REPORT
2001-2005

PAKISTAN NUCLEAR REGULATORY AUTHORITY

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Message from the Chairman

JamshedAzimHashmi
Chairman
PakistanNuclearRegulatoryAuthority
IslamicRepublicofPakistan

My colleagues andIarepleasedto present this report of the achievements of the Pakistan Nuclear Regulatory Authority (PNRA)initsfirst fiveyears,thatis,theperiodfrom2001to2005.

An independent and competent regulatory authorityisaprerequisitefor thesafeoperation ofnuclear installations andradiation facilitiesin a country. PNRA was created for this purpose underthePakistanNuclearRegulatoryAuthority Ordinance, 2001. Broadly, the Authority is responsible for protecting the public, workers andtheenvironmentfromtheharmfuleffectsof radiation;safeguardingtheinvestmentsmadein nuclear facilities byreducing the consequences of nuclear incidents; and protecting the nation fromthemisuseofradiationsources.

An important element of our role isdeveloping andimplementingthelegislativeandregulatory framework for nuclear and radiation safety. In this regard,PNRAhasformulatedandnotifieda numberofregulationsintheGazetteofPakistan.

Since its inception, PNRA has brought about significant improvements in the regulation of radiationfacilities.Aregistryofionizingradiation sources has been established to track all radioactive sources imported into Pakistan. Through various initiatives, PNRA has encouraged a large majority of diagnostic radiation facilities to get registered, obtain licencesandenteritssafetynet.

Asanationalnuclearregulator,PNRArepresents Pakistan in several international organizations and is responsible for fulfilment of national commitments accruing from bilateral and multilateral agreements aswellasinternational conventions. We presented Pakistan's National Reports in the review meetings of the IAEA ConventiononNuclearSafetyanddemonstrated Pakistan's commitment to fulfilment of obligations. We also ensured that all the obligations under the Conventions on “Early Notification of a Nuclear Accident”, “Assistance intheCaseofaNuclearAccidentorRadiological Emergency” and“Physical Protection of nuclear materials”werefulfilled.

Efforts are in progress to further build emergency preparedness and response coordination,andcooperationwithnationaland internationalorganizations.

Alongside its routine work, PNRA has been striving for continuous improvement of its regulatory performance. Towards the end of 2003, weinvitedamission of the International Regulatory Review Team (IRRT) of the International Atomic Energy Agency (IAEA) to conduct a full-scope reviewofitspractices.The Team was of the opinion that PNRA has all the prerequisites of a good regulatory body and fulfils its national and international commitments. In 2005, an IAEA Radiation SafetyInfrastructureAppraisal(RaSIA) Mission was invited toreviewPNRA'sworkonradiation, waste and transport safety aspects. Successive IAEA peer reviews and appraisals demonstrated that Pakistan's regulatory infrastructure continues to develop in line with internationalstandards.Asafurtherstepinthis direction,withtheapprovaloftheGovernment of Pakistan, PNRA also established, in June 2005, a technical support organization-the Centre for Nuclear Safety-for its institutional strengtheningandcapacitybuilding.

Continuous and thorough reviews and assessments by PNRA revealed that the operationof nuclearinstallations in thecountry remainedsafeandreliablein2001-05andthat all commitments resulting from international agreementsandconventionswerefulfilled.

Wearedeeplycognizantofourgrowingroleand responsibilitiesinthecomingyears:tomeetthe country's future power needs, the Government of Pakistan envisages an expansion in the nuclear powerprogramthatwillincreasepower production from the current 437MWe to 8,800 MWe by 2030. In this regard, PNRA has proactively identified, planned and initiated a numberofnecessaryactions.

Building a soundrelationship with the publicis important at PNRA, and I am confident that readers will find this report a very useful introductiontoPNRA,itswork,andthestatusof nuclearandradiationsafetyinourcountry.

Abbreviations and Acronyms

ACISS	Advisory Committee on Draft International Safety Standards
ACRD	Advisory Committee on Research and Development
ALARA	As Low as Reasonably Achievable
ANSN	Asian Nuclear Safety Network
ASME	American Society for Mechanical Engineers
C-1	Chashma Nuclear Power Plant, Unit 1
C-2	Chashma Nuclear Power Plant, Unit 2
CENS	Centre for Nuclear Safety in Central and Eastern Europe
CIIT	COMSATS Institute of Information Technology
CNS	Convention on Nuclear Safety; Centre for Nuclear Safety
HMC	Heavy Mechanical Complex
IAEA	International Atomic Energy Agency
IRRT	International Regulatory Review Team
ISO	International Standards Organization
KANUPP	Karachi Nuclear Power Plant
LUMS	Lahore University of Management Sciences
M&E	Monitoring and Evaluation
MCR	Main Control Room
MRML	Mobile Radiological Monitoring Laboratory
NERS	Network of Nuclear Regulators of Countries with Small Nuclear Program
NOC	No Objection Certificate
NRECC	National Radiation Emergency Coordination Centre
NSD	Directorate of Nuclear Safety
PARR	Pakistan Research Reactor
PINSTECH	Pakistan Institute of Nuclear Science and Technology
PNRA	Pakistan Nuclear Regulatory Authority
PHWR	Pressurized Heavy Water Reactor
PWR	Pressurized Water Reactor
R&D	Research and Development
RaSIA	Radiation Safety Infrastructure Appraisal
RNSD	Regional Nuclear Safety Directorate
RPO	Radiation Protection Officer
RSD	Directorate of Radiation Safety
SRS	Sealed Radiation Source
STUK	Finish Nuclear and Radiation Safety Authority
USNRC	United States Nuclear Regulatory Commission
WSD	Directorate of Transport and Waste Safety

CONTENTS

1. Introduction to PNRA 1

2. Regulatory Framework 3
   Regulations 3
   Technical Guides and Guidelines 3

3. Nuclear Safety 4
   Review and Assessment 4
   Licensing of Operating Personnel 6
   Inspections of Nuclear Installations 6

4. Radiation Safety 7
   Review and Assessment 7
   Licensing of Radiation Facilities 8
   Authorization of Import and Export of Radiation Sources and Equipment 8
   Inspection Activities 8

5. Nuclear Waste and Transport Safety 9
   Review and Assessment 9
   Inspection of Waste Management and Disposal 9
   Safe Transport of Radioactive Materials 9

6. Emergency Preparedness 10
   Plans and Drills 10
   National Radiation Emergency Coordination Centre 10

7. National and International Cooperation 11
   National Linkages 11
   International Cooperation 12
   Technical Cooperation with IAEA 13

8. Tools for Continuous Improvement 15
   Establishment of Centre for Nuclear Safety 15
   Developing the Next Generation of Regulators 15
   Research and Development 16
   Monitoring, Evaluation and Improvement 16

Vision

The vision of PNRA is to become a world class regulatory body with highly trained, competent and dedicated personnel working in unison with a zeal to foster a positive safetycultureintheirlicenseesandtoregulatenuclearsafetyto protectthepublic, the workersandtheenvironmentfromtheharmfuleffectsof radiationandinamannerthatwinstheconfidenceofallthestakeholdersviz.the public,theGovernmentandthelicensees.

