



REPORT
2007

PAKISTAN NUCLEAR REGULATORY AUTHORITY

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MESSAGE FROM THE CHAIRMAN



As the new countries are thinking of embarking on nuclear power and the countries with modest program are seriously considering expanding their nuclear power programme to meet the growing energy need, a concern that has been raised time and again is about the ageing of nuclear workforce and the disappearance of nuclear knowledge. Therefore right from its inception, PNRA has stressed on preservation of nuclear knowledge to be the top priority and ensured that knowledge and skills of the current generation of experienced nuclear professionals are transferred effectively. A School for Nuclear and Radiation Safety (SNRS) has been established to develop the new and younger generation with relevant education and skills to replace the ageing nuclear workforce. In order to further improve the performance of PNRA, the major focus over the next few years will be to develop a comprehensive programme to enhance regulatory competency. All staff members of PNRA at all levels will be led through a structured programme of knowledge acquisition consistent with their current job duties as well as their future assignments. The programme will focus on ongoing education and training as well as coaching and mentoring for all staff members both at the School and in the field at the headquarters and regional offices.

PNRA must become a fountainhead of knowledge in nuclear and radiation safety, waste and transport safety as well as nuclear security and be a breeding ground of experts in all disciplines and the associated analytical tools.

The craft of regulatory decision making will be taught through case studies and by carrying out reviews and assessment of Safety Analysis Reports (SARs).

To sum up, the PNRA would continue to be seen as a learning organization making constant efforts to improve itself; and offer fair, independent, impartial service to its licensees while assuring that the public, workers and the environment is protected from the undesirable effects of ionizing radiation.

ABBREVIATIONS AND ACRONYMS

| | |
|----------|--|
| ACIURI | Advisory Committee on Improving Utility-Regulatory Interface |
| ACRD | Advisory Committee on Research and Development |
| ALARA | As Low As Reasonably Achievable |
| C-1 | Chashma Nuclear Power Plant Unit-1 |
| C-2 | Chashma Nuclear Power Project Unit-2 |
| CNS | Centre for Nuclear Safety, PNRA |
| CNNC | China National Nuclear Corporation |
| CNPO | China Nuclear Power Operation Technology Corporation |
| ESP | Energy Security Plan |
| HMC-3 | Heavy Mechanical Complex-3 |
| IAEA | International Atomic Energy Agency |
| IRRS | Integrated Regulatory Review Services |
| JTS | Joint Technical Study |
| K-1 | Karachi Nuclear Power Plant Unit-1 |
| K-2 | Karachi Nuclear Power Project Unit-2 |
| KESC | Karachi Electric Supply Corporation |
| LUMS | Lahore University of Management Sciences |
| MWe | Megawatt-electric |
| NDMA | National Disaster Management Authority |
| NSAP | Nuclear Security Action Plan |
| NNSA | National Nuclear Safety Administration, China |
| NOC | No Objection Certificate |
| NRECC | National Radiation Emergency Coordination Centre |
| NSC | Nuclear Safety Centre, China |
| NuSECC | Nuclear Security Emergency Co-ordination Centre |
| PAEC | Pakistan Atomic Energy Commission |
| PARAS | Pakistan Radiation Services |
| PARR | Pakistan Atomic Research Reactor |
| PNRA | Pakistan Nuclear Regulatory Authority |
| PINSTECH | Pakistan Institute of Nuclear Science and Technology |
| PSDP | Public Sector Development Programme |
| PWR | Pressurized Water Reactor |
| RNSD | Regional Nuclear Safety Directorate |
| SNRS | School of Nuclear and Radiation Safety |
| SRS | Sealed Radiation Sources |
| TRANSSC | Transport Safety Standards Committee |

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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

Pakistan signed the Convention on Nuclear Safety in 1994. One of the obligations of this Convention is that regulatory functions be institutionally separated from promotional and utilization activities involving nuclear energy in the country. Government of Pakistan fulfilled its obligation under this Convention and promulgated the Pakistan Nuclear Regulatory Authority Ordinance in 2001. Under this ordinance, the Directorate of Nuclear Safety and Radiation Protection (DNSRP), a part of the Pakistan Atomic Energy Commission (PAEC), was transformed into a separate and independent institution, i.e., the Pakistan Nuclear Regulatory Authority (PNRA). PNRA is emerging as a progressive public sector organization committed to ensure that safety and security of nuclear and radiation facilities are maintained at all times. We believe in transparency and openness in our functioning. Issuance of PNRA Annual Report is a manifestation of this commitment. The current report contains the activities of PNRA during the year 2007. This is the third report in the series since the inception of PNRA. The first report covered the period from 2001 to 2005 and the second report covered the year 2006. The reports are available on our website www.pnra.org.

RESPONSIBILITIES AND FUNCTIONS

Under the Ordinance, PNRA is entrusted with the responsibility of regulation of nuclear installations, radiation generators and facilities using ionising radiation which include:

- Nuclear Power Plants;
- Nuclear Research Reactors;
- Medical applications of radiation including therapeutic and diagnostic radiography and irradiators for sterilization of medical equipment;
- Industrial applications of radiation including industrial radiography units, irradiators and scanners, oil well logging and nuclear gauges;
- Transport of radioactive material and
- Waste facilities.

PNRA is fully aware of its mission to ensure safe operation of nuclear and radiation facilities and to protect radiation workers, the general public and the environment from the harmful effects of ionizing radiation. This mission is achieved by formulating and implementing effective regulations, building a relationship of trust with the licensees, and maintaining transparency in regulatory actions and decisions.

PNRA prepares regulations, licenses nuclear and radiation facilities, reviews/ assesses safety submissions/ cases, inspects facilities, and takes enforcement actions where needed. It also ensures that adequate emergency preparedness programmes exist at all nuclear and radiation facilities to respond to radiological emergencies. PNRA ensures that the safety and security of nuclear material/facilities is maintained at an acceptable level. All regulatory activities are carried out according to well established regimes based on national regulations as well as international practices. A system of self-assessment enables PNRA to continually assess its own performance.

PNRA performs various types of inspections according to the annual inspection plan. For this purpose, PNRA has established three Regional Nuclear Safety Directorates (RNSDs) in Islamabad, Kundian and Karachi. Resident inspectors have been posted at the two nuclear power plants, K-1 and C-1.

HIGHLIGHTS OF THE PREVIOUS REPORT

Details of following key activities were presented in the pervious report:

1. Interim permission was granted to K-1 to operate at reduced power, while re-licensing activities continued;
2. The performance of C-1 was consistently regulated and a marked improvement in performance was observed. It achieved the highest continuous operation of 162 days;

INTRODUCTION AND BACKGROUND

3. Construction License to C-2 was awarded ahead of schedule;
4. The number of X-ray machines and other radiation facilities brought under regulatory control increased significantly;
5. Two national regulations were approved for gazette notification;
6. The School for Nuclear and Radiation Safety (SNRS) was formally established;
7. The Nuclear Security Action Plan (NSAP) was initiated under the PSDP;
8. National and international cooperation and links were further enhanced for improved flow of knowledge;
9. An International Peer Review of Centre for Nuclear Safety (CNS) by National Nuclear Safety Administration of China was conducted on the request of PNRA.

MAJOR ACTIVITIES IN 2007

PNRA is working to fulfil its responsibility to meet the Government's Energy Security Plan (ESP) for increasing nuclear energy generation capacity from the current 425 MWe to 8,800 MWe by the year 2030. Cognizant of the resulting need of massive infrastructure and manpower development, PNRA has maintained a proactive approach for acquiring the latest state-of-the-art knowledge and keeping abreast with current developments in the nuclear technology and regulatory practices for fulfilment of its

obligations. The trend of change in the overall PNRA regime with respect to capacity Building and institutional strengthening continued in the year 2007. Figure-1 shows the rearrangement in the organizational structure of PNRA with clear lines of communication and reporting relationship. This institutional rearrangement has brought the essential strengthening measures required to meet the future challenges. The fifth recruitment drive was successfully completed during 2007 and twenty nine (29) scientists and engineers were inducted. Presently, there are 180 technical professionals at PNRA's strength and by 2015 the manpower strength has to be increased to 415, through direct recruitment drives and fellowship schemes to cater for the expanding nuclear power generation capacity.

With the establishment of the School for Nuclear and Radiation Safety (SNRS), PNRA has broadened its efforts for improving the competency level, knowledge and skills of the newly recruited officers and updating the knowledge of its experienced staff so as to fulfil its regulatory responsibilities in an effective and efficient manner. PNRA maintained a steady progress towards becoming a world class regulatory body.

