources. In addition, PNRA ensures that physical protection measures around nuclear installations and high risk radioactive sources are satisfactory. This is accomplished by formulating and implementing effective regulations, and providing assistance through regulatory guides.

All the nuclear and radiation facilities in the country are required to get a license from PNRA to carry out their activities. The operator of the facility has to submit certain documents in pursuance to national regulations. These documents are reviewed by PNRA. When PNRA is satisfied that the operation of the nuclear or radiation facility could be carried out safely and securely in accordance with the national regulations, a licence is issued.

The facilities and activities that need a licence from PNRA are mainly divided into two categories i.e. Nuclear Installations and Radiation Facilities. Further sub-division of these categories is given below:

a) Nuclear Installations

- Nuclear power plants;
- Nuclear research reactors;
- Any installation that utilizes or stores, nuclear/ fissile materials.

b) Radiation Facilities

- Medical applications of radiation, including therapeutic and diagnostic radiology;

- Irradiators for sterilization of medical equipment or food products;
- Industrial applications of radiation, including industrial radiography, oil well logging and nuclear gauges;
- Radiation scanners;
- Radioactive waste management facilities;
- Agriculture facilities using radioisotopes;
- Transport of radioactive material.

The prime responsibility for safe operation always rests with the operator of the facility. In order to ensure that the nuclear and radiation facilities are being operated safely and in accordance with the national regulations, PNRA carries out various types of inspections according to the national inspection programme. For this purpose, PNRA has established three Regional Nuclear Safety Directorates (RNSDs) at Islamabad, Karachi and Kundian. Resident inspectors have been posted at all the nuclear power plants.

The radioactive wastes, including gaseous, liquid and solid waste, from the nuclear and radiation facilities are also monitored by PNRA. The waste data is collected by PNRA on regular basis and it is ensured that ambient levels of radiation in the environment do not increase due to operation of these facilities.

PNRA is also participating in the Public Sector Development Programme (PSDP) of the Government of Pakistan. Currently, PNRA is working on five such projects which are mainly focused on capacity building in different areas.

The organizational structure of PNRA is presented in Figure 1, which shows clear lines of communication and interface between different Directorates at PNRA. PNRA has two wings, the Executive and the Corporate, each headed by a full-time Member.

Highlights of Previous Report

The two operating Nuclear Power Plants K-1 and C-1 remained under close monitoring by PNRA. Releases to the environment and radiation doses to workers remained well below regulatory limits at both the plants.

The following major activities were detailed in the previous report of 2008:

1. Monitoring of the fifth refuelling outage of C-1;
2. Monitoring of construction work at C-2;
3. Review of the Site Evaluation Report for C-3;
4. Issuance of three national regulations:
   - Regulations for licensing of manufacturers of nuclear safety class equipment – PAK/907;
   - Regulations for the siting of nuclear power plants – PAK/910;
   - Regulations on the management of a nuclear or radiological emergency – PAK/914.
5. Initiation of two new PSDP-funded projects;
6. Submittal of the Fourth National Report on Nuclear Safety in Pakistan in the Fourth Review Meeting of the Convention on Nuclear Safety;
7. Establishment of regional offices at Peshawar and Quetta to assist law enforcement agencies in combating illicit trafficking of radioactive sources and material;
8. Inauguration of new office building for Regional Nuclear Safety Directorate-II at Chashma Site; and
9. Inauguration of construction of SNRS new building at Islamabad.

Major Activities in 2009

The start of the year 2009 saw the end of an era for the PNRA as its first Chairman, Mr. Jamshed Azim Hashmi, retired after completing his maximum tenure of eight years. This era witnessed the evolution of PNRA into an independent, strong and progressive public sector organization committed to safeguard the safety and security of nuclear and radiation facilities in the country. In 2001, PNRA faced the uphill tasks with the small number of workforce that could be counted on fingers, working in rented buildings. Today PNRA headquarters with its technical support organizations are housed in its own buildings thus providing a firm infrastructural base for ensuring nuclear safety and security in the country.

During this reporting year, PNRA has achieved many short term goals thereby ensuring continuous improvement in its performance. Some of the success stories of the year 2009 include regulatory oversight of the two operating and one under-construction nuclear power plants, review of Site Evaluation Report for C-3, equipping eight entry/exit points at international borders with radiation detection equipment for the strict control of radioactive sources, training of officials of Pakistan Customs in the use of detection equipment, inclusion of special courses on Nuclear Security in the existing Programme of MS Nuclear Engineering at PIEAS, mobilization of the projects like Nuclear Dosimetry and Protection Level Calibration Laboratories and National Programme for Environmental Radioactivity Surveillance, the finalization of the Management System Manual, initiation of self-assessment using the Self-Assessment Tool of the IAEA, etc. The details of these are given in the later sections of this report.

A summary of the major activities of PNRA during the year 2009 is presented below:

1. The start of 2009 witnessed a very smooth change of leadership at PNRA. The former Chairman Mr. Jamshed Azim Hashmi retired after a meritorious service of eight years. Government of Pakistan appointed Mr. Anwar Habib, formerly Member Corporate of PNRA as the next Chairman of the Authority.
2. Safety of the two nuclear power plants, namely, Karachi Nuclear Power Plant, Unit 1 (K-1) and Chashma Nuclear Power Plant, Unit 1 (C-1) remained under regulatory oversight of PNRA. During 2009, the releases to the environment and radiation doses to workers remained well below regulatory limits at both the plants.
3. After successful completion of fifth refuelling outage (RFO-5) C-1 was put into operation in January 2009. Post RFO-5 operational activities of C-1 remained under review and inspection by PNRA and the plant performance was found to be satisfactory through out the year.
4. During 2009, C-2 construction and installation activities remained in progress. PNRA inspectors participated in a number of Control Point Inspections of C-2.
5. Review of Site Evaluation Report for C-3 was completed.
6. Work remained in progress on the following Regulations:
   - PNRA Enforcement Regulations-PAK/950;
   - Revision of PNRA Regulations-PAK/909 "Licensing of Nuclear Installations in Pakistan";
   - Revision of PNRA Regulations-PAK/911 "Safety of Nuclear Power Plant Design".
7. The following regulatory guides remained in the process of development:
   - Quality Assurance in Nuclear Medicine;
   - Radiation Safety in Industrial Radiography;
   - Probabilistic Safety Analysis for Nuclear Power Plants (Level-1);
   - Dosage and Distribution of Potassium Iodide Tablets in Radiation Emergencies;
   - Transportation of Radiopharmaceuticals in Pakistan;
   - Aging Management of Nuclear Power Plants.
8. The National Radiation Emergency Coordination Centre (NRECC) participated in IAEA ConvEx-2D exercise and coordinated with other national and international response organizations to analyse its capacity for accurate information exchange well in time.
9. Work remained in progress to finalize PNRA Management System Manual in 2009 and initiated work on internal audit of regulatory activities under the Management System.
10. Review of PNRA Self Assessment Report was conducted in Vienna, Austria, by the IAEA experts in preparation of the Integrated Regulatory Review Service to be conducted in 2011.
11. The Centre for Nuclear Safety (CNS) provided technical support to other directorates in the following activities:
    - Review of Safety Analysis Report of C-2;
    - Review of C-2 Commissioning Programme;
    - Periodic Safety Review of C-1 for 10 year license renewal;
    - Analysis of Design Basis and Beyond Design Basis Accident scenarios;
    - Probabilistic Safety Analysis of K-1, and C-1;
    - Pre-service and In-service Inspection Programme (PSI/ISI) of C-2;

- In-service Inspection Programme(ISI) of C-1 for second ten yearly interval;
- Participation in inspection of C-2 during equipment manufacturing, construction and installation phase;
- Re-evaluation of seismic hazards at NPP sites regarding g-value;
- Estimation of damage caused by nuclear accident considering Chashma site as a reference;
- Stress analysis of K-1 steam generator tubes.

12. Two training courses for first responders and officers of RESCUE 1122 were conducted in Lahore. More than 80 officers and 500 first responders were educated in response to a radiological emergency.
13. Specialized trainings in different areas of nuclear security were provided to the officials from different national organizations like first responders, emergency response personnel, front line officers, law enforcement agencies, operators etc.
14. The PNRA School for Nuclear and Radiation Safety conducted twenty five (25) courses in which 321 officers from PNRA as well as PAEC participated. In addition, PNRA arranged thirteen (13) training courses at external organizations in which sixty nine (69) PNRA officials received training in various disciplines. Physical models of Primary System Equipments are being manufactured at China Nuclear Power Corporation to be used at SNRS.
15. NPP Soft Panel Training Simulator, developed in collaboration with PAEC has been installed and is in the process of commissioning at PNRA Head Quarters.
16. The newly established regional inspectorates at Peshawar and Quetta have become fully functional and field inspections were initiated during 2009.
17. Strategically important eight entry/exit points like Torkham, Chamman, Sost, Taftan, Wagha and sea ports of Gawadar, Karachi and Bin Qasim were equipped with radiation detection equipment and manpower was trained.
18. A network of six incident response mobile Laboratories has been established to provide guidance and expert opinion to first responders in case of a nuclear security incident in the country.

Targets for the Year 2010

The targets set for the year 2010 are briefly outlined below:

1. Continue to monitor the licensees activities to avoid any major incident, overexposure to workers and releases to the environment;
2. Enhance the licensing net for diagnostic radiation facilities by another five (05) percent;
3. Strive to issue the PNRA Enforcement Regulations (PAK/950) and Regulations on the Safety of Nuclear Research Reactors Operation (PAK/923);
4. Revise the following PNRA Regulations:
   - Regulations on "Licensing of Nuclear Installations in Pakistan – PAK/909" ;
   - Regulations on "Safety of Nuclear Power Plant Design – PAK/911".
5. Issue the following Regulatory Guides:
   - Quality Assurance in Nuclear Medicine;
   - Radiation Safety in Industrial Radiography;
   - Probabilistic Safety Analysis for Nuclear Power Plants (Level-1);
   - Dosage and Distribution of Potassium Iodide Tablets in Radiation Emergencies;
   - Aging Management of Nuclear Power Plants.
6. Initiate Self Assessment of regulatory activities using IAEA SAT Tool in preparation of IRRS Mission – 2011;
7. Provision of security upgrades at twelve medical centres using Category 1-3 radioactive sources in private and public sector;
8. Establishment of physical protection laboratories and repair maintenance Laboratories at PNRA in collaboration with IAEA.

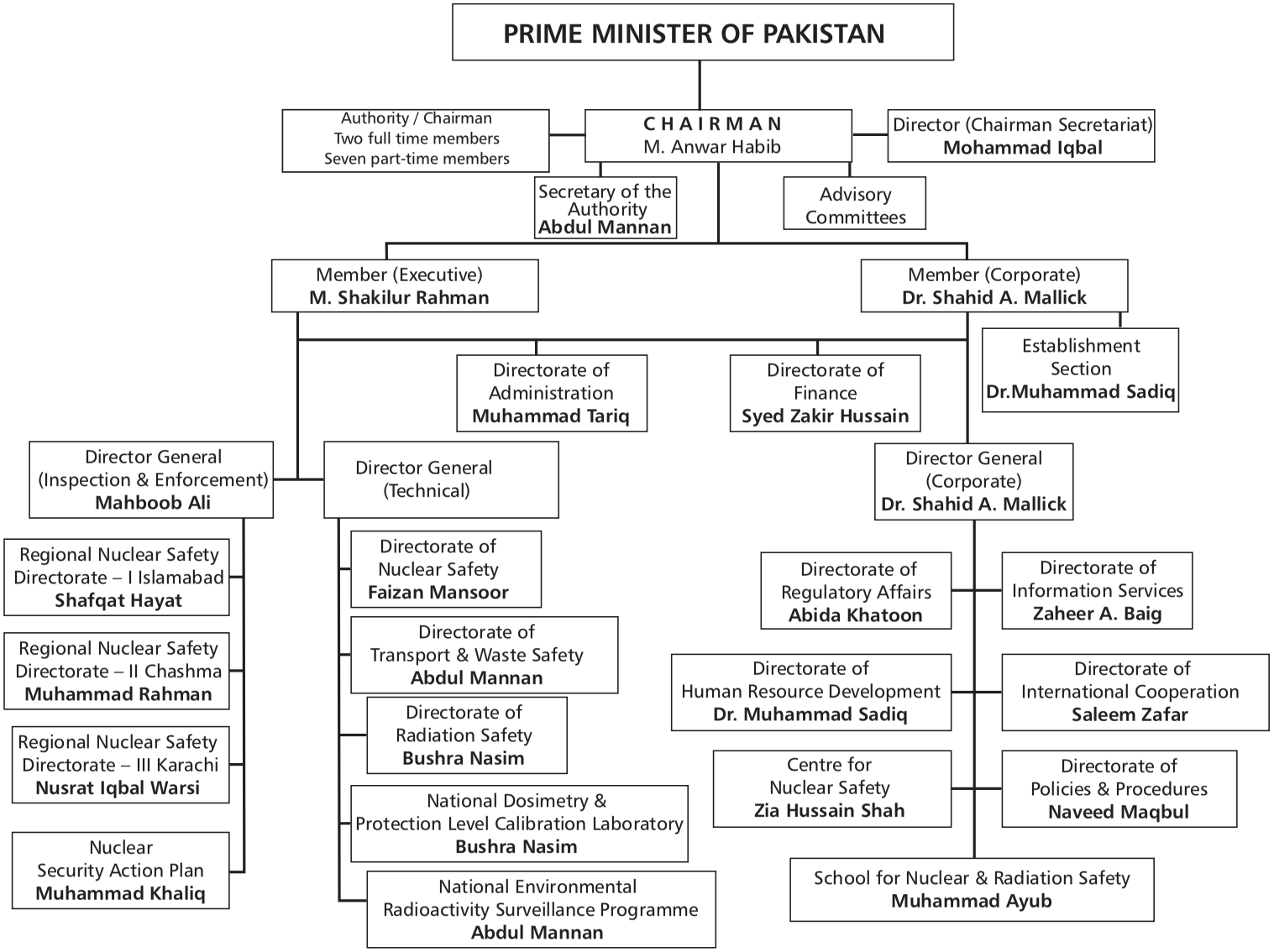


Fig.1: Organizational Structure of PNRA

2 REGULATORY FRAMEWORK

Under the provisions of PNRA Ordinance 2001, PNRA has established a regulatory framework to regulate nuclear installations and radiation facilities in the country. This framework provides national regulations, regulatory guides and applicable safety standards in accordance with the provisions of the Ordinance for licensing of nuclear installations and radiation facilities in Pakistan. The compliance with the regulatory requirements prescribed by the Ordinance, national regulations and conditions attached to a license or authorization is verified through review and assessment of licensee's submissions and regulatory inspections. The non compliance of regulatory requirements is controlled through enforcement actions such as warning notices, curtailing activities, shutting down the facility, suspension and or revocation of a licence in extreme cases.

