

# Emergency Preparedness and Response Framework

## Challenges Ahead

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- **Mission of AERB**
- **Nuclear Safety Objective**
- **Fundamental Safety Functions**

### Goals of EPR

- Goal of Emergency Preparedness
- Goals of Emergency Response

| Strategy                       | Accident prevention   |  |  | Accident mitigation  |  |                        |                     |
|--------------------------------|---|--|--|--|--|------------------------|---------------------|
| Operational state of the plant | Normal operation  | Anticipated operational occurrences                                      | Design basis and complex operating states                                    | Severe accidents beyond the design basis   | Post-severe accident situation   |                        |                     |
| Level of defence in depth      | Level 1   | Level 2  | Level 3  | Level 4  | Level 5  |                        |                     |
| Objective                      | Prevention of abnormal operation and failure                  | Control of abnormal operation and detection of failures                  | Control of accidents below the severity level postulated in the design basis | Control of severe plant conditions, including prevention of accident progression, and mitigation of the consequences of severe accidents, including confinement protection | Mitigation of radiological consequences of significant releases of radioactive materials |                        |                     |
| Essential features             | Conservative design and quality in construction and operation | Control, limiting and protection systems and other surveillance features | Engineered safety features and accident procedures                           | Complementary measures and accident management, including confinement protection   | Off-site emergency response  |                        |                     |
| Control                        | Normal operating activities                                   |  | Control of accidents in design basis   | Accident management  |  |                        |                     |
| Procedures                     | Normal operating procedures                                   |  | Emergency operating procedures   | Ultimate part of emergency operating procedures  |  |                        |                     |
| Response                       | Normal operating systems                                      |  | Engineered safety features   | Special design features  | Off-site emergency preparations  |                        |                     |
| Condition of barriers          | Area of specified acceptable fuel design limit                |  | Fuel failure   | Severe fuel damage   | Fuel melt  | Uncontrolled fuel melt | Loss of confinement |

### Defence-in-Depth

Colour code: NORMAL (Green), POSTULATED ACCIDENTS (Yellow), EMERGENCY (Red)



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## Robust EPR Framework

Developing, implementing and sustaining an EPR programme requires:

- Clear and consistent regulation,
- Resilient oversight mechanism,
- Comprehensive emergency preparedness framework,
- Stakeholder engagement and
- Co-ordination with other agencies that are part of national emergency preparedness and response framework for a nuclear and radiological emergency.



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## Revision/Update of REGDOCS for EPR

Evolving nature of management of nuclear and radiological emergency

### INTERNATIONAL

ICRP 103 (2007), ICRP 109 (2009), ICRP 111 (2011), ICRP 146 (2020)

Fukushima nuclear accident (2011) & learning (*Response actions can result in doing more harm than good*)

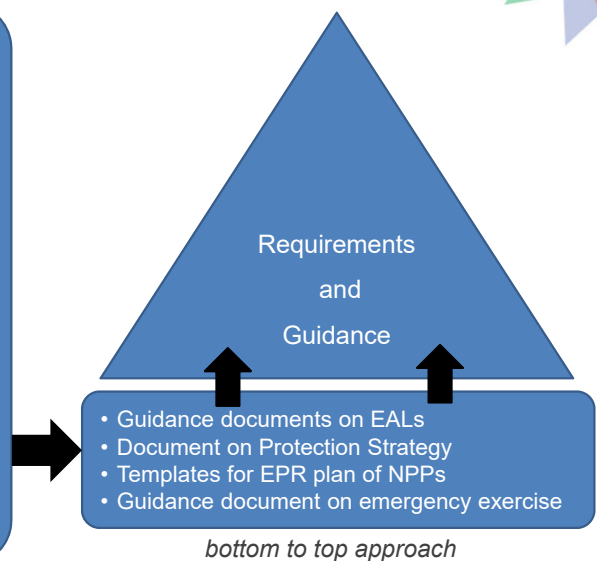
*Importance of decision making and response in the early phase based on plant conditions (EALs)*

IAEA GSR Part-7 (2015)

### NATIONAL

DM Act, 2005, NDMA, DM policy, 2009 & NDMP, 2019.

*Feed back from conduct of emergency exercise*



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# Consolidation of REGDOCS for EPR under New Structure

## Requirements for Management of Nuclear and Radiological Emergencies

AERB Safety Code (AERB/NRF/SC/NRE)

Safety Code Published in December 2022

- Atomic Energy Act, 1962, RPR, 2004
- DM Act, 2005, National DM Plan (NDMP, 2019)
- Existing Regulatory Requirements
- ICRP publications (103, 109, 111, 146)
- IAEA Safety Standards (GSR Part-7, GSR Part -3, G SG 2.1, GSG-2, GSG-11, GSG-14 etc.
- Other international REGDOCS (NRCs, ONR, OECD, CNSC, etc.)