The joint PNRA/PAEC technical study (JTS) initiated by the Centre for Nuclear Safety (CNS) which started in 2005 with the objectives of

History of Nuclear Safety Regime in Pakistan

| | |
|------|---|
| 1956 | <i>Pakistan Atomic Energy Council established</i> |
| 1964 | <i>Pakistan Nuclear Safety Committee (PNSC) established.</i> |
| 1965 | <i>Pakistan Atomic Energy Ordinance promulgated.</i> |
| 1970 | <i>Nuclear Safety and Licensing Division (NSLD) established.</i> |
| 1984 | <i>Pakistan Nuclear Safety and Radiation Protection (PNSRP) Ordinance promulgated under which Directorate of Nuclear Safety and Radiation Protection (DNSRP) established.</i> |
| 1990 | <i>Pakistan Nuclear Safety and Radiation Protection (PNSRP) Regulations promulgated.</i> |
| 1994 | <i>Pakistan signs the Convention on Nuclear Safety.</i> |
| 1994 | <i>Pakistan Nuclear Regulatory Board (PNRB) established as a quasi-independent body</i> |
| 2001 | <i>Pakistan Nuclear Regulatory Authority Ordinance, 2001 promulgated thereby creating an independent regulatory body.</i> |

improving the regulatory body-utility interface and developing manpower for indigenization of nuclear power in Pakistan remained in progress in 2007.

Under the “Nuclear Security Action Plan” project for the assessment of security levels and up-gradation of security measures at radiation facilities in Pakistan, a number of training courses were organized in collaboration with IAEA during 2007. Various technical professionals from different organizations were trained at Nuclear Safety/Security Training Centre and Nuclear Security Emergency Co-ordination Centre. A media campaign was launched for the creation of awareness about radiation symbols and harmful affects of radiation.

The self Assessment project which started in 2006 in collaboration with LUMS concluded in 2007.

The key milestones accomplished by PNRA in 2007 included the following:

1. Issuance of Operating License to Karachi Nuclear Power Plant Unit-1 (K-1) for two years on 31 December 2007 after successful completion of re-licensing activities;

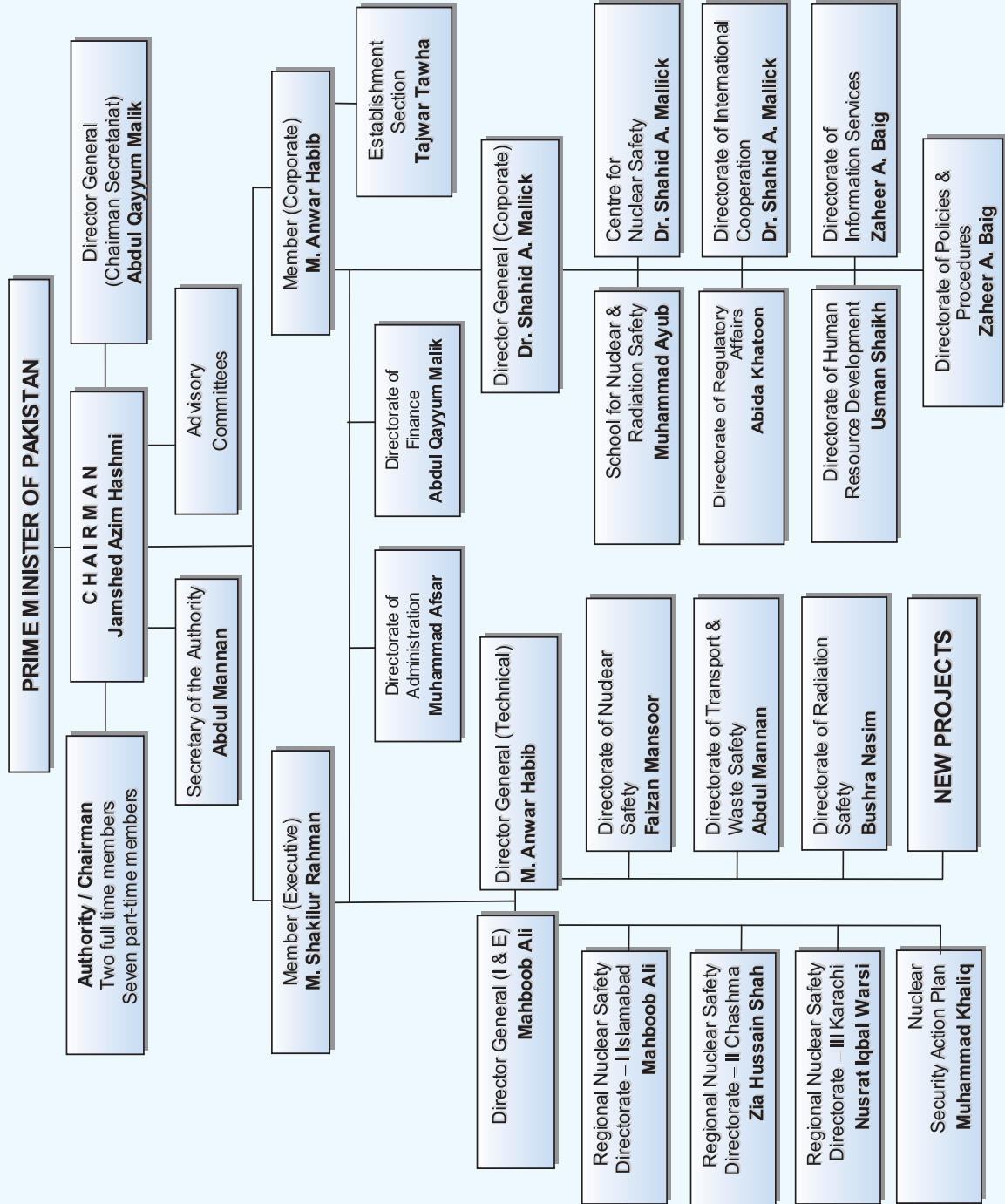
2. Enhanced the licensing net for diagnostic radiation facilities by another 10 percent;
3. Finalization of a set of three regulations for approval from the Authority for Gazette Notification;
4. Self Assessment of PNRA performance initiated in 2006 in collaboration with Lahore University of Management Sciences (LUMS) was completed in April 2007;
5. Nuclear Security Training Centre and Nuclear Security Emergency Co-ordination Centre were established at Islamabad;
6. Fifth recruitment drive was successfully completed and about 29 scientists and engineers were inducted increasing the number to 180 technical professionals;
7. A media campaign was conducted to create awareness in the general public about orphan radioactive sources. This campaign drew the attention of national and international electronic media.

Details of these and other activities are presented in the following pages.



Tutorial on Nuclear Perspective

FIGURE 1: ORGANIZATION STRUCTURE OF PNRA



2 REGULATORY FRAMEWORK

Pakistan Nuclear Regulatory Authority Ordinance 2001 provides the statutory basis for the Authority. Under the Ordinance, the prime responsibility of formulating national regulations on nuclear and radiation safety lies with PNRA. These regulations are notified in the official Gazette of Pakistan for implementation throughout the country,

The PNRA Ordinance, together with the national regulations forms the basis of a nuclear regulatory framework in Pakistan. The highest level document in the framework is the Ordinance 2001. The next tier is mandatory national regulations based on internationally acceptable requirements. Below these are non-mandatory guides which describe methods acceptable to PNRA to meet the requirements of regulations. Other methods can be adopted provided it can be demonstrated to the Authority that the proposed methods achieve the same or better level of safety and quality.

REGULATIONS

PNRA issues new national regulations and revises existing regulations after reviewing them in the light of current safety requirements and international practices, licensees' feedback, national experiences and operating experience feedback. During 2007 "Regulations on Licensing Fee by PNRA – PAK/900" and "Regulations for the Safe Transport of Radioactive Material – PAK/916" were gazette notified. The set of following three regulations were finalized for approval from the Authority and are expected to be gazette notified in 2008:-

1. "Regulations for Licensing of Nuclear Safety Class Equipment and Components Manufacturers – (PAK/907)";
2. "Regulations on the Safety of Nuclear Installations – Site Evaluation (PAK/910)";
3. "Regulations on Management of a Nuclear or Radiological Emergency - (PAK/914)".

