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Establishing the Safety Infrastructure for a Nuclear Power Programme

Emergency Preparedness and Response
Learning Objectives

• To understand lessons learned from past failures of a Nuclear Power Programme
• To understand the position of emergency preparedness and response (EPR) in the Safety Infrastructure for a Nuclear Power Programme
• To understand essential elements of framework of EPR
• To understand tasks for establishing a framework of EPR in Member State embarking on a Nuclear Power Programme
Content

1. Position of emergency preparedness and response (EPR) in the Safety Infrastructure for a Nuclear Power Program
2. Essential elements of framework of EPR
3. Tasks for establishing a framework of EPR in Member State embarking on a Nuclear Power Programme
General scenario for embarking

State has little or no nuclear power plant relevant experience.

State has no regulatory body and no operating organization at the beginning of the process.
DS-424 Actions: Phase 1

• Action 133: The government should develop awareness of the need for the early establishment of emergency plans.

• Action 134: The government should identify institutions and new arrangements for supporting emergency preparedness and response.
• Action 135: The government should specify the national institutions with responsibilities for emergency preparedness and response.

• Action 136: The government should specify the general approach for emergency preparedness and response on the basis of probability and severity of the emergency.
• Action 137: The government should start implementing new arrangements as identified in Phase 1 for strengthening the infrastructure for emergency preparedness and response.
• Action 138: The regulatory body should develop basic regulations on emergency preparedness and response, as necessary, for the development of infrastructure.
DS-424 Actions: Phase 3 (1)

• Action 140: The regulatory body should establish detailed regulations on emergency preparedness and response.

• Action 142: The government and the regulatory body should develop and implement emergency preparedness programmes at the local, national and international level.
Action 143: The government and the regulatory body should establish arrangements for coordination between the emergency response plan of the nuclear power plant and the plans of the relevant national institutions that would be involved in emergency response.
• Action 144: The regulatory body should review and assess the emergency programme, plans and procedures for nuclear power plants, and should verify compliance with the regulatory requirements.
DS-424 Actions: Phase 3 (4)

- Action 145: The government, the regulatory body and the operating organization should demonstrate emergency response capabilities by conducting appropriate exercises that include local authorities and local communities.
Requirement 8: Emergency preparedness and response

The government shall make provision for emergency preparedness to enable a timely and effective response in a nuclear or radiological emergency.
So, **WHAT** is Emergency Preparedness and Response?
Defence in Depth

Defence in depth is the combination of a number of consecutive and independent levels of protection that would have to fail before harmful effects could be caused to people or to the environment. (INSAG 10)
Defence in Depth (cont.)

Level 1: Prevention of abnormal operation and failures

Level 2: Control of abnormal operation and detection of failures

Level 3: Control of accidents within the design basis

Level 4: Control of severe conditions including prevention of accident progression and mitigation of the consequences of a severe accident

Level 5: Mitigation of the radiological consequences of significant external releases of radioactive materials
Emergency preparedness and response are based on:
- Threat assessment
- Emergency classification
- Allocation and assignment of functions
- Coordination of preparedness and response
IAEA Safety Standards


Goals of Emergency Response

• To regain control of the situation;
• To prevent or mitigate consequences at the scene;
• To prevent the occurrence of deterministic health effects in workers and the public;
• To render first aid and to manage the treatment of radiation injuries;
• To prevent, to the extent practicable, to prevent the occurrence of stochastic health effects in the population;
Goals of Emergency Response (2)

• To prevent, to the extent practicable, the occurrence of non-radiological effects on individuals and among the population;
• To protect, to the extent practicable, property and the environment;
• To prepare, to the extent practicable, for the resumption of normal social and economic activity.
Goals of Emergency Preparedness

To ensure that arrangements are in place for a timely, managed, controlled, co-ordinated and effective response at the scene, and at the local, regional, national and international level, to any nuclear or radiological emergency.
## Threat Categories for Nuclear Power Programme