The Ordinance provides the statutory basis for the Authority and defines its powers, functions and responsibilities with regards to grant of authorization, conducting inspections and taking enforcement actions in case of non-compliance.

The Ordinance empowers PNRA to:

1. devise, adopt and enforce regulations and rules for nuclear safety and radiation protection in accordance with the provisions of the Ordinance;
2. grant authorization or issue licence for the production storage, trade in and use of any nuclear substance and nuclear material in accordance with the rules and regulations issued under the Ordinance;
3. inspect all nuclear installations, radiation facilities, waste facilities, nuclear substances or radioactive materials to ensure that regulations concerning safety measures are properly being followed;
4. cancel or suspend a license in case of non-compliance of any of the provisions of the Ordinance, regulations, or failure to comply with the terms and conditions of the license;
5. determine the extent of civil liability for an operator of a nuclear installation in case of nuclear accidents thereby safeguarding the public against risk from nuclear damage.

The Ordinance is the highest level document in the legislative or regulatory pyramid of PNRA followed by national regulations which are mandatory for the licensees and the regulatory guides which describe methods acceptable to PNRA to meet the requirements of regulations. The national regulations also have provisions for the licensee to follow the other international guidance documents in the areas in which the PNRA regulatory guides are not available subject to demonstrating that the safety is not compromised. The regulatory pyramid of PNRA is shown in Figure 2:

Regulations

The regulations provide the regulatory basis to PNRA for performing its functions for protecting the radiation workers, public and environment from harmful effects of radiation. The regulations are developed in a transparent manner by seeking and incorporating the opinion of all the stakeholders of PNRA including the government and the general public. The regulations approved by the Authority are formally notified in the official Gazette of Pakistan.

National regulations which have been officially notified so far are available at PNRA Website http://www.pnra.org.

According to the procedure for preparation, revision and adoption of Regulations, the regulations once issued are subject to review after every five years of promulgation. If required, the regulations are revised on the basis of implementation experience,

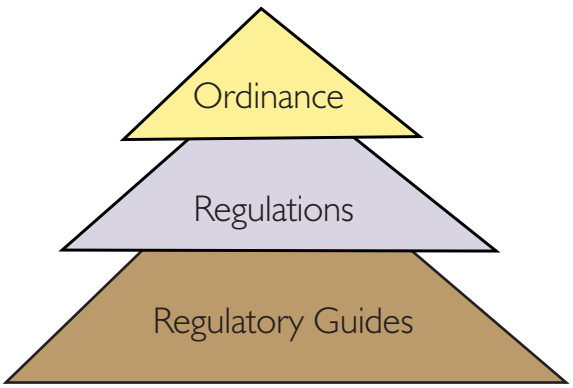


Fig. 2

feedback from licensees and regulatory staff, request from the stakeholders and current international practices. During 2009, work was initiated on revision of the following regulations which have completed five years of promulgation:

1. Regulations on the Safety of Nuclear Power Plant-Design – (PAK/911);
2. Regulations for Licensing of Nuclear Installation(s) in Pakistan – (PAK/909);
3. Pakistan Nuclear Safety and Radiation Protection (PNSRP) Regulations – 1990.

In addition, development of the following draft regulations remained in progress during 2009:

1. Pakistan Nuclear Regulatory Authority Enforcement Regulations – (PAK/950);
2. Regulations on Safety of Nuclear Research Reactor(s) Operation – (PAK/923);
3. Regulations on Decommissioning of Facilities using Radioactive Material – (PAK/930).

Regulatory Guides

The regulatory guides are developed with the view to facilitate the licensee in understanding the requirements of national regulations and provide guidance for their implementation. In case, where PNRA regulatory guides are not available, the guidance from regulatory guides of USNRC or IAEA is acceptable under provisions of PAK/909.

During 2009 following regulatory guides remained in the process of development:

1. Quality Assurance in Nuclear Medicine.
2. Radiation Safety in Industrial Radiography.
3. Probabilistic Safety Analysis for Nuclear Power Plants (Level-1).
4. Dosage and Distribution of Potassium Iodide Tablets in Radiation Emergencies.
5. Transportation of Radiopharmaceuticals in Pakistan.
6. Aging Management of Nuclear Power Plants.

Procedures

PNRA has developed a central registry of all regulatory documents generated within PNRA including Regulations, Regulatory Guides and internal working procedures at its Directorate of Policies and Procedures. The main objectives of central registration are standardization, harmonization, and effective control of regulatory documents issued so that uniform regulatory practices are followed throughout PNRA.

Participants of a Meeting for the Finalization of a National Regulation

3 NUCLEAR SAFETY

One of the primary functions of PNRA is to regulate the operation of nuclear installations and facilities to protect the workers, the general public and the environment from the harmful effects of radiation. These goals are achieved by formulating and implementing various regulations. Under these regulations the owners of nuclear facilities are required to fulfil a number of requirements throughout the lifecycle of the nuclear facility starting right from its siting till decommissioning and rehabilitation of the site. Further, the operators of nuclear installations also need to be licensed by PNRA. Nuclear facilities have to maintain a certain minimum acceptable level of safety during the operation and PNRA keeps vigilance over safety performance through normal regulatory processes of review and assessment, inspections and enforcement. Moreover PNRA proactively interacts with the licensees to identify and resolve potential safety issues. In this regard PNRA conducts quarterly meetings with the licensees of nuclear power plants on safety issues. PNRA also uses enforcement measures such as directives for corrective action, curtailing activities etc. to require licensees to take corrective actions against the regulatory findings/deficiencies.

At present, PNRA is regulating a number of nuclear installations including two operating nuclear power plants, one under construction nuclear power plant, two nuclear power plants in planning phase, two research reactors and one facility for manufacturing of nuclear safety class equipment. Details of these facilities are given in Table 1:

Review and Assessment

Operating Nuclear Power Plants

PNRA performs review and assessment of submissions made by its licensees and applicants in support of their applications for licensing or modification in their facilities. They also have to submit a number of routine and non-routine reports required under national regulations or conditions of authorization. All these reports are reviewed at PNRA. The purpose of review and assessment is to verify compliance of licensees' activities with regulatory requirements (i.e. national regulations, licence conditions, applicable codes and standards and proven engineering practices). PNRA issues directives for necessary actions if the review and assessment indicates non-compliances with the regulatory requirements or adverse trend in safety performance is found. In 2009, PNRA issued five

Table -1

Sr.No.	Installation/Facility	Status	Type	Capacity	Commercial Operation
1.	Karachi Nuclear Power Plant (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)	Under Construction	Pressurized Light Water Reactor	340 MWe	2011 (expected)
4.	Chashma Nuclear Power Plant Unit-3 (C-3)	Planning Phase	Pressurized Light Water Reactor	340 MWe	2015 (expected)
5.	Chashma Nuclear Power Plant Unit-4 (C-4)	Planning Phase	Pressurized Light Water Reactor	340 MWe	2016 (expected)
6.	Pakistan Research Reactor-1 (PARR-1)	In Operation	Research Reactor	10 MWt	1965
7.	Pakistan Research Reactor-2 (PARR-2)	In Operation	Research Reactor	30 kWt	1991
8.	Heavy Mechanical Complex-3 (HMC-3)	Production	Manufacturer of Mechanical Equipment	Safety class 2 and 3 tanks, vessels and heat exchangers	2006

(05) directives to K-1, eighteen (18) to C-1 and nine (09) to C-2. K-1 has completed actions on three of these directives whereas actions on remaining two directives will be completed during the implementation of approved modifications. Out of eighteen directives issued to C-1, actions on fifteen (15) directives have been completed whereas C-2 has completed actions on eight (08) directives. Figure 3 provides information on review and assessment activities carried out by PNRA for operating nuclear power plants K-1 and C-1 during 2009.

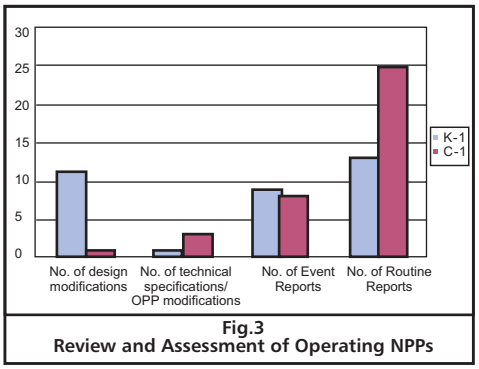


Fig.3
Review and Assessment of Operating NPPs

PNRA also reviewed In-Service Inspection (ISI) programme for C-1 for next ten years cycle. Under the existing regulations, operating licence is issued to nuclear power plants for ten years. After completion of ten (10) years of operation, plant has to perform its comprehensive safety review called "Periodic Safety Review" (PSR). In PSR it has to be determined that the plant can be safely operated and can meet the current regulatory requirements and safety standards. The operating licence issued to C-1 will expire in December 2010 and currently the plant is undergoing a PSR. PNRA is performing online review of PSR reports by forming a dedicated review team. A detailed work plan has been prepared in consultation with C-1 for completing the review in time. The submission of reports will complete in June 2010 and review is expected to complete in the third quarter of 2010 so that a decision regarding licence revalidation may be taken by the end of 2010. K-1 has submitted a request to PNRA to extend the operating licence for ten years i.e., upto 2019. The request is being analysed at PNRA and a decision for extending the licence or otherwise will be made by the end of this year.

Under Construction Nuclear Power Plant (C-2)

In November 2009, PNRA received an application from PAEC for allowing fuel loading in C-2. The request was accompanied with the Final Safety Analysis Report (FSAR) and Probabilistic Safety Assessment (PSA) report alongwith other submissions required for the permit. PNRA has started the review of submissions and a review team comprising experts in relevant fields has been formed for performing the review and a detailed work plan has been prepared with targets and milestones to complete the review. The detailed review is expected to be completed by November 2010.

PNRA has completed the review and assessment of commissioning programme and Pre-Service and In-Service Inspection (PSI/ISI) programme of C-2. The implementation of corrective action on review queries of both the documents is being followed-up.

In 2009, PNRA issued nine (09) directives to C-2 and the licensee has completed actions on eight (08) of these directives.

Nuclear Power Plants in Planning Stage

Pakistan Atomic Energy Commission (PAEC) has planned to install two new nuclear power plants (C-3 and C-4) of 340 MWe at Chashma site. PAEC submitted application for registration of site for

C-3 and C-4 alongwith Site Evaluation Report (SER). The national regulations require submission of SER and No-Objection Certificates (NOCs) from relevant government agencies for registration of site. PAEC has submitted some of the required NOCs whereas some are still awaited. A decision on site registration will be made after receiving the remaining NOCs.

Licensing of Operating Personnel

PNRA ensures that each nuclear installation has appropriately qualified and trained operating personnel available throughout the life span of the facility. In accordance with Regulations PAK/913, the operating personnel requiring a license from PNRA include the Shift Supervisors, Shift Engineers and Reactor Operators. PNRA conducts oral and practical operating examination for award of licenses to these personnel. Such licenses are renewed annually.

During the reported period, twelve (12) personnel at C-1 and three (03) at K-1 were granted new Operator's Licences. The licences of existing plant operating personnel were also renewed, including thirty five (35) at C-1, thirty (30) at K-1, and twenty-one (21) at PARR-I and PARR-II. Figures 4 and 5 present a picture of licenses issued to C1 and K1 operating personnel respectively.

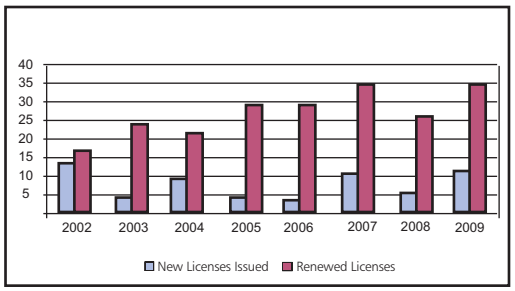


Fig. 4
Licensing of Operating Personnel of C-1

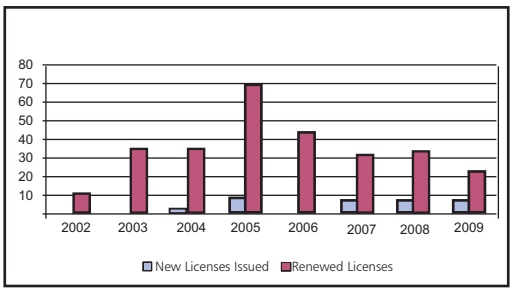


Fig. 5
Licensing of Operating Personnel of K-1

Inspections of Nuclear Installations

The main purpose of regulatory inspections at nuclear installations is to ensure that the licensees are conducting their operation in accordance with the national regulations, license conditions and the directives issued from time to time. It is also verified that appropriate measures are being taken by the licensee to promote safety culture. Various types of routine as well as unplanned and reactive inspections are carried out in agreement with the "PNRA Inspection Programme".

To carry out inspection activities, PNRA has established three Regional Nuclear Safety Directorates in Islamabad, Kundian and Karachi, namely RNSD-I, RNSD-II and RNSD-III, respectively. Resident inspectors have been posted at the two nuclear power plants, K-1 and C-1. The RNSDs conduct regulatory inspections of nuclear installations in their respective regions.

PNRA performed regulatory inspections of various safety related structures, systems and components at K-1. PNRA conducted a total of sixty four (64) inspections and issued five (05) directives to K-1 requiring various actions to be taken to enhance the plant safety. A comparison of regulatory inspections performed during the previous years is presented in Figure 6.