The following regulations remained in the process of review in 2007:

1. Pakistan Nuclear Regulatory Authority Enforcement Regulations – (PAK/950);
2. Regulations for Licensing of Radioactive Materials Exploration(s) in Pakistan – (PAK/926);
3. Regulations on Safety of Nuclear Research Reactors Operation – (PAK/923).

REGULATORY GUIDES AND GUIDELINES

To help its licensees better understand the nature and requirements of national regulations, and to facilitate them in their implementation. PNRA issues regulatory guides. During 2007, PNRA issued a regulatory guide namely, "Transportation of Radioactive Material by Roads in Pakistan – (PNRA-RG-916.01)".

The following regulatory guides remained in the process of review in 2007:

1. Quality Assurance in Nuclear Medicine;
2. Protection of Patients in Diagnostic Radiology;
3. Dosage and Distribution of Potassium Iodide Tablets (a Thyroid Blocking Agent) in Radiation Emergencies.

List Of Gazette Notified Regulations

- (a) *For Nuclear Power Plants:*
 - i. *Regulations for Licensing of Nuclear Installation(s) in Pakistan-PAK/909*
 - ii. *Regulations on the Safety of Nuclear Power Plants Design-PAK/911*
 - iii. *Regulations on the Safety of Nuclear Power Plants Quality Assurance-PAK/912*
 - iv. *Regulations on the Safety of Nuclear Power Plants Operations-PAK/913*
 - v. *Regulations on Radioactive Waste Management-PAK/915*
 - vi. *Regulations for the Safe Transport of Radioactive Material-PAK/916*
 - vii. *Regulations on Licensing Fee by PNRA-PAK/900*
- (b) *For Installation(s) Other Than Nuclear Reactors:*
 - i. *Regulations on Radiation Protection-PAK/904*
 - ii. *Regulations for the Licensing of Radiation Facilities other than Nuclear Installations-PAK/908*

3 NUCLEAR SAFETY

PNRA ensures that all licensees fulfil their obligations and comply with the requirements prescribed by national regulations. PNRA also ensures that the licensee maintains an acceptable level of safety and takes necessary actions to avoid degradation of safety at nuclear installations. During 2007, no significant incident occurred at nuclear installations throughout Pakistan. PNRA monitors the performance of NPPs by a combination of measures, including review and assessment of the licensee's documents,

verification of information through inspections and, in case of non-compliance, implementation of enforcement actions. It is mainly the Directorate of Nuclear Safety (NSD) that holds the responsibility for licensing, review and assessment, preparation of regulations and other regulatory oversight on all matters related to nuclear safety at nuclear installations in Pakistan. Inspection and enforcement actions are mainly carried out by the Regional Nuclear Safety Directorates (RNSDs)

| <i>Status of Existing Nuclear Installations</i> | | | |
|---|----------------|-----------------|---------------------------|
| | K-1 | C-1 | C-2 |
| Status | In Operation | In Operation | Under Construction |
| Location | Karachi, Sindh | Chashma, Punjab | Chashma, Punjab |
| Type | CANDU | PWR | PWR |
| Capacity (gross) | 137 MWe | 325 MWe | 325 MWe |
| First fuel loading | July 1971 | November 1999 | September 2010 (expected) |
| First criticality | August 1971 | May 2000 | April 2011 (expected) |
| First commercial operation | December 1972 | September 2000 | 2011 (expected) |

REVIEW AND ASSESSMENT

KARACHI NUCLEAR POWER PLANT, UNIT 1

Karachi Nuclear Power Plant Unit-1(K-1) completed its 30-year design operating life and applied for re-licensing in 2002. Since then the plant has undergone a detailed re-licensing process in accordance with the Regulations for Licensing of Nuclear Installation(s) in Pakistan (PAK/909). Based on the review of the submissions K-1 was initially allowed to operate at a maximum power of 50 MWe for a period of three months in January 2007 with certain conditions. After satisfactory completion of the safety upgrades and improvements as per regulatory requirements, K-1 was allowed to operate up to 90 MWe. As part of re-licensing activities PNRA

witnessed the K-1 emergency drill conducted in November 2007. Review of K-1 FSAR Rev. 2 and Operating Polices and Principles was completed. Upon completion of review and actions on safety issues, K-1 was licensed on December 31, 2007 to operate at 90 MWe or 1131 MBTU/hr whichever is less till December 31, 2009 instead of 15 years as requested by the licensee. KESC grid problem has been enhanced in the last few years and is the main contributor for most of the reactor trips. This has been taken up by PNRA at Government level for necessary actions to improve the grid condition and reliability. In addition, ageing of major equipment is also causing problems in the operation of the plant. PNRA is continuously monitoring the operation of K-1.

KARACHI NUCLEAR POWER PLANT, UNIT 2

In fulfilment of the Government of Pakistan's plan to enhance the present installed nuclear power capacity of 425 MWe to 8,800 MWe by the year 2030, the Joint PNRA/PAEC Technical Study (JTS) for new nuclear power plant remained an ongoing activity for the reported period. During the first phase (JTS-I), a pre-Preliminary Safety Analysis Report (pre-PSAR) for a 600 MWe PWR initially proposed to be installed at Karachi was prepared and reviewed against the current regulatory requirements and codes & standards.

CHASHMA NUCLEAR POWER PLANT, UNIT 1

Operating License was issued to Chashma Nuclear Power Plant Unit-1 (C-1) by PNRA in 2004. The plant is being regulated according to national regulations and operating license conditions. The plant performance, in general, remained satisfactory throughout the year. However, instability of grid is a major concern. In 2007, C-1 completed fourth refuelling outage. After a thorough analysis of the refuelling activities PNRA allowed C-1 to make the reactor critical. The safety performance of C-1 is continuously being monitored and assessed under the review and assessment program of PNRA.

CHASHMA NUCLEAR POWER PLANT, UNIT 2

Construction work of Chashma Nuclear Power Plant, Unit-2 (C-2) remained in progress during the reporting period. The containment dome was placed five months ahead of schedule. About 80%

of civil construction work has been completed. PNRA performed regulatory inspections of construction and manufacturing activities. PNRA also performed inspections to observe the effectiveness of quality assurance program of C-2, its contractor and sub-contractors. The construction and manufacturing is being done as per approved design and no significant non-conformance has so far been reported.

PAKISTAN RESEARCH REACTORS I AND II

PNRA continued its regulatory surveillance of the research reactors, Pakistan Research Reactors (PARR) I and II. During 2007, four regulatory inspections were carried out at PARR-I and PARR-II in the areas of operation, radiation protection, environmental protection and radioactive waste management. In addition, PNRA renewed licences of a number of supervisors and operators of the two reactors.

HEAVY MECHANICAL COMPLEX 3

PNRA issued a licence to manufacture nuclear safety class equipment to HMC-3 in 2005. HMC-3 has since then been engaged in the manufacturing of safety class equipment for C-2. The manufacturing of such equipment is closely monitored by PNRA through inspections to verify compliance with the licence, international codes and industrial practices. Selected processes and test results were witnessed and records reviewed to verify compliance and were found acceptable.

Policy On Licensee's Requirements

"A policy on safety shall be developed by the licensee and applied by all site personnel. This policy shall give safety the utmost priority at the plant, overriding if necessary the demands of production and project schedules. The policy shall include a commitment to excellent performance in all activities important to safety and shall encourage a questioning attitude."

Source: Regulations on the Safety of Nuclear Power Plants Operation (PAK/913)(Rev. 1) Section 5 (11)

LICENSING OF OPERATING PERSONNEL

An important concern at PNRA is to ensure that sufficient number of qualified staff i.e. staff with appropriate education, training and retraining, are

available to conduct all safety-related activities at each nuclear installation throughout its life. In this regard, PNRA requires licensees of nuclear installations to obtain Operator's Licenses for their operating personnel. Before issuance of an

Operator's License, PNRA verifies basic engineering qualifications, training and examinations as well as the medical and psychological fitness of the operator. The renewal of Operator's Licenses also entails a rigorous procedure of oral, written and practical examinations.

PNRA conducted the oral and operating examinations as part of licensing of C-1 Main Control Room operating personnel. During 2007, eleven operating personnel licenses were awarded to Shift Supervisors and Shift Engineers of C-1. Twenty one (21) Shift Supervisor licenses and Fourteen (14) Shift Engineer licenses were revalidated up to December 31, 2008 upon fulfilment of requirements of Regulations on Safety of Nuclear Power Plants Operations (PAK/913).

During 2007, PNRA awarded seven (7) operating personnel licenses to Reactor Operators and Shift Engineers of K-1. Thirty one (31) Operator licenses were revalidated as per regulatory requirement.