## Consolidate and update the existing guidance (new REGDOCS)

Safety Guide on Management of Emergencies in Nuclear Facilities

AERB Guide (AERB/SG/NRE-1)

Safety Guide on Management of Emergencies in Radiation Facilities

AERB Guide (AERB/SG/NRE-2)

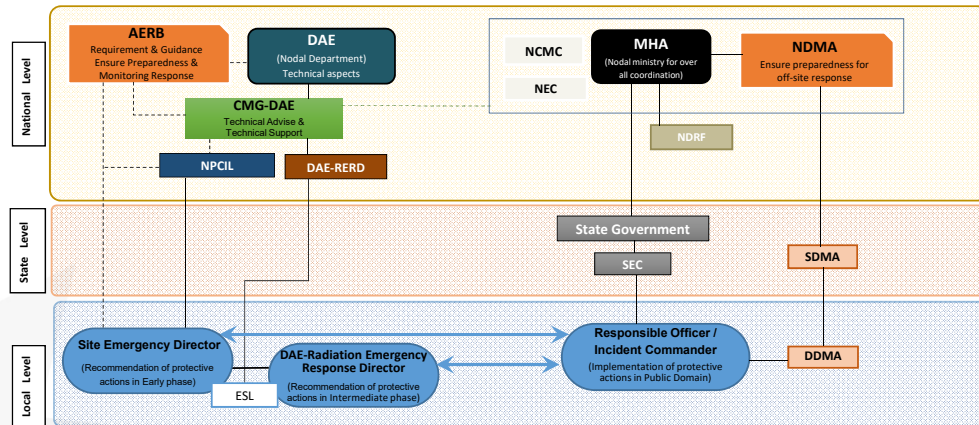
AERB Safety Guide on Management of Emergency during Transport

AERB Guide (AERB/SG/NRE-3)



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# Institutional Framework for Management of Nuclear Emergency



This represents merely the institutional pathways for coordination, decision-making and communication for management nuclear emergency and does not imply any chain of command.



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## Different Phases of Nuclear Emergency

| Phases               | Early (hours - days)                                     |             | Intermediate (days – months)       | Long Term/Recovery (months - years) |
|----------------------|--|-------------|------------------------------------|-------------------------------------|
|                      |  | Pre-Release | Release                            | Transition to recovery              |
| Exposure Situation   | Emergency Exposure                                       |             |                                    | Existing Exposure                   |
| Protective Actions   | Urgent Protective Action including Precautionary Actions |             | Implement early protective actions | Adjustment to prevailing conditions |
| Operational Criteria | Triggers based on EALs, OILs                             |             | OILs, survey and dose assessment   | Survey and dose assessment          |



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## Key areas for a robust EPR

- Hazard Assessment
- Infrastructure for Emergency Response (On-site & Off-site)
- Emergency Planning Zones and Distances
- EPR Plans
- Emergency Exercises
- Response Framework for Management of Nuclear Emergency

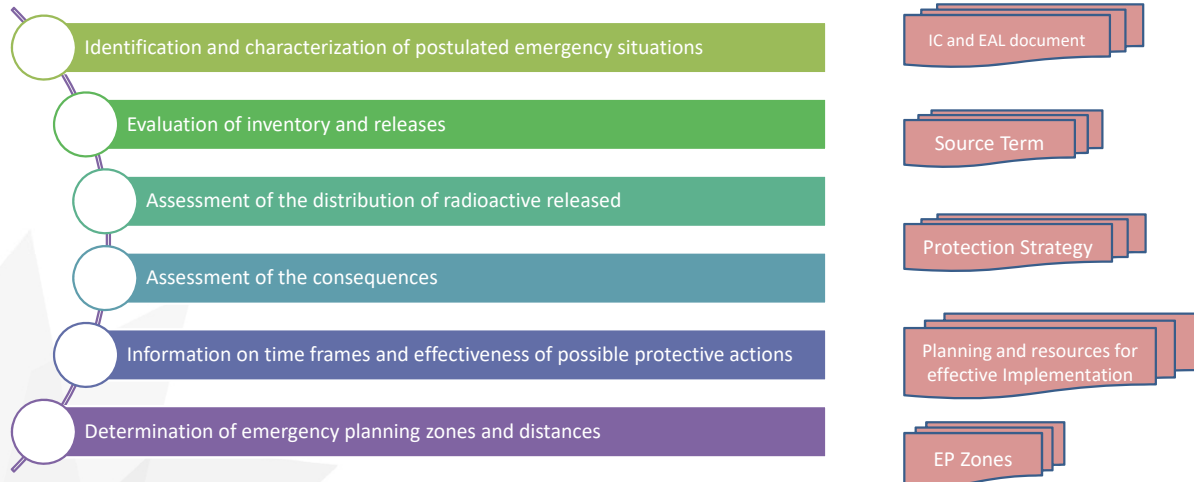
***Other important areas of concern for an effective response:***

