International Guidance on Radiation Emergency Management

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Disclaimer

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Purpose of this talk

- To provide insight into international guidance available for emergency preparedness and response to a nuclear or radiological emergency
- International Atomic Energy Agency
- *Why me?*

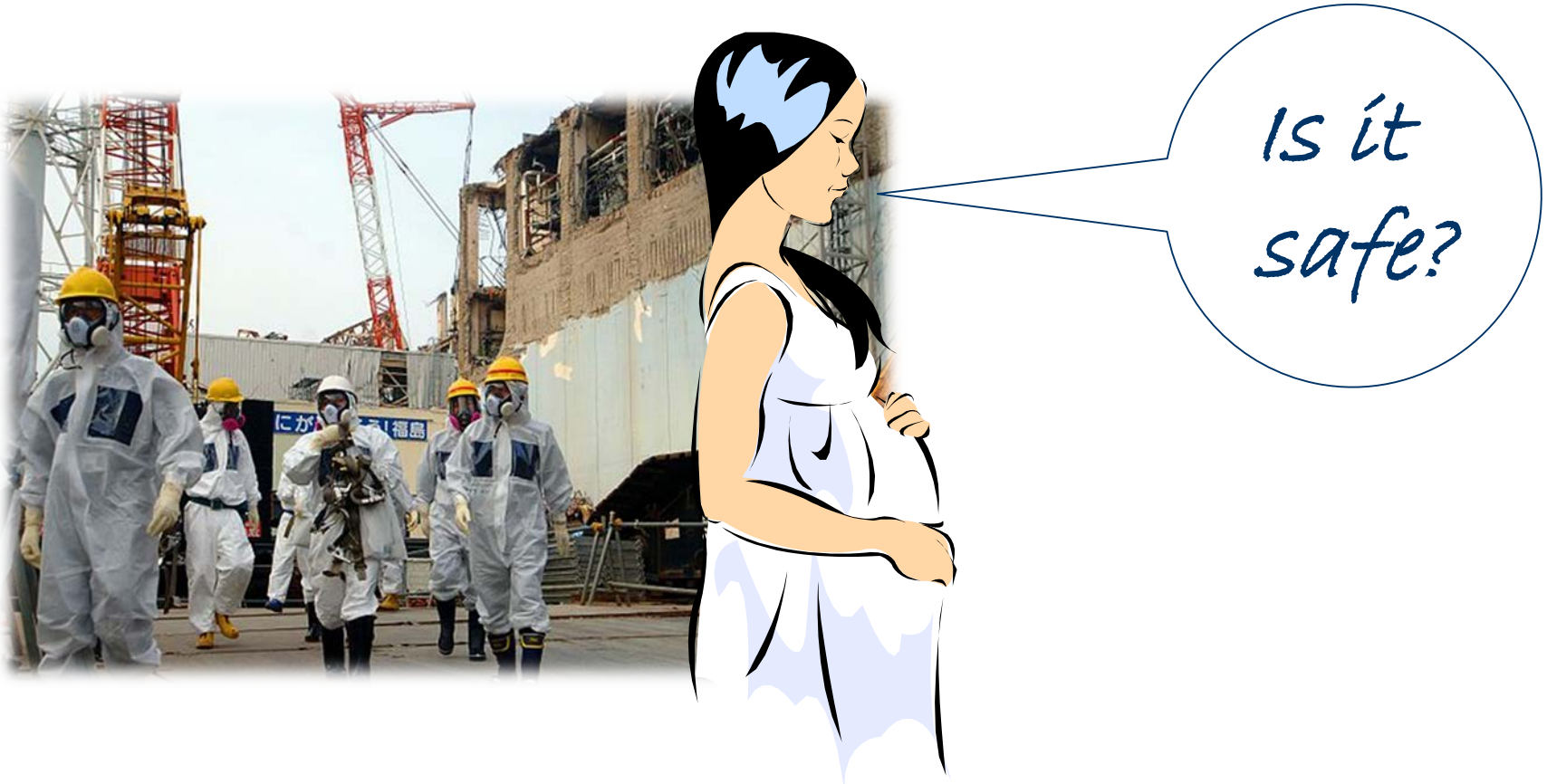
Limitations of International Guidance

- The only agency that MUST follow IAEA guidance is…….the IAEA!

except

- If a Member State requests IAEA assistance, they must demonstrate that they follow IAEA guidance

The Big Question

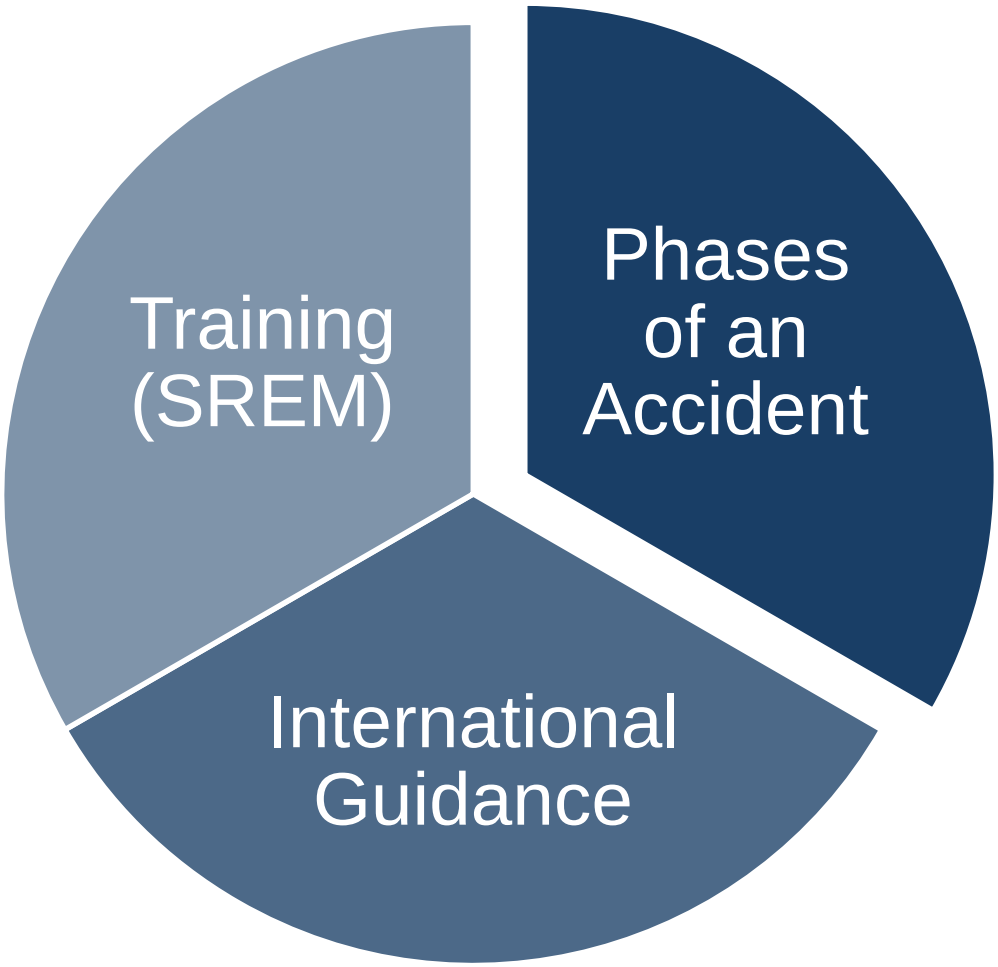


Remember

Everybody goes home safely at the end of their shift.