Mission

ThemissionofPNRAistoensurethesafeoperationofnuclearfacilitiesandto 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.

1
Introduction to PNRA

The Pakistan Nuclear Regulatory Authority (PNRA) was established by the Government of Pakistan in January 2001, with the promulgation of the Pakistan Nuclear Regulatory Authority Ordinance, 2001, as an independent regulatory body. This step was taken to ensure effective separation of regulatory activities from the work of nuclear energy promotion. The leadership of PNRA comprises of a Chairman, two full-time Members and seven part-time Members. The Chairman reports directly to the Prime Minister. The organization structure of PNRA is presented in Figure 1.

PNRA is empowered to control, regulate and supervise all matters related to nuclear safety and radiation protection in Pakistan. In this regard, it is empowered to develop and enforce rules and regulations, and issue guides for nuclear safety and radiation protection; develop and execute policies and programs for the protection of life, health and property against the risk arising from ionizing radiation; regulate the nuclear and radiation safety aspects of nuclear installations and radiation facilities; grant authorization, or issue licences, to nuclear installations or radiation facilities and their operators for the use of nuclear material and radioactive sources; and inspect all such facilities to ensure that regulations concerning safety measures are properly followed. PNRA also issues No Objection Certificates to importers and exporters of radioactive sources and Radiation Free Certificates for exportable food items.

Apart from on site operations, transportation and disposal of radioactive materials also fall under PNRA's purview.

In addition, PNRA is the lead agency for ensuring that national preparedness for nuclear and radiological accidents is maintained by the operating organizations or licensees. It is also the point of contact for international agreements and collaborations concerning nuclear and radiological emergencies.

These core responsibilities are supported by related activities, such as: awareness building of concerned workers and the general public about nuclear and radiation safety issues; liaison with relevant government ministries and public administration bodies to improve implementation of safety measures in their spheres of work; and collaboration with national institutions for research in nuclear and radiation safety.

Activities are carried out according to well-established regimes that cater to national as well as international aspirations. As a young and forward-looking organization, PNRA lays great stress on enhancing its regulatory effectiveness and efficiency, particularly through capacity building and institutional strengthening measures.

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Introduction to PNRA

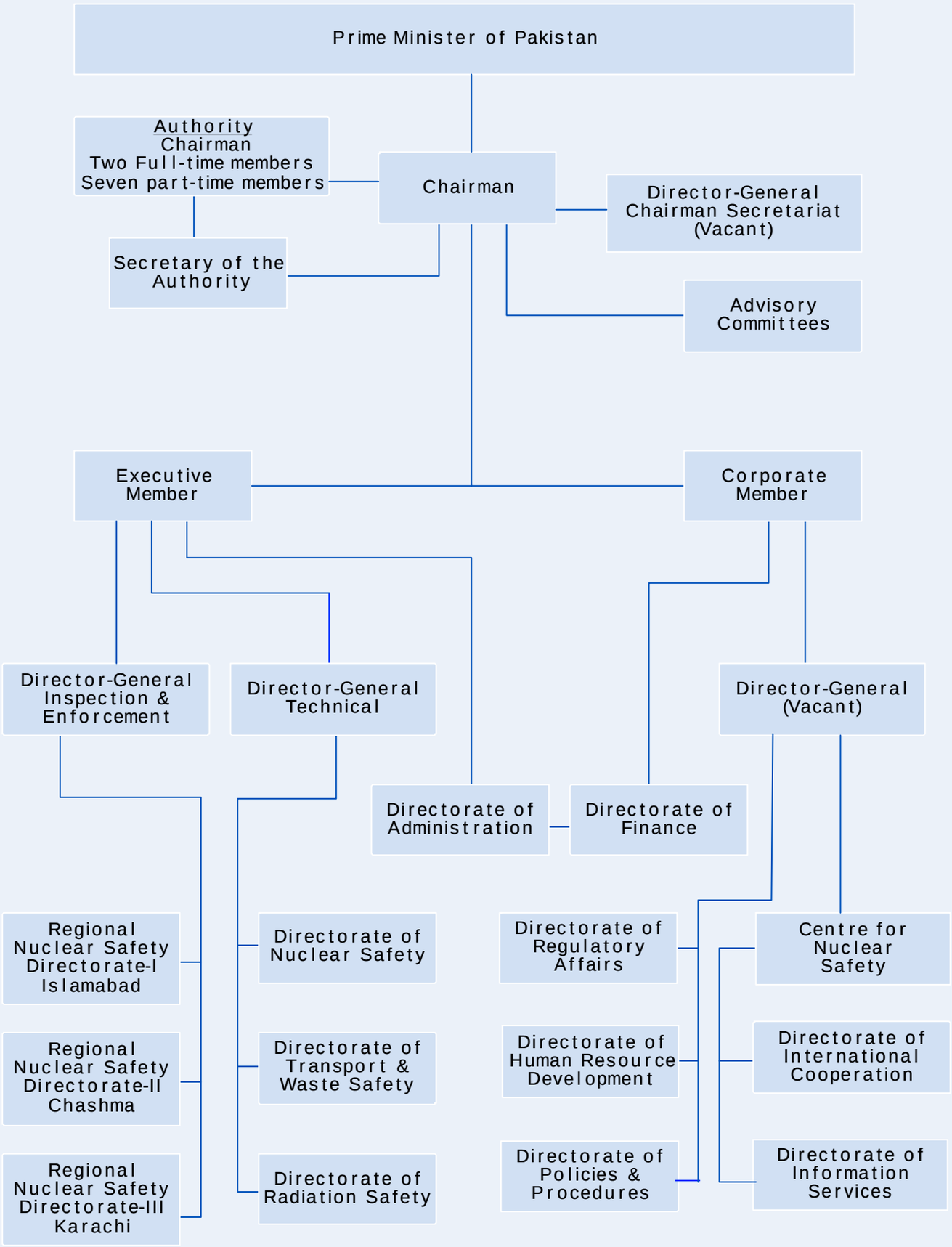

Figure1:OrganizationStructureofPNRA

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2
Regulatory Framework

The creationof PNRA,afullyindependentregulatory body, reflectsthecommitment oftheGovernmentof Pakistantoensuringoptimum nuclearandradiation safety in the country. Using its powers under the Pakistan Nuclear Regulatory Authority Ordinance, 2001 (PNRA Ordinance), and keeping in view the requirements of international conventions, PNRA made significant progress in buildingtheregulatory frameworkfornuclearsafety.