- Identification, Classification, Notification and Activation of response
- Principles for public protection (Justification, Optimization & Reference Levels)
- Non-radiological Consequence
- Protection Strategy



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## Hazard Assessment



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## Infrastructure for Emergency Response (On-site)

- On-site facilities for handling emergency (by the licensee)
  - Main Control Room
  - Plant Emergency Control Center (PECC)
  - On-site Emergency Support Centre (OESC)
- Communication
- Instrumentation and Data management
- On-site Emergency Response Facilities
- Safety Parameter Display System
- Decision Support System



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## Infrastructure for Emergency Response (Off-site)

- Facilities for handling emergency off-the site (by the nodal department)
  - Off-site Emergency Support Centre (OFESC)
  
- Arrangements for handling emergency by the Local authorities
  - Emergency Operations Center (EOC)
  - Incident Command Post (ICP)
  - Shelter Place
  - Rallying Post



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## Emergency Planning Zones and Distances

|                                    | PAZ   | UPZ   | EPD   | ICPD   |
|------------------------------------|---|---|---|--|
| Goal                               | Avoid and minimize severe deterministic effects   | Reduce the risk of stochastic effects                             | Reduce the risk of stochastic effects                           |  |
| Response Action                    | Urgent protective actions including precautionary actions (e.g. iodine thyroid blocking, evacuation...) |   | Reduce inadvertent ingestion                                    | Restrict local produce, milk and rainwater       |
|                                    |   |   | Locate hotspots for relocate                                    | Collect and analyse food, milk and water samples |
| Implementation of Response Actions | Within hours of declaration of Off-site emergency   |   | On declaration of an Off-site emergency and following a release |  |
| Based on                           | Plant conditions  | Plant conditions and environmental monitoring and sampling (OILs) | Environmental monitoring and sampling (OILs)                    |  |
| Arrangements at Preparedness stage | Comprehensive   |   | Limited   |  |



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## EPR Plans

- The Licensee (NPPs) maintain the following EPR plan
  - Plant Emergency Preparedness and Response Plan
  - Site Emergency Preparedness and Response Plan
  - Off-site Emergency Preparedness and Response Plan

*These plans are reviewed and approved by AERB*

- The Local Authorities maintain

- Off-site Emergency Preparedness and Response Plan

*Prepared by District Authorities in coordination with Licensee and approved by relevant Authorities considering AERB review observations.*

***Maintained as part of the integrated district disaster management plan (DDMP) for emergency response under an all hazard approach.***



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## Off-site Emergency Exercise (OSEE) Methodology

In order to strengthen the level of preparedness, new system for conducting OSEE developed. Different types of OSEEs were conceptualized and conducted, focusing on different aspects of emergency management, covering the following:

- Table Top Exercise (TT)
  - Emphasizing on technical decision making and response of plant personnel
- Integrated Command Control and Response Exercise (ICCR)
  - Command control functions, operation of response facilities, early warning & field response, inter-agency co-ordination and public information
- Field Exercise and Demonstration (FE&D)
  - Resource, field drills and demonstrating protective measures in public domain