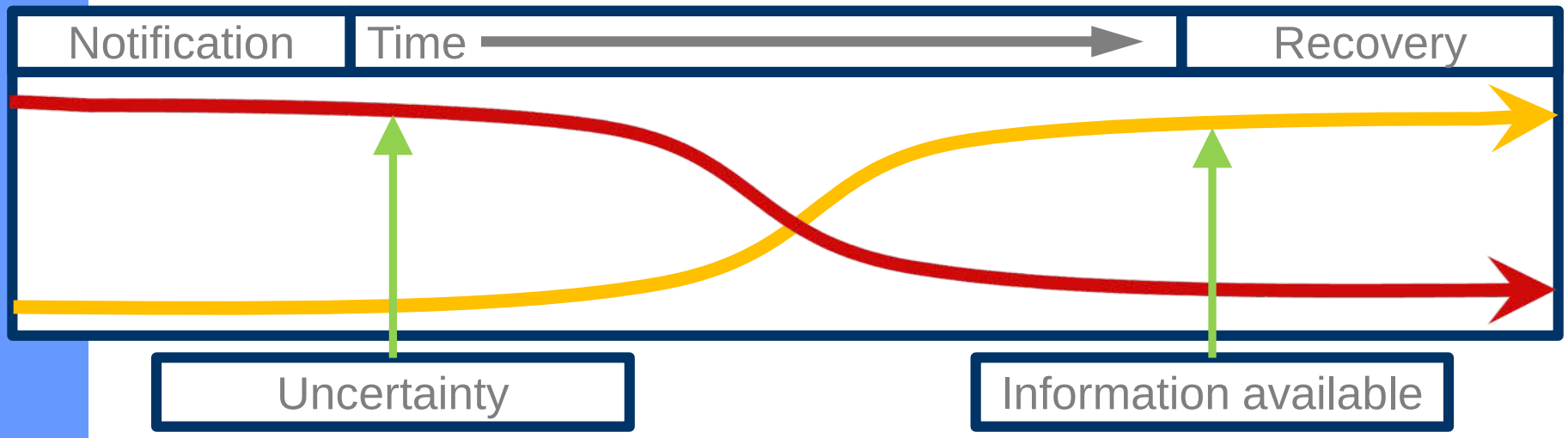
Cameco

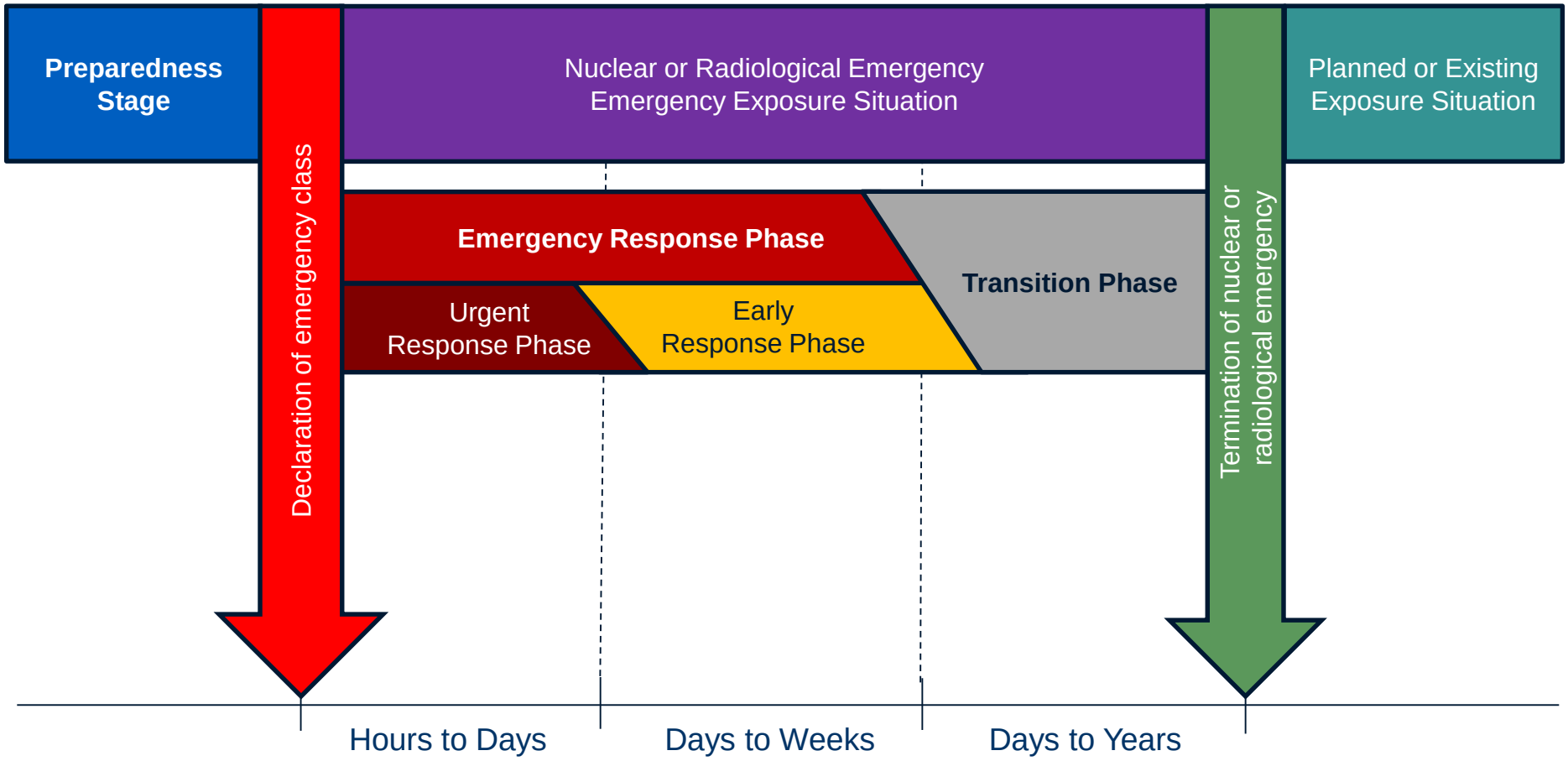
Cigar Lake Operation


Phases of an Accident
International Guidance
Training (SREM)