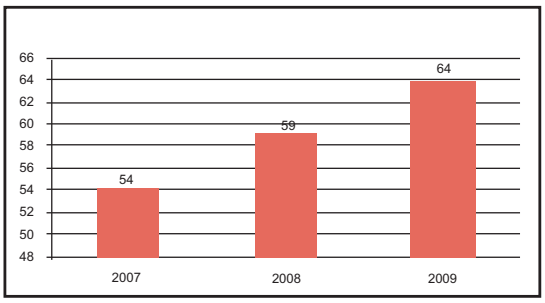


Fig.6
Regulatory Inspections of K-1

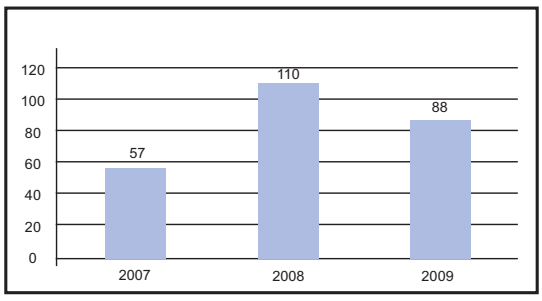


Fig. 7
Regulatory Inspections of C-1

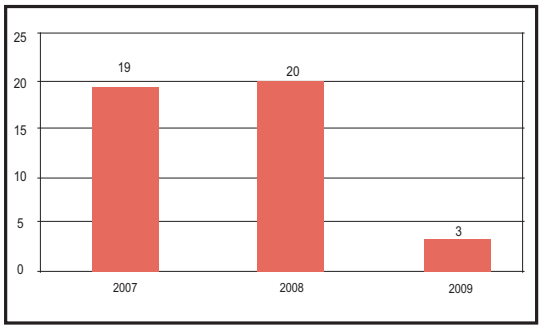


Fig. 9
C-2 Equipment Manufacturer Inspections at China

In 2009, PNRA performed periodic inspections in addition to routine and daily inspections of C-1. Main Control Room inspections were performed as part of daily inspections. In all, PNRA performed eighty eight (88) inspections and issued eighteen (18) directives to C-1 requiring various actions for safety improvement. Regulatory inspections carried out at C-1 have been graphically represented in Figure 7. The findings and observations of these inspections were communicated to C-1 and would be followed-up in subsequent inspections.

PNRA carried out Control Point Inspections at the site of under construction nuclear power plant C-2. During control point, PNRA witnesses the activity or reviews the test results and after the acceptance, licensee is allowed to proceed further. Inspection reports were issued requiring various actions from the licensee, its contractors and sub-contractors. In all, PNRA performed four hundred and thirty six (436) inspections and issued three (03) directives to C-2 requiring various actions for safety improvement. In addition, PNRA performed three (03) inspections at China during equipment manufacturing (Figures 8 and 9).

PNRA performed six (06) inspections of PARR-I and PARR-II in 2009 including special inspection regarding irradiation of Uranium for Mo-99 production at PARR-I. Recommendations were issued identifying deficiencies and requiring the licensee to take necessary actions for improvements in safety.

Equipment Manufacturer (HMC-3)

HMC-3 has been licensed by PNRA for manufacturing safety class mechanical equipment for nuclear power plants in Pakistan. Figure 10 provides the overall representation of the regulatory inspections performed during the manufacturing of these equipment. In 2009, PNRA conducted thirty four (34) regulatory inspections for manufacturing of emergency feed water tank, post accident sampling cabinet and low pressure filter of auxiliary system.

The decreasing trend of regulatory inspection was mainly due to the decrease in number of equipment to be manufactured for C-2 in 2009.

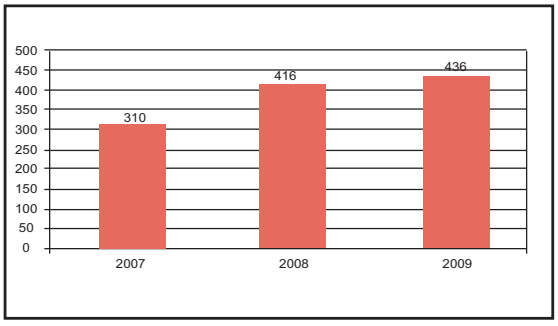


Fig. 8
Regulatory Inspections of C-2

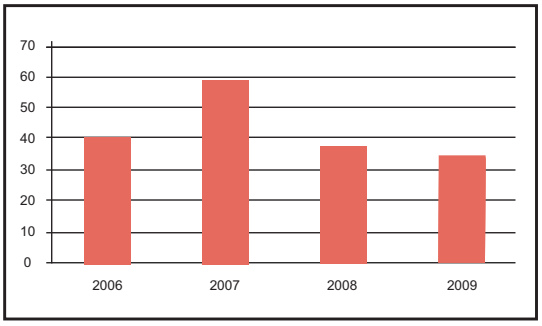


Fig. 10
Regulatory Inspections of HMC-3

4 RADIATION SAFETY

"To protect the radiation workers, general public and the environment from harmful effects of radiation" is the prime responsibility of PNRA. In order to fulfil this responsibility PNRA regulates all issues related to radiation safety at nuclear installations and radiation facilities in the country. PNRA performs licensing of nuclear installations and radiation facilities and conducts review, assessment, inspection, enforcement and other regulatory activities relevant to radiation safety being implemented at these installations and facilities.

PNRA closely monitors the radiation exposure records of radiation workers in nuclear installations and radiation facilities and these records are routinely updated in database of radiation exposures. During the reported period radiation exposures of all radiation workers remained within regulatory limits at all licensed nuclear installations and radiation facilities.

A plan for radiological protection of patients has been initiated to assess the radiation doses to patients in diagnostic and therapeutic radiology. The programme includes data collection from various hospitals and medical centres in the country and subsequent analysis against guidance levels provided in national regulations.

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 programmes of various nuclear and radiation facilities were reviewed during the reporting period. Similarly certain radiation safety implementing procedures and ALARA plans of installations and facilities were also evaluated. Dosimetry programme and dose results were assessed. Evaluation and trending of ambient radiation levels around the nuclear power plants is continuously performed at PNRA. A trend of average ambient radiation levels around nuclear power plants during the previous years is given in Figure 11.

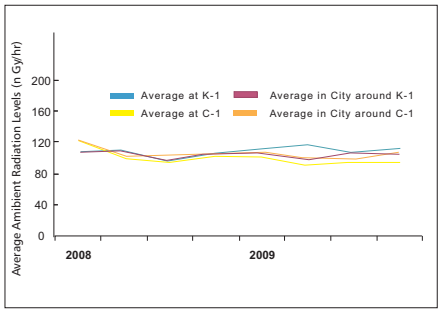


Fig. 11
Trend of Average Ambient Radiation Levels Around Nuclear Power Plants

Radiation Safety at Nuclear Installations

Karachi Nuclear Power Plant, Unit 1

As mentioned in the earlier chapters, K-1 was re-licensed for operation beyond its design life until December 2009. PNRA reviewed several submissions regarding radiation safety during the reported period. K-1 dosimetry programme was evaluated and recommendations were communicated to K-1 for improvement. K-1 annual safety report for the previous year and monthly technical reports of reported period were reviewed. Assessment of radiation exposures to plant workers was performed and these were found to be within regulatory limits. During the reported period a detailed evaluation of radiation exposures to K-1 workers over the past nine years was performed and it was observed that more than 90% workers remained below 10 mSv dose range (Figure 12). Ambient radiation levels at K-1 and in the city were evaluated during the reported period and it was observed that these are generally at the level of natural background of area. Radiation safety remained a core concern in all inspections of K-1. PNRA, in collaboration with K-1 management, ensured better implementation of ALARA and radiation safety principles.

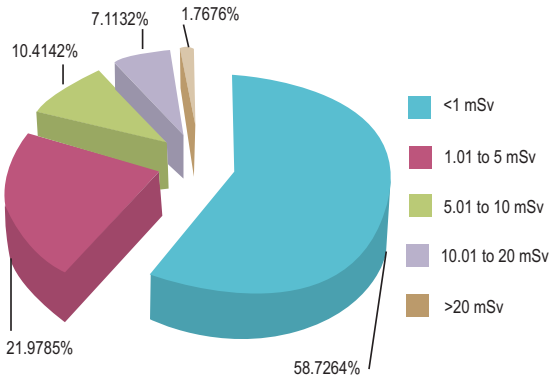


Fig. 12
K-1 Average Distribution of Workers in Different Dose Ranges

Chashma Nuclear Power Plant, Unit 1

After successful completion of 5th Refuelling Outage

(RFO-5) which lasted over a period of about 5 months, C-1 came back into operation in January 2009. RFO activities at C-1 were monitored by PNRA with emphasis on ALARA implementation. Radiation exposures received during RFO-5 were evaluated against exposure estimates, ALARA plans and previous experiences. C-1 annual reports on radiation exposure to workers and environmental monitoring results for the previous year were reviewed during the reported period and results were found to be in compliance with regulatory requirements. A detailed evaluation of radiation exposures to C-1 workers over the past nine years was performed during reported period and it was found that about 95% workers remained in below 1 mSv dose range (Figure 13). C-1 monthly reports were assessed while continuous evaluation and trending of ambient radiation levels at C-1 and in the city was performed in the reported year. It was observed that ambient radiation levels at C-1 are generally at the level of natural background of the area.

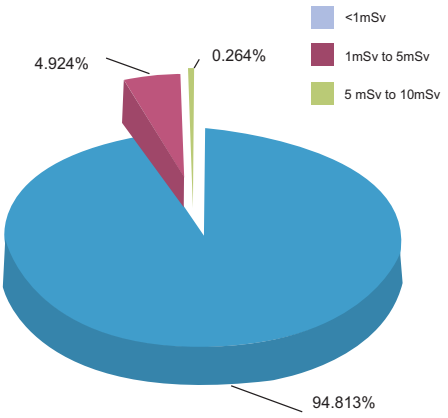


Fig. 13
C-1 Average Distribution of Workers in Different Dose ranges

Radiation Safety at Radiation Facilities

The radiation facility is defined as any facility other than a nuclear installation that uses radioactive material or devices or apparatus capable of generating ionizing radiation for scientific, medical, industrial or research purposes. These facilities include therapeutic and diagnostic radiology centres, nuclear medicine centres, industrial radiography services, blood, food and material irradiators, baggage scanners, oil well logging units, educational and research establishments, agricultural centres etc. PNRA ensures that these facilities are operating safely and the doses to the workers and the general public not only remain well within the regularoy limits but the facilities also follow the ALARA principal.

Licensing of Radiation Facilities

A license from PNRA is required for use of any radioactive material or radiation equipment in medical, industrial, research or any other area. This license is issued for a specific use and for a specified time after thorough review and assessment of safety provisions. By the end of reporting period more than 1975 radiation facilities were licensed with PNRA. These include around 50 large medical centres, 175 industrial users, 48 research institutes, 8 irradiators, 98 importers and more than 1600 diagnostic x-ray facilities. Currently all radiation facilities and about 50% of the diagnostic x-ray centres are licensed with PNRA. PNRA has been working to bring all diagnostic medical facilities under effective regulatory control. During the reported period around 5% increase was observed in the number of licensed radiation facilities. Distribution of various types of radiation facilities are shown in Figure 14.

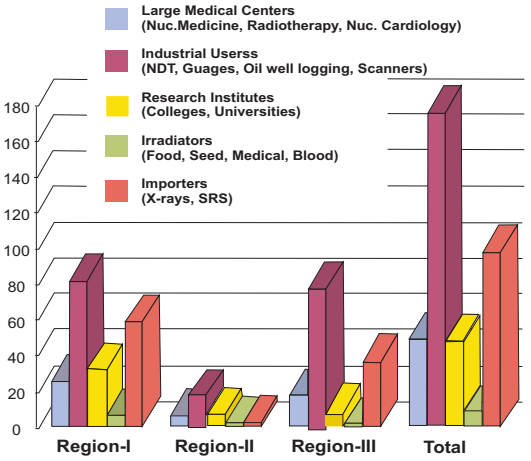


Fig. 14
Distribution and Types of Licensed Radiation

Fig. 15

According to national regulations an appropriate radiation protection programme commensurate with hazard categorization of facility is required to be documented and effectively implemented at radiation facilities. During the reported year, radiation protection programmes and relevant procedures of several major radiation facilities were thoroughly reviewed. Radiation safety design features of a large number of facilities were assessed in the reported year and directives were issued to the respective facilities for improvement. Most of the directives have been complied with and the remaining are being actively pursued by PNRA.

Occupational Exposures at Radiation Facilities

In accordance with national regulations the licensees are required to provide radiation exposure record of all radiation workers on annual basis. This record is verified by PNRA through comparison with the reports of dosimetry service provider. Currently nuclear power plants provide radiation dosimetry services to their own workers while PINSTECH & Karachi Institute of Radiotherapy and Nuclear Medicine (KIRN) provide this service not only to their own workers but also to other radiation workers in private sector on commercial basis.

PNRA maintains a database of this record. Currently, record of around 6,000 radiation workers is available in the database. The database helps in assessing compliance of regulatory dose limits, control of itinerant workers and trending of ALARA implementation. Assessment of radiation exposures to workers was performed and these were found to be within regulatory limits. It was assessed during a study of ten years record that around 95 % of workers remained in less than 5 mSv dose range. Distribution of workers of radiation facilities in different dose ranges is given in Figure 16.

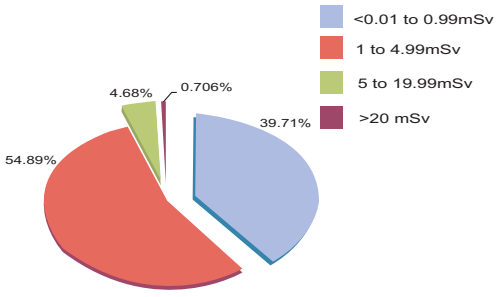


Fig. 16
Distribution of Workers of Rediation Facilities In Different Dose Ranges (1998-2008)

Inspections of Radiation Facilities

In order to ensure compliance with regulatory requirements and implementation of radiation safety / ALARA principle at licensed facilities PNRA conducts periodic inspections of all radiation facilities and if required special inspections are also performed. Around one thousand five hundred (1500) inspections of radiation facilities were performed throughout the country during the year. These inspections mainly focused on facility-design, functioning, work practices and ALARA implementation. Inspection reports containing recommendations for improvement in compliance of regulations and ALARA principle were issued to inspected facilities and appropriately followed-up. An increasing trend of number of inspections performed is observed during the preceding years (Figure 17) which is mainly because of increased number of licensees and improved regulatory control.