PNRA renewed twenty six (26) licenses of operating personnel at PARR-I and PARR-II during 2007.

INSPECTION OF NUCLEAR INSTALLATIONS

PNRA ensures that the licensees take appropriate actions to promote safety and prevent degradation of safety at all nuclear installations and comply with the requirements prescribed by national regulations and license conditions. During 2007, no significant incident occurred at any nuclear power plant in Pakistan.

PNRA performs various types of routine as well as unplanned and reactive inspections according to the annual inspection plan. For this purpose, PNRA has established three Regional Nuclear

Safety Directorates (RNSDs) in Islamabad, Kundian and Karachi, namely RNSD-I, RNSD-II and RNSD-III respectively. Resident inspectors have been posted at the two nuclear power plants, K-1 and C-1.

In 2007, RNSD-I carried out four regulatory inspections at PARR-I and PARR-II in the areas of operation, radiation protection, environmental protection and radioactive waste management.

RNSD-II performed Periodic Inspections in addition to routine and daily inspections of C-1. Main Control Room inspections were also performed as part of daily inspections. RNSD-II along with the staff of PNRA Headquarters performed inspections and witnessed refuelling, maintenance and testing activities during the Fourth Refuelling Outage (RFO-4). As a result of these inspections a number of findings and observations were communicated to C-1 which were followed-up in the subsequent follow-up inspections. C-1 was required to expedite the process of implementation of corrective actions of the findings.

RNSD-III performed regulatory inspections of various safety related structures, systems and components and an inspection of safety culture of K-1. In addition many inspections related to re-licensing activities were also conducted; actions necessary for improvement in the safety were communicated to K-1 for implementation. PNRA conducted a total of fifty four (54) inspections and issued ninety one (91) directives to K-1 requiring various actions to be taken.

During the construction and manufacturing activities in Pakistan and China for C-2, PNRA selected various hold and witness points to observe the licensee performance as per national requirements and industrial practices.

No Accident And No Serious Incidents

The statutory responsibilities of PNRA are related to protection of radiation workers, public and the environment from the harmful effects of radiation. However, as a proactive approach, PNRA also helps to "protect investment" by verifying that the licensee strives for "no accident and no serious incidents". According to a rough estimate, by 2030, when additional capacity for 8,400 MWe will have been installed, there will be about 1.5 trillion rupees worth of investment to be protected.

4 RADIATION SAFETY

PNRA regulates all issues related to radiation safety at nuclear installations and radiation facilities in the country. It ensures that licensees take appropriate actions to maintain acceptable levels of safety, prevent degradation of safety and promote safety improvements. PNRA is responsible for review and assessment of submissions of the applicants and preparation of regulations and other regulatory oversight on all matters related to radiation safety at nuclear installations and radiation facilities in Pakistan. During 2007, no significant incident was reported at any nuclear installation or radiation facility throughout Pakistan.

The Regional Nuclear Safety Directorates (RNSDs) are primarily responsible for registration/licensing of all radiation facilities other than nuclear power plants (NPPs) and inspecting all nuclear and other radiation facilities, including NPPs. Each RNSD has its defined area of jurisdiction and collectively three RNSDs, namely RNSD-I, RNSD-II and RNSD-III cover the entire country.

REVIEW AND ASSESSMENT

Before registration/licensing process, PNRA performs review and assessment of documents submitted by the applicants to ensure proper design and safe operation of their radiation facilities. Review and assessment is carried out in accordance with the requirements prescribed by the PNRA Regulations on Radiation Protection-PAK/904. PNRA performs review and assessment of submissions of the applicant/licensee on regular basis before as well as after the registration/licensing of radiation facilities. In this

regard, PNRA reviews the reports submitted by the licensees, conducts periodic inspections of the facilities, activities, work practices and monitors the radioactive releases from nuclear installations.

KARACHI NUCLEAR POWER PLANT, UNIT 1

Karachi Nuclear Power Plant unit 1(K-1) has been operating since 1972. After completion of its design operating life in 2002, K-1 went under major maintenance and refurbishment process till the end of 2007 and eventually has been re-licensed for beyond design life operation till December 2009. Several major activities involving high radiation exposures were performed during the year. PNRA kept continuous regulatory oversight of these activities and ensured the application of ALARA (As Low As Reasonably Achievable) principle through inspections, and review and assessment of licensee activities. As a result a decrease in collective radiation dose and maximum individual dose was achieved during 2007 as compared to previous years. It was ensured that K-1 keeps the individual doses below regulatory limit, plant effluents within release limit and there is no significant contribution in ambient radiation level.

CHASHMA NUCLEAR POWER PLANT, UNIT 1

Chashma Nuclear Power Plant Unit 1 (C-1) is being operated since late 2000. C-1 performed its fourth Refuelling Outage (RFO) during the year. Several documents and reports as required by PNRA were submitted by C-1. PNRA ensured that ALARA principle was applied in letter and spirit by reviewing the ALARA plans and assessment of dose estimates. It was ensured that C-1 keeps the individual doses below regulatory limit, plant

Types Of Radiation Facilities In Pakistan

Nuclear installations
Medical therapeutic and diagnostic radiology centres
Nuclear medicine centres
Educational and Agricultural research centres
Industrial radiography units
Irradiators and Scanners
Oil Well Logging and Nuclear Gauges

RADIATION SAFETY

effluents within release limit and there is no significant contribution in ambient radiation level.

RADIATION FACILITIES

Process of review and assessment of application submitted by the applicant is very important at the time of registration/licensing of a radiation facility. In this process PNRA makes an assessment regarding shielding design, competency of the radiation workers, status of radiation monitoring instruments, availability of safety gadgets etc. so that decision regarding registration/licensing of a radiation facility may be made accordingly. PNRA also performs review and assessment process if the licensee makes any alteration in existing radiation facility.

In 2007, PNRA performed review and assessment of technical documents/information submitted by various radiation facilities specially shielding design calculations and procedures for safe working with radioactive sources/radiation apparatus etc.

LICENSING OF RADIATION FACILITIES

PNRA is enhancing its licensing net to bring all radiation facilities, especially diagnostic X-ray facilities, under its effective regulatory control. During the year 2007, the number of radiation facilities (including medical, industrial, agricultural and educational etc.) registered/licensed with PNRA increased by about ten percent. These include Food Irradiator, Cyclotron and Linear Accelerators. As a part of persuasive approach, PNRA inspectors approached a large number of diagnostic x-ray facilities which were not registered with PNRA and convinced them to get themselves licensed.

PNRA initiated the task of centralization of dosimetry record of radiation workers in previous year. During 2007 a computerized database of dosimetry record was developed which is being continuously updated. The database has facilitated independent analysis and audit of dosimetry record by PNRA to maintain overall regulatory control on occupational exposures at



Rescue workers with IAEA team during an exercise

national level. The occupational exposure of workers in almost all radiation facilities remained within regulatory limits during the year.

AUTHORIZATION FOR IMPORT AND EXPORT OF RADIATION SOURCES AND EQUIPMENT

PNRA issues permits and NOCs to control import/export of radiation sources/apparatus. NOC from PNRA is mandatory for Custom clearance of any radiation source/apparatus. The purpose of controlling import/export is to ensure the effective regulatory control over the radiation sources/apparatus from cradle to grave. To keep track of such sources, a central registry is maintained at PNRA. PNRA issues NOC for import/export to only those facilities which have valid registration/license with PNRA. The number of radiation sources used for industrial purposes is increasing gradually. PNRA has issued a large number of NOCs for import of radiation sources/apparatus during the year 2007. NOCs for export of radiation sources/apparatus and empty source containers were also issued by PNRA.

NATIONAL CAPABILITY FOR HANDLING OVEREXPOSED/CONTAMINATED INDIVIDUALS

During 2006, PNRA focused attention on developing national capabilities for handling and management of overexposed / contaminated individuals and several further steps were taken in 2007. As part of this program, a field exercise was arranged to demonstrate role of emergency medical services regarding handling and management of overexposed / contaminated individuals. Representatives from several first response agencies and medical community

participated in this exercise. Similarly a table top exercise was arranged to identify role of emergency response organizations and to improve coordination in cases of terrorist activities involving radioactive dispersal devices. Several meetings of the committee comprising of medical doctors and health physicists from various organizations were conducted to finalize the syllabus and schedule of a training seminar to be held in early 2008.