<table>
<thead>
<tr>
<th>Threat category</th>
<th>Radiological threat</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>Severe deterministic effects on-site and off-site. <strong>Highest level of capabilities for Nuclear States</strong></td>
</tr>
<tr>
<td>II</td>
<td>Warranting urgent protective actions off-site, deterministic effects only on-site</td>
</tr>
<tr>
<td>III</td>
<td>No urgent protective actions off-site are warranted, severe deterministic effects only on-site</td>
</tr>
<tr>
<td>IV</td>
<td>Severe deterministic effects at unpredictable place. <strong>Minimum level of capabilities for all States</strong></td>
</tr>
<tr>
<td>V</td>
<td>Food contamination due to contamination caused by radioactive release necessitating food restrictions</td>
</tr>
<tr>
<td>Threat category</td>
<td>Radiological threat</td>
</tr>
<tr>
<td>-----------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>I</td>
<td>Facilities, for which on-site events (including very low probability events) are postulated that could give rise to severe deterministic health effects off the site, or for which such events have occurred in similar facilities. These include reactor units of nuclear power plant with thermal capacity exceeding 100 MWt (thermal) which is adequate to electric power of about 30 MWe (electrical).</td>
</tr>
</tbody>
</table>
Requirement for Emergency Zones around facility of I and II Category of Threat

On-site
- Facility

Off-site
- PAZ precautionary action zone
- UPZ urgent protective action zone
- FRP food restriction planning radius

IAEA Emergency preparedness and response
Precautionary Actions Zone (PAZ)

Precautionary actions taken before monitoring for severe emergencies:

- Prompt decision-making (30 minutes)
- Promptly notify the public and recommend protective action (1 hour)
- Provisions for evacuation or sheltering the public (No time guidance).
Urgent Protective Action Planning Zone (UPZ)

- Prompt notification of the public to shelter and listen for additional information (1 hr)
- Monitoring of environment and making decisions on additional protective action (4 hrs)
- Provisions for evacuation or sheltering following monitoring.
- Includes PAZ
Food Restriction Planning

• Plans for monitoring agriculture, food and water
• Plans to take long-term protective actions:
  • Ingestion control
  • Relocation
  • Resettlement
• Includes UPZ and PAZ.
# Radii of NPP Emergency Zones

<table>
<thead>
<tr>
<th>Cat.</th>
<th>Power, MWt</th>
<th>PAZ precautionary action zone</th>
<th>UPZ urgent protective action planning zone</th>
<th>FRP food restriction planning radius</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>&gt; 1000</td>
<td>3 ... 5 km</td>
<td>5 ... 30 km</td>
<td>300 km</td>
</tr>
<tr>
<td></td>
<td>100 - 1000</td>
<td>0.5 ... 3 km</td>
<td>5 ... 30 km</td>
<td>50 ... 300 km</td>
</tr>
<tr>
<td>II</td>
<td>10 - 100</td>
<td>None</td>
<td>0.5 ... 5 km</td>
<td>5 ... 50 km</td>
</tr>
<tr>
<td></td>
<td>2 - 10</td>
<td>None</td>
<td>0.5 km</td>
<td>2 ... 5 km</td>
</tr>
</tbody>
</table>
**Classification of Emergencies**

**General emergencies** at facilities in threat category I or II involving an actual, or substantial risk of, release of radioactive material or radiation exposure that warrants taking urgent protective actions off the site.

**Site area emergencies** at facilities in threat category I or II involving a major decrease in the level of protection for those on the site and near the facility.

**Facility emergencies** at facilities in threat category I, II or III involving a major decrease in the level of protection for people on the site.

**Alerts at facilities** in threat category I, II or III involving an uncertain or significant decrease in the level of protection for the public or people on the site.
Objective and Scope

To assist the Member States to develop adequate level of preparedness and capability for response to nuclear emergencies before commissioning the first nuclear power plant and to enable emergency preparedness and response to be maintained during the life of the facility.
Application of the EPR-EMBARKING

The EPR-EMBARKING provides recommendations on steps that should be taken by Member States embarking on a Nuclear Power Programme to establish an effective framework of preparedness and response to a radiation emergency, which is an important part of safety infrastructure for a Nuclear Power Programme.
Arrangements for emergency preparedness and response are based on allocation and assignment of functions, responsibilities and duties at international, national, local and operator level for all involved parties:

- Government
- National coordinating authority
- Regulatory body
- Local authority
- Operating organizations
- Response organizations
Government

A system of executing authorities, through which a Member State exercises its authority at a national and international level and manages public policy.