The hierarchyoftheregulatoryframeworkofPNRAis depicted in Figure 2. PNRA formulates regulations that are based onthePNRAOrdinanceandbinding on thelicensees.In addition, non-mandatoryguides and guidelines are issued to provide technical guidanceformeetingregulatoryrequirements.

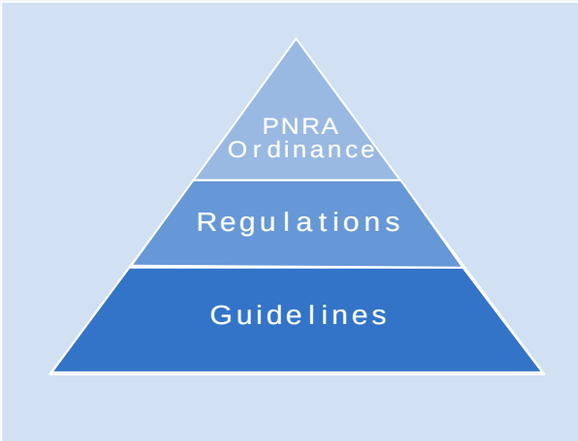

Figure2:ThePNRARegulatoryPyramid

REGULATIONS

PNRAissuedthefollowingseven regulationsduring 2001-2005:

- RegulationsonRadiationProtection(PAK/904)
- Regulations for the Licensing of Radiation Facility(ies) other than Nuclear Installation(s) (PAK/908)
- Regulations for Licensing of Nuclear Installation(s)inPakistan(PAK/909)
- Regulations on the Safety of Nuclear Power Plants Design(PAK/911)
- Regulations on the Safety of Nuclear Power Plants QualityAssurance(PAK/912)
- Regulations on the Safety of Nuclear Power Plants Operation(PAK/913)
- RegulationsonRadioactiveWasteManagement (PAK/915)

PNRAalsodraftedregulationson“SafetyofNuclear Power Plant Siting”, “Nuclear Accident or Radiological Emergency Management”, and “Licensing of Nuclear Safety Class Mechanical Equipment Manufacturers”. These are currently underreviewandareexpectedtobegazettenotified inthenearfuture.

Notably, under the PNRA Ordinance, the regulationsthatwereissuedbeforePNRA'sinception still apply until the Authority issues its own regulations. Such previously issued regulations include the Pakistan Nuclear SafetyandRadiation Protection (PNSRP) Regulations, 1990; Treatment of Food by Ionizing Radiation Regulations, 1996; Export Policy and Procedures Order, 2000; Import Trade and Procedures Order, 2000; Licensing Procedure for Research Reactors in Pakistan; and Regulations for Licensing of Nuclear Research ReactorOperatingPersonnel.

TECHNICAL GUIDES AND GUIDELINES

To facilitate licensees in complying with its safety regulations, and effecting and maintaining the required improvements at their facilities, PNRA developed and adapted a number of technical guides and guidelines. These concerned safety of nuclear installations, radioactive waste management,medicalexposurecontrol,anduseof sealedradiationsources.

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3
NUCLEAR SAFETY

The PNRA Ordinance provides the legal basis for PNRA to regulate all matters related to nuclear safety at nuclear installations in the country. To ensure theirsafeoperation,PNRAfollowsagraded approach based on the assessment of risk to workers, the public and the environment. The Authority has established a Directorate ofNuclear Safety(NSD)tooverseenuclearsafetymatters.NSD formulates the necessary regulations, guides and procedures for effective implementation of safety norms at nuclear installations, in addition to carrying out review, assessment, inspection and licensingactivities.

REVIEW AND ASSESSMENT

KARACHI NUCLEAR POWER PLANT

Karachi Nuclear Power Plant (KANUPP) started commercial operation in 1972 and completed its designlifeof30yearsin2002.

When the licensee applied for the renewal of the plant's operating licence, re-licensing activities in accordance with Regulations PAK/909 were initiated.

PNRAconductedasafetyassessmentoftheplantto identify significant weaknesses so that suitable corrective actions couldbetaken.Theassessment report, issued in September 2001, identified 24 safety concerns.Theplantis currently inprocessof refurbishment to fulfil all the necessary safety requirements.

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KarachiNuclearPowerPlant(KANUPP),a 137-MW$_e$ PressurizedHeavyWaterReactor(PHWR)

CHASHMA NUCLEAR POWER PLANT, UNIT1

Chashma Nuclear Power Plant, Unit 1 (C-1) was connectedtothegridonJune13,2000andattained full powerinSeptember2000.After all regulatory requirements had been met, the plant's formal operatinglicencewasissuedinOctober2004valid up toDecember 2010.Theplantunderwent three refuelling outages, which were conducted in September 2002, April 2004, and October 2005 and monitored closely by PNRA. During these outages,several safetytestswereperformedbythe licensee andregulatoryinspectionswereperformed byPNRA.

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ChashmaNuclearPowerPlant,Unit1,a325-MW$_e$ PressurizedWaterReactor(PWR)

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Scenes fromtheceremonyatwhichC-1'sOperatinglicense, validuptoDecember2010,wasissued.

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CHASHMA NUCLEAR POWER PLANT, UNIT 2

The second unit of Chashma Nuclear Power Plant is being built by China under a turnkey project. Formalities to issue a construction license to the plant are underway.

The first part of the licensing process was the plant's site registration. PNRA registered the site after reviewing and assessing the Site Evaluation Report and confirming that other requirements such as No Objection Certificates (NOCs) from relevant government departments had been fulfilled.

Complying with regulatory requirements, C-2 submitted its application for a construction licence along with the required technical reports. When a detailed analysis of these technical reports revealed no safety issues related to foundation design, PNRA gave provisional permission for pouring concrete in the base-mat of the nuclear island, which commenced on December 28, 2005. The license for the construction of the plant was issued on March 23, 2006 after PNRA has conducted a complete review of the required documentation and C-2 has agreed to fulfil all the regulatory requirements.

Environmental Impact of Nuclear Power Plants in Pakistan

To keep the environment clean of the effects of the nuclear industry, PNRA exercises constant vigilance over the radioactive releases to the environment. The annual gaseous and liquid effluents released from KANUPP and C-1, including radioactive materials, remained well below regulatory limits in 2001-05. No detectable effect or concentration of radio-nuclides has been observed in the environment due to radioactive effluent releases and no radiation damage to population and environment has been observed.

It may be concluded that the nuclear installations under the purview of PNRA are operating in a safe manner, and do not have any harmful effect on the health of workers, the public or the environment.