INSPECTION ACTIVITIES

Inspections are conducted to verify compliance with regulatory requirements and ensure that the facilities maintain their approved design and operate within the safety envelope. It is also ensured that the radiation exposure to workers, the public and the environment is kept as low as reasonably achievable. Inspection activities at nuclear installations and radiation facilities by PNRA inspectors remained an important activity during 2007. The Regional Nuclear Safety Directorates maintained regulatory surveillance of all the nuclear installations and radiation facilities as per inspection plan for the year 2007.

A large number of inspections of K-1 were conducted during the re-licensing activity including a safety culture inspection. PNRA ensured that a Radiation Protection Program is in place and ALARA principle is being implemented in both the plants.

Similarly a large number of inspections were conducted at C-1 including a Periodic Inspection. During this inspection, PNRA verified that a sound Radiation Protection Program is in place,

Exercise for handling of contaminated individuals

In order to give practical training to the medical community, PNRA had arranged a medical exercise (FiedEx 02) in August 2007 in collaboration with KRL. The objective was to train the first responders on the handling and management of overexposed and contaminated individuals and demonstrate the protocols of transport of such individuals to the hospitals. This exercise was aimed to increase the awareness of first responders and observer organizations regarding rescue operation in contaminated area, medical treatment to contaminated individuals, decontamination of individuals and steps required for limiting the spread of contamination.



Exercise for handling of contaminated individuals

ALARA principle, regulatory requirements and working procedures are implemented and complied with at the nuclear power plant. Implementation and effectiveness of Environmental Radiation Monitoring program was also evaluated during this inspection.

Due to increase in the number of licensed radiation facilities, the number of inspections has also increased many folds. PNRA Inspectors monitored radiation safety during operation, maintenance and repair in these facilities in detail. It was ensured that the radiation facilities are complying with the regulatory requirements to ensure safe operation.

In addition to the routine regulatory inspections, PNRA inspectors also performed persuasive visits and surveys of un-licensed X-ray facilities to familiarize the owners of these facilities with the regulatory requirements of national regulations

and persuade them to obtain a license for the facility.

ENFORCEMENT ACTIONS

In 2007, PNRA took some enforcement actions against the radiation facilities violating national Regulations to ensure the safe use of radiation sources/apparatuses and to ensure protection of public, worker and the environment from harmful ionizing radiation. Detail of the enforcement actions taken during this year is given below:-

- The license of an industrial radiography company was suspended due to non conformance of radiation safety measures during radiography procedures.
- Violation notices were issued to a number of industries which did not comply with regulatory requirements

General Survey Of Unregistered Radiation Facilities (persuasion)

In addition to the regulatory inspections, PNRA also performs persuasive visits and surveys of un-licensed X-ray facilities to make the facility holders familiar with the national regulations on radiation protection. During the survey of these facilities, a general inspection, to check the radiation exposures on all possible sides/location of X-ray machines, was performed and the owners or users were briefed about harmful effects of radiations and necessary protective measures to be taken to avoid the radiation exposure to the workers and general public. In addition, they were also informed about the legal requirement for registration/licensing of radiation apparatus, procedure for registration and licensing and provision of prescribed application forms on the PNRA website. Furthermore, the contacted facilities were also apprised about the information, regulations and regulatory guides available on the PNRA website.

PNRA is responsible for regulating and controlling licensees' activities related to safety in radioactive waste management and transportation of radioactive materials. The Directorate of Transport and Waste Safety (WSD) is responsible for ensuring that licensees take appropriate measures for the management of radioactive waste safety. In addition, WSD also ensures that waste from nuclear and radiation facilities have a minimal impact on the environment from the time that these facilities are designed until their decommissioning.

The Directorate of Transport and Waste Safety establishes and maintains regulatory framework in these areas and ensures compliance with regulatory requirements through joint regulatory inspections with regional directorates. The Regulations on Radioactive Waste Management PAK/915 set requirements for all aspects of radioactive waste management, including collection, segregation, characterization, classification, treatment, conditioning, storage, and disposal of radioactive waste arising from the operation and decommissioning of nuclear installations and from the cleanup of contaminated sites.

PNRA ensures that the licensee of nuclear power plants allocates adequate resources for the safe management of radioactive waste during operation and for decommissioning activities of the plants.

REVIEW AND ASSESSMENT

NUCLEAR INSTALLATIONS

PNRA regularly reviews the licensee's submissions in accordance with the regulatory requirements and ensures that the radiation exposure to the public is kept as low as reasonably achievable by controlling the release of radioactive effluents from the plant. As per regulatory requirement, an on-line monitoring of the releases is performed by the licensee and PNRA ensures that the gaseous and liquid effluent releases from the plant are well below the derived release limits. On the average gaseous releases remained less than 1% of annual release limits and the liquid effluents released to sea remained in the order of 0.15% of annual release limit for Tritium for K-1.

At C-1, all liquid and gaseous effluents are monitored before release to the environment. Liquid effluents are released from C-1 into the discharge canal, which falls into the Indus River. On the average, gaseous releases remained less than 1.2% and liquid effluent releases were less than 0.1% of annual release limit for C-1.

RADIATION FACILITIES

Radiation facilities generate radioactive waste due to the use of sealed and unsealed sources during normal operation. In Pakistan, the disused sealed radiation sources are transferred to PINSTECH and K-1 for safe and secure storage. PNRA gives particular consideration to the safe and secure management of disused SRS in the country. PNRA

Waste Policy

The licensee shall be responsible for the safe management of the radioactive waste and its security and shall take all necessary steps towards achieving this aim by:

- (a) Keeping the generation of both the activity and volume of radioactive waste to the minimum practicable by suitable design, operation and decommissioning of its facilities;*
- (b) ensuring that radioactive waste is managed by appropriate classification, segregation, treatment, conditioning, storage and disposal, and maintaining records of such activities including inventory of radioactive waste;*
- (c) ensuring that disposal of radioactive waste is not unnecessarily delayed; and*
- (d) reporting to the Authority the required information at such intervals as may be specified in the licence.*

Source: Regulations on Radioactive Waste Management – PAK/915 – Section 5

ensures that the radioactive waste generated due to use of unsealed sources in radiation facilities is disposed off by the facility according to the national Regulations.

INSPECTION OF WASTE MANAGEMENT AND DISPOSAL

During 2007, the Regional Nuclear Safety Directorates conducted numerous inspections of nuclear and radiation facilities to verify compliance with the regulatory requirements. The inspections focused on storage facilities and radioactive waste management programs to assess the safety of waste collection, classification, treatment, storage and disposal practices at these facilities.

K-1 management in consultation with PNRA, is working to select the most appropriate option for extending the plant's spent fuel storage capacity to cater to its extended operational life. In this regard, construction work has started of a dry storage facility for K-1 spent fuel. The planned facility will store spent fuel generated from K-1 up to 2017. This facility will be licensed by PNRA before starting operation.

SAFE TRANSPORT OF RADIOACTIVE MATERIALS

PNRA ensures safety in transportation of radioactive materials in the country and conducts regulatory inspections of the radioactive materials

transported in and out of the country. In order to harmonize national transportation practices with international requirements, PNRA formally adopted the IAEA Regulations for the Safe Transport of Radioactive Material, 1996 Edition (As Amended 2003), No. TS-R-1 and gazette notified the "Regulations for the Safe Transport of Radioactive Material - PAK/916" in 2007. A regulatory guide entitled "Transportation of Radioactive Material by Road in Pakistan" has also been published in 2007 to guide concerned stakeholders regarding the measures to be taken for safe and secure transportation of radioactive material in the country.

Training Seminars and workshops were arranged for the Governmental departments like the Civil Aviation Authority and Customs Department to apprise them about the hazards associated with the transport of radioactive material and the safety measures to be taken during transportation.

PNRA has joined IAEA Database System on Events in the Transport of Radioactive Material (EVTRAM). PNRA regularly receives information on transport events that occur in IAEA Member States and is useful for improving transport practices in the country.

Policy on Management of sealed radioactive sources procured by the users/importers

- *Sealed radioactive sources 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:*
 - (a) *no longer useful for the intended purpose (i.e., spent sources) or*
 - (b) *not useful for another purpose or*
 - (c) *not useful to another user in the country for another purpose.*
- *This condition shall be included as part of the purchase contract without which no objection certificate for import will not be granted by the Authority. The user/importer is required to provide copies of the purchase contract, shipping and other related documents to the Authority when applying for no objection certificate for import/export of the sealed radioactive sources."*

Source: Regulations on Radioactive Waste Management – PAK/915. Section 19

6 EMERGENCY PREPAREDNESS

PNRA is responsible for ensuring that the licensees take appropriate measures to respond to any major nuclear or radiological emergency. In order to mitigate the consequences of any such event, PNRA is setting requirements in the form of Regulations on Management of Nuclear Accidents or Radiological Emergency – PAK-914. During the year, these Regulations have been finalized and are expected to be approved by the Authority and Gazette notified in 2008.