Government acts as a responsible party at a national and international level.
National Coordinating Authority

National Coordinating Authority is a competent authority whose function, is
• to coordinate the assessment of the threats within the Member State,
• to coordinate the resolution of differences and potentially conflicting arrangements between the various response parties, and
• to coordinate the National Radiation Emergency Plan
National Coordinating Authority (2)

- shall ensure that the functions and responsibilities of operators and response organizations are clearly assigned and are understood by all response organizations, and that arrangements are in place for achieving and enforcing compliance with the requirements.
- acts as a responsible party at a national level.
An authority or a system of authorities designated as having legal authority for conducting the regulatory process includes rulemaking, authorization, inspection and enforcement, and thereby regulating nuclear, radiation, radioactive waste and transport safety together with protection of the public, the environment and property from conventional hazards.
Regulatory Body (2)

In preparedness for, and in the event of, emergencies, the regulatory body shall act as an adviser to the government and competent authorities in respect of nuclear safety and protection of the public from radiation and conventional hazards.

Regulatory Body acts as a responsible party at a national level.
Local authority

A system of executing authorities through which a Member State exercises its authority at a local level.

Local authority acts as a responsible party at a local level.
Operating organization

Any organization or person applying for authorization or authorized and/or responsible for nuclear, radiation, radioactive waste or transport safety when undertaking activities or in relation to any nuclear installations or sources of ionizing radiation.

Operating organization acts as a responsible party at an operator level.
Response organization

Any organization whose function, among others, is to respond for radiation emergency in accordance to National or Local Radiation Emergency Plan. It includes off-site response organizations.

Response organization acts as a responsible party at a local level.
Emergency Planning at National Level

National planning is warranted in case of

**Cat. I** - for States with territory within the PAZ, UPZ or food restriction planning radius of threat category I facilities;

**Cat. II** - for States with territory within the UPZ or food restriction planning radius of a threat category II facility;

**Cat. III** - for States containing a threat category III facility.

**Cat. IV** - for all States;

**Cat. V** - for States with territory within food restriction planning radius for a threat category I or II facility to include those located in other States.
Emergency Planning at Local Level

Local planning is warranted in case of

**Cat. I** - for jurisdictions responsible for urgent protective actions within the PAZ and UPZ of a threat category I facility;

**Cat. II** - for jurisdictions responsible for urgent protective actions within the UPZ of a threat category II facility;

**Cat. III** - for jurisdictions responsible for providing emergency services to a threat category III facility, including fire fighting, police and medical;

**Cat. IV** - for all jurisdictions;

**Cat. V** - for jurisdictions with farming or food processing facilities and/or responsible for taking local actions for agricultural and ingestion control within food restriction planning radius for a threat category I or II facility.
Integrated Planning Concept

NATIONAL (ALL HAZARDS) EMERGENCY PLAN

Other national emergency plans

National Radiation Emergency Plan

Local government emergency plans

Participating organizations emergency plans

Facilities (on-site) or operators emergency plans

Implementing procedures

Implementing procedures

Implementing procedures
What is a Framework for EPR?

A framework for EPR includes:

• Capabilities for emergency preparedness and response;
• Arrangements for emergency preparedness and response;
• Regulations for emergency preparedness and response.
Establishing a Framework for EPR

- Basic elements of a framework for preparedness and response to a radiation emergency
- Establishing a framework for preparedness and response to a radiation emergency
Basic Elements of a Framework (1)

1. Strengthening Global Nuclear Safety Regime;
2. Infrastructure for Preparedness and Response to Radiation Emergency;
3. Regulations on Preparedness and Response to Radiation Emergency;
4. Organization of Emergency Preparedness and Response;
5. Capabilities for Initiating a Response to Radiation Emergency;
6. Capabilities for Taking Mitigatory and Urgent Protective Actions;
Basic Elements of a Framework (2)

