



International Seminar on
“Nuclear Safety and Nuclear Security Challenges of 21st Century”
21-23 April, 2011

Regulatory Assessment of Emergency Planning and Preparedness at Nuclear Power Plants

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Scheme of Presentation

- **Basis of Assessment**
- **Institutional Framework**
- **Process of Assessment**



Basis of Assessment

- Ordinance
- Regulations
- Regulatory Guides



PNRA Ordinance (III of 2001)

Section 39 of the Ordinance

- The Authority shall **ensure, co-ordinate** and **enforce** preparation of emergency plans.
- Such plans shall include, reporting , communication, the co-ordination of **action** between the various public bodies involved, the training of personnel and the provision of necessary facilities.
- The **actions** may include isolating people and objects, limiting the transfer of persons and foods, curtailing or prohibiting sales of food-stuffs, water, evacuating certain zones or forbidding entry thereto....



PNRA Regulations

The Gazette of Pakistan

S.R.O. 995(I)/2004.- In exercise of the powers conferred by section 56 of the Pakistan Nuclear Regulatory Authority Ordinance, 2001 (III of 2001), the Pakistan Nuclear Regulatory Authority is pleased to make the following regulations.

1. **Short title and commencement.**-(1) These regulations may be called "Regulations on the Safety of Nuclear Power Plants Operation (PAK/913) (Rev. 1)".

(2) These regulations extend to the whole of the Pakistan.

(3) These regulations shall come into force at once.

2. **Definitions.**- In these regulations, unless there is anything repugnant in the subject or context,

- (a) "accident" means any unintended event, including operating error, equipment failures or other mishaps, the consequences or potential consequences of which are not negligible from the point of view of safety or protection.
- (b) "accident conditions" mean deviations from normal operation more severe than anticipated operational occurrences, including design basis accident and severe accidents.
- (c) "accident management" means taking of a set of actions during the evolution of a beyond design basis accident:-
 - (i) to prevent the escalation of event into a severe accident.
 - (ii) to mitigate the consequences of severe accident; and
 - (iii) to achieve a long-term safe stable state.
- (d) "anticipated operational occurrences" means operational processes deviating from Normal Operation which are expected to occur at least once during the operating lifetime of a facility, but which, in view of appropriate design provisions, do not cause any significant damage to items important to safety nor lead to accident conditions.
- (e) "ASME code" means the American Society of Mechanical Engineers Boiler Pressure Vessel Code.
- (f) "commissioning" means the process during which systems and components of installation(s) and activities, having been

The Gazette of Pakistan

EXTRAORDINARY
PUBLISHED BY AUTHORITY

ISLAMABAD, TUESDAY, OCTOBER 9, 2001

PART II

Statutory Notification (S.R.O)

PAKISTAN NUCLEAR REGULATORY AUTHORITY
NOTIFICATIONS

Islamabad, September 21, 2001

S.R.O. 699(1)/2001 -In exercise of the powers conferred by Section 16 of the Pakistan Nuclear Regulatory Authority Ordinance 2001 (III of 2001), Pakistan Nuclear Regulatory Authority is pleased to make and promulgate the following Regulation -

1. **Short title, extent and commencement.**-(1) This regulation may be called **Regulation for Licensing of Nuclear Installation(s) in Pakistan - PAK/909 (Rev. 0)**.

- (2) This regulation extends to the whole of Pakistan.
- (3) This regulation shall come into force at once.
- (4) This regulation shall also apply to all the establishments of the Pakistan Atomic Energy Commission.

2. DEFINITIONS

In this Regulation, unless there is anything repugnant in the subject or context,

- (a) **ALARA** means the process of determining what level of protection and safety makes exposures, and the possibility and magnitude of potential exposures, "as low as reasonably achievable, economic and social factors being taken into account" (ALARA), as required by International Commission on Radiological Protection (ICRP) Systems of Radiological Protection.
- (b) **Chairman PNRA** means chief executive officer of PNRA, and shall subject to the provisions of the Ordinance, the rules and regulations, is responsible for the day to day administration of the affairs of the authority.
- (c) **Commissioning** means the process during which nuclear installation(s) components and systems, having been constructed, are made operational and verified to be in accordance with design assumptions and to have met the performance criteria.