PLANS AND DRILLS

PNRA ensures that the operators of the nuclear power plants have developed emergency plans to respond to any nuclear accident as per regulatory requirements for the operation of nuclear power plants in Pakistan (PAK/913). These plans are approved by PNRA and the licensee periodically demonstrates the effectiveness of these plans through drills and exercises which are witnessed by PNRA. During 2007, C-I, K-I and PARR-I conducted emergency exercises. Officials from PNRA witnessed these drills.

The emergency plans of radiation facilities are verified during regulatory inspections. During the year 2007, PNRA provided assistance to the licensees in developing emergency plans for the Molybdenum facility at PINSTECH and PARAS.

NATIONAL RADIATION EMERGENCY COORDINATION CENTRE

PNRA has set up a National Radiation Emergency Coordination Centre (NRECC) for reporting of

nuclear or radiological emergencies. The centre is equipped with necessary communication channels at national and international levels and is available round the clock to receive emergency notifications. NRECC also has its own Mobile Radiological Monitoring Laboratory (MRML) which is equipped with radiation monitoring equipment, personnel safety equipment and a system of communication with PNRA and other relevant organizations. NRECC and MRML regularly conduct drills and exercises to test their own preparedness and efficiency.

Pakistan is a party to the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. Pursuant to Article 7 of the Early Notification Convention and Article 4 of the Assistance Convention, Government of Pakistan has identified Pakistan Nuclear Regulatory Authority as the National Competent Authority and contact point for the two conventions. In this respect, PNRA participates in the announced and unannounced drills conducted by the Incident and Emergency Centre (IEC) of IAEA. These exercises are called “ConvEX Exercises” and are conducted to test the availability and accuracy of the contact points and their ability to properly access the protected Early Notification and Assistance Convention (ENAC) website and exchange of information during emergency situation. During 2007, NRECC participated in three IAEA ConvEX exercises.

National Radiation Emergency Coordination Centre (NRECC)

NRECC has been set up to facilitate, in the event of an actual or potential nuclear or radiological emergency. The centre is equipped with necessary communication channels at national and international levels and is available round the clock to receive emergency notifications.

*For additional information, please contact:
National Radiation Emergency Coordination Centre
PO Box 1912 Islamabad, Pakistan
Tel: +92 (51) 9262 019, Fax: +92 (51) 9261 724
Officer-in-Charge: +92 300 8540 319
Email: nrecc@ins.pnra.org
<http://www.pnra.org>*

PNRA continued to interact with national and international institutes of repute. During 2007, PNRA signed memoranda of understanding with Ghulam Ishaq Khan Institute of Technology (GIK), University of Engineering and Technology, Peshawar and China Nuclear Power Operation Technology Corporation (CINPO) for joint research and training activities.

PNRA maintains a relationship of mutual respect and trust with the Government, and ensures that this confidence of the Government is maintained at all times. In order to enhance the liaison PNRA interacted with the Ministry of Health, Prime Minister Inspection Commission, and National Disaster Management Authority (NDMA).

PNRA regularly submits an annual report to the government at the end of each calendar year. These submissions have improved transparency and keep the Government abreast of PNRA efforts for ensuring safety of the workers, the public and the environment from the harmful effects of ionizing radiation.

NATIONAL LINKAGES

RELATIONS WITH LICENSEES

The interface between PNRA and PAEC was enhanced by the establishment of the Advisory Committee for Improving Utility-Regulatory Interface (ACIURI) in 2005, which includes representatives of both PNRA and PAEC. During the reporting period Chairman PNRA extended the period of the ACIURI. The operating organizations remained satisfied and no significant issue was raised in the ACIURI by PAEC during the current year. PNRA as a part of its policy distributed its draft regulations for manufacturers of nuclear grade component, siting and emergency preparedness to the operating

organizations for their inputs/comments before final approval.

In fulfilment of the Government of Pakistan's plan to enhance the present installed nuclear power capacity to 8,800 MWe by the year 2030 the joint PNRA/PAEC technical study (JTS) for new nuclear power plant i.e. K-2, a 600 MWe PWR type NPP which was initially proposed to be installed at Karachi remained an ongoing activity in 2007. During the first phase (JTS-I), a pre-Preliminary Safety Analysis Report (pre-PSAR) for 600 MWe PWR was prepared and reviewed against the current regulatory requirements and codes & standards. In the second phase of JTS (JTS-II), work is in progress on selected design basis and beyond design basis accident sequences.

PNRA has also designed courses for licensees of radiation facilities for developing understanding of PNRA requirements. During 2007, three such courses were conducted at Lahore, Karachi and Islamabad for industrial radiographers. The personnel from NPPs also participated in these courses.

PNRA also hosted a seminar on the monitoring of nuclear and radioactive materials across the country, especially near borders. A wide range of Government departments participated, including Pakistan Customs, Police and Ministry of Health, among others.

COLLABORATION WITH NATIONAL ACADEMIC INSTITUTIONS

PNRA has started collaborating with the national academic institutions to enhance the technical capabilities of its newly recruited officials. In 2007, PNRA continued interaction with national academic institutions and universities to carry out training and research activities. Memoranda of

During 2007, PNRA interacted with the Ministry of Health, Prime Minister Inspection Commission, and National Disaster Management Authority (NDMA). PNRA invited officials from NDMA and various ministries to witness the communication set-up of the National Radiation Emergency Coordination Centre (NRECC) at PNRA Headquarters G-8, Islamabad, which was activated in response to integrated emergency exercise conducted at K-1.

Understanding (MOU) were signed with Ghulam Ishaq Khan Institute of Technology (GIK) and University of Engineering and Technology, Peshawar for joint research and training activities. A number of training courses were arranged for PNRA officials who received technical as well as management courses from institutes such as Pakistan Institute of Management (PIM), Lahore University of Management Sciences (LUMS), National Institute of Design Analysis (NIDA), National Centre for Non Destructive Testing (NCNDT) PAEC and Pakistan Materials Research Society (PMRS) etc.

As committed “Self Assessment of Regulatory Performance of PNRA” was completed in collaboration with the Lahore University of Management Sciences (LUMS).

PNRA has signed an MOU with PINSTECH for provision of technical assistance in the field of dosimetry and environmental radioactivity

surveillance.

In addition, through the PNRA Fellowship Programme, PNRA continued to sponsor graduate students at the KANUPP Institute of Nuclear Power Engineering (KINPOE) and Pakistan Institute of Engineering and Applied Sciences (PIEAS).

RELATIONS WITH THE PUBLIC

PNRA is committed to perform its functions in a manner that ensures confidence of the general public. In this regard, PNRA launched a campaign in the print media to educate the general public on how to identify a radioactive source and what to do if they find a lost or stolen radioactive source. This campaign drew the attention of national and international electronic media. In addition, some brochures were published and press releases were issued.



Participants at a meeting of Government Liaison Officers at PNRA Headquarters

INTERNATIONAL COOPERATION

REPRESENTATION AND FULFILMENT OF OBLIGATIONS

PNRA maintains a relationship of mutual respect and trust with the Government, and ensures that this confidence of the government is maintained at all times. PNRA continued to fulfil Pakistan's international obligations under the four conventions related to nuclear safety to which Pakistan is a signatory. In 2007, PNRA submitted the Fourth National Report under the Convention on Nuclear Safety (CNS), responded to questions posed on its report and prepared questions on National Reports submitted by other Contracting Parties. The questions posed and responded by Pakistan were posted on the secured website of the CNS secretariat. PNRA will also lead the Pakistan delegation to the Fourth Review Meeting of CNS in April 2008. In addition, PNRA prepared briefs and reports for other Conventions and the IAEA General Conference as well as other reports for the Government.

IAEA has established a Response Assistance Network (RANET) under the Convention on Assistance in case of a Nuclear Accident or Radiological Emergency. The objective of this network is to pool resources to provide assistance to signatories of the Convention. PNRA has also registered in this Network. The expertise and resources have been identified to take part in this program.