PAKISTAN RESEARCH REACTORS I AND II

Pakistan Research Reactors I and II (PARR I and PARR II) are situated at the Pakistan Institute of Nuclear Science and Technology (PINSTECH) in Islamabad. They are used mainly for research studies in physics, isotope production, and training of engineers, scientists and technicians.

Several regulatory inspections were carried out by PNRA inspectors at the two reactors, which resulted in improvements in the facilities' emergency procedures, operation record-keeping and data entry, and periodic testing program. Following review, assessment and inspection activities, the operating licences for the two reactors were also renewed.

HEAVY MECHANICAL COMPLEX 3

In 2003, the Heavy Mechanical Complex 3 (HMC-3) expressed interest in manufacturing nuclear-grade mechanical equipment. As one of the large projects in Pakistan's heavy engineering sector, HMC-3 is envisaged to play a pivotal role in self-reliance, indigenization and import substitution, and in providing continued technical support to the nuclear industry in Pakistan.

To initiate the licensing process for HMC-3, PNRA formulated licensing requirements based on international licensing and certification systems, such as those of American Society for Mechanical Engineers (ASME) and the International Standards Organization (ISO), as well as those adopted by other regulatory authorities. These requirements were made available to HMC-3 in December 2003 and, at the same time, work was initiated to develop formal regulations for licensing, review and assessment, and inspection and enforcement of nuclear-grade mechanical components.

HMC-3 submitted its licence application in January 2004. After fulfilment of all the requirements, PNRA authorized HMC-3 to manufacture safety class 2 and 3 nuclear grade equipment (i.e., pressure vessels, tanks and heat exchangers). The manufacturing licence was issued on July 19, 2005, valid for five years.

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LICENSING OF OPERATING PERSONNEL

The qualification and training of operating personnelisofgreatimportanceinensuringsafety atnuclearinstallations,andPNRAensuredthatthis area received due attention. PNRA sets the personnel qualification criteria in terms of basic engineering qualifications, training, examinations, and medical and psychological fitness; approves the training syllabus of the operating personnel; witnessesthewrittenexaminationsconductedbythe management at each plant; conducts oral and operating examinations; and awards licences to operating personnel. Operating examinations are conducted in the Control Room or on plant simulators. Operators'licences are awarded for a periodofoneyearandrenewedannually.

INSPECTION OF NUCLEAR INSTALLATIONS

While the responsibility for ensuring safety at nuclear installations lies with the licensees, PNRA performsroutineaswellasunplannedandreactive inspections to verify thatthelicensees take all the required safety measures. For this purpose PNRA has established three Regional Nuclear Safety Directorates (RNSD-I, II and III) at the sites of nuclearinstallations,i.e., Islamabad, Kundianand Karachi. Residentinspectorshavealsobeenposted atthetwonuclearpowerplants,KANUPPandC-1. In addition the RNSDs conduct regulatory inspectionsofallthelicensednuclearandradiation facilities of their respective regions, ensuring that facilities in allparts ofthecountryreceive focused attention.

PNRA conducted various types of inspections throughout 2001-05 toverifythattheprovisions ofthePNRAOrdinance,relatedregulations,terms andconditionsoflicencesandapprovedtechnical specifications were being met at nuclear facilities. All such inspections are conducted in accordance with the PNRA Inspection Program and cover operation, maintenance, and personnel training activities,radiationprotection,wastemanagement, emergency preparedness, and safety culture aspectsoftheplant.ResidentinspectorsatKANUPP and C-1 conduct daily inspections of the plants, includingtheMainControlRoom(MCR).

The routineinspections are conducted against an inspection plan, while different types of reactive inspections are performed in response to unusual eventsandsituations.Inspectionreportsidentifying deficiencies are issued and followed up until corrective actions are completed by the licensee. Quarterly inspection reports summarizing the activities of the Regional Directorates are also issued.

PromotingaSafetyCulture

Inconsonancewithinternationalpractice,PNRAis placingincreasingemphasisonpromotionofa'safety culture'atnuclearfacilitiesasanecessarycomponent of its overall nuclear safety regimen. At facilities whereasafetycultureprevails,allpersonnelaredeeply conscious of the need for safety measures, even in relativelyinsignificantaspectssuchashousekeeping. In addition,asafetycultureencourages openness so thaterrorscanbedetectedorpinpointedsoonerrather thanlater,withoutfearofretribution.Suchaculture also rewards initiatives taken to enhance safety. PNRAconductedspecialinspectionstodeterminethe statusofthesafetycultureatKANUPP(inDecember 2004) and C-1 (in July 2005). These inspections identifiedtheareaswhereimprovementswereneeded tofosterasafetycultureattheutilities.

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4
RADIATION SAFETY

PNRA regulates all matters related to radiation protection of nuclear installations and radiation facilitiesinthecountryunderthe powers conferred by the PNRA Ordinance. The Authority has established a DirectorateofRadiationSafety(RSD) to formulate necessary regulations, guides and procedures for effective implementation of safety norms in relation to radiation protection and the safe use of radiation sources, and to carry out relatedreview,assessment,inspectionandlicensing activities.

TypesofRadiationFacilitiesinPakistan

- *Nuclearinstallations*
- *Medicaltherapeuticanddiagnosticradiologycenters*
- *Nuclearmedicalcenters*
- *Agriculturalresearchcenters*
- *Industrialradiographyunits*
- *Industrialirradiators*
- *Otherresearchfacilities*

REVIEW AND ASSESSMENT

As with nuclear facilities, PNRA exercises its regulatory control over radiation facilities in accordance withtherequirementsofitsregulations and the terms and conditions of the licences awarded to the facilities. It verifies the licensees' compliance with safety requirements through reviews, assessments and inspections, providing technicalassistance or taking enforcement actions wherenecessary.

NUCLEAR INSTALLATIONS

Eachnuclearinstallationisrequiredtohaveinplace a Radiation Protection Program, which is reviewed byPNRA.Throughouttheoperatinglifeoftheplant, PNRA ensures that thelicensee fully implementsits radiation protection program. The licensee is also required to maintain and submit a record of the radiationdosestoplantpersonnel.

From 2001 to 2005, the collective and personnel radiation doses to KANUPP and C-1 personnel remained wellwithinsafelimits.

Notably, nuclear facilities in Pakistan applythe"As LowasReasonablyAchievable"(ALARA)philosophy in operations where staff radiation exposure is unavoidable. Experience has shown that this approachleadstoevenlowerexposurelevelsthan anticipated.