PHASES OF AN ACCIDENT

A nuclear or radiological emergency does not follow and ideal timeline…




Preparedness Stage
Declaration of emergency class
Nuclear or Radiological Emergency
Emergency Exposure Situation
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Emergency Response Phase
Transition Phase
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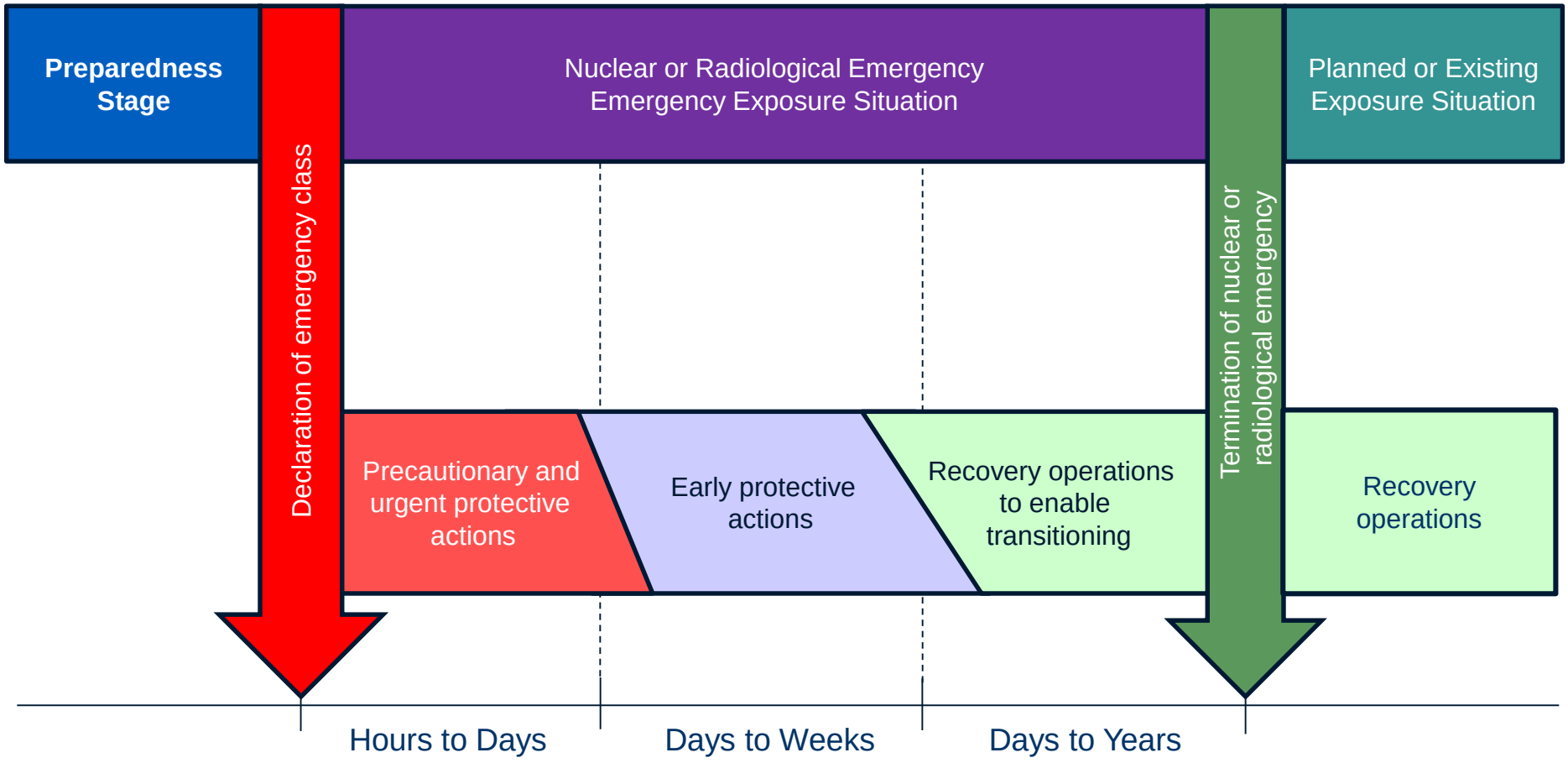
Early Response Phase
Termination of nuclear or radiological emergency
Hours to Days
Days to Weeks
Days to Years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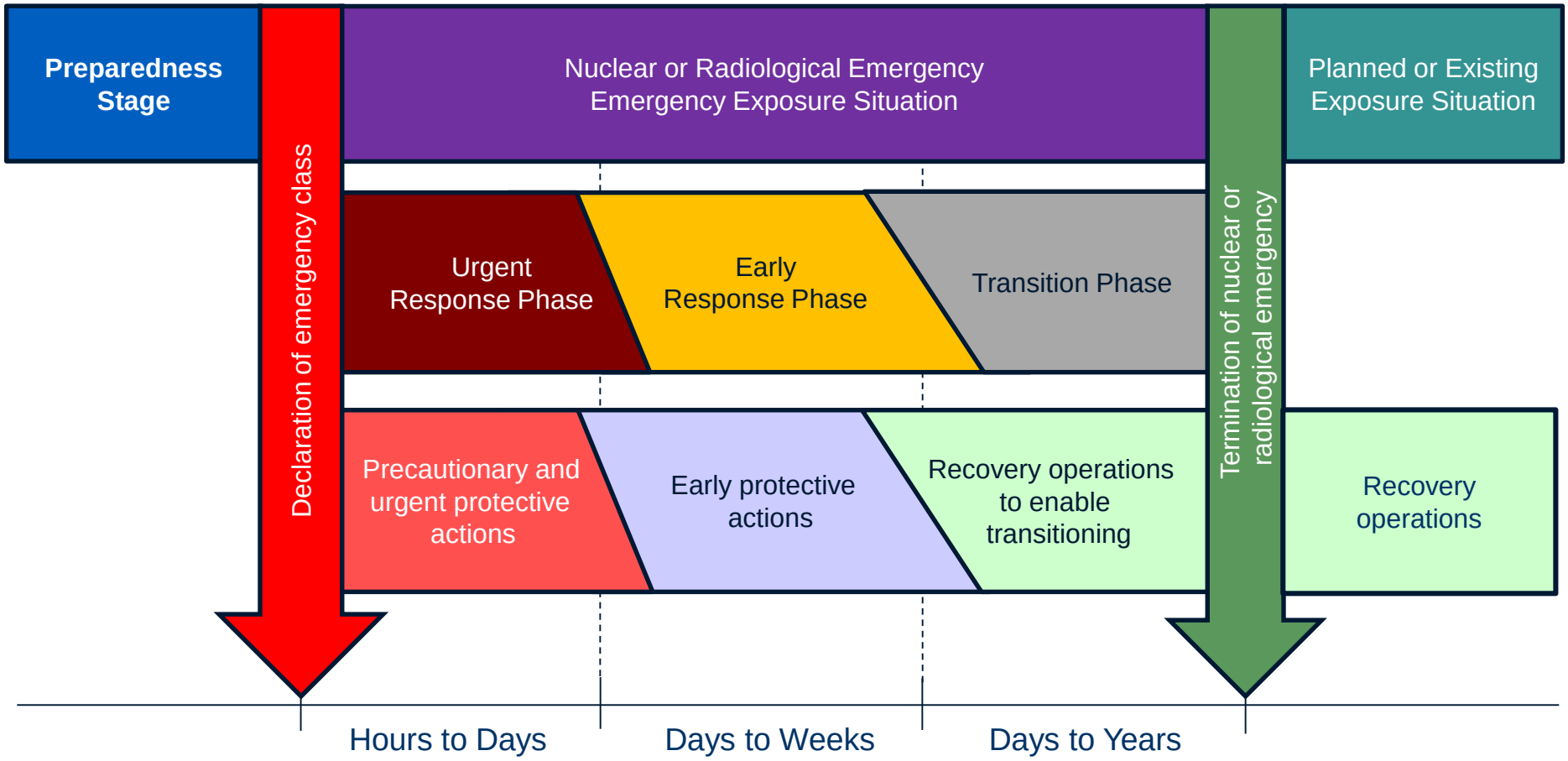
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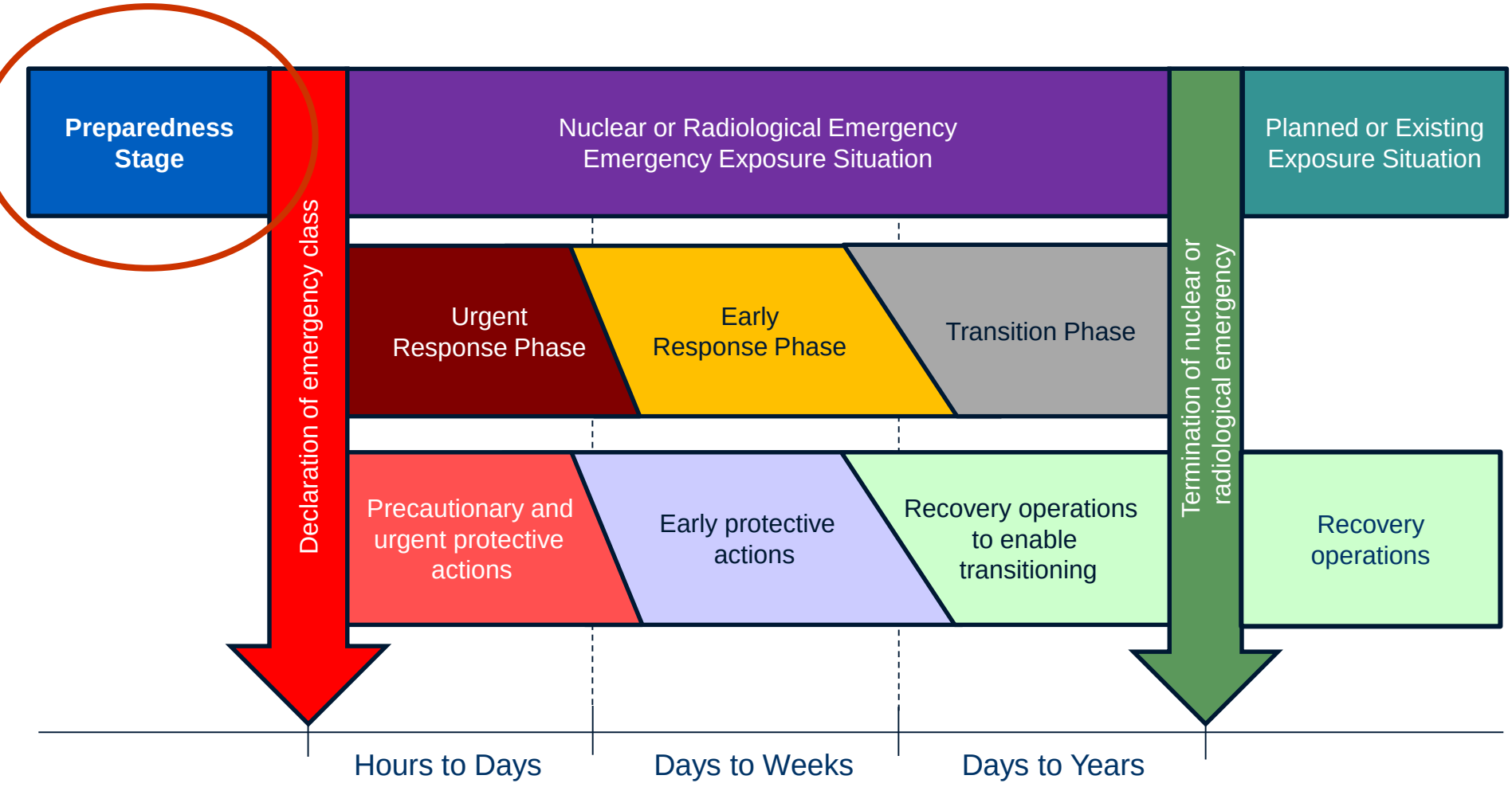
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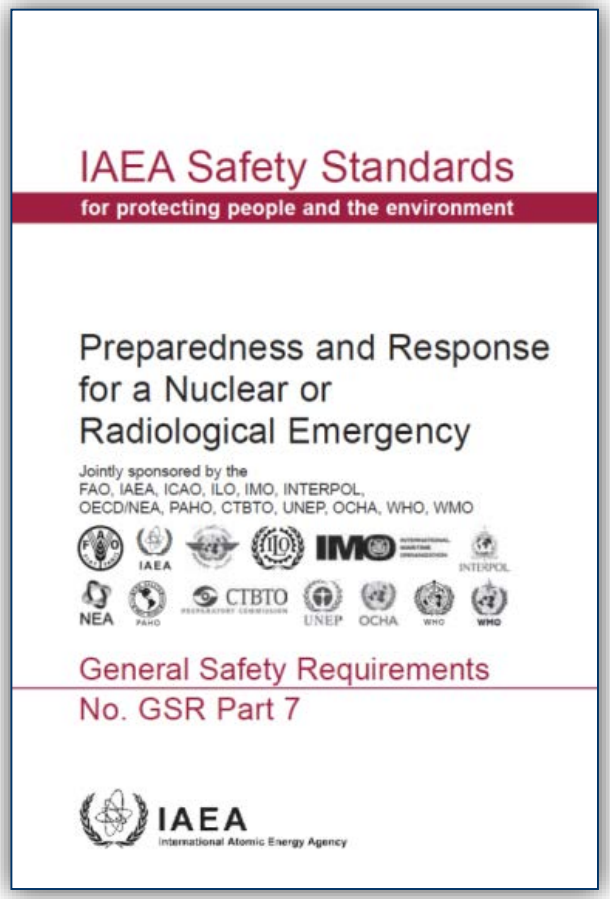
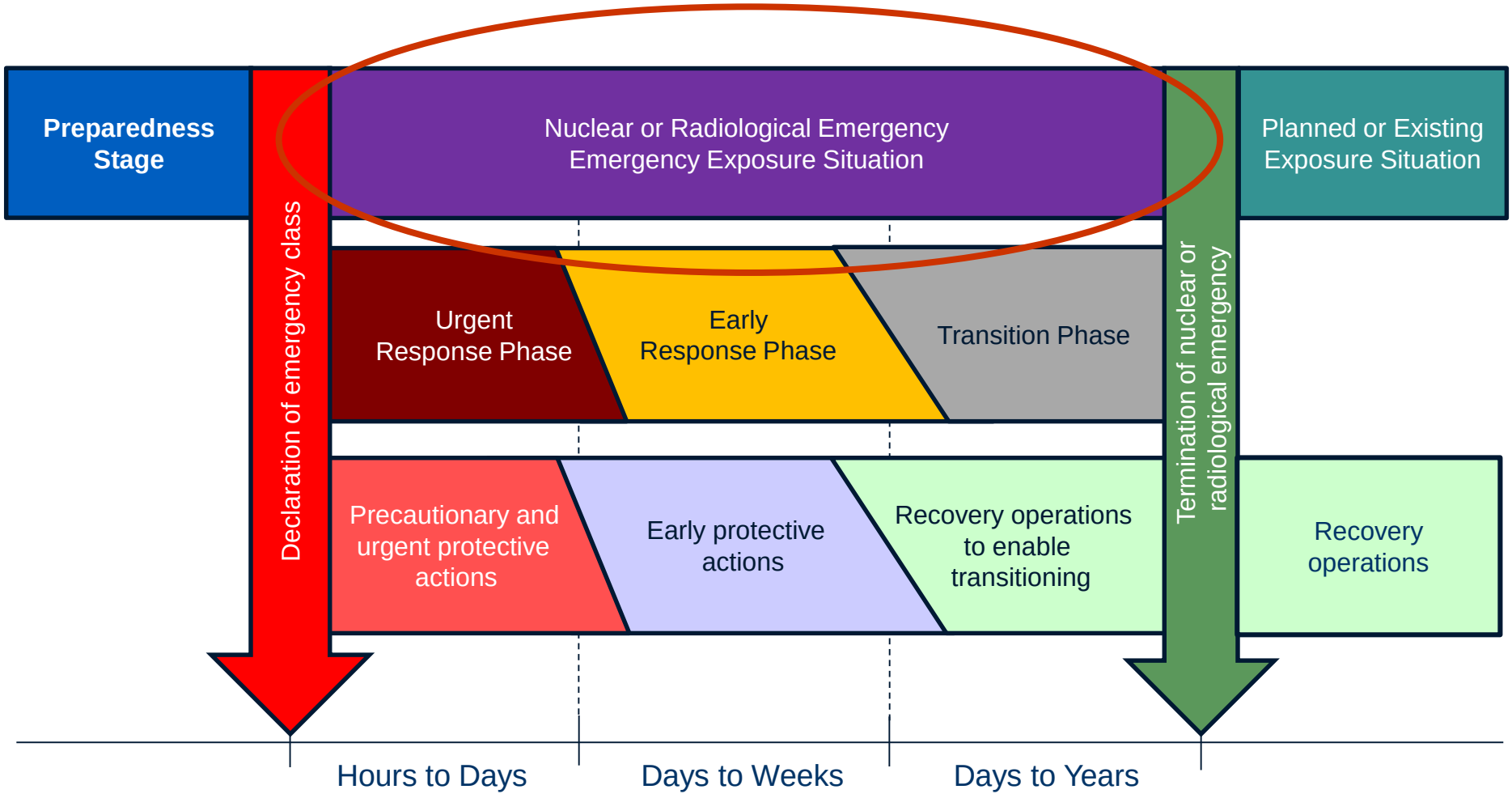
Preparedness Stage

IAEA Safety Standard Series No. GSR Part 7 defines the preparedness stage as:

The stage or phase at which arrangements for an effective emergency response are established prior to a nuclear or radiological emergency.