PNRA regularly participates in the development of international safety standards and is a member of different committees established in the IAEA for this purpose. These committees include Committee on the Safety Standards (CSS), Nuclear Safety Standards Committee (NUSSC), Radiation Safety Standards Committee (RASSC)

and Transport Safety Standards Committee (TRANSSC).

Development of the national Nuclear Security Action Plan (NSAP) fulfilled an obligation of the Convention on Physical Protection and Security of Nuclear Material. Work remained in progress at the "Nuclear Security Action Plan" project for the assessment of security levels and up-gradation of security measures at radiation facilities in the country. Nuclear Security Training Centre and Nuclear Security Emergency Co-ordination Centre (NuSECC) established at Islamabad conducted a number of training courses locally and in collaboration with IAEA during 2007. A number of personnel from different organizations were trained in the reporting period. A media campaign was launched for the creation of awareness about radiation symbols and harmful affects of radiation.

BILATERAL AND MULTILATERAL COOPERATION

PNRA signed bilateral cooperation agreements with China Nuclear Power Operation Technology Corporation (CNPO), Wuhan, China to provide training to PNRA staff on nuclear power plant systems, In-Service Inspections (ISI) of NPPs systems, accident analysis, and experience feedback. The National Nuclear Safety Administration (NNSA) of China continued assisting PNRA in assessments for licensing of nuclear power plants and manufacturers of safety class nuclear power plant components.

PNRA is a member of the Network of Regulators of the countries with Small Nuclear Programme (NERS) and regularly participates in its annual meetings. Information is continuously exchanged between the member countries through this platform. PNRA maintains the NERS website.

PNRA is the focal point for the following four international Conventions to which Pakistan is a signatory

- *Convention on Nuclear Safety*
- *Convention on Early Notification of a Nuclear Accident*
- *Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, and*
- *Convention on Physical Protection of Nuclear Material.*

The third bilateral meeting of PNRA and United States Nuclear Regulatory Commission (USNRC) was held in Washington D.C. in April, 2007. In this meeting, discussions were held for enhancing future cooperation and exchange of safety related information and personnel. In 2007, one officer from PNRA participated in the Stimson Fellowship Programme in Washington D.C.

TECHNICAL COOPERATION WITH IAEA

The two ongoing IAEA-assisted technical cooperation projects namely, "Further Improvement of Regulatory Infrastructure in Pakistan- PAK/9/028" and "Applicability of IAEA Safety Standards in Licensing of NPP in Pakistan -

PAK/9/030" showed satisfactory progress during 2007. PNRA has also submitted a proposal for a third technical cooperation project namely "National Technical Project for Strengthening the Radiation, Waste and Transport Safety Infrastructure in Pakistan". PNRA participated in various expert missions, fellowships and scientific visits of the IAEA.

IAEA has initiated to develop Safety Analysis Report Review Plan (SARRP). PNRA is participating in this activity in the areas of reactor physics, reactor coolant system, engineered safety features, instrumentation and controls, electric power and auxiliary system.

Safety and Security of Radioactive Sources

The safety and security of radioactive sources has become an important concern worldwide due to the heightened risk of malevolent use of nuclear or radioactive materials. During 2007, PNRA reviewed and tightened its security and physical protection requirements. As per PNRA's strategy to address the issue in accordance with the internationally accepted criteria and practices, PNRA brought together national authorities and helped them understand the security and physical protection requirements and respond appropriately at their respective levels. In this context, PNRA arranged several training courses in collaboration with IAEA with the participation of different national organizations, such as Pakistan Customs, Inter Services Intelligence (ISI), Frontier Core (FC) and PAEC.

With the establishment of Nuclear Security Action Plan (NSAP) PNRA remained engaged in the implementation of applicable clauses of IAEA Code of Conduct on Safety and Security of Radioactive Sources and UN Security Council Resolution 1540. This will help boost stockholder's confidence in the nuclear energy sector.

*Nuclear Security Emergency Coordination Centre (NuSECC)
Pakistan Nuclear Regulatory Authority
Mauve Area, G-8/1
Islamabad
Tel: 0800 777 66*



PNRA /IAEA Joint training workshop at Nuclear Security Emergency Coordination Centre

PNRA, backed by its determination and core values to pursue the highest standards of integrity, transparency and competence, is committed to meet the future challenges as a world class nuclear regulatory body. PNRA proactively avails national and international opportunities to enhance its institutional capabilities and to impart to its team the necessary knowledge, skills, tools and international exposure for keeping pace with the rapid development and advancement in the nuclear industry. PNRA continuously assesses the quality of its work to direct efforts for improving its own capabilities so as to protect radiation workers, the public and the environment from any harmful effect of radiation and any potential damage to nuclear and radiation facilities.

To cope with the new challenges and future responsibilities, the Centre for Nuclear Safety (CNS), Nuclear Security Action Plan (NSAP) and School for Nuclear and Radiation Safety (SNRS) were established, financed by the Public Sector Development Program (PSDP) which resulted in continuous improvement of technical capabilities within PNRA. In addition, during 2007 new projects submitted by PNRA, have been approved by PSDP, to set up infrastructure for country-wide environmental surveillance, dosimetry services and calibration laboratories.

In order to further improve its regulatory activities in an effective and efficient manner, PNRA has increased its interaction with governmental organizations and has started involving them in its regulatory activities.

PROGRESS AT THE CENTRE FOR NUCLEAR SAFETY

Centre for Nuclear Safety (CNS), which is the PNRA's technical support organization established under the PSDP funding, has contributed significantly for capacity building of PNRA to perform its regulatory functions in an effective and efficient manner. The performance of CNS is continuously being monitored by the Planning and Development Division, Government

of Pakistan. During three years of its establishment, CNS has mainly focussed on developing regulatory competence among the newly inducted scientists and engineers by imparting training in local and international institutions and involving them in core regulatory activities. In 2007, 22 officers were sent on fellowships under IAEA technical cooperation projects and to different institutes in China to enhance their technical skills in the field of nuclear safety analysis, review and assessment and inspection of NPPs. In order to impart hands-on experience to the incumbents, CNS personnel are also involved in on-going regulatory activities to provide assistance to technical Directorates in review and assessment, inspection and licensing of nuclear facilities. In addition, CNS is determined to transform PNRA into a knowledge based organization for which development of a web based knowledge portal is in progress at CNS.

Following are some of the milestones achieved by CNS in 2007:

- *Participation in C-2 Review:* The CNS team includes a relatively large number of newly recruited officers, who, from day one, were assigned the review of Preliminary Safety Analysis Report (PSAR) of C-2 under the guidance of a senior staff member. In addition, the review of C-2's Probabilistic Safety Assessment (PSA) Report, submitted by the licensee as part of the submission requirement for the grant of a Construction License, was successfully completed.
- *Placement in China's Regulatory Body:* The newly inducted officers of CNS were attached in groups with Nuclear Safety Centre (NSC), Beijing, a technical support organization of National Nuclear Safety Administration (NNSA) of China. Furthermore, CNS staff was also placed at Shanghai Regional Office, responsible to conduct nuclear safety inspections of NPPs in China. In addition to the training activities, CNS officers also

conducted regulatory inspections of different plant components being manufactured in China for C-2. Thirty two (32) officers from PNRA including 18 CNS officers were placed by CNS in different institutes in China for a period of three months in batches.

- *Joint technical study with PAEC:* Thirty seven officers (37) from CNS participated in the preparation and safety review of the pre-PSAR and Site Evaluation Report (SER) under the PNRA-PAEC Joint Technical Study (JTS). The team also conducted a comparison of design, material and functions of two different types of power reactors namely AP-1000 and M-310. The objectives of this ongoing exercise are to develop capability of indigenization of nuclear power in Pakistan and to develop consensus between PAEC and PNRA on NPP safety issues. A Joint Analytical Study (JAS) is also being carried out for developing capability in deterministic safety analysis of NPPs by CNS and PAEC under the JTS umbrella.
- *Bilateral cooperation agreements:* CNS has signed bilateral cooperation agreements with CNPO, a technical support organization of China, to provide training to CNS staff on nuclear power plant systems, in-Service inspections and safety analysis.
- *Local Trainings:* Thirty (30) officers from CNS participated in trainings arranged by PNRA in its premises. In addition, sixty (60) officers from CNS participated in various courses at the following institutes in Pakistan:
 - Pakistan Welding Institute (PWI), PAEC, Islamabad.
 - National Centre for Non-Destructive Testing (NCNDT), PAEC, Islamabad
 - Pakistan Institute of Management (PIM), Lahore
 - CHASNUPP Training Centre, Chashma, Kundian
 - Technical Services Centre (TSC) of Pakistan Standards Quality Control

Authority

- *Preparation of SARRP Documents:* Under IAEA technical cooperation project “Applicability of IAEA Safety Standards in Licensing of NPP in Pakistan – PAK/9/030”, CNS staff participated in development of Safety Analysis Report Review Plan (SARRP) in the areas of reactor physics, reactor coolant system, engineered safety features, instrumentation and controls, electric power and auxiliary system.