RADIATION FACILITIES

Key objectives of PNRA's radiationsafety effortsat radiation facilities are: ensuring that the facilities are properly designed for their intended work; ensuring that thefacilitieshaveproperlayoutand shieldingtominimizeexposure;keepingtrackofall sealed radiation sources (SRS) in the country; ensuringthesafetyandsecurityofSRSwhileinuse; ensuringthat workers, the generalpublic andthe environment are protected against any ionizing radiation that accrues from the practices of radiation facilities; regulating the import and export of SRS; and verifying that exported food productsareradiation-free.

AmajorfocusofPNRAhasbeentheregistrationof facilities that are yet to be licensed. By exempting earlier licence fees in 2004-05, PNRA persuaded a majority of diagnostic radiation facilities, mainly operatorsofX-raymachinestoobtainlicences.Allthe nuclearmedicalcentresinthecountryarenowlicensed with PNRA, while more than half of diagnostic radiologyunitshaveobtainedlicences.AlistoflicensedmedicalradiationfacilitiesinPakistanisavailableon thePNRAwebsite(http://www.pnra.org).

The needtoensurethesafetyandsecurityofSRS haslongbeenrecognized by the Government of Pakistan. Since its establishment, PNRA has continuedtoupdatethenationalregistryofSRSto keep track of the sources 'from cradle to grave'. Presently,theinventoryismaintainedusinganin-housecomputerizeddatabase.

The unsealed radiation sources used in agricultural, medical, and research facilities are also under the regulatory purview of PNRA. The mannerinwhichthesesourcesaredisposedofhas important safety implications. Most of these sourcesareshort-livedandPNRAensuresthatthey areproperlydisposedofaftertheyhavedecayed.

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OneofPNRA'smajorresponsibilitiesistoensurethat the public is not unduly exposed to radiation at diagnostic x-ray facilities, radiation therapy and nuclearmedicalcentres.Tothisend,PNRAroutinely carries outinspection and enforcement activities at such facilities, ensuring that radiation exposure of workers,patients,andthepublicremainsoptimized andwithinregulatorylimits.

LICENSING OF RADIATION FACILITIES

PNRA issues authorization andlicences to users of radiation sources and equipment after carefully reviewingthesafetyaspectsofplannedactivities.The licensing process entailssystematic assessment and inspections by PNRA toensure thattheapplicantis capableofsafeandsecureuseandmaintenanceof radiation materials and equipment. Licensees are encouraged to implement the requirements of regulationsonfacilitydesign,shieldingand radiation protectioninfrastructure.

Improvementdueto RegulatoryInspections

Regulatoryinspectionsandsafetyrecommendationshave played an important role in the enhancement of public safety.Duringaninspection,PNRAinspectorsobserved that a Labour Room of a majorhospitalwas located adjacenttotheX-RayRoom causing unduly radiation exposureto thenewborninfantsandmothers.TheLabour Room was shifted to a safer part of the building on PNRA'srecommendation.

AUTHORIZATION OF IMPORT AND EXPORT OF RADIATION SOURCES AND EQUIPMENT

PNRAregulatestheimportandexportofnuclearand radioactive materials and apparatus. Licensed importers and exporters are required to obtain an NOC from PNRA and comply with the national regulations. Before the NOC is granted, PNRA verifies that safety is ensured at all stages of the importandexportprocess.

AnothercommitmentofPNRAistoensurethatfood exports are radiation-free. As part of its commitments, PNRA analyzes food samples and issuesRadiation-FreeCertificates.

INSPECTION ACTIVITIES

As mentioned earlier, PNRA established three RegionalNuclearSafetyDirectorates,RNSD-I,IIand III, to conduct regulatory inspections of nuclear installations and radiation facilities in the country and to verify that regulatory safety standards are observed.Duringinspections,PNRAverifies,among other matters, that personal protective gear is provided to workers who need it; a qualified Radiation Protection Officer (RPO) is available; personal and area monitoring equipment are present andfunctioning; radiation doserecordsfor workersaremaintained and indicatethatdosesare withinsafelimits; andadequatephysical protection and security measures aretaken.PNRA's regulatory activities led to improved measures forminimizing radiationexposureof thegeneralpublic.

As a policy, import of sealed radiation sources containing long-lived radio-nuclides is prohibited unless the suppliers or manufacturers undertake to accept the return ofthese sources when theyareno longerusefulfortheirintendedpurpose.

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IAEAExpertMissiononSelfAssessmentofRegulatory EffectivenessatPNRAHeadquarters

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NUCLEAR WASTE AND TRANSPORT SAFETY

The PNRA Ordinance empowers the Authority to regulateandcontrolallmattersrelatedtosafetyinthe management anddisposalofradioactivewasteand transportation of radioactive materials in Pakistan. PNRA has established the Directorate of Transport and Waste Safety (WSD)to developandimplement thenecessaryregulations,guidesandprocedurestoregulatelicensees'activitiesinthesespheres.

Thetransportationofradioactivematerialsrequiresa number of special safety measures, such as appropriate packagingandlabelling,toprotectthe public and the environment from possible hazards. PNRAhasundertakenavarietyofstepstoensurethat thesafetystandardsobservedinthissensitiveprocess areinlinewithinternationalregulations.

Radioactive waste is generated when radiation sources are utilized for various purposes. The generationand managementofradioactivewasteis adistinctfocusofPNRA,becauseradioactivewaste, like other radioactive materials, poses the risk of ionizing radiation exposure for workers, the environmentandthegeneralpublic.

The broad strategy PNRA prescribes for minimal waste generation is optimal reuse and recycling of radioactive materials, and maximum use of short-lived radio-nuclides (which emit radiation for a shorterperiod).

REVIEW AND ASSESSMENT

NUCLEAR INSTALLATIONS

PNRA closely monitors waste generation and management at the twooperational nuclear power plants, KANUPP and C-1. It also reviews and suggests measures for improving the radioactive wastemanagementprogramattheseinstallations.

For both the plants, periodic assessments were conducted to verify that waste reduction and managementactivitieswerebeingundertakenasper regulatory requirements. It was ensured that radioactiveeffluentsandemissionsweremonitored, treated where needed, and released to the environmentonlyaftertheirradioactivityhadreached acceptabledischargelimits.Recordsoftotalreleases andenvironmentalmonitoringweremaintained.

RADIATION FACILITIES

Radioactive waste from radiation facilities is mostly generated from the utilization of sealed radiation sources. At present, spent radiation sources are disposed of at two designatedsites in the country. PNRA conducted regular inspections to verify that storage and disposal practices at these sites were in compliancewithregulatoryrequirements.