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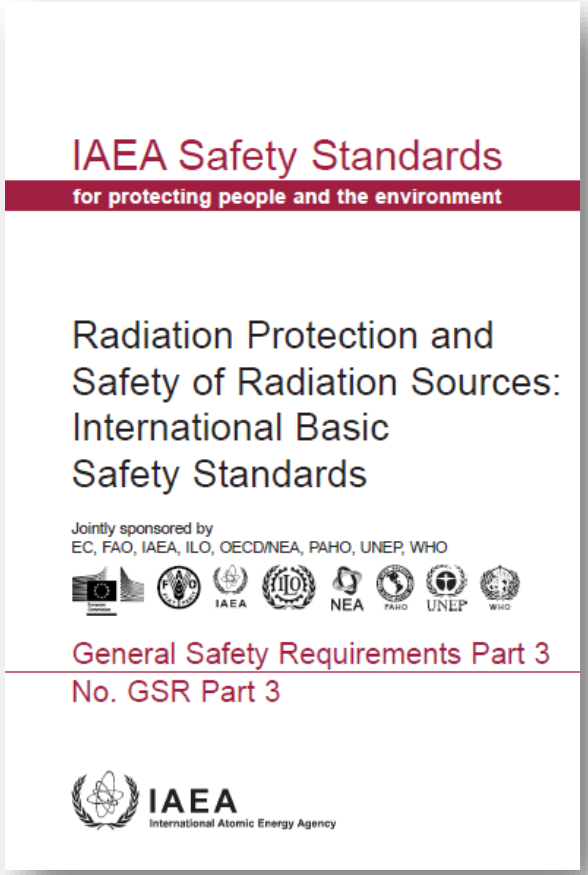
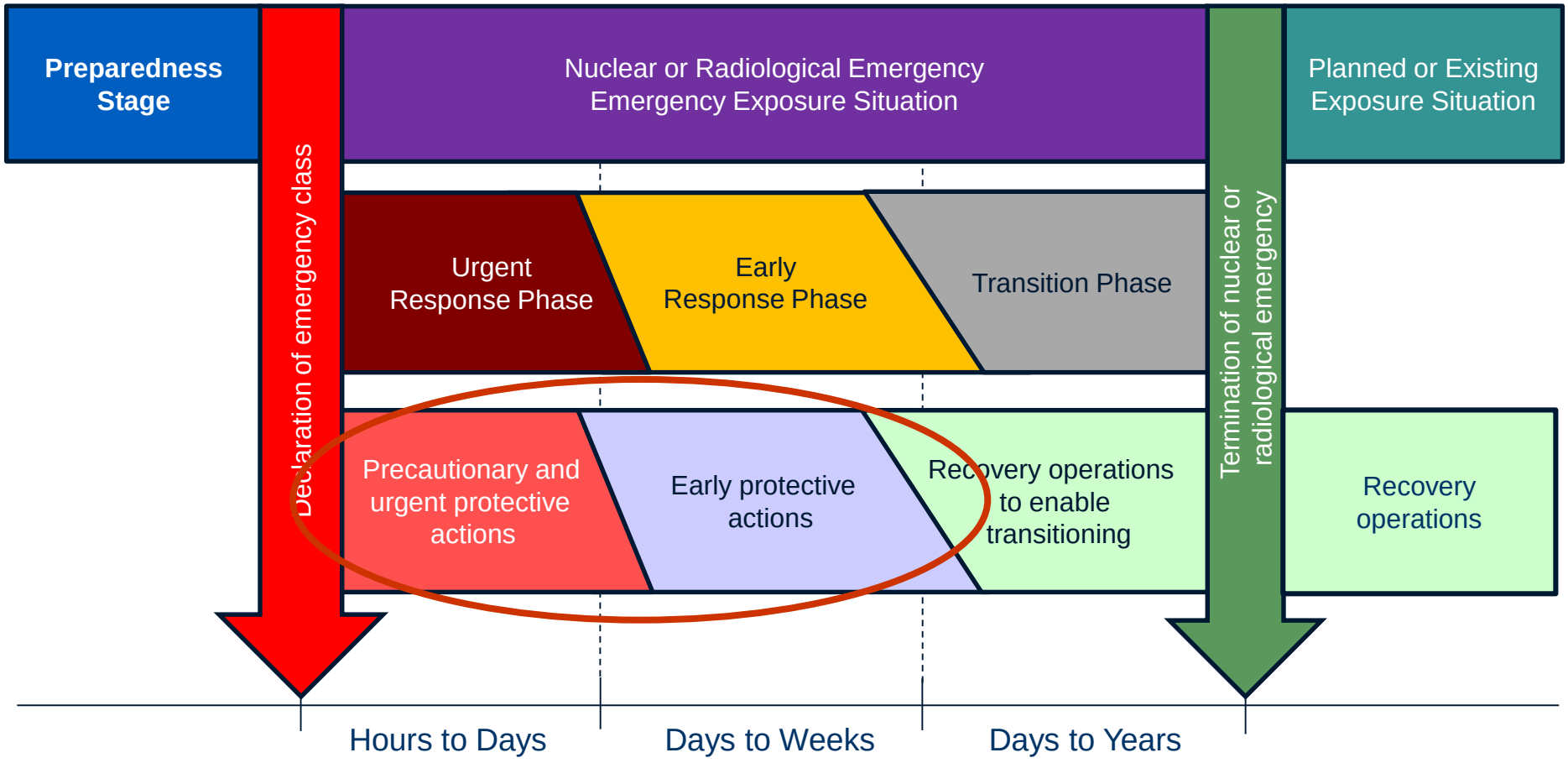
Emergency exposure situation

IAEA Safety Standard Series No. GSR Part 3 defines the emergency exposure situation as:

A situation of exposure that arises as a result of an accident, a malicious act or other unexpected event, and requires prompt action in order to avoid or reduce adverse consequences.

Emergency exposures can be reduced only by protective actions and other response actions.

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Protective actions

IAEA Safety Standard Series No. GSR Part 7 defines a protective action as:

An action for the purposes of avoiding or reducing doses that might otherwise be received in an emergency exposure situation or an existing exposure situation.

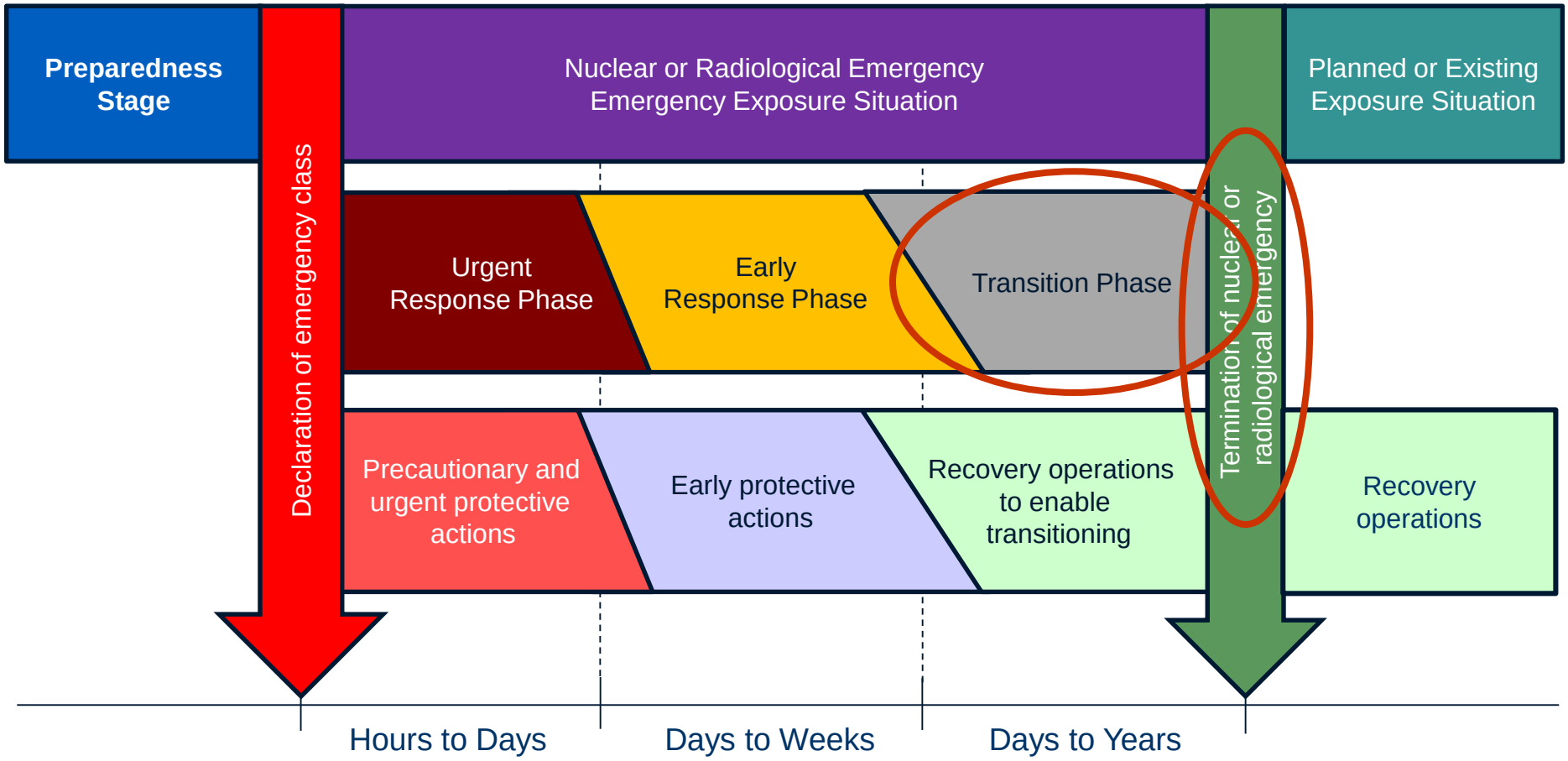
- ***Mitigatory action:*** *Immediate action by the operator or other party:*
  - *(a) To reduce the potential for conditions to develop that would result in exposure or a release of radioactive material requiring emergency response actions on the site or off the site; or*
  - *(b) To mitigate source conditions that may result in exposure or a release of radioactive material requiring emergency response actions on the site or off the site.*

Protective actions

- ***Urgent protective action:*** *A protective action in the event of a nuclear or radiological emergency which must be taken promptly (usually within hours to a day) in order to be effective, and the effectiveness of which will be markedly reduced if it is delayed.*
  - *Urgent protective actions include* ***iodine thyroid blocking, evacuation, short term sheltering, actions to reduce inadvertent ingestion, decontamination of individuals and prevention of ingestion of food, milk or drinking water possibly with contamination.***
  - *A precautionary urgent protective action is an urgent protective action taken before or shortly after a release of radioactive material, or an exposure, on the basis of the prevailing conditions to avoid or to minimize severe deterministic effects.*

Protective actions

- ***Early protective action****: A protective action in the event of a nuclear or radiological emergency that can be implemented within days to weeks and still be effective. The most common early protective actions are* ***relocation*** *and* ***longer term restriction of the consumption of food*** *potentially affected by contamination.*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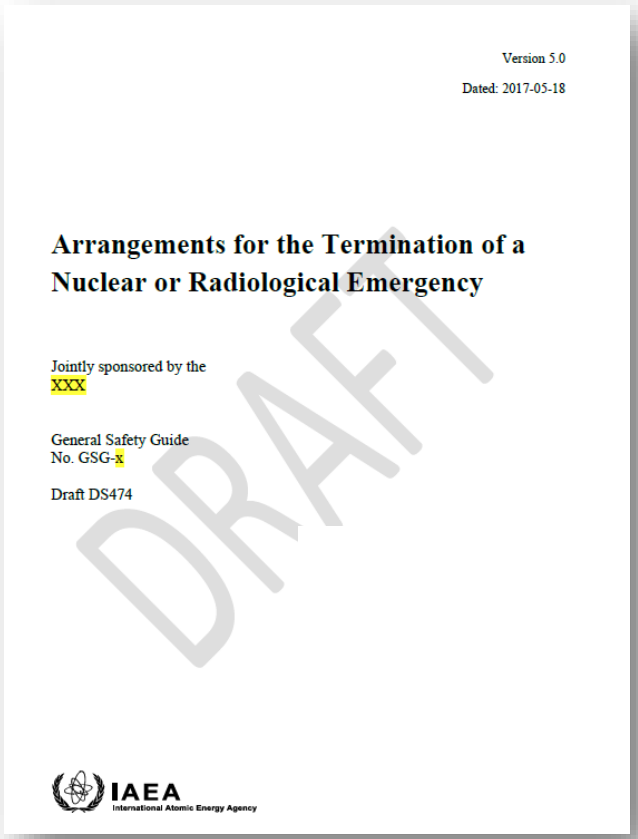
Termination of the emergency