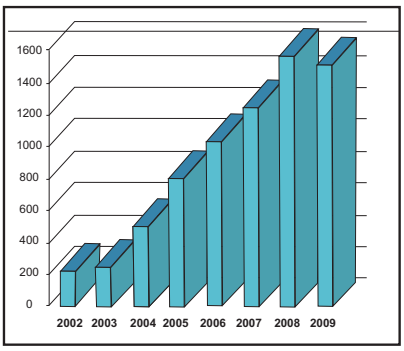


Fig. 17
Regulatory Inspections of Rediation Facilities

Authorization for Import and Export of Radiation Sources and Equipment

PNRA keeps a "cradle to grave" control on all radiation sources being imported and used in the country. In this regard record of all radiation sources or equipment being imported in or exported out of the country is maintained. A No Objection Certificate (NOC) from PNRA is required for import or export of any radiation source or equipment. This NOC is issued to only licensed users or importers after verification of source / equipment information details and intended end use. During the reported period number of NOCs issued was more than 1100. Out of these, about 1000 NOCs were issued for import of Sealed Radioactive Sources (SRS) and radiation apparatus while about 100 were issued for the export of disused sources to the original supplier.

5
WASTE AND TRANSPORT SAFETY

Radioactive waste is generated as a result of operation of nuclear facilities, and application of radionuclides in industry, medicine, research, etc. Such waste contains materials that emit ionizing radiation, which has been recognized as a potential hazard to human health and the environment. The safe management of radioactive waste is therefore essential to protect members of the public and the environment from the harmful effects of ionizing radiations now and in the future, without imposing undue burdens on future generations. Long term safety of radioactive waste cannot be ensured until it has been emplaced in a disposal facility so as to contain it and isolate it from the biosphere. This requires formulation of a national waste management policy wherein the roles and responsibilities of relevant government organizations are clearly defined.

The responsibility for regulating the safe management of radioactive waste has been entrusted to PNRA under the Ordinance. Subsequently, PNRA has established national regulations on radioactive waste management – PAK/915 for the safe management of radioactive waste in the country. PNRA ensures that the requirements of these regulations are implemented by every user of radioactive material through review and assessment, inspection, authorization and enforcement actions at various stages.

Radioactive Waste Safety at Nuclear Facilities

PNRA ensures safety of radioactive waste of nuclear facilities through review and assessment of licensees' submissions, inspection, issuance of authorization, etc. During these processes, it is ensured that discharges due to the operation of nuclear facilities are kept as low as reasonably achievable (ALARA) so that the doses to the members of the public are kept to a minimum possible. Following is a brief description of the discharges and radioactive waste management practices at different facilities:

Karachi Nuclear Power Plant, Unit 1

PNRA ensures that the operator maintains round the clock monitoring of gaseous effluent such as tritium, radioiodine, radioactive noble gases and radioactive particulates, released through KANUPP stack. The liquid effluent is discharged to sea. KANUPP has established its Derived Release Limits (DRLs) for liquid and gaseous effluents based on 30% of public dose limit (1 mSv) as required under PAK/915. The annual gaseous releases to atmosphere (Figure 18), via stack remained well below these derived release limits during the year 2009. During the same period, the activity released to sea, as liquid effluent (Figure 19), was also much lower than the release limits.

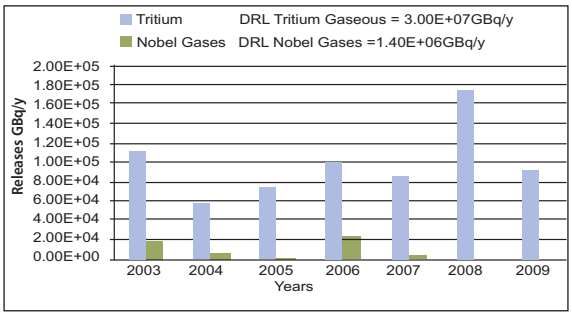


Fig. 18
Gaseous Effluent Releases from K-1

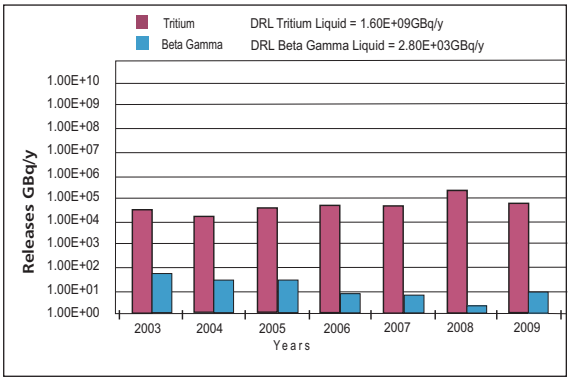


Fig. 19
Liquid Effluent Release from K-1

Solid Waste

K-1 has radioactive waste of more than 35 years of its operation. PNRA ensures the safety and security of this radioactive waste. On the recommendations of PNRA, K-1 has started to compile the inventory of all radioactive waste generated since its operation. So far, K-1 has provided the inventory of the last 18 years. During this year PNRA asked K-1 to expedite the compilation of remaining inventory. K-1 has also started work for the establishment of radioactive waste storage facility. Figure 20 provides information regarding the number of compacted drums stored at K-1 as solid radioactive waste generated due to operation of K-1. The total activity of solid radioactive waste has been shown in Figure 21.

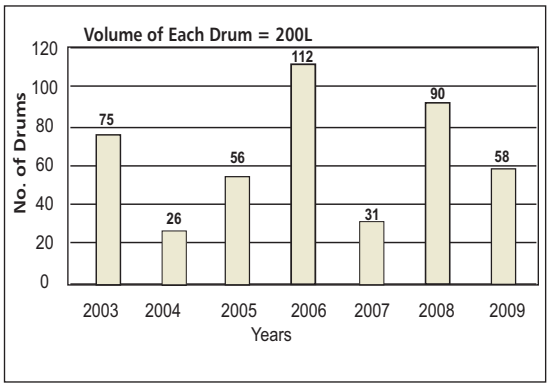


Fig. 20
Compacted Waste (LILW-SL) Drums Generated at K-1

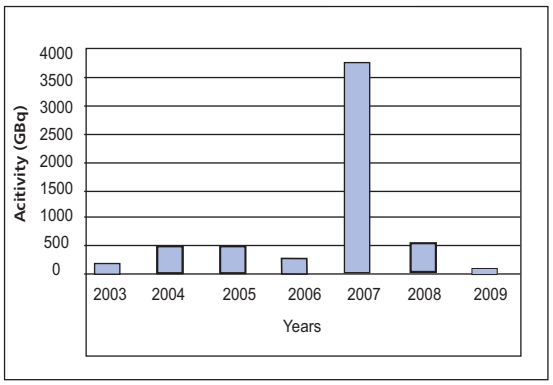


Fig. 21
Total Activity of Solid Radioactive Waste Generated at K-1

Chashma Nuclear Power Plant, Unit 1

PNRA emphasises that the releases of radioactive effluents from C-1 to the environment are kept at minimum possible and ensures that in no case should exceed the regulatory limits.

Gaseous waste treatment at C-1 includes pressurized storage of the radioactive hydrogenated effluents in 6 hold-up tanks for 60 days until they decay down to a value allowable for discharge to the environment. Discharge of gaseous waste is allowed to continue if the radioactivity level is less than 10 GBq/m3 and discharge is terminated if radioactivity level is greater than this value. Figure 22 provides the total activity released in gaseous effluents by C-1 during the previous years. The discharges remained less than 2% of the technical specification limit.

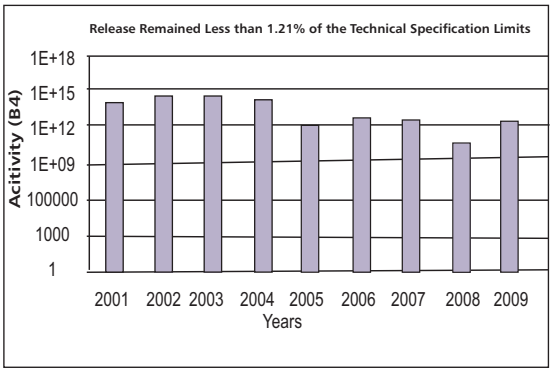


Fig. 22
Total Activity Released in Gaseous Effluents from C-1

The liquid wastes, depending upon radioactivity level and nature of source are collected in three different and independent collecting tanks. The liquid waste is directly discharged to environment if the radioactivity level of liquid waste is less than the limit 370 KBq/m3. Figure 23 provides the total activity released in liquid effluents by C-1 since the start of its operation in 2001. The discharges remained less than 1% of the technical specification limits.

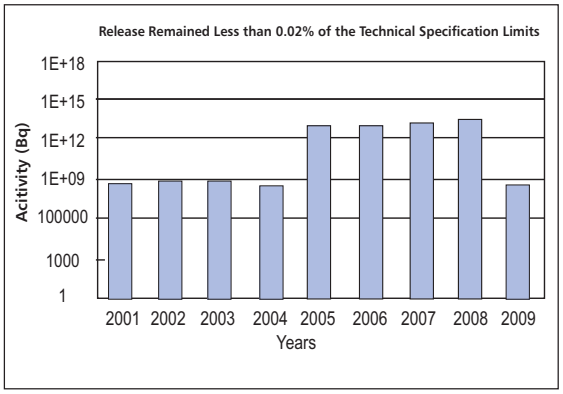


Fig. 23
Total Activity Released in Liquid Effluents from C-1

Solid Waste

The solid wastes generated at the plant are stored in the storage building at the plant. The design capacity of the storage building is for 10 years. PNRA ensures that during the operation of NPP, consideration is given to the minimization of radioactive waste generation. PNRA also keeps a watch on the available capacity of waste storage building and ensures that sufficient space is available for radioactive waste to be generated as a result of operation of C-1.

At C-1, the waste includes spent activated charcoal,

decontaminated large equipment and components, spent filter cartridges, low level cartridges, contaminated spare parts and miscellaneous dry wastes. Only the miscellaneous dry soft wastes are hydraulically compressed.

At the start of the operation, C-1 had a capacity of 1700 drums available for storage. At the end of the year 2009, the total number of stored drums was 1015 and the available capacity was 685 drums. Figure 24 provides the numbers of compacted waste drums produced and stored at C-1 against the available space which is periodically monitored by PNRA resident inspectors. PNRA is pursuing C-1 to increase the storage capacity for future operation. C-1 has started work for the establishment of additional waste storage building for the storage of radioactive waste to be generated as a result of the operation of nuclear power plant at Chashma site.

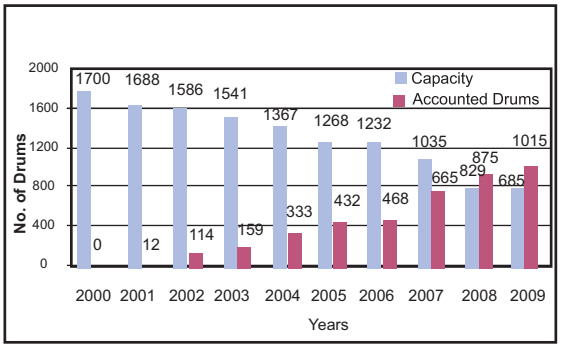


Fig. 24
Compacted Waste Drums Accumulation vs Capacity at C-1

PINSTECH

PINSTECH is a multidisciplinary research facility of PAEC which has two research reactors, PARR-1 and PARR-2. Besides generating waste from R & D activities, PINSTECH is one of the designated sites for storage of waste generated from other radiation facilities in Pakistan. Solid waste is collected in batches and generally consists of cotton overshoes, rags, tissue papers, cotton dusters, gloves, towels, empty vials, etc. The medium level active waste is usually spent resin and water filters from demineralizer and carbon filters from reactor exhaust stack. It is embedded in cement-sand-concrete matrix and filled in concrete lined standard mild steel (MS) drums [Figure 25] as RCC barrels. Compaction facility having 4-5 times volume

Fig. 25

reduction capability is available at PINSTECH. The volume of low level waste (LLW) collected at PINSTECH varied from year to year. Figure 26 shows the number of cementized and compacted containers produced at PINSTECH. The waste management activities at PINSTECH are regularly monitored and no deviation from the requirements of national regulations and international standards were observed during the reporting year.

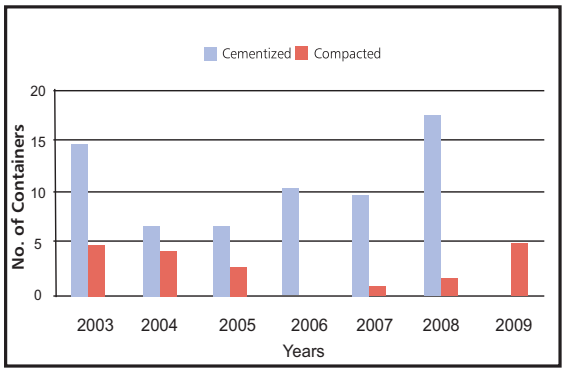


Fig. 26
Cementized and Compacted Containers at PINSTECH

Management of Disused Sealed Radioactive Sources

The national regulations on radioactive waste management require that sealed radioactive sources (SRS) containing long lived radionuclides (half life >1 year with initial activity of 100 GBq or more) shall not be purchased without the undertaking from the manufacturer/supplier to accept the return of the source(s) when it is no longer useful:

Disused sealed radioactive sources (DSRS),

maintained in the inventory of the users for disposal and those not covered above shall be transported within Pakistan only under prior intimation to PNRA. The responsibility for the sources will remain that of the user/licensee until such time as the source(s) passes into the custody of waste storage facility designated by PNRA. K-1 and PINSTECH have been designated as interim storage facilities for DSRS generated from industrial, medical, research, etc. facilities located in the southern and northern part of Pakistan. The DSRS management patterns are depicted in Figures 27 and 28. Of the total SRS imported so far in Pakistan, 3% have been returned to the supplier as per above policy, 56% have been transferred to PINSTECH and (12%) are stored at K-1. The remaining 29% are in use by the licensees.