INSPECTION OF WASTE MANAGEMENT AND DISPOSAL

The Regional Nuclear Safety Directorates regularly conducted inspections of storage facilities and radioactivewastemanagementprogramstoassessthe safety of waste collection, classification, treatment, storageanddisposal practices. Theassessments were based on operator records as well as observations during regulatory inspections. At health facilities in particular,PNRAplayedanimportantroleinfacilitating the safe management of radioactive waste. Health facilities wereassistedintaking measures tominimize storage of waste materials at their premises, and guided in economical packing, transportation and disposalatthedesignatedsites.

In compliance with national regulations, highly radioactive solid waste was keptconfined in shielded steeltanks/binsandstoredinconcrete-linedtrenchesat designatedlocationsinthecountry.

SAFE TRANSPORT OF RADIOACTIVE MATERIALS

PNRA regulates the transportation of all radioactive materialsinthecountrytominimizeriskstothegeneral public,workersandtheenvironment.

Radioactivematerialscanbetransportedinmanyways, depending on the weight ofpackages, characteristics and composition of the radioactive contents, the distancetobeshipped,andthe availability of transportation facilities and transport infrastructure. Shipment packages are required to be appropriately labeled for easy identification.Figure3showsa typicallabelrequiredtobeposted on packagesduring transportation.Facilities engaged inexportorimportofradioactivematerialareinspected regularly by PNRA. During such inspections, among otheraspects,shippingdocumentsarereviewedandit is verified that the shipments meet national and international requirements. Import/export permissions are issued only after satisfactory compliance with regulatory requirements. Through PNRA's efforts, the package design of radio-pharmaceuticals being transported to medical centres in the country has improvedandisinlinewithinternationalstandards.

Figure3:ATypicalLabel

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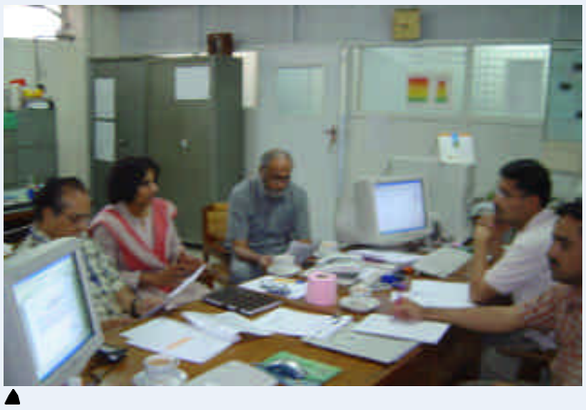
6
EMERGENCY PREPAREDNESS

From the design stage to the end of operating life, each nuclear power plant and radiation facility in the country is closely regulated and monitored by PNRA. Despite extreme care by licensees and PNRA, however, unexpected events may occur, posing risks to the health of workers, the general public and the environment. To mitigate the possible consequences of any events that might occur during the operational life of a nuclear or radiation facility, licensees are responsible for maintaining emergency preparedness. PNRA ensures that this important responsibility is fulfilled by each licensee, and takes further measures to ensure that national arrangements are in place to respond to any major incident.

PLANS AND DRILLS

PNRA ensures that onsite and offsite emergency preparedness plans, duly approved by the Authority, are in place at nuclear and radiation facilities. PNRA also assesses the effectiveness of these emergency plans by observing emergency drills that are conducted periodically to verify the state of preparedness. During observations of such drills, PNRA pays special attention to emergency response systems and recommends improvements where necessary. The follow-up to these recommendations is verified at the next periodic drill.



▲ *National Radiation Emergency Coordination Centre*

NATIONAL RADIATION EMERGENCY COORDINATION CENTRE (NRECC)

PNRA is the National Focal Point for emergency notification and for seeking assistance in case of a nuclear/radiological accident. For this purpose, the National Radiation Emergency Coordination Centre (NRECC) was established at PNRA. NRECC functions as the focal point for round-the-clock reporting and monitoring of nuclear and radiological accidents. It also coordinates the response measures at national and international level.

Upon perceiving that an operational event or accident condition may arise at their facilities, licensees are required to inform NRECC immediately. The licensee informs the population in the vicinity of the facility in consultation with local governmental authorities. NRECC is required to disseminate accident information to the designated national and international authorities and the general public after verifying the authenticity of the report.

NRECC notifies the concerned PNRA personnel via an established chain of command, and coordinates radiological monitoring in support of the licensee and other authorities. For independent analysis, the NRECC also mobilizes its Mobile Radiological Monitoring Laboratory (MRML), equipped with radiation monitoring equipment, personnel safety equipment and a system of communication with PNRA and other relevant national organizations.

Interior view

▲ *Mobile Radiological Monitoring Laboratory*

▼ *External view*

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7
NATIONAL AND INTERNATIONAL COOPERATION

Open communication, transparency and cooperationareimportantvaluesatPNRA,andare regarded as essential features of relations with national and international stakeholders for regulatoryeffectivenessandefficiency.Indeed,three ofPNRA'stwelvestrategicperformance indicators (page 16) pertain to the trustitinspires among its licensees,thegeneralpublicandtheGovernment.

In its regulatory approach, PNRA departs from conventional top-down methods and, instead, adopts a facilitative approach, working with licensees to help them appreciate safetyconcerns, develop responsive practices, and improve their protectionmeasuresinlinewithinternationaltrends.

Regulatory decisions arebasedonregulationsand guides,andmadewithoutunduedelays,withclarity and transparency. The incidence of enforcement activities is minimal because PNRA motivates compliancebypromotingasafetyculture.

On important issues, such as regulatory changes, extensive consultation is conducted with the licensees, particularly the Pakistan Atomic Energy Commission (PAEC), to incorporate their perspectives and thereby increase the efficiency of thenewinitiatives.

This section discusses the ways in which, in a relatively brief span of five years, PNRA has conductedandinitiatedcollaborationswithnational and international organizations for enhanced nuclearandradiationsafety,anditsefforts tobuild public awareness regarding nuclear and radiation issues.

NATIONAL LINKAGES

LIAISON WITH GOVERNMENT BODIES

Toensurethatitsregulatoryactivitiesarecarriedout aseffectivelyandefficientlyaspossible,PNRAworks incooperationwithothergovernmentbodieswhere needed. This also enables the concerned government institutions to better play theirrolesin maintaining and improving nuclear and radiation safetyinthecountry.PNRAhasforgedlinkageswith various Federal Government organizations in the implementation of regulations concerning their domains, including the Federal Ministries of Law, Environment, Foreign Affairs, Interior, Health, and TransportandCommunication,aswellasthePublic Administration, Civil Aviation Authority, and other relatedinstitutions.

Collaboration with National Academic Institutions

Forsomeofitsresearchactivities,andasalong-term strategyforhumanresourcedevelopment,PNRAhas startedexploringpartnershipswithreputedacademic institutionsinPakistan,suchasCOMSATSInstituteof InformationTechnology (CIIT), AirUniversityandthe LahoreUniversityofManagementSciences(LUMS).