The termination of the emergency is defined in the IAEA Safety Standard Series No. GSR Part 3 and GSR Part 7 and in the draft Safety Guide DS474 as*:*

- *The **transition** from an emergency exposure situation to an existing or planned exposure situation:*


Version 5.0

Dated: 2017-05-18

Arrangements for the Termination of a Nuclear or Radiological Emergency

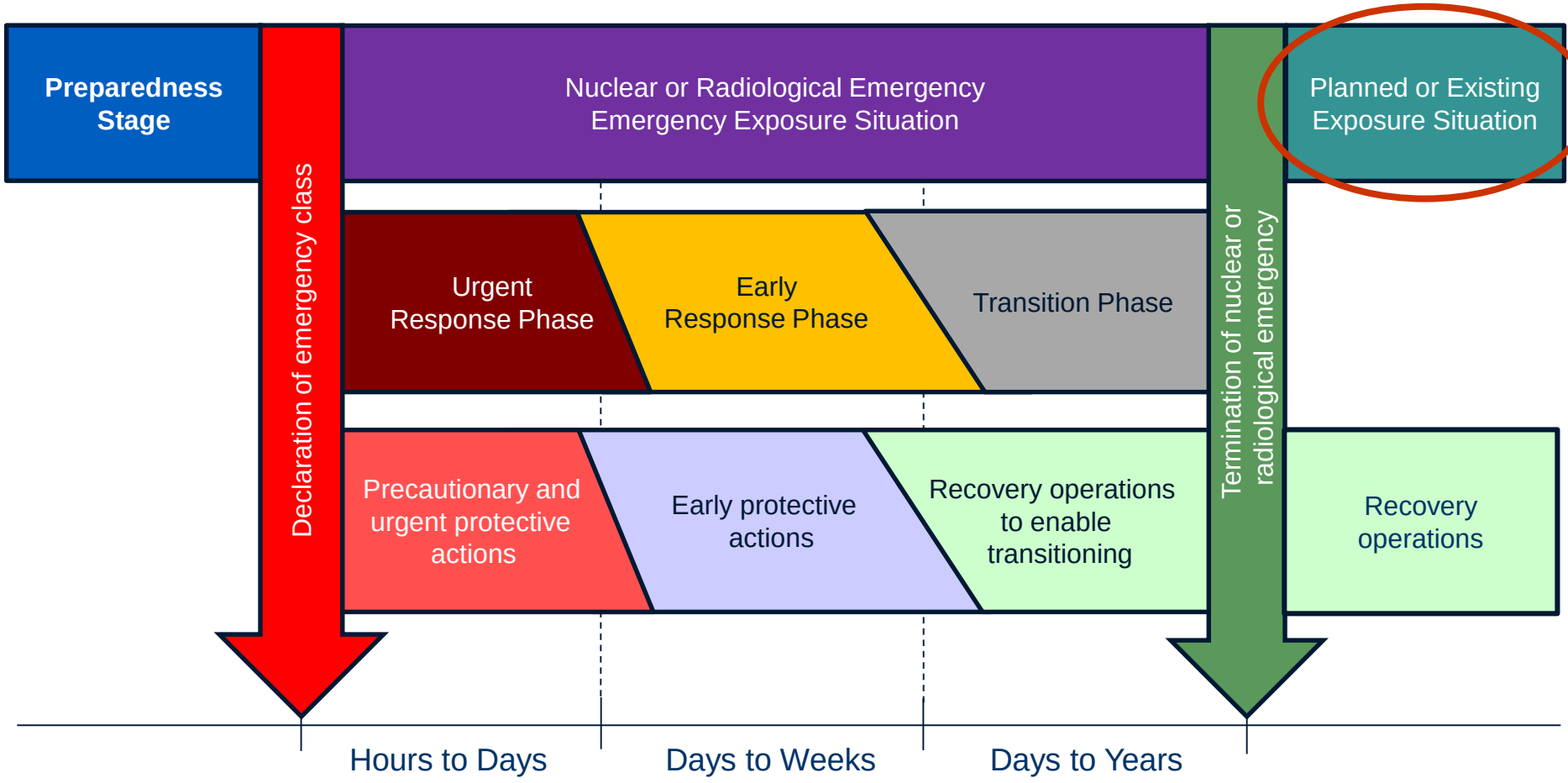
Jointly sponsored by the XXX

General Safety Guide No. GSG-x

Draft DS474

DRAFT

IAEA International Atomic Energy Agency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Existing and Planned Exposure Situations

IAEA Safety Standard Series No. GSR Part 3 defines the existing and planned exposure situations as:

- **Existing exposure situation:** A situation of exposure that already exists when a decision on the need for control needs to be taken. Existing exposure situations include
  - exposure to **natural background radiation** that is amenable to control
  - exposure due to **residual radioactive material that derives from past practices** that were never subject to regulatory control, or
  - exposure due to **residual radioactive material deriving from a nuclear or radiological emergency** after an emergency has been declared to be ended
- **Planned exposure situations:** The situation of exposure that arises from the **planned operation of a source or from a planned activity** that results in an exposure due to a source.

INTERNATIONAL GUIDANCE

Four Categories:

1. Safety standards
2. EPR series
3. Training materials
4. Accident reports

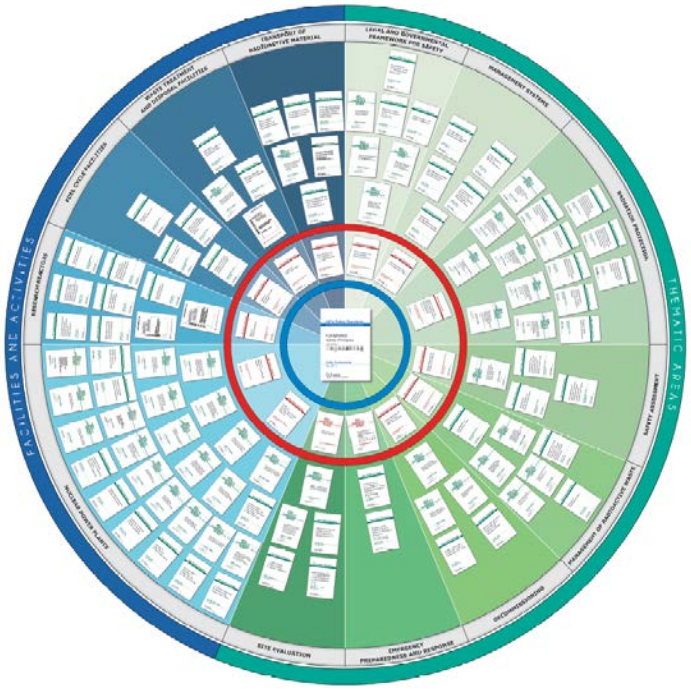
Available IAEA Guidance

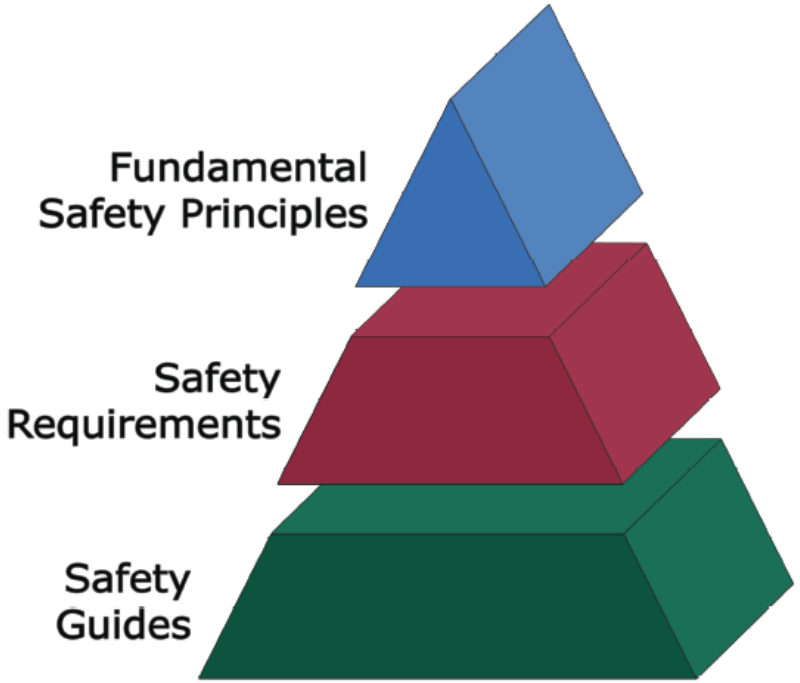
1. **Safety standards**
2. EPR series
3. Training materials
4. Accident reports

Introduction

- IAEA Statute authorizes the Secretariat to establish or adopt, … **standards** of safety for protection of health and minimization of danger to life and property
- IAEA is also authorized to provide for **application** of these standards

IAEA Safety Standards





Safety Standards
General

Images courtesy IAEA

✓ *An **international consensus** on what constitutes a high level of safety for protecting people and the environment from harmful effects of ionizing radiation…*

Safety Standards Categories

Images courtesy IAEA

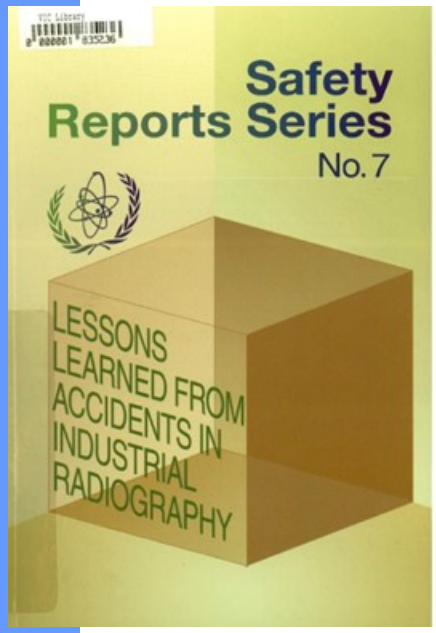
Safety Fundamentals:
Fundamental safety objective and principles for protecting people and environment