The Gazette of Pakistan

EXTRAORDINARY
PUBLISHED BY AUTHORITY

ISLAMABAD, TUESDAY, OCTOBER 6, 2004

PART II

Statutory Notification (S.R.O)

GOVERNMENT OF PAKISTAN

PAKISTAN NUCLEAR REGULATORY AUTHORITY

NOTIFICATIONS

Islamabad, the 5th October, 2004

S.R.O. 836(I)/2004 - In exercise of the powers conferred by section 56 of Pakistan Nuclear Regulatory Authority Ordinance, 2001(III of 2001), the Pakistan Nuclear Regulatory Authority is pleased to make the following regulations:-

1. **Short title and commencement.** - (1) These regulations may be called the **Regulations for the Licensing of Radiation Facility(ies) other than Nuclear Installation(s)- PAK/908**.

- (2) These regulations extend to the whole of Pakistan.
- (3) These regulations shall come into force at once.

2. **Definitions.**- In these regulations, unless there is anything repugnant in this subject or context,-

- (a) "applicant" means any person who applies to the Authority for a license or/and authorization to undertake specified activities;
- (b) "Authority" means the Pakistan Nuclear Regulatory Authority established under section 3 of the Ordinance;
- (c) "authorization" means an authorization granted under section 20 or, as the case may be, sections 21,22 or 23 of the Ordinance;
- (d) "Chairman" means the Chairman of the Authority;
- (e) "inspection" means an examination, observation, measurement or test undertaken to assess structure, systems, components and materials as well as operation activities, processes, procedures and personnel competence;

The Gazette of Pakistan

PART II

Statutory Notification (S.R.O)

GOVERNMENT OF PAKISTAN

PAKISTAN NUCLEAR REGULATORY AUTHORITY

NOTIFICATIONS

Islamabad, the 24th July, 2008

S.R.O. 912 (I)/2008 - In exercise of the powers conferred by Section-56 of the Pakistan Nuclear Regulatory Authority Ordinance, 2001 (III of 2001), the Pakistan Nuclear Regulatory Authority is pleased to make and promulgate the following regulations:-

1. **Short Title and Commencement.**-(1) These regulations may be called the **Regulations on Management of a Nuclear or Radiological Emergency - (PAK/914) (Rev.0)**.

- (2) These regulations shall extend to the whole of Pakistan.
- (3) These regulations shall come into force at once.

2. **Definitions.**- In these regulations, unless there is anything repugnant in the subject or context, the following expressions shall have the meanings hereinafter assigned to them:

- (a) "accident" means any unintended event, including operating errors, equipment failures or other mishaps, the consequences or potential consequences of which are not negligible from the point of view of protection or safety;
- (b) "action level" means the level of dose rate or activity concentration above which remedial actions or protective actions should be carried out in chronic exposure or emergency exposure situations. An action level can also be expressed in terms of any other measurable quantity as a level above which intervention should be undertaken;
- (c) "activity" means the quantity A for an amount of radionuclide in a given energy state at a given time, defined as:
$$A(t) = dN/dt$$
where dN is the expectation value of the number of spontaneous nuclear transformations from the given energy state in the time interval dt .
- (d) "arrangements" (for emergency response) means the integrated set of infrastructural elements necessary to provide the capability for performing a specified function or task required in response to a nuclear or radiological



PNRA Regulations

Licensing of Nuclear Installations

- **(PAK/909):** section-4(8) requires that the licensee is to submit the Emergency Preparedness Plan, prior to introducing the nuclear material into the system of the nuclear installation.
- The Plan will be approved by PNRA prior to grant fuel load permit subject to completion of other regulatory requirements

Management of Nuclear or Radiological Emergency

- **(PAK/914):** section 7(1)(e) requires that the licensee shall demonstrate complete emergency preparedness before the commencement of operation.