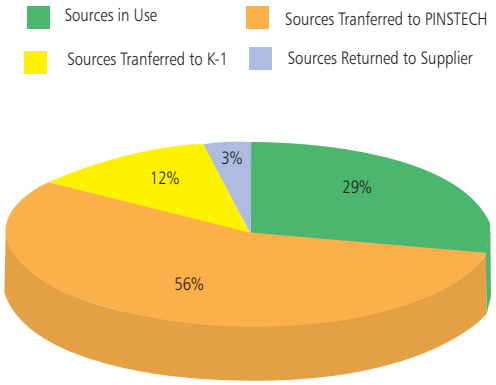


Fig. 27
Status of Imported SRS

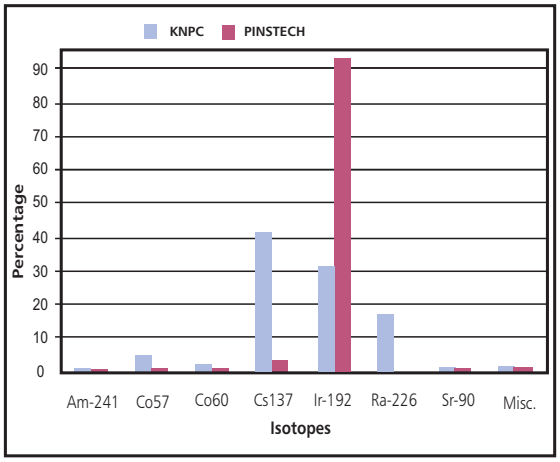


Fig. 28
Disused Sources in Country

Inspections in the Area of Waste Management

In addition to routine inspections by all the three Regional Directorates, WSD in coordination with Regional Nuclear Safety Directorates (RNSDs) conducted special inspections of nuclear and radiation facilities to verify compliance with the regulatory requirements. These inspections mainly focused on storage facilities and radioactive waste management programmes to assess the safety of waste collection, classification, treatment, conditioning, storage and disposal practices at these facilities. During 2009, WSD also conducted 17 special inspections in collaboration with regional directorates in the area of environmental and waste safety.

Safe Transport of Radioactive Materials

Besides controlling radioactive waste in the country, PNRA also regulates transportation and ensures safe transportation of radioactive material to protect the public and the environment from the associated hazards. To regulate the safe transport of radioactive materials, PNRA adopted the IAEA Regulations for the Safe Transport of Radioactive Material 1996 Edition (TS-R-1 as amended 2003) and gazette notified them as National Regulations for Safe Transport of Radioactive Materials (PAK/916). In accordance with these regulations, technical guidance was provided to the various establishments dealing with transportation of radioactive material or radioactive sources, specifically regarding proper labelling, marking, content limiting of packages, etc.

PNRA ensures that consignors and carriers fulfil their obligations and comply with the national 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 the national and international requirements for transportation.

The Regional Directorates of PNRA conducted inspections to verify compliance with regulatory requirements and ensure the safety of the radioactive materials being transported within the country.

6
EMERGENCY PREPAREDNESS

Nuclear installations and radiation facilities are designed and operated to a very high level of safety with advanced engineered safety features to prevent any accident. A strict regulatory control is exercised throughout the life of installations and facilities commencing from siting, continuing throughout the design, construction, installation, commissioning, operation and terminating at decommissioning to ensure safe operation and prevention of accidents. Nevertheless there always remains a probability of occurrence of accidents, though quite rare as compared to other conventional industries. Therefore there is always a need for preparedness to respond and mitigate the consequences of incidents that might occur at a nuclear installation or radiation facility affecting workers, public and environment. PNRA has been obliged by the Ordinance to ensure, coordinate and enforce the preparation and implementation of emergency plans for actions to be taken following a radiological emergency.

PNRA has developed National Regulations on Management of Nuclear Accident or Radiological Emergency (PAK/914) which require the licensees to have the emergency plans, necessary workforce, equipment and mechanism in place for responding to any such eventuality. The licensees are also required to have their own setup for synchronization with offsite response organizations for actions to be taken if need arises.

Nuclear installations and radiation facilities have been categorized according to hazards associated with them and requirements for emergency preparedness are commensurate with their hazard categorization. PNRA not only reviews and approves the emergency preparedness plans of the facility but also witnesses the implementation of these plans through exercises and drills.

PNRA is maintaining a National Radiation Emergency Coordination Centre (NRECC) and Nuclear Security Emergency Coordination Centre (NuSECC) at Islamabad to play key role of coordination with licensees, government organizations, response agencies and other international bodies.

Emergency Plans and Drills

The objective of regulatory review of emergency plans is to ensure that emergency plan is commensurate with regulatory requirements, all possible control and mitigation steps are incorporated and over all plan is implementable. During the reported period, PNRA has evaluated the emergency plans of nuclear power plants and major radiation facilities. K-1 submitted its on-site and off-site emergency response plan which was reviewed in detail and recommendations for improvement were communicated to the licensee. K-1 will submit the revised plan in the next year for re-evaluation. Similarly PINSTECH also submitted off-site emergency response plan which was reviewed in the light of applicable requirements and advice was provided to licensee for improvement.

Emergency plan implementing procedures of C-1 were also reviewed during reported year. Emergency plans of major radiation facilities including radiotherapy and nuclear medicine hospitals, industries and research institutes were reviewed and accordingly recommendations were communicated for compliance.

The licensee is required to conduct exercises and drills on regular basis to ensure the effectiveness and implementability of emergency plans. Such exercises and drills of nuclear installations and major radiation facilities are closely witnessed by PNRA to confirm that the plans are workable and the licensee is fully prepared to execute them as and when required. PNRA also invites representatives from the relevant governmental departments / ministries to witness drills at nuclear power plants. During the reported period PNRA witnessed seven exercises and drills conducted by various licensees.

PNRA observed integrated and partial emergency exercises of C-1 in May and December 2009 respectively. K-1 annual radiological emergency exercise was also witnessed in reporting year. Similarly PINSTECH conducted its annual emergency drill in December 2009. Emergency drills of certain industries were also conducted during reported year. Recommendations for improvement were discussed with licensees and communicated in detailed reports for implementation.

National Radiation Emergency Coordination Centre (NRECC)

PNRA established National Radiation Emergency Coordination Centre (NRECC) in 1988 for

coordination of nuclear or radiological emergencies at national and international level. Since then the centre is operational and being improved. Currently this centre is equipped with necessary communication facilities and is operational round the clock. The centre is supported by two Mobile Radiological Monitoring Laboratories (MRMLs) and various types of radiation detection and personal protective equipments are available in this centre.

Pakistan is a signatory to the International Conventions on Early Notification and Assistance in case of Radiological Emergency. Under these conventions member states are obliged to notify IAEA and neighbouring counties in case of any radiological emergency in their country which can affect neighbouring countries. NRECC has been designated as the National Warning Point (NWP) under the obligations of these conventions.

NRECC conducts different types of emergency exercises and also participates in exercises and drills conducted by its licencees and IAEA. Exercises conducted by NRECC include COMmunication Test EXercise (COMTEX), Mobile Radiological Monitoring Laboratory Exercise (MRML Exercise) and Field

Demonstration of NRECC Role and Activities to Public Visitors

Views During an Emergency Exercise

Exercises (FieldEx). In the COMTEX exercise NRECC verifies the availability of communication channels with licensees and regional directorates of PNRA while in MRML exercise the capability to respond to an event involving radiation monitoring is tested. During the reported period NRECC conducted three COMTEX exercises and four MRML exercises. NRECC also conducted a field exercise in collaboration with KRL. During this exercise different response activities including radiation survey, rescue of victims, monitoring and decontamination of responders were demonstrated.

NRECC participates in exercises conducted by IAEA under the international conventions (ConvEx). These exercises focus on verification of international communication channels and capability of member states to evaluate and respond to different radiological accidents. IAEA conducted four ConvEx exercises during 2009 and NRECC participated in all these exercises. One of these exercises was a major exercise conducted on 13-14 August 2009. NRECC remained fully active during this exercise for 48 hours and representatives from other organizations were also invited for technical evaluation and support. Technical evaluation of the exercise by NRECC was communicated to IAEA and requested assistance was offered in this regard.

Technical Evaluation by Representatives of PNRA and other Organizations During Response to Exercise

Nuclear Security Emergency Coordination Centre (NuSECC)

PNRA established Nuclear Security Emergency Coordination Centre (NuSECC) in Islamabad in year 2007 to assess, control, respond and co-ordinate in case of an emergency pertaining to nuclear security at national level. This centre is equipped with radiation monitoring and identification devices and remote handling tools. This centre is currently supported by five nuclear security inspectorates in Islamabad, Chashma, Peshawar, Karachi and Quetta and one inspectorate in Multan is planned to be established. PNRA is in the process of establishing six nuclear security emergency response vehicles to be stationed one each at Islamabad, Peshawar, Kundian, Multan, Karachi and Quetta. It is envisaged

Network of Emergency Mobile Laboratories

that in case of an emergency these mobile laboratories will be able to reach within four to six hours in most areas of the country.

In order to increase awareness among masses about radiation, its hazards, radiation protection principles and detection techniques, NuSECC participated in 2nd National Disaster Management Exhibition and Conference, organized by NDMA at Islamabad.

Nuclear Security Emergency Exercise

IAEA Response Assistance Network (RANET)

IAEA Response Assistance Network (RANET) is an integrated system established by IAEA under the International Convention on Assistance in case of Nuclear Accident or Radiological Emergency. Under this network member states register and pool their capabilities to detect, measure, respond or mitigate radiological emergencies and when required any member state can request or offer assistance under this network. PNRA is the national contact point under this network. In 2008 Pakistan registered its assistance capabilities in different areas of response. During the reporting period, PNRA arranged coordination meetings of RANET team members comprising of officials from PNRA, PAEC and KRL to streamline the pre-requisites in order to render or request assistance under RANET. Procedures were developed for requesting or offering assistance. These procedures were tested during the conduct of IAEA ConvEx exercise in August 2009, aimed to test such procedures of participating states.

Awareness and Training of First Responders

In case of any emergency, members of rescue organizations are always the first ones to reach the scene of accident. The trained rescuers can play important role to avoid spread of contamination and over-exposure to the radiations. In order to train the first responders, PNRA developed liaison with Punjab Emergency Service RESCUE 1122 and NBC wing of Pakistan Army. During 2009, two training courses were arranged at RESCUE 1122 Academy and around 500 first responders and 80 officers participated in these courses. The training was based on class room lectures, table top exercise and field exercise. The programme also included practical demonstration on use of different radiation detection and personal protective equipment. Coordination with NBC wing of Pakistan Army was developed during reported period and "train the trainer" programmes were proposed to be conducted during coming year.

Coordination Meeting of RANET Team Members from PNRA, PAEC and KRL

Training of First Responders at the RESCUE 1122

For the awareness of the first responders, PNRA has prepared pamphlets and booklets regarding rescue activities, control of contamination spread and personal protection during response to a radiological emergency.

Training of Medical Professionals in Handling of Radiation Injuries

A committee was instituted in 2005 for development of national capabilities for handling and management of exposed/contaminated individuals. This committee comprises of representatives from PNRA, PAEC, KRL, NESCOM and GHQ. The committee is aimed to pay special attention to ensure that adequate level of capabilities exist among medical doctors on medical management of radiation victims. During the reported period the committee continued its activities. Management level meetings of members from the participating organizations were conducted to discuss progress of proposed activities and give recommendations for future planning. The committee planned that PNRA in collaboration with GHQ arrange short training courses for medical doctors in CMH/MH and hold seminars at various hospitals in 2009; however these were postponed for 2010. Committee proposed establishing model units for medical management of radiation victims in different cities of Pakistan. Development of first model unit in this regard as proposed by the committee is in progress at KRL Hospital, Islamabad.

Meeting with Medical Professionals for Developing the National Capabilities for Handling of Overexposed / Contaminated Individuals

7 PUBLIC SECTOR DEVELOPMENT PROJECTS

The Government of Pakistan has approved the following six PSDP funded projects for capacity building and strengthening of PNRA:

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

The progress on each of these projects in 2009 is given below:

Institutional Strengthening and Capacity Building of PNRA Regarding Regulatory Activities Related to Licensing of NPPs

This project started in June 2005. Under this project PNRA has established a technical support organization called the "Centre for Nuclear Safety" to provide technical support for review and assessment of Chashma Nuclear Power Project Unit-2. As per plan, the project was to be completed by the mid 2010, however, due to paucity of funds (not released from the government as per allocation), some of the essential training items which also involve fundamental element of foreign training, are yet to be completed. Therefore, the project has been extended for a further period of one year i.e. up to 2011. Although, the project is yet in the execution phase, the CNS is providing technical support to PNRA technical directorates in the review & assessment and inspection of the licensees. In addition, CNS has also taken initiatives in research and development activities which will form the basis for regulatory decision making in specialized areas such as deterministic and probabilistic safety analysis, stress analysis, NPP site evaluation, radiological hazard analysis in case of anticipated accidents at NPPs etc. All these activities will lead to the development of indigenized capability of PNRA to perform regulatory functions in an effective and efficient manner, contrary to the previous practice of reliance on the regulators of foreign countries for assessment of plant safety.

Fifty five professional staff have been recruited and trained under this project and these professionals are now responsible for the review of C-2 Final Safety Analysis, preparation of national report on Convention of Nuclear Safety and periodic safety review of C-1 as part of ten yearly license renewal process.

The performance of CNS is continuously monitored by the Planning and Development Division, Government of Pakistan. During the monitoring the planning Division has appreciated the initiatives and achievements of CNS against various milestones and termed the project as a model project. CNS has been contributing to PNRA technical directorates in various licensing activities pertaining to nuclear power plants and nuclear research reactors.