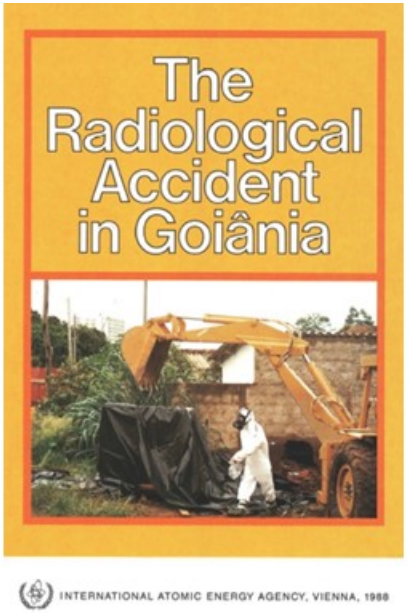
Safety Requirements:
Requirements that must be met to ensure protection of people and environment

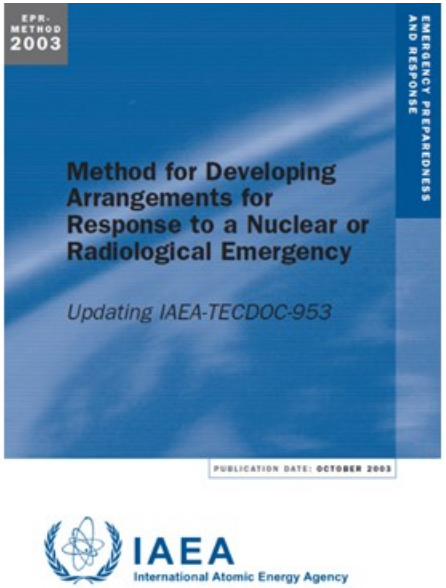
Safety Guides:
Recommended ways of meeting the requirements

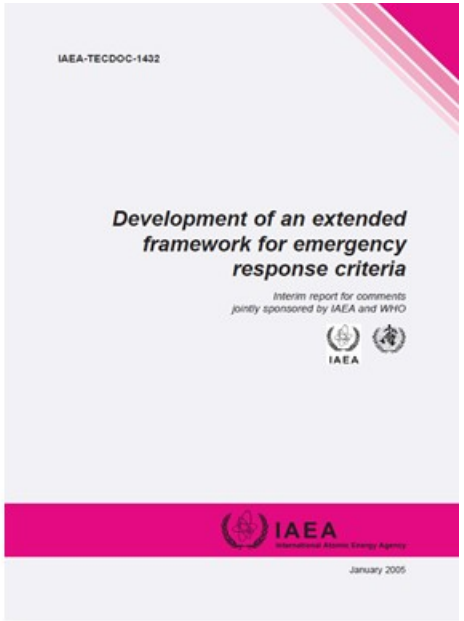
Safety Standards
What is not a Safety Standard

- Agency publications other than Safety Fundamentals, Safety Requirements and Safety Guides, for example:









Images courtesy IAEA

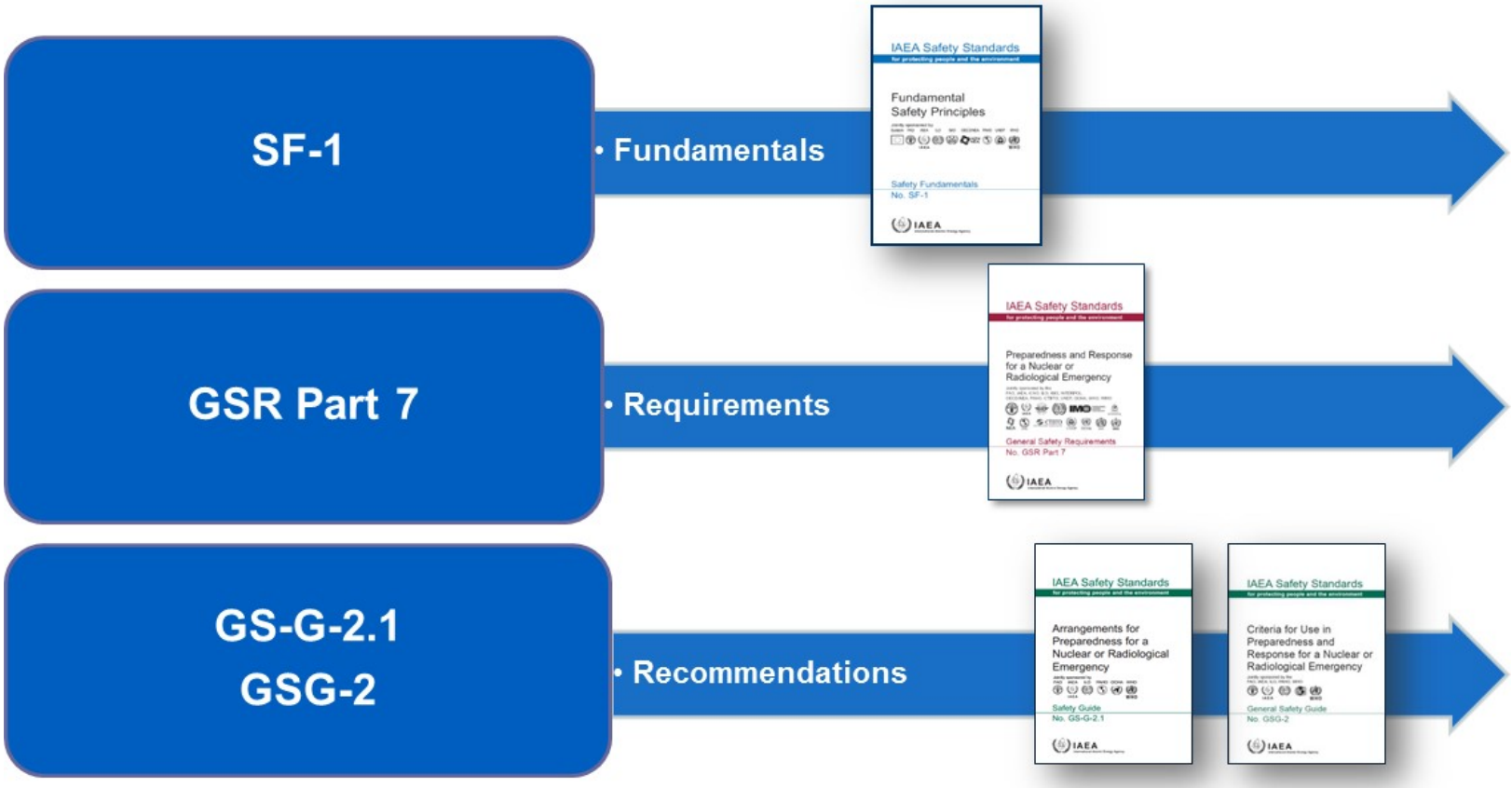
Safety Standards Overall Structure

Image courtesy IAEA

Safety Standards Status

- Safety Standards are:
  - **Non binding on Member States** but may be adopted by them
  - **Binding for IAEA**'s own activities
  - **Binding on States in relation to operations assisted by the IAEA** or States wishing to enter into project agreements with IAEA

Safety Standards in EPR Overview



Safety Requirements in EPR General Requirements

- To be fulfilled before any emergency planning can start
  - Emergency management system
  - Roles and responsibilities
  - Assessment of hazards
  - Protection strategy

Safety Requirements in EPR Functional Requirements

- Functions to be performed for response to be effective and goals of emergency response to be met
  - **Managing** emergency response operations
  - **Identifying, notifying** and **activating**
  - Taking **mitigatory** actions
  - Taking urgent protective and other response **actions**
  - Providing **instructions**, **warning** and relevant **information** to the public
  - Protecting emergency **workers and helpers**
  - Managing the **medical response**

Safety Requirements in EPR Functional Requirements (cont)

- Functions to be performed (cont)
  - **Communicating** with the public
  - Taking early **protective** and other actions
  - Managing radioactive **waste**
  - **Mitigating** the non-radiological consequences
  - Requesting, providing and receiving international **assistance**
  - **Terminating** an emergency
  - **Analysis** of emergency and the response

Safety Requirements in EPR Graded Approach

- EPR to be commensurate with hazards and potential consequences of an emergency associated with facility, activity or source
  - Concept of hazard assessment
    - Emergency preparedness categories I - V
- Safety requirements apply this graded approach and they are addressed for facilities, activities and sources in specific category(ies)
  - If applicable for all categories, no category is specified in requirements

Safety Requirements in EPR
Guidance Values for Emergency Workers

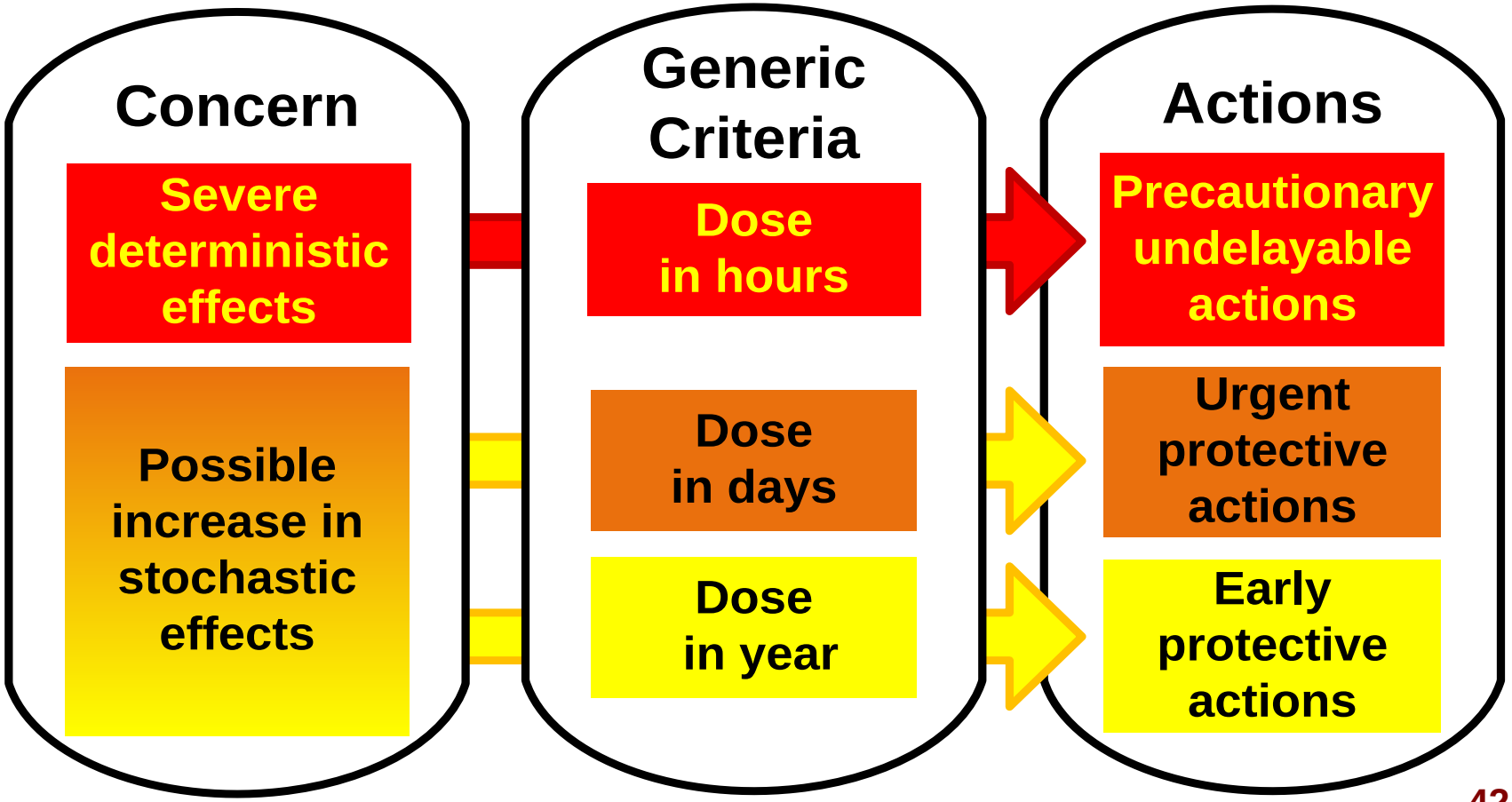
- Appendix I of GSR Part 7
- Guidance values for $H_P(10)$, E and AD_T for **restricting further exposure** of emergency workers in response to a nuclear or radiological emergency