BuildingNationalLinkagesfor NuclearandRadiationSafety

PNRA conducted a meeting in August 2005 with liaison officers from various ministries to forge cooperative administrative arrangements with the provinces(throughtheFederalGovernment)regarding the implementation of regulations in the areas of health,environmentandotherpublicdomains.Sucha federal-provincial regulatory arrangementwillbein linewiththeinternationalbestpracticeandenhance nuclearsafetythroughoutPakistan.

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Figure4:ThehomepageofPNRA'swebsite

RELATIONS WITH THE PUBLIC

Overthelastfiveyears,PNRAhasestablishedapublic awarenessprogramregarding nuclearandradiation safety.

The key tools for public awareness and education include press releases on safety issues and an interactive website(www.pnra.org),thehomepageof which is shown in Figure 4. The website provides useful information about PNRA,alistofregulations andguides,andapplicationsforlicensingandother related documents. In January 2004, PNRA also published a supplement about its activities in a nationaldailynewspaper.

INTERNATIONAL COOPERATION

REPRESENTATION AND FULFILMENT OF OBLIGATIONS

As a national nuclear regulator, PNRA represents Pakistanin severalinternationalorganizationsandis responsibleforfulfilmentofcommitmentsarisingfrom international conventions as well as bilateral and multilateral agreements. Recently, PNRA became a "second point of contact" for IAEA, responsible for directliaisonwiththeinternationalagencyinmatters ofnuclearsafetyandsecurity,technicalcooperation, andconventions.

Pakistan is a partytofourinternational conventions, includingtheConventionon Nuclear Safety (CNS); Convention on Physical Protection of Nuclear Material;ConventiononEarlyNotificationofNuclear Accidents;andConventiononAssistance intheCase ofNuclearandRadiologicalAccidents.Pakistanisin complete fulfilment of its obligations under these conventions.

Along with the other 55 Contracting Parties, Pakistan is required to submit a report every three yearsonnationalimplementationoftheobligations under CNS. PNRA led the development and presentation of the second and third National Reports from Pakistan, participating in the Third Review Meeting in April 2005 to presenttheThird NationalReport.Afterthepeerreviewofthereports, Pakistan posed several questions on the national reportssubmitted by otherContracting Parties and responded to questions on its own report; the country's active participation demonstrated its commitment to fulfilment of obligations under the Convention.

BILATERAL AND MULTILATERAL COOPERATION

PNRA enjoys strong bilateral relations with the National Nuclear SafetyAdministration (NNSA) of China. NNSA provided technical assistance and services to PNRA in the licensing assessments of nuclearpowerplantsC-1andC-2aswellasHeavy MechanicalComplex3.

PakistanisalsoamemberoftheCentreforNuclear SafetyinCentralandEasternEurope(CENS),which was established in 2002 and works under a subsidiaryof the SwissandSlovakgovernments.In addition, PNRA and the United States Nuclear Regulatory Commission (USNRC) are exploring bilateralagreementsfortheexchangeofpersonnel andsafetyrelatedinformation.

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In 2004, Pakistan became a member of the Network of Nuclear Regulators of Countries with SmallNuclearProgramme(NERS),aninternational network of nuclear regulators and inspectors dedicated tothefreeexchangeanddissemination ofnuclearregulatoryinformation.PNRAhostedthe eighthworkingsessionofNERSfromMay16to20, 2005, in which representatives of Finland, SwitzerlandandSloveniaparticipated.

▲

TheeighthworkingsessionofNERSisinprogress.

In addition, PNRA is working with the Finnish NuclearandRadiationSafetyAuthority(STUK)and technical support organization (VUJE) of Slovak Republic. It also joined the Asian Nuclear Safety Network (ANSN) with the aim of sharing and creatingknowledgeamongAsianstates.

Asian NuclearSafetyNetwork

PNRAhasjoinedtheAsianNuclearSafetyNetwork (ANSN) withtheaimofknowledgesharingamong Asian states.ANuclearSafetyKnowledgeportalhas beendevelopedtopool,useandcreatesafetyrelated knowledge.

TECHNICAL COOPERATION WITH IAEA

PNRA's cooperation with IAEA in the area of technical projects has been highly successful. In 2001, PNRA was involved in two projects concerningnuclearsafetyandradiationprotection.

PNRA is currently engaged in a number of IAEA technicalcooperationprojects,including:

- Strengthening of Nuclear Safety Regulatory Authority;
- Further improvement of Regulatory Performance for Pakistan Nuclear Regulatory Authority;
- Applicability of Agency Nuclear Safety StandardsforNuclearPowerPlants;
- Development of Technical Capabilities for Sustainable Radiation and Waste Safety Infrastructure;
- DevelopmentofAsianNuclearSafetyNetwork;
- Developing Technical Capabilities for the Protection of Health and Safety of Workers exposedtoIonizingRadiation;
- Strengthening Radiological Protection of PatientsandMedicalExposureControl;and
- EstablishingNationalCapabilitiesforResponse toaRadiologicalandNuclearEmergency.

From2001to2005,PNRAhosted112IAEAexperts' missions,includingfull-scopepeer reviewmissions, an International Regulatory Review Team (IRRT) mission, Radiation Safety Infrastructure Appraisal (RaSIA)missions andvariousothertypesofmeetings andevents.TheseeventslargelyhelpedPNRAinthe capacitybuildingofitshumanresource.

PNRA alsoplaysanactive role in fiveoftheIAEA's standardscommittees,includingtheCommissionon Safety Standards, Transport Safety Standards Committee, Nuclear Safety Standards Committee, Radiation of Safety Standards Committee, andthe Advisory Committee for Nuclear Installations. For effective participation in international standards development, PNRA established an Advisory Committee on DraftInternational Safety Standards (ACISS) to review IAEA safety standards, prepare Pakistan's recommendations, and analyze their applicationandimplicationsinPakistan.

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NATIONAL AND INTERNATIONAL COOPERATION

In December 2003, Pakistan invited an IRRT mission to conduct a full-scope review of its regulatory activities. The findings of the review were generally quite positive, with the Mission concluding that Pakistan had made good progress towards establishing an independent and sustainable nuclear regulatory regime. The Mission also identified a number of "Good Practices" at PNRA, which were noted for sharing with other regulatory bodies. The report of the IRRT Mission included a few recommendations and suggestions for the improvement of PNRA's regulatory performance. The report is available on PNRA's website (http://www.pnra.org).

The suggestions and recommendations of the Mission are being implemented by PNRA. The follow-up IRRT Mission will be conducted in 2007.