In 2009, CNS has provided technical input during review of design modifications and inspections. Following are some of the major assignments in which CNS has provided technical support to PNRA during the reporting period:

- Review of Safety Analysis Report of C-2;
- Review of C-2 Commissioning Programme;
- Periodic Safety Review of C-1 for 10 year license renewal;
- Analysis of Design Basis and Beyond Design Basis Scenarios;
- Probabilistic Safety Analysis of K-1, and C-1;
- Pre-service and In-service Inspection Programme (PSI/ISI) of C-2;
- In-service Inspection Programme (ISI) of C-1 for second ten yearly interval;
- Participation in inspection of C-2 during equipment manufacturing, construction and installation phase;

- Re-evaluation of seismic hazards at NPP sites regarding g-value;
- Estimation of damage caused by nuclear accident considering Chashma Site as a reference;
- Stress analysis of K-1 steam generator tubes.

Capacity Building of PNRA to Implement National Nuclear Security Action Plan

The Nuclear Security Action Plan (NSAP) project started in 2006 and since its inception it is steadily progressing to develop a sustainable national nuclear security programme with a response and recovery capabilities, integrated with national laws. The proactive role played by PNRA through this programme in promoting nuclear security culture in Pakistan has resulted in positive feedback from the national as well as international circles. Over the past year, the Project has accomplished major tasks envisaged in the plan which are described below:

PNRA continued to ensure, through inspections, adequacy of physical protection measures around nuclear installations including K-1, C-1, C-2 and PARR-I & II and other radiation facilities. During 2009, six (6) inspections of nuclear facilities and fifty three (53) inspections of radiation facilities using Category 1-3 sources were conducted to review the status of physical protection measures. PNRA recommended the use of technology based solutions to upgrade the physical protection measures on such facilities. PNRA is assisting twelve medical centres in the public and private sector using high activity radioactive sources for their physical protection upgrades.

As one of the licensing conditions, PNRA obtains physical security plans (PSP) for the nuclear and radiation facilities using high activity radioactive sources. During the reported period licensee's submittals on the PSPs for K-1, C-1 and C-2 and of twenty two radiation facilities were reviewed and directives were issued for further improvement of their plans. These will be verified during the subsequent inspections.

Under Nuclear Security Training Centre(NSTC) which aims to provide trainings in the field of nuclear security with a comprehensive approach of prevention, detection of and response to potential nuclear and radiological threats, following activities were conducted in 2009:

- Eleven (11) training courses were conducted on Physical Protection of nuclear material & nuclear facilities and security of radiation facilities using high activity sources.Two hundred and twenty two (222) personnel from different organizations were trained.
- Nine (9) training courses were arranged for Pakistan Customs on "Combating Illicit Trafficking of Nuclear and Other Radioactive Materials" and on "Use of Radiation Detection Equipment for Detection of Nuclear & other Radioactive Materials at International Borders". One hundred and sixty two (162) officials were trained in these courses.
- Training was provided to the personnel from response organizations, District managements, law enforcing agencies etc. about their roles in responding to malicious acts involving nuclear or other radioactive materials. During the reported year NSAP conducted two (02) tabletop exercises for the establishment of coordination with response organizations based at Karachi and Islamabad. In addition, a field exercise on "Response to Malicious Act in a Public Area" at Islamabad was also conducted to test the capabilities of response and coordination among different organizations.

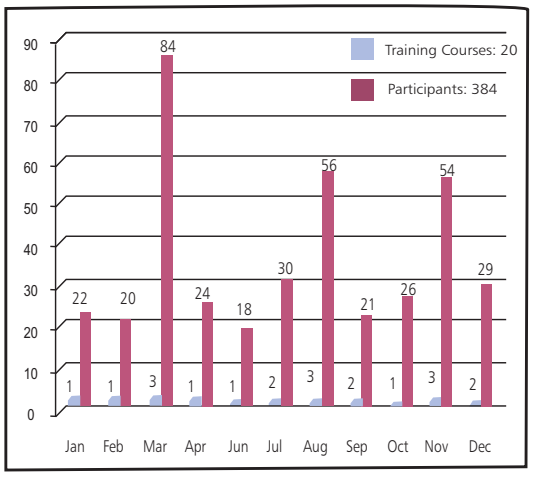


Fig 29
Training Courses Conducted by NSAP

Orphan Radioactive Sources Recovered in 2009

The orphan radioactive sources can result in a number of undesirable consequences to human health as well as economic and environmental damages. Therefore, PNRA has chalked out a strategy for "Locating and Securing Orphan Radioactive Sources in Pakistan" and continued this effort during the year 2009. Under this approach, thirty one (31) non-physical and physical searches were conducted at the target locations including airport cargo terminals, dry ports, seaports, scrap yards, steel mills, and exploration sites etc. During these searches, three orphan sources were recovered. These incidents were reported to IAEA Illicit Trafficking Database (ITDB).

An important step to combat illicit trafficking of nuclear and other radioactive materials is to interdict their unauthorised movement at the international borders. PNRA provided training and radiation detection equipment to Pakistan Customs at International borders which include Sost (Pak-China Border), Torkhum (Pak-Afghan Border), Taftan (Pak-Iran Border), Chaman (Pak-Afghan Border), Wahga (Pak-India Border), Gwadar, Karachi and Bin Qasim Sea Ports (Arabian Sea). A continuous coordination is established with these border posts for issues related to operationalization and sustainability of the equipment and provision of expert opinion on suspected material.

A Glimpse from a Field Exercise at Chaman

School for Nuclear and Radiation Safety

The project started in 2005 and is expected to be completed in 2011. Under this project PNRA has established a School for Nuclear and Radiation Safety (SNRS) to improve the competency level, knowledge and skills of the newly recruited officers as well as to conduct refresher courses for the existing staff. A separate school building is under construction whereas, for interim period school is established in PNRA Headquarters building.

SNRS has arranged a number of courses between 2003 and 2009 and trained a large number of officials as shown in Figure 30.

The School possesses well equipped class rooms, computers and multimedia systems and can assist the international community in enhancing the competency of those professionals who are expected to be engaged in nuclear regulatory activities.

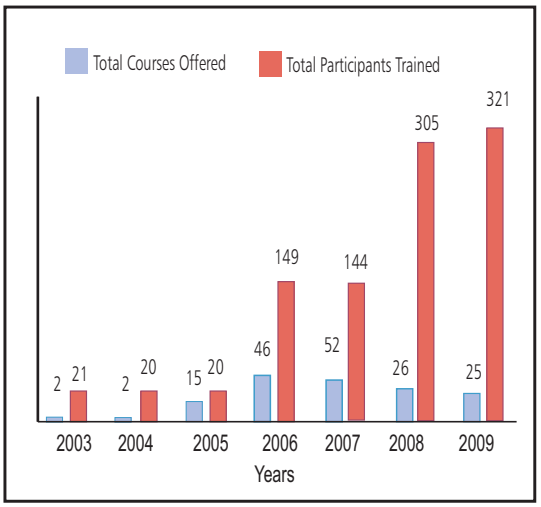
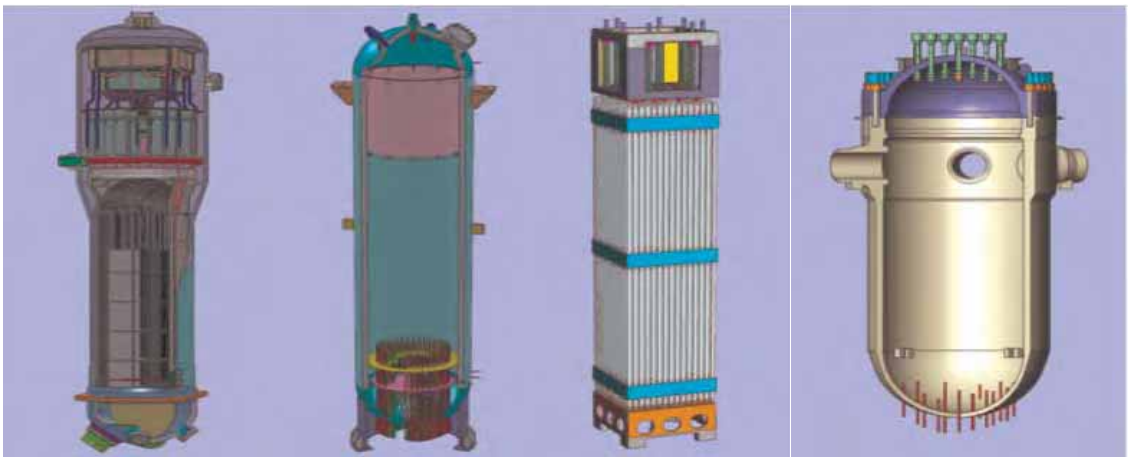


Fig. 30
Training Courses Conducted at SNRS



Models of Steam Generator, Pressurizer, Fuel Assembly and RPV

Other facilities at the training centre include PWR simulator, physical models of plant equipment, radiation protection laboratory and various computer codes.

During 2009, SNRS has conducted fifteen (15) training courses and ten (10) lectures on specialized areas. A total number of 259 officers from PNRA as well as PAEC have been trained in these courses whereas the lectures were attended by 62 officials from PNRA.

SNRS also arranged 13 courses for its employees at different local training institutes. A total of 69 officials of PNRA participated in these courses. A comparison of the training courses attended by officials of PNRA at various national institutes during the previous years is shown in Figure 31.

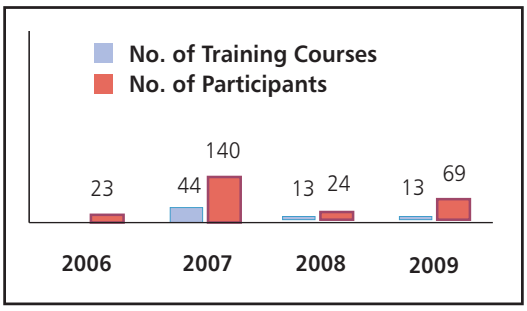


Fig. 31
Training Courses Arranged at Local Training Institutes

National Dosimetry and Protection Level Calibration Laboratory

Radiation dosimetry services are currently being provided by K-I and C-1 to their workers only while

Classroom Pictures

private users as well. These services are insufficient to cater future demands as the number of radiation workers in the country are increasing with the increased use of ionizing radiation sources/generators in industry, medicine, agriculture, energy, research and development. PNRA being a key organization for radiation protection in Pakistan felt the need and a proposal for the establishment of dosimetry services at national level was initiated.

The PC-1of the project "Establishment of National Dosimetry and Protection Level Calibration Laboratories-(NDCL)" sponsored by PNRA was approved by the Government of Pakistan under the Public Sector Development Programme (PSDP) in year 2007 for the provision of:

- External Dosimetry Services (TLD & Film Badge Dosimetry);
- Internal Dosimetry Services (Whole Body Dosimetry & Bio-Assay Laboratory);
- Protection Level Calibration Services.

Under this project two full fledges NDCL laboratories are being established in Islamabad and Karachi and one internal dosimetry services laboratory at Kundian.

The project will complete its 3 years in June-2010. The project has achieved important physical targets including recruitment of staff and their training at PINSTECH, selection and procurement of some laboratory and office equipments, acquisition of land and finalization of designs for construction of laboratory.

Keeping in view the needs and objectives of the project and current financial constraints every possible effort is being made to establish the NDCL laboratories in stipulated time and within allocated resources.

National Programme on Environmental Radioactivity Surveillance

Under the obligations of PNRA Ordinance, PNRA is required to implement a national programme of environmental surveillance to check any build up of radioactivity that might affect public. Accordingly, the Government of Pakistan approved a PC-1 for the project on Establishment of National Environmental Radioactivity Surveillance Programme (NERSP) under the Public Sector Development Programme in 2007. Work remained in progress for the establishment of national laboratories in Islamabad, Kundian and Karachi. In this regard, land has been acquired for the establishment of laboratories at Islamabad and Karachi. In order to make NERSP laboratories operational, the process of procurement of necessary equipment from foreign countries is in progress and the first set of equipment consisting of two Gamma Spectrometry Systems (GSS) are expected to reach Pakistan very soon.

Considering the delay in the implementation of the project due to financial constraints and realizing the importance of the programme, PNRA has already started implementation of the programme from its own resources.

PNRA has started to measure the level of radioactivity in sand/soil, air, water, flora and fauna. The activity started with collection of soil samples through Regional Directorates of PNRA and so far about 157 samples from 25 districts located in various provinces have been collected. Work is under progress for the analyses of these samples using Gamma Ray Spectrometry system installed at PNRA Headquarters to establish the base line levels and to check any build-up of radioactivity in the environment. Soil samples collected from the vicinity of NPPs and research reactors have been analyzed and compiled in reports.

Safety Analysis Centre

This project was approved in September 2009 for development of Safety Analysis Centre (SAC) in Karachi to provide regulatory support for indigenisation of NPP in Pakistan. The main objective of this project is to develop a centre of excellence in southern region of Pakistan to provide regulatory support for new nuclear power plants. However, due to paucity of funds, no releases have been made so far in this project.

8
NATIONAL AND INTERNATIONAL COOPERATION

At national level PNRA interacts closely with Pakistan Atomic Energy Commission (PAEC), Lahore University of Management Sciences (LUMS), Ghulam Ishaq Khan Institute of Engineering and Technology (GIK), University of Engineering and Technology Peshawar, University of Engineering and Technology Taxila, Qaid-i-Azam University Islamabad and also with the national regulators namely OGRA, PTA, PPRA, CAA and NEPRA on issues related to safety and regulatory activities in the country.

At the international level, PNRA interacts with various institutions under bilateral as well as multilateral cooperation programme. PNRA assists the Government 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 extend cooperation for international peer reviews, and provide experts for international regulatory missions when requested by the IAEA.

National Linkages

Relations with Licensees

PNRA maintains a relationship of mutual respect and trust with all its stakeholders including its licensee. In 2009 apart from licensing activities, PNRA involved its stakeholders especially the PAEC, which is the owner and operator of nuclear power plants in Pakistan, in many of its public awareness and education and training activities. Twenty (20) officers from PAEC participated in PNRA School for Nuclear and Radiation Safety training courses. Centre for Nuclear Safety (CNS) the Technical Support Organization of PNRA worked jointly with PAEC on projects of mutual interest.

PNRA conducted several courses for licensed radiation facilities to develop an understanding on the implementation of relevant regulatory requirements. Two professional trainings were also organized to enhance the nuclear/radiation security capabilities of the licensees.

As a regular practice, PNRA places its draft national regulation on its website http://www.pnra.org for feedback from its stakeholders including the public before finalizing and gazette notification.