Images courtesy IAEA

Safety Requirements in EPR Generic Criteria

- Appendix II of GSR Part 7
- Comprehensive set of **generic criteria** at which emergency response actions need to be taken:
  - To avoid or minimize severe **deterministic** effects
  - To reduce the risk of **stochastic** effects
  - To mitigate **non-radiological consequences** in relation to international trade
  - To transit to **existing exposure situation**

Generic Criteria

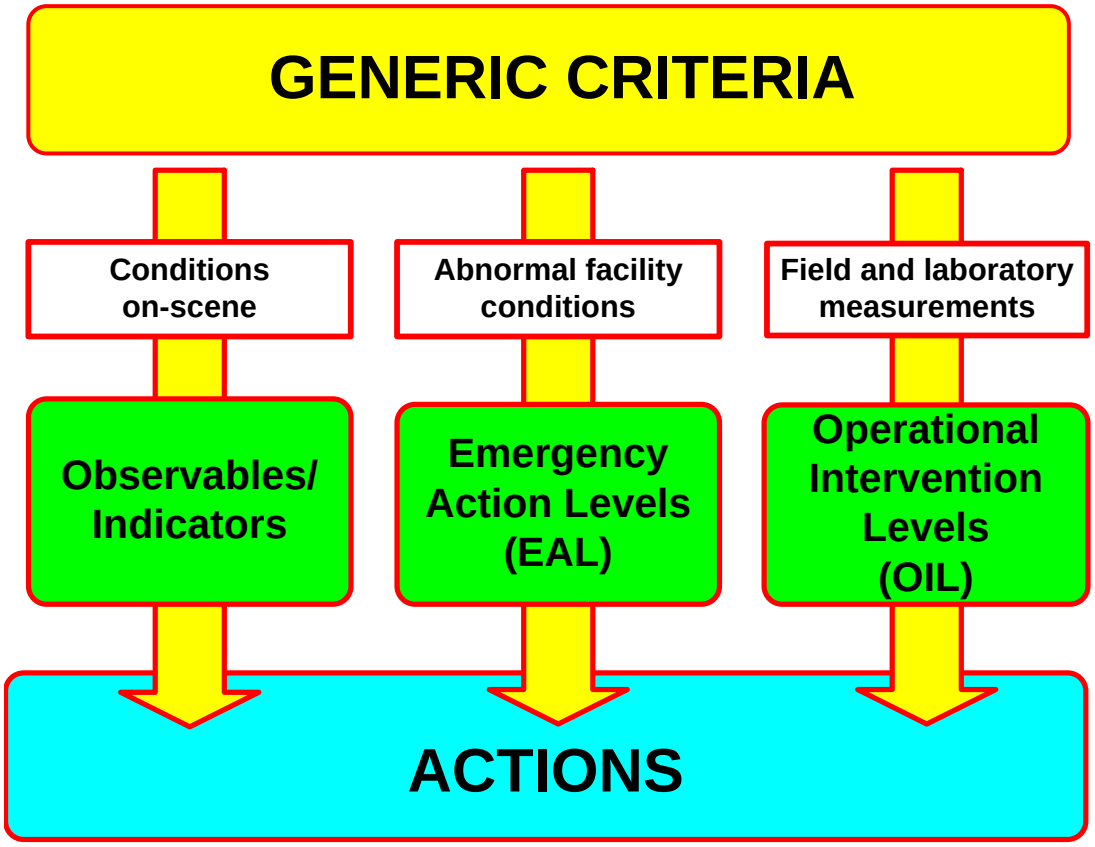


Operational Criteria

- GC cannot be used directly in the response
  - They are based on projected or received dose…
  - …which needs to be calculated
  - Taking into account a large number of considerations and uncertainties.

- Hence the need to develop criteria that can be used directly in the response (i.e **operational criteria**) during the preparedness phase based on the GC

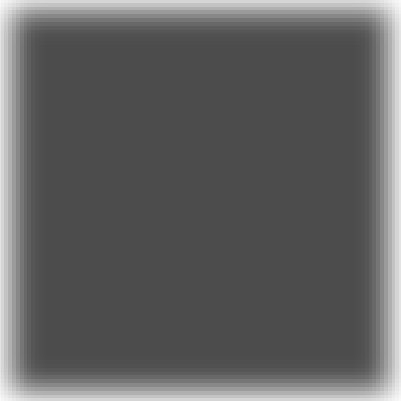
Generic Criteria form the basis for Operational Criteria



Observables / Indicators

- e.g. fire, earthquake, loss of control, unshielded source, RTG, RDD







Images courtesy IAEA

Emergency Action Levels

- EALs are specific, predetermined and observable criteria to detect, recognize and determine the emergency class

Initiate pre-planned response

Cannot protect core!

Example for a general emergency at an NPP

EAL exceeded

Off-site decision maker implements predetermined protective actions

Declaration of General Emergency

Pressure above xx Bar

Failure to SCRAM

Temperature above xx K

Dose rate above xx µSv/h

Loss of power for xx min

Operational Interventional Levels (OILs)

Predetermined level of a measurable quantity to trigger response actions (based on GC) on the basis of monitoring and sampling:

Default OIL value exceeded

Immediate action

e.g. Evacuate (establish cordon) if either of the following is exceeded:

- γ → 100 µSv/h at 1 m
- α → 10 cps at 1 cm
- β → 200 cps at 2 cm

Image courtesy IAEA

Safety Fundamentals No. SF-1 (2006)

- Establishes the fundamental safety objective, safety **principles and concepts** that provide the bases for the IAEA's safety standards and its safety related programme
- Principle 9:
  - Emergency preparedness and response
  - "*Arrangements must be made for emergency preparedness and response for nuclear or radiation incidents.*"

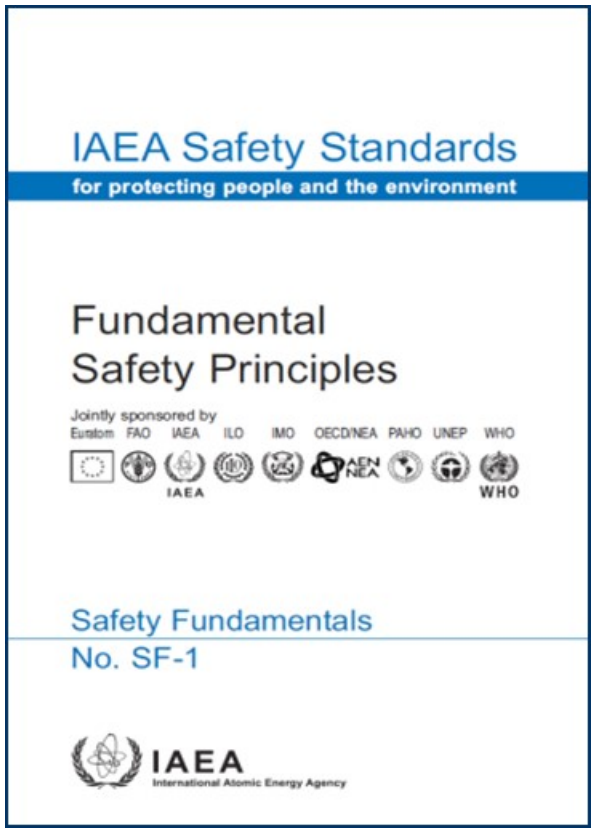


Image courtesy IAEA

Safety Requirements No. GSR Part 7 (2015)

- Establishes requirements for an **adequate level of preparedness and response** for a nuclear or radiological emergency, irrespective of its cause
- Requirements level: ‘Shall’ or ‘What’ to be done

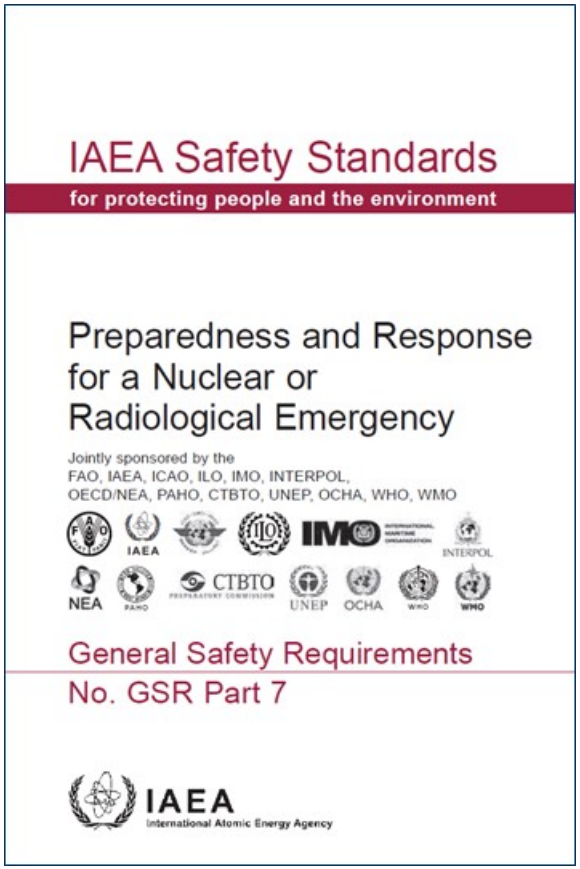
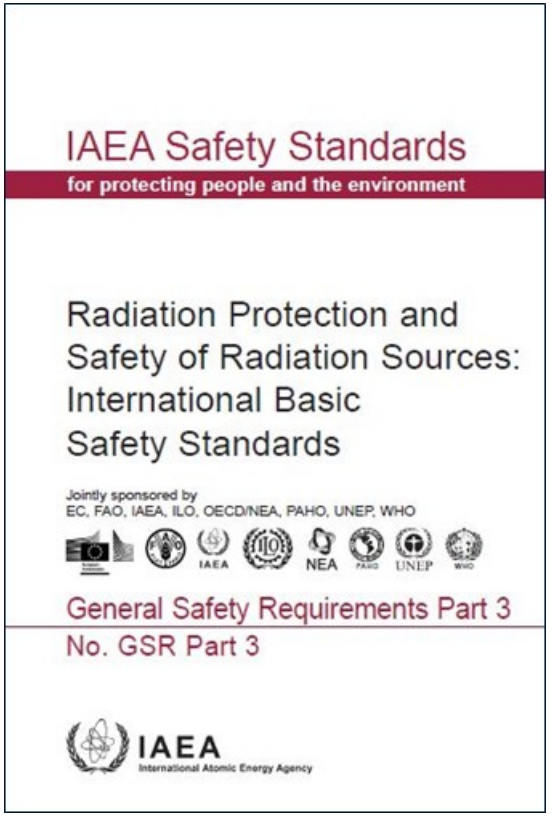