IAEA Radiation Safety Infrastructure Appraisal (RaSIA) Mission

An IAEA team conducted a RaSIA mission in Pakistan from March 28 to April 1, 2005. The overall conclusions of the mission were:

Pakistan has a well-developed legal infrastructure for radiation safety and an effective operational system of licensing, inspection and enforcement for the control of radiation sources. The Regulatory Authority has achieved effective independence. Successive IAEA peer reviews and appraisals demonstrate that the Pakistan regulatory infrastructure continues to develop in line with international standards. There are some opportunities for procedural improvements, in particular regarding the national register of sources and the need to bring all x-ray generators fully under the control of the regulatory authority.

▲ ***The International Regulatory Review Team (IRRT) Mission at*** **PNRA** ▶

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8
TOOLS FOR CONTINUOUS IMPROVEMENT

PNRA is a forward-looking organization, deeply committed to improving its own regulatory effectivenessand efficiency,andtherebyaffording greater nuclear and radiation protection to workers,thegeneralpublicandtheenvironmentin Pakistan. Nearly all of PNRA's international collaborations discussed in Section7 aregeared to enhance the capacity ofitsownteamthrough exposuretocutting-edgeapproachesandstate-of-the-arttechnologies,aswellas intensivetechnical training. Collaborations with the IAEA are especiallyfruitfulinthisregard.

In addition,PNRA has takenanumberofinternal measurestoensurethatitcontinuallyimprovesits performance and its contribution to the country. Amongthesemeasuresareinitiativestodevelopa pool of trained, competent and dedicated personnel; a knowledge-based organizational structure that channels expertiseand energies for priority concerns; an institutional structure that ensures regulatory independence;andastringent self-evaluation mechanism that drives PNRA towardsexcellenceinallspheresofitsactivities.

ESTABLISHMENT OF CENTRE FOR NUCLEAR SAFETY

Soonafteritsinception,aneedwasfeltatPNRAfor a dedicatedtechnicalsupport unittofocusonthe deeply technical but multifaceted task of internal capacity building and institutional strengthening. PNRA's proposal for such a unit was approved by theGovernmentofPakistaninOctober2004and a "Centre for Nuclear Safety (CNS)" was establishedinJune2005.

TheinitialfocusofCNSremainedon:

- Creating national and international opportunitiesforthecapacitybuildingofPNRA personnel, such as specialized training, professionalexchangevisits,andparticipation innuclearsafetyresearch;
- Procuringsoftware tools forconfirmatory and audit calculationsforregulatoryanalyses;
- Developing a documentation base, including anInformationCentre;and
- Developing and strengthening bilateral links with nuclear regulatory bodies of other countriesandinternationalorganizations.

Withinashortperiod,theCentreforNuclearSafety signed four bilateral agreements with regulatory bodiesandtechnicalsupportorganizationsofother countries.

DEVELOPING THE NEXT GENERATION OF REGULATORS

The technical and specialized nature of its work makes it essential for PNRA towork proactively to developitscurrentandfutureteam.Atthetimeofits establishment, there was a severe shortage of technical staff at PNRA.Therefore,three fast-track recruitment drives were conducted in which sixty young scientists and engineers were inducted. Further recruitmentisunderwayagainstalonger-termneedsassessment.

Simultaneously a systematic training needs assessment of PNRA staff was performed in collaboration with LUMS, based on which a responsivetrainingpolicyandstrategyweredevised. The PNRA training needs assessment was considered a 'good practice' by the IRRT mission whenitvisitedPNRAinDecember2003.

PNRA'sTrainingNeedsAssessment Replicatedas InternationalGoodPractice

PNRA'strainingneeds assessmentwasnotedbyan IRRT mission as aninternational best practice and became a milestone in the development, not onlyof PNRA,butalsoofmanyotherregulatorybodiesinthe world. The study was referred and duplicated in Romania,Thailand,IndonesiaandMalaysia,andwas also used in developing the basic Nuclear Safety ProfessionalCourseinFrance.

Todeveloptheextgenerationofregulators,PNRA established the School of Nuclear and Radiation Safety.TheSchoolconductedanumberofintensive professionaltrainingcoursesfornewrecruits,aswell as other courses on technical and management topicsfornewaswellseniorofficers.

In addition, PNRA initiated a fellowship program with the Pakistan Institute of Engineering and Applied Sciences (PIEAS)under whichstudents are sponsored in postgraduate courses in nuclear/system engineering and medical physics. SuccessfulcandidatesjoinPNRA.

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As mentioned in Section 7, PNRA also benefitted from several training and learning opportunities with IAEA. A large number of PNRA staff participated in IAEA'sregional(Asia)programmes, technical cooperation projects, regional training courses, technical meetings, project workshops, expert missions, and other conferences and meetings.

Inviewoftheexpandingnuclearpowerprogramof thecountry,morestringentplansonnuclearsafety aspects were made. PNRA plans to develop and reviseitsregulationsinthelightofdevelopmentsin international standards, recommendations from differentstakeholders,anditsownexperienceinthe field of nuclear and radiation safety. Recognising that research and development (R&D) is essential for this undertaking, PNRAconstituted an Advisory Committee on ResearchandDevelopment(ACRD) in2004.TheCommitteeservesasapointofliaison with the scientific community, national research institutes, academia and other stakeholders in research on nuclear and radiation safety; it plays the important role of bringing together different stakeholders to collaborate in required research projects.

PNRAisalsoidentifyingfurthertopicsfor research, awardingresearchprojectstonationaluniversities, and offering research contracts leading to MPhil andPhDdegrees.

ThecreationofACRDsignifiesPNRA'scommitment towards promoting and conducting R&D for enhanced safety at nuclear installations and radiationfacilities,incooperationwiththenational scientificcommunity, publicuniversities and other stakeholders.

Soonafter its establishment,PNRA initiated a self-assessmentprogramformonitoringandevaluating its regulatory performance. The monitoring and evaluation (M&E) system is based on 12 strategic performance indicators, against which a progress review is compiled and presented to the Prime MinisterofPakistaneveryyear.

Currently, PNRA rates itself qualitatively, based on management decisions, against a five-tier rating scale.

PNRA'sperformancefor2001-2005issummarized in Figure 5. Efforts are under way to make the assessment quantitative and to incorporate the review of trends in performance against each indicator.ThisisexpectedtomaketheM&Esystem evenmorerigorousanduseful.AnagreementwasreachedwiththeLahoreUniversityof Management Sciencesforsystematicregulatoryself-assessment.

In addition to conducting self-assessments, PNRA invited international organizations for external auditing and evaluation of its performance. The most notable events in this regard were the IRRT MissionandtheRaSIAMission,bothofwhichfound PNRA's performance to be comparable with internationalregulatorystandards

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