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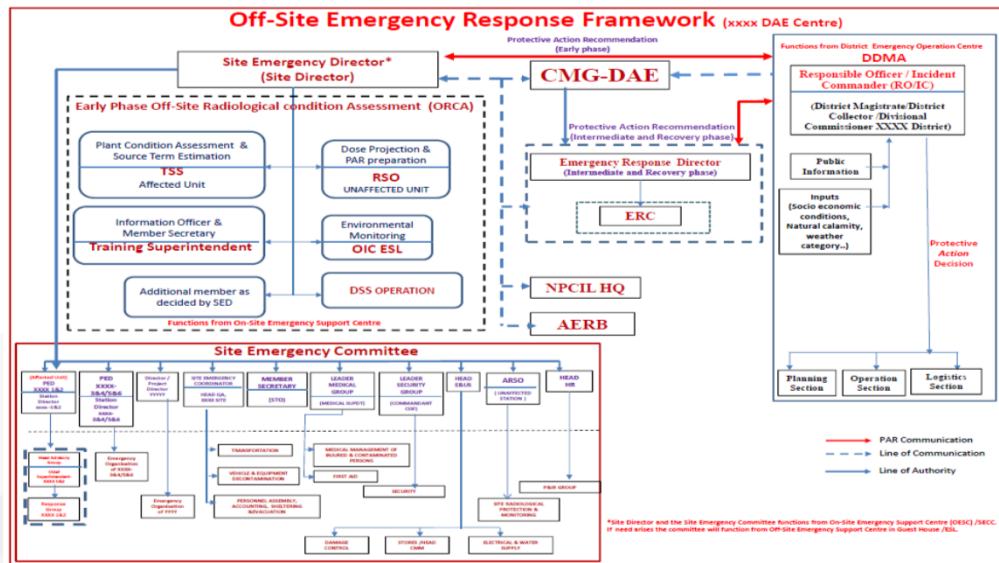
## Off-site Emergency Exercise – Overall Framework

| Type of Exercise                               | Target Response Agencies                    | Frequency  | Responsible Agency  | Oversight   |            |
|--|---|--|---|-------------|------------|
| Table Top (TT) Exercise                        | NPPs  | In every two years for each station and within 6 months of a new Station Director/Site Director taking charge                                | NPP   | AERB        | Modular    |
| Field Exercise and Demonstration (FED)         | District Authorities                        | Once in every year and all areas to be covered over a period of 8 years.   | District Authority (Supported by NPP for planning and technical inputs) | NDMA        | Modular    |
| Integrated Command Control and response (ICCR) | NPPs, CMG-DAE, RERD<br>District Authorities | In every 3 years.<br>The date of conduct of exercise shall be chosen such that exercises cover different seasons and metrological conditions | NPP & District Authority  | AERB & NDMA | Integrated |



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## Response Framework for Management of Nuclear Emergency (Emergency Phases)



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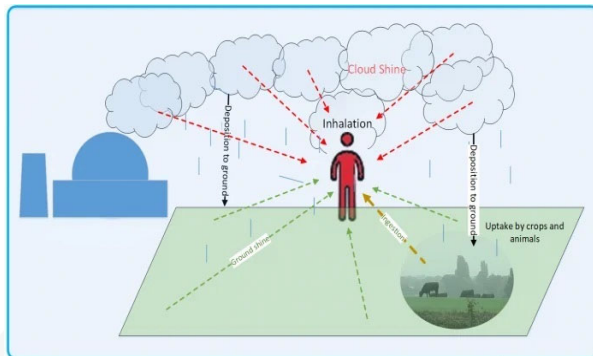
## Challenges Ahead for Regulation w.r.t. EPR

- Brownfield Sites: Urban or Semi Urban Sites
  - Population Density and Socio-economic Factors
- Mix of NPP Technologies: New Innovative Concepts & FOK
  - New reactor designs for diverse application with limited inherent risk
- Demand for total exemption from EPR requirements: Level 5 of D-i-D
  - Credit for advances in design and technology
- Multi-module or Multi-unit Site
  - Reasonable worst-case scenario for Extent of Emergency Preparedness
- Public perception on radiation risk



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## Exposure Pathways and Protective Actions



| POTENTIAL EXPOSURE PATHWAYS                       | PROTECTIVE ACTIONS                        |
|---|---|
| External radiation from plume                     | Sheltering, Evacuation and Access Control |
| Inhalation of radioactive iodine                  | Admiration of ITB, Sheltering             |
| Contamination of skin and cloths                  | Decontamination                           |
| External radiation from ground deposited activity | Evacuation, Relocation, Decontamination   |
| Ingestion of contaminated food, water             | Food and water control                    |
| Inhalation of re-suspended activity               | Relocation, Decontamination               |



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## Integrated Emergency Management System

- Integrated Analytical Tools, Software & Systems for
  - Assessment of Plant Damage State and Real-time & Predicted Source Term
  - Identification, Classification, Notification and Activation of response
  - Decision Support System as an aid to decision making in Early Phase of Emergency
  - Field data assimilation and reconstruction of public doses for decision in Intermediate Phase of Emergency
- National Redundant Reliable & Secure Communication Network for Coordination
- Post clean-up operation and Remediation measures



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