PNRA Regulations

Management of Nuclear or Radiological Emergency (PAK/914)

- Applicable to all those practices and sources that have the potential for causing radiation exposure or environmental radioactive contamination warranting an emergency intervention.
- Establishes the requirements for an adequate level of preparedness and Response for a nuclear or radiological emergency according to the associated hazard. (Hazard categorization of sources, facilities)



Hazard Category-1 (PAK/914)

Facilities, such as Nuclear Power Plants, for which on-site events that could give rise to severe deterministic health effects off the site



Guidelines for Intervention Levels PAK/914

Protective Action

Intervention Level

Sheltering

10 mSv/two days

Evacuation (temporary)

50 mSv/week

Administration of Stable Iodine

100 mGy
(absorbed dose to thyroid)



Guidelines for Intervention Levels PAK/914

Protective Action

Intervention Level

Initiating Temporary Relocation

30 mSv in first month

Terminating Temporary Relocation

10 mSv in a month

Permanent Resettlement

10 mSv not expected to
fall within a year or two
or life time dose is
projected to exceed 1 Sv



Generic Action Levels for Food Stuffs PAK/914

Radionuclide	Action Level (Bq/kg)	
	Food destined for general consumption	Milk, Infant food and drinking water
CS-134, CS-137 RU-103, RU-106 SR-89	1000	1000
I-131	1000	100
SR-90	100	100
AM-241, PU-238 PU-239, PU-240 PU-242	10	1



Rev. 0
October 2007

PNRA-RG-913.01



Regulatory Guide

**DOSAGE AND DISTRIBUTION OF POTASSIUM IODIDE TABLETS
(A THYROID BLOCKING AGENT)
IN RADIATION EMERGENCIES**

**PAKISTAN NUCLEAR REGULATORY AUTHORITY
P.O. Box 1912, Islamabad**

Rev. 0

PAK-1406



GUIDELINE

**PREPAREDNESS OF THE LICENSEE FOR EMERGENCIES AT
NUCLEAR POWER PLANTS**

**PAKISTAN NUCLEAR REGULATORY AUTHORITY
P.O. Box 1912, Islamabad**

Rev. 0
June 2006

PAK-9401



REGULATORY GUIDE

**GUIDELINES FOR MEDICAL PRACTITIONERS ON HANDLING,
TRANSPORT AND TREATMENT OF CONTAMINATED AND
EXPOSED PATIENTS**

**PAKISTAN NUCLEAR REGULATORY AUTHORITY
P.O. Box 1912, Islamabad**



Institutional Framework

Licensee

- Emergency Preparedness
- Emergency response

(based on requirements of PAK/914, proportionate to level of emergency)

PNRA

- NRECC
- Regional Directorates
- Environmental Monitoring Laboratories



□ Licensee Framework (PAK/914)



Preparedness/ Response for Hazard Category-1

- Establishment of an emergency Response set up with clear allocation of responsibilities of persons and organizations taking charge during an emergency & arrangements for efficient and effective cooperation, coordination and communication within the established set up.
- Emergency facilities and equipment (e.g., radiation monitoring equipment, KI tablets, Personal Protective Equipment, medical, logistic(transport) etc)
- Establishment of criteria for classification of emergency and proportionate preparedness and response arrangements
- Identification of populations at risk & estimation of projected doses for taking precautionary and urgent protective actions. Optimized protection strategies for the termination of the protective measures.