DEVELOPING THE NEXT GENERATION OF REGULATORS

PNRA has taken a number of initiatives to ensure continuous improvement in its regulatory performance. As a forward-looking, knowledge-based organization, it is committed to working proactively to develop and maintain the competency of its current and future human resources.

The fifth recruitment drive was successfully completed during the reported year and about 29 scientists and engineers were inducted as against the target of 50. Presently, there are 180 technical professionals at PNRA's strength and by 2015 the manpower strength has to be increased to 415,



Signing of bilateral agreement of cooperation with CNPO, Wuhan China (D.G Corporate PNRA and Vice President of CNPO)

| <i>SNRS Conducted Internal Courses in 2007 A total of 127 officials Participated (95 PNRA 32 PAEC)</i> | |
|---|--|
| 1 | Nuclear Reactor Material -16 – 20 April |
| 2 | Regulations and Regulatory Guides issued by PNRA, 28 May - 08 June |
| 3 | Short Course on "Reactor Physics" - 6 - 10 August |
| 4 | 7 th Level-I Training Course - 3 September - 12 October |
| 5 | "Orientation Course for International Relations Analyst" , October 22 - November 16 |
| 6 | 3 rd Level-II Basic Professional Training Course on "PWR Systems" Specific to C -1, October 24- November 29 |

through direct recruitment drives and fellowship schemes, to cater for the expanding nuclear power generation capacity. The newly inducted scientists and engineers are undergoing an intensive one-year training programme, which involves classroom as well as on-job training. Classroom training is provided by senior PNRA staff members as well as international experts from IAEA and the nuclear regulatory bodies of other countries, mostly China.

PNRA has awarded around 15 fellowships to candidates for Masters programme in nuclear and power engineering disciplines at PIEAS and KINPOE. These fellows will join PNRA after successful completion of studies.

PNRA has made agreements with some reputed national universities and organizations, through its School for Nuclear and Radiation Safety (SNRS), for training and research activities. A number of Memoranda of Understanding (MoUs) were signed between PNRA and these institutions to enhance the technical capabilities at PNRA as part of its national cooperation programme. In December 2007, PNRA signed a MoU with PINSTECH for provision of technical assistance in

the field of dosimetry and environmental radioactivity surveillance projects. A number of PNRA officials received management related training at the National level from Pakistan Institute of Management (PIM).

The School continually arranges intensive professional training courses both for the newly inducted officers and senior staff of PNRA. With the establishment of the School for Nuclear and Radiation Safety (SNRS), PNRA has helped broaden the efforts in improving the competency level, knowledge and skills of the newly recruited officers for the regulation of nuclear power plants in Pakistan. In 2007 six (06) courses were conducted at PNRA School for Nuclear and Radiation Safety in which 130 officers from PNRA as well as PAEC participated.

During the last seven years PNRA has achieved phenomenal growth from 38 technical professionals to 180 technical professionals. This growth has created numerous challenges for recruitment, training and development of the regulatory staff. In order to meet these challenges a leadership development programme was initiated at PNRA in collaboration with Lahore University of Management Sciences (LUMS). A total of twenty (20) young officers with leadership potential were selected for this programme. This programme includes; 360 degree feedback processes, action learning project, and leadership development framework (LDF) for organization. A leadership development framework (LDF) based on 4 Cs and 1P i.e. Competitiveness, Compassion, Credibility, Consistency and Passion was established. It is expected that this leadership development framework (LDF) may be adopted and adapted by other regulatory bodies accordingly.

RESEARCH AND DEVELOPMENT

Research and development constitutes a critical component of PNRA's self-improvement program. As mentioned earlier, PNRA is liaising with a wide range of national academic institutions

to promote research on nuclear and radiation safety. A number of Memoranda of Understanding (MoUs) were signed between PNRA and these institutions to enhance the technical capabilities at PNRA as part of its national cooperation program. In December 2007, PNRA signed a MoU with PINSTECH for provision of technical assistance in the field of dosimetry and environmental radioactivity surveillance projects. In addition, during 2007, PNRA entered into agreement with Ghulam Ishaq Khan Institute (GIK) at national level and with China Nuclear Power Operation Technology Corporation (CNPO), Wuhan, China at international level for regulatory activities related to Research and Development.

MONITORING, EVALUATION AND IMPROVEMENT

PNRA's efforts towards performance improvement is a clear manifestation of its commitment to accomplish its mission in ensuring safety to workers, public and the environment against harmful effects of ionising radiation arising from nuclear installations and radiation facilities. In this context, Monitoring and Evaluation (M&E) has become an important and routine activity at PNRA. In addition to regular self-evaluation and performance reporting to the Government and the public, PNRA frequently invites international reviews. These assessments drive PNRA towards improved performance in all of its activities.

As part of its Management System the Authority

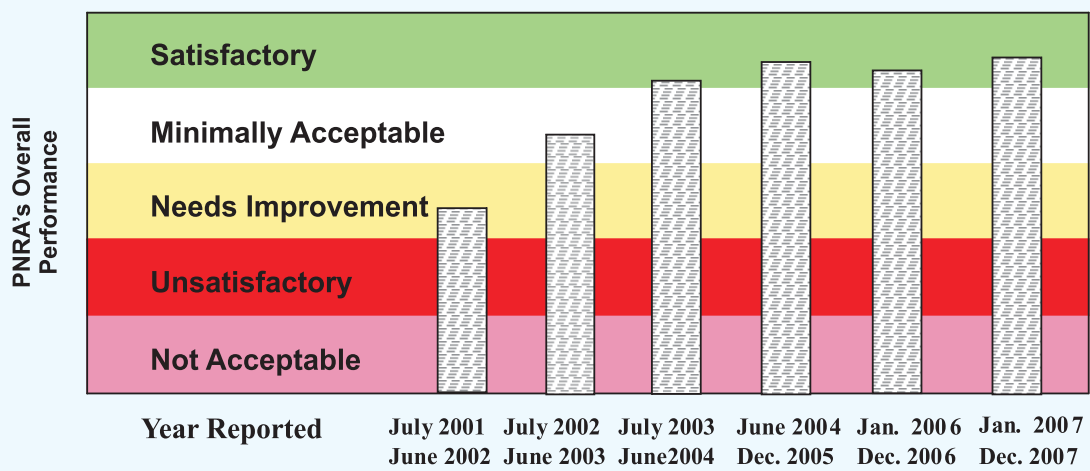
completed a study in April 2007 on "Self Assessment of Regulatory Performance of PNRA" in collaboration with Lahore University of Management Sciences (LUMS). PNRA responded to the Self Assessment Questionnaire prepared by LUMS which was independently reviewed, audited and verified by LUMS. This systematic and rigorous assessment was completed in March 2007. A comprehensive report identifying areas of strength and weaknesses of PNRA was submitted by LUMS in April 2007. PNRA prepared an action plan to focus its resources for the improvement of these weak areas during the coming years. A Strategic Plan Team (SPT) was formulated to prepare a written document for development of Strategic Plan 2008-2010 of PNRA vis-à-vis PNRA's Vision, Mission, Core Values, Strategic Planning Process, Stakeholder Analysis and Objectives.

PNRA assesses its performance qualitatively, based on 12 strategic performance indicators using a five-level rating scale. The two figures below present a comparison of its overall performance since its inception and summarize PNRA's assessment of its performance in 2007. PNRA assesses that the internal monitoring and evaluation shows signs of improvement as compared to previous years in all areas of operation.



CNS trainees with Chinese experts during a visit to ageing management test facility at BINE, China in Sept, 2007

PNRA's Overall Performance over the Years




| Rating Scale | |
|--------------|----------------------|
| Green | Satisfactory |
| White | Minimally acceptable |
| Yellow | Needs improvement |
| Red | Unsatisfactory |
| Pink | Not acceptable |

Assessment of Performance, January – December 2007

| | | |
|--|--|---|
| 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 function 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 |



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