Linkages with the Government

PNRA keeps a close liaison with other governmental organizations for maintaining nuclear and radiation safety in Pakistan.

In March 2009, PNRA hosted the second liaison meeting of the major national regulators for exchange of information. Representative of NEPRA, OGRA, PPRA and CAA participated in this meeting. The main objective of this meeting was to discuss the licensing process of various regulatory bodies so as to identify national best practices and learn from mutual experiences.

In addition, PNRA participated in a "Regulatory Conference", organized by Nestlé Company at Lahore, for establishing a "National Regulatory Framework and Code of Conduct on Food Products" and held meetings with Ministry of Health and

Liaison Meeting with Various Government Ministries and Organizations (STI) held in March 2009 at PNRA Headquarters

Ministry of Food, Agriculture and Livestock for establishing the regulatory requirements on treatment of food by ionizing radiation.

As a part of transparency and confidence building, in 2009, PNRA invited senior government officials participating in courses of Secretariat Training Institute (STI) to visit PNRA headquarters for presentation of its activities. The submission of annual report of the activities of PNRA to the Government of Pakistan and the general public is a regular feature of PNRA. This submission enables PNRA to keep the public, the Government and other stakeholders informed of its efforts for ensuring safety of the public, the workers and the environment from ionizing radiation.

Second Liaison Meeting with National Regulatory Authorities held at PNRA Headquarters in March 2009

Collaboration with National Academic Institutions

PNRA strives for continuous improvement of its regulatory performance and therefore has initiated a number of collaborative programmes with prestigious national academic institutes.

In 2009, two junior officers of PNRA completed a two months training course on full scope simulator at Chashma Centre for Nuclear Training (CHASCENT). These officers are involved in commissioning of the first soft panel based simulator in Pakistan which is being developed by PAEC and PNRA as a part of joint research activities.

The Department of Physics of the Karachi University and School of Nuclear and Radiation Safety (SNRS) has signed a memorandum in 2009 to initiate joint research activities of mutual interest in future.

A project on Soil Structure Interaction Analysis (SSIA) has been initiated in collaboration with the University of Engineering and Technology (UET) Peshawar. In this regard, a two weeks workshop was organized for PNRA and PAEC officials to get hands on experience in computer code SAP 2000.

Relations with the Public

PNRA keeps the public informed about its activities and about any event at nuclear installations and radiation facilities in a timely manner through press releases. During 2009, pamphlets namely; "Instructions for First Responders in Case of Radiological Emergency" and "Instructions for Public in Case of Radiological Emergency" were published in national language for raising the awareness of general public about radiological hazard and ways and means of handling emergencies. PNRA web site www.pnra.org is a continuous source of information about PNRA activities for the public.

Participation of PNRA in the" Regulatory Conference" for establishing a National Regulatory Framework and Code of Conduct on Food Products

Participants of a Seminar Conducted by PNRA

International Cooperation

Fulfillment of Obligations

PNRA made efforts to fulfil Pakistan's international commitments and obligations arising from four conventions namely the Convention on Nuclear Safety (CNS), Convention on Early Notification of a Nuclear Accident, Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; and Convention on Physical Protection of Nuclear Material and Code of Conduct on Safety and Security of Radiation Sources.

In September 2009, PNRA participated in the "First Extraordinary and Fifth Organizational" meeting of the Convention on Nuclear Safety held at IAEA headquarters in Vienna, Austria. The objective of the meeting was to discuss the format and content of fifth national report that is to be submitted in 2011 and to define the group of countries. Pakistan is placed in group 1 along with USA, Sweden, Spain and Mexico. Representative of PNRA was elected as a Rapporteur for the fifth review meeting of the Convention on Nuclear Safety to be held in April 2011.

Bilateral and Multilateral Cooperation

Cooperation with China

PNRA has established strong bilateral relationship with National Nuclear Safety Administration (NNSA), China Nuclear Power Operation Technology Corporation (CNPO) and Nuclear Safety Centre (NSC) of China. The bilateral agreements with these organizations provide a forum for free exchange of information on matters related to nuclear safety. These prestigious Chinese institutes are assisting PNRA in the review and assessment as well as inspections for Chashma Nuclear Power Projects. Signing ceremony of extension of bilateral cooperation agreement with National Nuclear Safety Administration (NNSA), China Nuclear Power Operation Technology Corporation (CNPO) and Nuclear Safety Centre (NSC) was held in January 2009 in Urumqi, China, in which Chairman, PNRA and Vice Minister, SEPA, China, participated along the sidelines of 4th Steering Committee meeting between China and Pakistan on Nuclear Safety Cooperation.

Co-operation with Other Nuclear Organizations

Besides Chinese, PNRA has made bilateral agreements with VUJE, of Slovak Republic. VUJE is an engineering, design and research organization specializing in nuclear power plant technology, safety and environmental issues and provides assistance in training of PNRA personnel in nuclear safety specifically safety review and inspection of pressurized water reactor components.

PNRA is interacting with the United States Nuclear Regulatory Commission (USNRC) for institutional strengthening and capacity building in order to

The 4th Steering Committee Meeting between China and Pakistan on Nuclear Safety Cooperation

Signing of Bilateral Cooperation Agreements with the National Nuclear Safety Administration (NNSA), China, China Nuclear Power Operation Technology Corporation (CNPO), and Nuclear Safety Centre (NSC)

face the current challenges and issues related to nuclear safety. In this connection 4th annual meeting between both the organizations was held in Vienna in January 2009. Both the parties agreed to exchange information on issues such as development of severe accident management guidelines, licensing and inspection of fuel cycle facilities and accident analysis.

Being a member of Network of Regulators of Countries with Small Nuclear Programmes (NERS), PNRA is also participating in the activities of this forum. NERS is an international forum intended to facilitate communication between nuclear regulators and inspectors of countries with small nuclear programmes. It maintains and updates its website (www.ners.info). PNRA participated in 12th NERS annual meeting that was held on June 4-5, 2009 in Brussels, Belgium and discussed matters of mutual interest with other members of the NERS.

Technical Cooperation with the IAEA

Technical Cooperation Projects

Presently, PNRA is participating in the following IAEA assisted Technical Cooperation (TC) and Regional Asia (RAS) Projects:

Activities pertaining to these ongoing projects are under progress. Under the IAEA TC Projects PAK/9/028 and PAK/9/034, IAEA in collaboration with PNRA arranged three workshops for PNRA in Vienna. Out of these three workshops, two were on self assessment of PNRA using Self Assessment Tools (SAT) and one on strengthening emergency planning, preparedness and response infrastructure. Besides IAEA experts, National Counterparts and Project Coordinators also delivered lectures during the workshops. Moreover, two fellows from PNRA contributed in the "Development of Safety Analysis Report Review Plan (SARRP)" for Chapter 7 titled "Instrument and Control" of the safety analysis report. Under these projects, besides human resource development, IAEA also provided equipment for the establishment of radiation protection environmental laboratories at PNRA and models of pressurized water reactor component such as reactor pressure vessel, pressurizer, and steam generator for the training centre.

In addition, IAEA awarded three fellowships to PNRA officials in the areas of safety analysis, development of capabilities to manage ageing phenomena & stress analysis in NPPs and emergency preparedness.

TC Project No.	Title
PAK/9/028	Further Improvement of Regulatory Performance for the Pakistan Nuclear Regulatory Authority
PAK/9/034	Strengthening Infrastructure for Radiation, Transport and Waste Safety

RAS Projects

Project No.	Title
RAS/9/052	Strengthening Legislative and Safety Infrastructures
RAS/9/053	Strengthening Occupational Radiation Protection
RAS/9/054	Strengthening National Regulatory Infrastructures
RAS/9/055	Strengthening Radiation Protection in Medicine
RAS/9/056	Strengthening Capabilities for Protection of the Public and the Environment from Radiation Practices
RAS/9/057	Strengthening National and Regional Capabilities for Response to Radiological and Nuclear Emergencies
RAS/9/058	Supporting Education and Training in Radiation Protection
RAS/9/059	Strengthening Nuclear Regulatory Authorities in the Asia and the Pacific Region
RAS/9/060	Developing Human Resources in Nuclear safety

A Delegation of PNRA led by Chairman PNRA, visited IAEA in June 2009 for Review of PNRA Self Assessment Report 2007 in Preparation of IRRS mission 2001

Expert Missions

During the reported year, PNRA contributed actively in various IAEA regular TC and extra-budgetary programmes. In this regard, an officer from PNRA contributed in Integrated Regulatory Review Service (IRRS) mission to Vietnam as IAEA expert and lead the mission as Deputy Leader IRRS. Twenty one (21) professionals from PNRA participated in fourteen (14) international events that were organized by IAEA as IAEA experts and delivered lectures. Details of some missions are as follows:

- Basic Professional Training Courses organised by IAEA in Nigeria, Bangladesh and Lithuania;
- Regional Workshop for Sharing Experience in the Application of Knowledge Management (KM) Methods for Competence Building in Nuclear Safety, Dhaka, Bangladesh;
- Seminar on Systematic Training Needs Assessment, Dhaka, Bangladesh;
- Regional Workshop on Self Assessment Process for the Continuous Improvement of Regulatory Bodies, Ukraine;
- IAEA Regional Asia and Pacific Seminar on Facts of Nuclear Power and Consideration to Launch a Nuclear Power Programme at Chengdu, China;
- Seminar to Apply SNTA Methodology and Associated Software for Regulatory Bodies, Vienna, Austria; and

In 2009 PNRA Participated in the IAEA Program for Safety Analysis Review Plan (SARRP)

Experts from PNRA were Part of Integrated Regulatory Review Service (IRRS) Mission to Vietnam

PNRA Contributed in Basic Professional Training Courses Organized by the IAEA in Bangladesh

- Management System for Nuclear Power Plants, Thailand.

PNRA also provided advisory/consultancy services in IAEA Safety Assessment, Education & Training (SAET), Generic Reactor Safety Review (GRSR) and Nuclear Security programmes.

Moreover, eight (8) IAEA experts including Ms Anita Nilsson, Director, Nuclear Security Division from the Agency visited PNRA and discussed matters pertaining to nuclear security & safety.

Participation in Meetings Seminars, Symposiums, Conferences and Training Courses

During the reported year, one hundred and seventy eight (178) PNRA personnel participated in one hundred and five (105) international events such as meetings, workshops, training courses, fellowships, conferences, seminars, etc. in the areas of nuclear safety and security organized by IAEA.

Being a member of various IAEA committees such as Nuclear Safety Standards Committee (NUSSC), Transport Safety Standards Committee (TRANSSC), Waste Safety Standards Committee (WASSC), Radiation Safety Standards Committee (RASSC) and the Committee on Safety Standards (CSS), PNRA participated in the proceedings of these committees for the development of safety standards. PNRA is also nominated as observer in the United Nations Scientific Committee on the Effects of Atomic Radiation(UNSCEAR). Moreover, besides participating in the proceedings of the IAEA General Conference, PNRA prepared briefs and reports for the IAEA General Conference and other conventions during the year and participated in the Senior CANDU Regulators Meeting held in Argentina.

PNRA contributed in "International Symposium on Nuclear Security, Vienna", International Ministerial Conference on Nuclear Energy in the 21st Century, Beijing, China and chaired first session of "International Conference on Effective Nuclear Regulatory System; Further Enhancing Global Nuclear Safety and Security Regime," Cape Town, South Africa.

PNRA also reviewed various IAEA draft documents and the comments were sent to IAEA for discussion and inclusion in their final draft.

9
PERFORMANCE REVIEW

As part of its Management System, PNRA has been performing annual monitoring and evaluation (M&E) of its regulatory performance since its inception. In addition to regular self-evaluation and performance reporting to the Government and the public, PNRA frequently invites international experts for peer reviews. This process contributes to continuous improvement of regulatory effectiveness and efficiency and drives PNRA towards improved performance in all of its activities.

PNRA regularly submits its annual report to the government at the end of each calendar year. "Performance Review Report- 2008" of PNRA was submitted to the Prime Minister of Pakistan in February 2009. These submissions have improved transparency and enabled the Government to keep abreast of regulatory oversight of nuclear and radiation facilities in the country. Figure-32 below presents a comparison of its overall performance since its inception.

In September 2009, PNRA also published its fifth report entitled "PNRA Report 2008" which was widely distributed and is also available on the PNRA Website http://www.pnra.org

Monitoring, Evaluation and Improvement

Monitoring (measurement), Assessment (evaluation) and Improvement are integral parts of the management system at PNRA. PNRA management system ensures that a system of management review and assessment is established to monitor and evaluate regulatory performance qualitatively and quantitatively against pre-defined targets and goals; non-conformances and weak areas are identified; preventive and corrective actions are taken for improvement.

The progress of regulatory activities is monitored against targets and planned activities in a qualitative manner and documented in monthly progress reports (MPRs) which are reviewed to take corrective actions for the declining trends in performance. MPRs are evaluated for rating the performance areas based on 12 strategic performance indicators using a five-level rating scale namely Not Acceptable, Unsatisfactory, Needs Improvement, Minimally Acceptable and Satisfactory, against which a progress review is compiled and presented in Annual Reports. The evaluation and monitoring remained a continuous job during the reporting period. The result of the assessment for the year January-December 2009 is compiled in the current report for information of its stakeholders. PNRA's performance against 12 indicators for 2009 is summarized in Figure 33.