Preparedness/ Response for Hazard Category-1

- Onsite/ Offsite Notification point available 24/7, equipped with effective communication channels for declaration and notification of emergency class and issuance of commands for assembly, accounting, Sheltering, Iodine Prophylaxis, Evacuation, and Instructions and Warnings to the public
- Radiation monitoring for long term protective actions for restriction on food, agricultural countermeasures, recovery etc.
- Education and Training of all persons involved in emergency response, medical services and conduct of exercises.
Arrangements for protection of emergency workers



Emergency Classifications-licensee

The emergency classification system is divided into four emergency declaration levels beginning with the least severe:

- Standby Emergency
- Plant Emergency
- Site Emergency
- General Emergency



Emergency Classifications

☐ Standby Emergency

Class Description

- Specific conditions arise which may lead to an emergency situation, but still there is time to take pre-cautionary measures to prevent emergency situations.

Release Potential

- No release of radioactive material requiring off-site response or monitoring are expected

Preparedness/ Response

- Actions taken promptly to assess/ mitigate the consequences
- To increase the readiness of onsite emergency response organization, personnel and offsite authorities



Emergency Classifications

□ Plant Emergency

Class Description

- Events involving major decrease in the level of protection for the people on the site
- Events that are in process or have occurred which involve an actual or potential substantial degradation of the level of safety of the plant and consequences are likely to be confined to the limited section of the plant.

Release Potential

- Releases to limited area of the facility
- No off-site hazard

Preparedness/ Response

- Actions to mitigate the consequences and to protect people on the site.
- Activation of emergency facilities like TSC, ECC etc
- Notification to off-site authorities to increase readiness



Emergency Classifications

□ Site Emergency

Class Description

- Events involving major decrease in the level of protection for the people on the site and near the facility
- Events that are in process or have occurred which involve an actual or likely major failures of plant functions.

Release Potential

- Release of radioactive material extending beyond site boundary but not exceeding intervention levels

Preparedness/ Response

- Actions to mitigate the consequences and to protect the people on the site and near the facility
- Preparations to take protective actions off the site
- Activates emergency facilities like TSC, ECCs, AECC etc
- Notification and activation of off-site authorities



Emergency Classifications

□ General Emergency

Class Description

- Events involving an actual or substantial risk of release of radioactive material or radiation exposure that requires urgent protective actions off the site.
- Events that are in process or have occurred involving actual or imminent substantial core degradation or melting with potential for loss or loss of containment integrity.

Release Potential

- Release of radioactive material from the plant to the environment and will expose general public beyond Intervention levels.

Preparedness/ Response

- Activation of off-site authorities
- Actions to mitigate consequences
- Implementation of protective measure in the affected areas and protection of the people within the PAZ and UPZ as appropriate



Emergency Communications and Exercises

- Arrangements for reliable communication, efficient and effective cooperation and coordination within the organizational setup established by the licensee on the site and with offsite authorities is developed and is tested in different exercises
- Roles and responsibilities of persons, groups and organizations for emergency preparedness and response on-site and off-site is also tested in exercises
- Exercises are performed in varying frequencies which are defined in emergency plans



□ PNRA Framework



National Radiological Emergency Coordination Center

- NRECC is the National Warning Point (NWP) & focal point for notification, and coordination of nuclear or radiological incidents and emergencies irrespective of their cause
- Coordinate with IAEA to meet the obligations of notification and Assistance Conventions (RANET).
- Receipt and dissemination of information Domestic/ Abroad and reporting
- The Centre provides around-the-clock assistance in case of an radiological event or emergency



National Radiological Emergency Coordination Center

- Develop standards and guidance for Licensee
- Provide Guidance to licensee for preparation of its emergency plans and implementing procedures
- Evaluation of emergency plans during exercises
- Develops training programs to assist PNRA/ Licensee
- Conduct exercises (licensee, internal, Int.)
- Liaison with affected facility/public authorities
- Public and media liaison (if required)
- Field response operations (if required)



Regional Directorates at NPP sites

- A Regional Nuclear Safety Directorate of PNRA is established at each NPP site
- The directorates have MRMLs, Radiation Monitoring and Protective equipments

PNRA is establishing Dosimetry & Environmental Monitoring Laborites (Karachi, Islamabad and Kundian) to