7. Capabilities for radiological response to radiation emergency;
8. Capabilities for medical response to radiation emergency;
9. Capabilities for provision of information prior to and during the response to radiation emergency;
10. Considerations of emergency response in site survey and site selection for nuclear installation;
11. Ensuring emergency response.
Framework for Emergency Preparedness and Response

- Participation in Global Safety Regime
- Infrastructure
- Regulations
- Organization of response
- Initiation of response
- Site survey
- Capabilities for
  - Mitigatory actions
  - Medical response
  - Radiological response
  - Information response

EMERGENCY PREPAREDNESS AND RESPONSE

Ensuring efficiency of emergency preparedness
Phase 1 of establishing a framework for EPR

A robust emergency preparedness programme should be *initiated* in phase 1, but fully implemented during the commissioning phase [INSAG-22]

**Milestone $M_A$ Ready to introduce concept of operations**

✓ **Milestone $M_A$** is associated in time with **Milestone 1** of the establishing a safety infrastructure for a Nuclear Power Programme
Phase 2 of establishing a framework for EPR

Milestone $M_B$  *Ready to combat III, IV and V category of threats*

- **Landmark $L_{A1}$**: Issuance of regulations needed for preparedness and response to radiation emergency and National radiation emergency plan;
- **Landmark $L_{A2}$**: Issuance of local radiation emergency plans for threat categories III, IV and V;

✓ Milestone $M_B$ is associated in time with Milestone 2 of the establishing a safety infrastructure for a Nuclear Power Programme
Phase 3 of establishing a framework for EPR

Milestone $M_C$  \textit{Ready to combat I and II category of threats}

- \textbf{Landmark $L_{B1}$:} Ready to staff organizations involving in preparedness and response to radiation emergency at facilities of threat category I and II;

- \textbf{Landmark $L_{B,2}$:} Issuance of on-site and off-site radiation emergency plans for facilities of threat categories I and II.

✓ Milestone $M_C$ is associated in time with delivery of fresh nuclear fuel to the first NPP (at least 1 year before commissioning of the NPP)
Scenario establishing a framework for EPR

Phase 1: Appraisal
- Ready to introduce concept of operations
- Issue of regulations and National radiation emergency plan
- Ready to make a decision on whether or not to introduce nuclear power

Phase 2: T. Category III, IV and V
- Issuance of local radiation emergency plans for TCat III, IV & V
- Ready to invite bids

Phase 3: T. Category I and II
- Ready to staff organizations responding at facilities of TCat I & II
- Issuance of on-site and off-site radiation emergency plans for facilities of TC I & II
- Ready to commission and operate the first NPP

1 year

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Lessons Learned from failures of a Nuclear Power Programme

Zwentendorf NPP (Lower Austria, 1978)

- Zwentendorf NPP, was intended to be the first of six Austrian NPP. The construction which began in 1970 was completed in 1978, it is rated at 700 MWe.
- On November 5, 1978, 50.5% of the voters said “no” to operation of Zwentendorf because of concerns about possible accidents.

Shoreham NPP (Long Island, USA, 1989)

- Construction began in 1973, and in 1984 commissioning began. It is rated at 800 MWe.
- Local government would not participate in the emergency plan and perception was that the emergency plan was not workable. Plant costing US $5.6 billion was never operated!
Conclusions and Summary

The new IAEA publication from Emergency Preparedness and Response Series “Emergency Preparedness Considerations for Member States Embarking on a Nuclear Power Programme” (EPR-EMBARKING) assists the Member States to develop adequate level of preparedness and capability for response to nuclear emergencies before commissioning the first nuclear power plant and to enable emergency preparedness and response to be maintained during the life of the facility.
The IAEA services regarding EPR

- **Emergency Preparedness and Response Review (EPREV) mission.**
  Contact person - Mr. Peter Zombori (P.Zombori@iaea.org)

- **Training course in emergency preparedness and response for countries embarking on the use of nuclear power.**
  Contact person - Mr. Vladimir Kutkov (V.Kutkov@iaea.org)

Services are provided by the Incident and Emergency Centre of the IAEA (IEC)

http://www-ns.iaea.org/tech-areas/emergency/
Any questions?