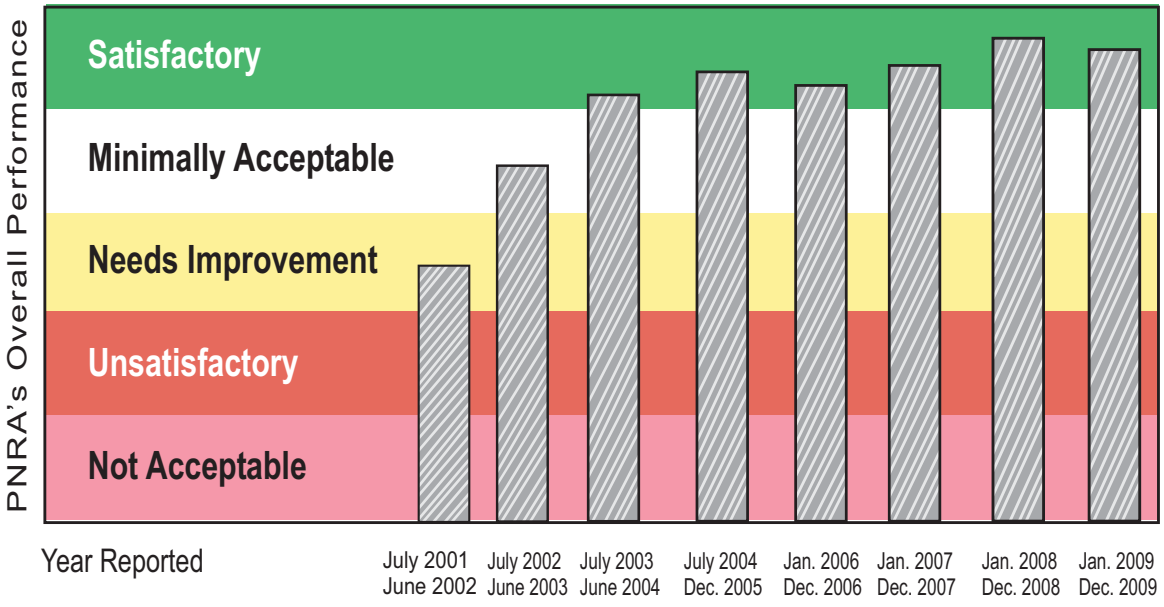


Figure-32 PNRA'S Overall Performance over the Years

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

Rating Scale

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

Figure-33 PNRA'S Performance in 2009

Qualitative Assessment of Performance

The activities and performance of PNRA from January to December 2009 are described briefly corresponding to the twelve (12) strategic performance indicators taking into account the targets set for the year 2009. The extent to which these targets were met during 2009 was a key factor in the qualitative assessment of PNRA's performance against each indicator, the result of which is shown in Figure 33.

Indicator 1 *(Ensures that acceptable level of safety is being maintained by licensees):* PNRA rates its performance as "Needs Improvement" because although the acceptable level of safety is maintained by licensees at all nuclear installations but the same cannot be said of many radiation facilities especially X-rays facilities.

Karachi Nuclear Power Plant, Unit 1 (K-1) remained in operation at 90 megawatts-electric (MWe). The plant remained under PNRA's regulatory oversight; its releases to the environment as well as radiation doses received by the workers remained within regulatory limits.

C-1 completed Re-Fuelling Outage-5 (RFO-5). The plant was started for sixth operation cycle and connected to the national grid in January 2009. The plant remained under regulatory vigilance of PNRA. The releases to the environment and the doses to the workers remained well below the permissible limits.

Construction work at Chashma Nuclear Power Plant, Unit 2 (C-2) was completed and installation of major equipment remained in progress during 2009. No significant non-conformance has so far been reported. PNRA site inspectors actively participated in the commissioning activities of C-2; Review of commissioning programme of C-2 remained in progress during 2009. PNRA monitored all the installation activities at Chashma site in accordance with the approved inspection programme, to verify compliance with national regulations and licence conditions.

In 2009, a total of three (03) regulatory inspections were carried out at PARR-I and PARR-II in the areas of operation, radiation protection, environmental protection and radioactive waste management. "Sector Emergency Procedures of PARR-I" were reviewed and comments were sent to DG PINSTECH. Operation licenses of PARR-I and PARR-II were issued.

The total number of licensed X-ray units rose from 2,800 to 2,931, signifying a 4.7 percent increase since December 2009. However, many radiation facilities also came out of the licensing net which resulted in the down grading of this indicator from "Minimally Acceptable" last year to "Needs Improvement" this year. All radioactive sources being employed by various types of facilities remained under strict regulatory control. At the end of the reported period around 2,500 sources were in use at licensed facilities.

A radiation exposure record of occupational workers at nuclear installations and radiation facilities is maintained at PNRA to evaluate the safety of workers and effectiveness of the licensees' radiation protection programmes. Currently, the record available with PNRA includes about 6,000 occupational workers. This year there was no case of over-exposure of any occupational worker where PNRA intervention was required.

Indicator 2 *(Ensures that regulations and procedures are in position and understood by licensees):* PNRA's performance rating has improved one level from "Minimally Acceptable" to "Satisfactory". During 2009, work was initiated on revision of the following notified regulations which have completed five years of promulgation:

1. Regulations on the Safety of Nuclear Power Plant-Design – (PAK/911);
2. Regulations for Licensing of Nuclear Installation(s) in Pakistan – (PAK/909);
3. Pakistan Nuclear Safety and Radiation Protection (PNSRP) Regulations – 1990.

In addition, development of the following draft regulations remained in progress during 2009:

1. Pakistan Nuclear Regulatory Authority Enforcement Regulations – (PAK/950);
2. Regulations on Safety of Nuclear Research Reactor(s) Operation – (PAK/923);
3. Regulations on Decommissioning of Facilities using Radioactive Material – (PAK/930).

During 2009 following regulatory guides remained in the process of development:

1. Quality Assurance in Nuclear Medicine;

2. Radiation Safety in Industrial Radiography;
3. Probabilistic Safety Analysis for Nuclear Power Plants (Level-1);
4. Dosage and Distribution of Potassium Iodide Tablets in Radiation Emergencies;
5. Transportation of Radiopharmaceuticals in Pakistan; and
6. Aging Management of Nuclear Power Plants.

PNRA achieved a "Satisfactory" rating on its performance under **Indicator 3** (Strives for continuous improvement of its performance). PNRA is committed to enhancing its regulatory effectiveness and efficiency in its vision of becoming a world class nuclear regulatory body. The efforts and commitment of PNRA for initiating the self assessment process for continuous improvement of regulatory performance has been appreciated widely and particularly by the IAEA. A delegation of PNRA led by Chairman PNRA, visited IAEA in June 2009 for review of PNRA Self Assessment Report in preparation for the IRRS mission planned for early 2011. In continuation to this review mission a self assessment team (SAT Team) also visited IAEA in October to receive hands on training on computer software Self Assessment Tool (SA Tool). SAT Team remained engaged in providing training on SA Tool to other PNRA officials before conducting a full scope self assessment in 2010. During the last quarter of 2009, PNRA has initiated work on conducting technical audit of its regulatory activities.

Indicator 4 *(Takes appropriate actions to prevent degradation of safety and to promote safety improvements):* PNRA has down graded its performance to a level lower than the last year. It rates its performance as "Needs Improvement" again because of the degradation of safety in radiation facilities, although there has been significant safety improvement at nuclear power plants. During 2009, PNRA reviewed various modifications, routine and non-routine reports, technical documents, etc. of C-1, C-2 and K-1, and identified various actions for improvement of safety. PNRA also issued five (05) directives to K-1 and eighteen (18) directives to C-1 requiring various actions to be taken to improve safety at the plants. Such activities were also carried out at research reactors and other radiation facilities in the country. PNRA participated in the Control Point and Hold Point Inspections of C-2 during the reporting period. It conducted inspections at manufacturing sites (in China) to verify that the equipment is being manufactured as per approved design and quality assurance requirements. PNRA conducted three inspections during equipment manufacturing for C-2 and issued reports requiring various actions from the licensee and its contractor and sub-contractors.

PNRA also conducted examination of operating personnel of C-1, C-2 and K-1 and issued licences to successful candidates to operate the plants.

In addition to ensuring the safe operation of nuclear installations, PNRA ensures safe use of X-ray machines and radioactive material for medical diagnosis/treatment, industrial and other uses through regulatory inspections and surveillance. In this regard, a total of 1500 inspections of radiation facilities were carried out throughout the country, however, the level of safety at radiation facilities was not at par with the nuclear installations. PNRA intends to focus more on radiation facilities in 2010.

The rating against **Indicator 5** *(Takes appropriate steps for human resource development and has competent and certified regulatory staff)* remained "Satisfactory" this year as well. PNRA intends to increase its technical officers' strength to 415 by 2015; to date it has two hundred and fifteen (215) technical professionals. Fellowships at Pakistan Institute of Engineering and Applied Sciences (PIEAS) were awarded to six officers during 2008 and to three officers in 2009. These fellows will join PNRA in 2010 and 2011 respectively after successful completion of their studies at PIEAS. During 2009, SNRS conducted fifteen training (15) courses, in which 259 officers from PNRA as well as PAEC participated. In addition, PNRA has arranged a total of thirteen (13) training courses at external organizations in which a total of sixty nine (69) PNRA officials received training in various disciplines

Indicator 6 (Ensures that adequate legal provisions exist for enforcement, e.g. dealing with non-compliance or licence violations): PNRA judges its performance to have declined from "Minimally Acceptable" level last year to "Unsatisfactory" for this year. In spite of its best efforts, Pakistan Nuclear Regulatory Authority Enforcement Regulations

(PAK/950) could not be gazette notified. In the absence of these regulations, PNRA is finding it very difficult to bring all the remaining radiation facilities in the country within its licensing net. In fact, last year because of the lack of enforcement action, many licensees refused to pay the annual license renewal fee and came out of the formal licensing net. This is the main reason for downgrading this indicator to "Unsatisfactory" level this year.

PNRA maintained it's "Satisfactory" rating on **Indicator 7** (Performs its functions in a timely and cost-effective manner). PNRA achieved all its regulatory activities and targets set for the year within the allocated budgets and schedules. PNRA has established a state-of-the-art communication link between its headquarters and regional offices to perform its functions efficiently and effectively.

Indicator 8 (Ensures that a well established quality management system exists): PNRA's rating against this has declined to "Needs Improvement" from the "Minimally Acceptable" level as compared to last year. Work remained in progress on the finalization of Management System Manual (MSM), however, the MSM could not be finalized. The MSM was prepared in accordance with international practices, IAEA safety standards GS-R-3 and GS-G-3.1; it was extensively reviewed internally at PNRA as well as by the IAEA experts. It is envisaged that MSM will be finalized and its implementation phase will commence in 2010.

Indicator 9 *(Ensures that adequate resources are available for performing its functions and technical support centre is available for specialist assistance when required):* PNRA's rating has improved one level from "Needs Improvement" to "Minimally Acceptable". The main purpose of technical support organization called Centre for Nuclear Safety is to strengthen and enhance the existing regulatory capabilities of PNRA to discharge its responsibilities for licensing of Chashma Nuclear Power Plant Unit-2 and future NPPs of Pakistan. The CNS remained available for specialist assistance to PNRAs technical directorates regarding safety aspects of C-2 and C-3 in spite of the limited budget releases. Despite the financial crunch resources were found so that the training activities to impart latest state-of-the art knowledge to PNRAs professional staff continued during the reported year at national and international level. For the first time in Pakistan the review of Final Safety Analysis Report and relevant audit calculations were undertaken solely by technical experts from CNS without any assistance from National Nuclear Safety Administration (NNSA), China.

Indicator 10 *(Performs its functions in a manner that ensures confidence of the operating organizations):* PNRA successfully maintained a "Satisfactory" rating during this year. The Advisory Committee for Improving Utility-Regulatory Interface (ACIURI) continued to ensure that the operating organizations remain satisfied and no issues were raised by the operating organizations during the reported period. ACIURI met four times in 2009 to ensure that an atmosphere of understanding, harmonization and consensus is maintained between the regulatory body and its licensees.

PNRA conducted several courses for licensed radiation facilities in Lahore, Peshawar, Karachi and Islamabad to develop an understanding of the licensees on the implementation of regulatory requirements.

Prior to finalization and gazette notification of national regulations, PNRA routinely shares their drafts with the licensees concerned for their feedback. Such drafts are also placed on the PNRA website for the information and comments of the general public.

Indicator 11 *(Performs its functions in a manner that ensures confidence of the general public):* Performance against this indicator has improved from "Needs Improvement" to "Minimally Acceptable" this year. PNRA did significant work to enhance public confidence during 2009. PNRA keeps the general public informed about its activities through its annual report for the general public. Special activities and any event at radiation facilities are also reported through timely press releases. During 2009, a number of pamphlets were prepared, translated in Urdu language and published for the general public. In addition, some brochures were also prepared which remained in the process of internal review at PNRA. It is envisaged that these brochures will be published in 2010 after finalization.

Indicator 12 *(Performs its functions in a manner that ensures confidence of the Government):* PNRA judges its performance against this indicator as "Satisfactory" for the reported period. PNRA continued to fulfill Pakistan's international

obligations under the four conventions related to nuclear and radiation safety. PNRA participated in the Organizational Meeting of the Convention on Nuclear Safety (CNS) held in September 2009 in Vienna, Austria, in preparation for the Fifth Review Meeting of CNS which will be held in April 2010. At the national level also, PNRA regularly holds meetings with Government authorities and officials of the national regulatory bodies.

Targets for the Year 2010

The targets set for the year 2010 are briefly outlined below:

1. Continue to monitor the licensees activities to avoid any major incident, over exposure to workers and releases to the environment;
2. Enhance the licensing net for diagnostic radiation facilities by another five (05) percent;
3. Strive to issue the PNRA Enforcement Regulations (PAK/950) and Regulations on the Safety of Nuclear Research Reactors Operation (PAK/923);
4. Revise the following PNRA Regulations:
   - Regulations on "Licensing of Nuclear Installations in Pakistan – PAK/909" ;
   - Regulations on "Safety of Nuclear Power Plant Design – PAK/911".
5. Issue the following Regulatory Guides:
   - Quality Assurance in Nuclear Medicine;
   - Radiation Safety in Industrial Radiography;
   - Probabilistic Safety Analysis for Nuclear Power Plants (Level-1);
   - Dosage and Distribution of Potassium Iodide Tablets in Radiation Emergencies;
   - Aging Management of Nuclear Power Plants.
6. Initiate Self Assessment of regulatory activities using IAEA SAT Tool in preparation of IRRS Mission – 2011;
7. Provision of security upgrades at 12 medical centres using Category 1- 3 radioactive sources in private and public sector;
8. Establishment of physical protection laboratories and repair/maintenance laboratories at PNRA in collaboration with IAEA.

Chairman PNRA on a Visit to Chashma Nuclear Power Plant, Unit 2

Pakistan Nuclear Regulatory Authority
P.O. Box 1912
Islamabad, 44000
Pakistan
Tel: +92 (51) 926 3001-6
Fax: +92 (51) 926 3007
Email: officialmail@pnra.org
www.pnra.org