- Provide dosimetry services to radiation workers/ Inspectors
- Environmental monitoring (in routine & emergency situations)
- Sample analysis of different food and environmental samples
- Air sampling
- Ambient radiation monitoring



Assessment Process



Assessment Process

- Review of Licensee submissions
- Regulatory Inspections
- Emergency Drills/Exercises



Review of Licensee Submissions

- Submissions prior to operation
 - Site selection, construction permit
 - Preliminary Safety Analysis Report (PSAR)
 - Final Safety Analysis Report (FSAR)
 - Fuel loading Permit
 - Issuance of Operating License
- Submissions during operation
 - Emergency exercises scenarios, schedules and reports
 - Notification of all emergency classes
 - Periodic submission (ambient dose levels, environmental operating reports etc)



Review of Licensee Submissions

Example of (EPP) review process – C2 PSAR

- Onsite & off-site Emergency response organization
- Contacts and arrangement made with local, provisional and Federal government
- Protective measures to be taken within site boundary and Emergency Planning Zones
- Emergency facilities (on-site & off-site)
- Training program
- Systems for identifying, notifying emergencies etc..



Review of Licensee Submissions

Example of (EPP) review process – C2 FSAR

- At FSAR stage existence of comprehensive emergency plans (on-site & off-site) with following main areas was verified
- Organization for coping with radiation emergencies
- Assessment of Emergency classification
- Activation of emergency organization
- Notification procedures
- Emergency facilities and equipment
- Training
- Maintaining emergency preparedness (emergency drills and exercises etc)
- Recovery



Regulatory Inspections

- Daily MCR visit (day-to-day activities)
- Periodic Inspections (as per annual inspection plan)
- General Surveillance Inspections (Radiation Protection, Emergency arrangements etc)
- Surveillance Test Inspections (during different operational / maintenance tests of equipment)
- Control Point Inspections (equipment maintenance, installation etc.)
- Reactive Inspection (followed by non-compliance to regulatory requirements/an incident)
- Unannounced Inspections



Emergency Drills/Exercises

- Licensee is required to demonstrate emergency planning and preparedness arrangements through drills/exercise
- PNRA regional directorates and headquarters team observe the conduct of exercises
- Observation checklists and relevant procedures are verified for consistency and compliance
- Major points are highlighted to management in Exit Meeting while a detailed report of observations, recommendations and corrective actions is issued
- Corrective actions are followed-up and if needed licensee is required to re-conduct make-up exercises



Developments in EPR Arrangements

DS379 (Radiation Protection and Safety of Radiation Sources-International Basic Safety Standards-2011 Edition)

- Generic criteria for acute doses (projected/received) for which protective actions and other response actions are expected to be undertaken under any circumstances to avoid or to minimize severe deterministic effects
- Generic criteria (dose-projected/received) for protective actions and other response actions in emergency exposure situations to reduce the risk of stochastic effects
- No emergency worker is subject to an exposure in excess of 50 mSv other than life saving, undertaking actions to avert large collective dose and to prevent development of catastrophic conditions. Qualified medical advice shall be obtained before any further occupational exposure at a received dose > 200mSv
- Reference level in terms of residual dose shall be set, typically an effective dose in the range of 20-100mSv, that includes dose contributions via all exposure pathways and protection strategy optimized.



Developments in EPR Arrangements

DS44 (Criteria for Use in Preparedness & Response)

- To act quickly in an emergency, there is a need to establish-in advance-operational criteria as a surrogate for the generic criteria for protective/response actions. Operational criteria are : Emergency Action Levels, Operational Intervention Levels, and Observables and indicators of on scene conditions.
- Includes default operational OILs in terms of dose rates, contamination levels, and concentration for:
 - Ground contamination
 - OIL value for skin & clothing contamination
 - Screening OILs of food, milk and water
 - Radionuclide specific OILs for food, milk & water



...FOR YOUR INTEREST!