Image courtesy IAEA

Safety Requirements No. GSR Part 3 (2014)

- Relevant requirements in Section 4 on **Emergency Exposure Situations**
  - Requirements level: ‘Shall’ or ‘What’ to be done



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Safety Guides No. GS-G-2.1 (2007)

- GS-G-2.1 provides recommendations on **implementation of specific safety requirements** established in GS-R-2 (now GSR Part 7)
  - Recommendations level: '**Should**' or '**How**' to be done

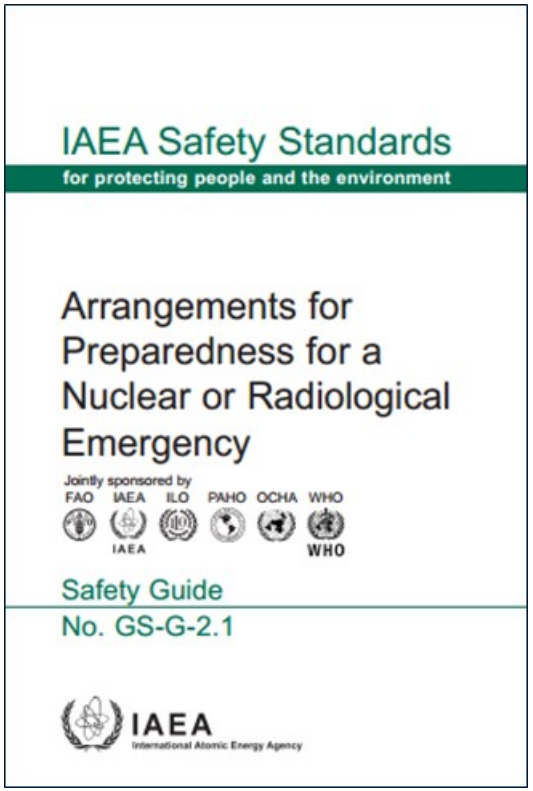
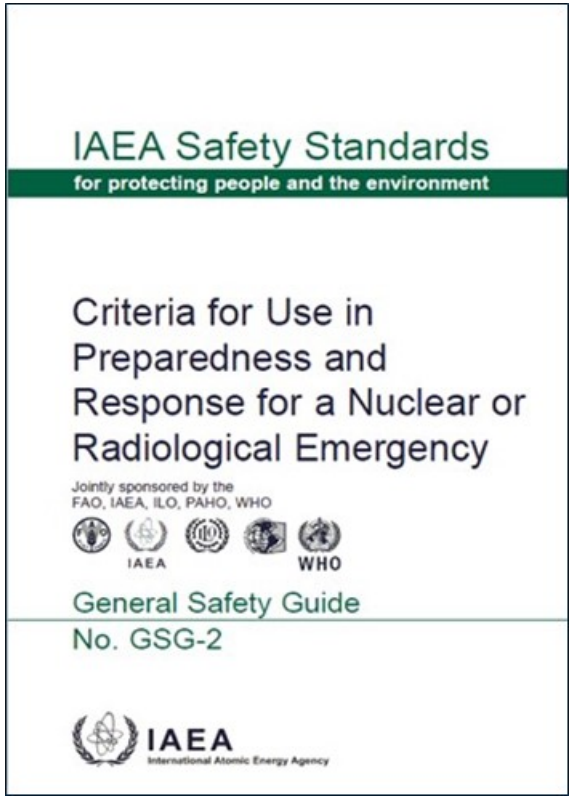


Image courtesy IAEA

Safety Guides No. GSG-2 (2011)

- GSG-2 provides guidance on **criteria for taking protective actions and other response actions** in a nuclear or radiological emergency
  - Recommendations level: '**Should**' or '**How**' to be done



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Available IAEA Guidance

1. Safety standards
2. **EPR series**
3. Training materials
4. Accident reports

Support for the Standards

- Safety Standards in EPR (GSR Part 7, GS-G-2.1 and GSG-2) describe "**what**" an adequate level of emergency preparedness and response is and provide guidance "**how**" that can be achieved
- EPR Series support the application of the IAEA Safety Standards:
  - EPR Series give further technical guidance and tools to support the establishment of effective and efficient EPR system by Member States

EPR Series - General

Images courtesy IAEA

EPR-Method (2003)

- Method for Developing Arrangements for Response to a Nuclear or Radiological Emergency
  - Provides guidance for meeting the requirements (GS-R-2; superseded by GSR Part 7)
  - Incorporates the lessons learned from use of IAEA-TECDOC-953

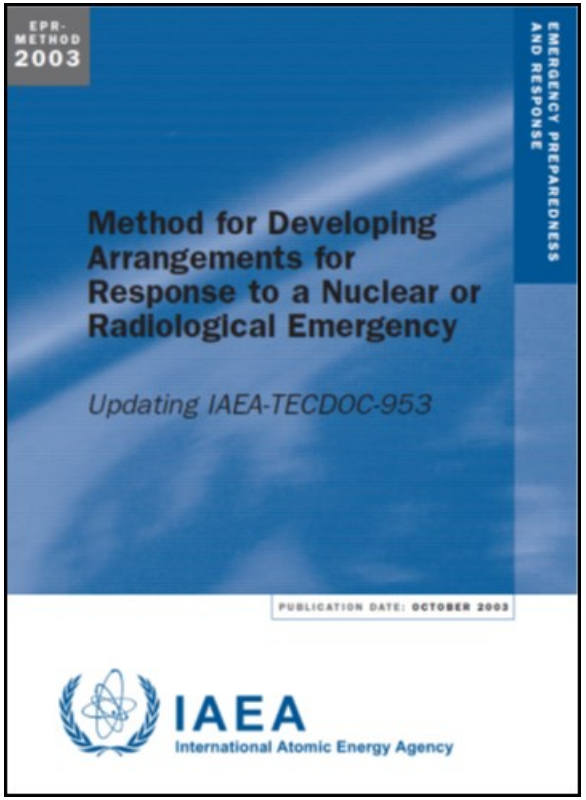


Image courtesy IAEA

EPR-Exercise (2005)

- Preparation, conduct and evaluation of exercises to test preparedness for a nuclear or radiological emergency
  - Provides practical guidance for planners to efficiently and effectively prepare, conduct and evaluate emergency response exercises

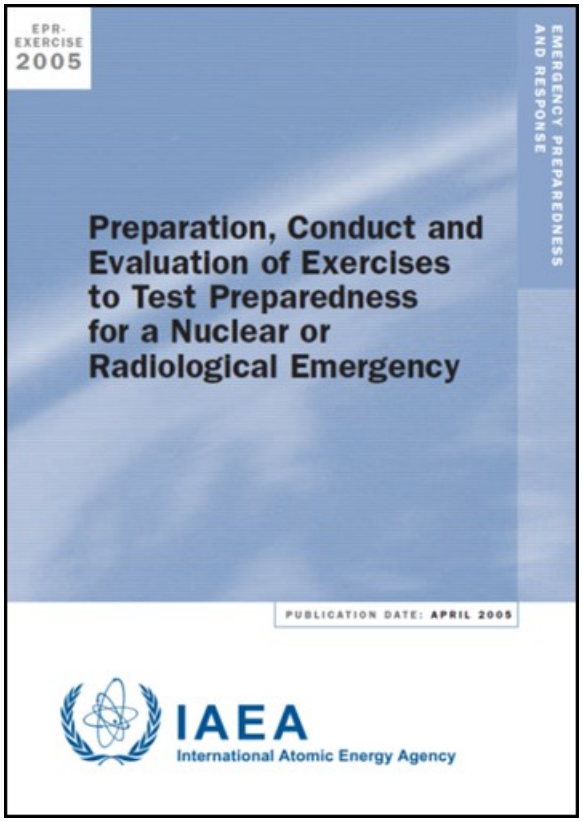


Image courtesy IAEA

EPR-Dangerous Values (2006)

- The objectives of this publication are
  - To describe, in detail, the basis for the D-values
  - To provide an expanded set of D-values that includes other radionuclides that may be important in the event of a nuclear or radiological emergency

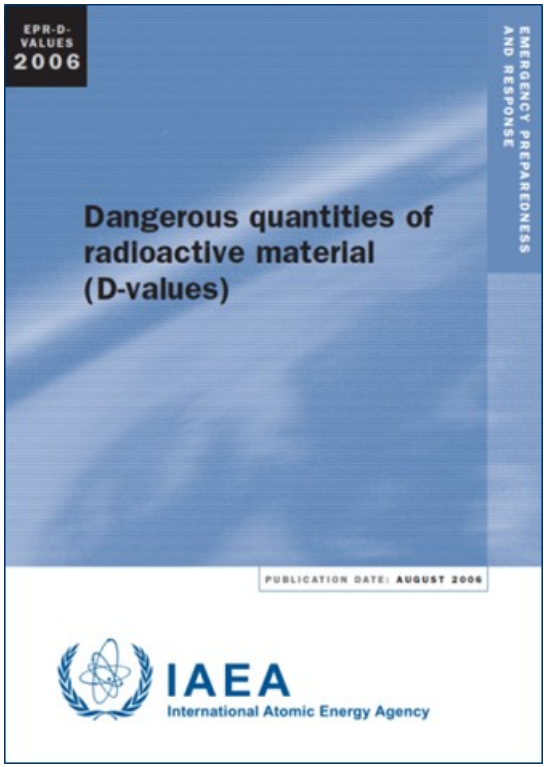


Image courtesy IAEA

EPR-Lessons Learned (2012)

- The objectives of this publication are
  - To provide a review of the lessons from the response to a number of radiation emergencies with the purpose of consolidate them.
  - To demonstrate the necessity of establishing arrangements for EPR

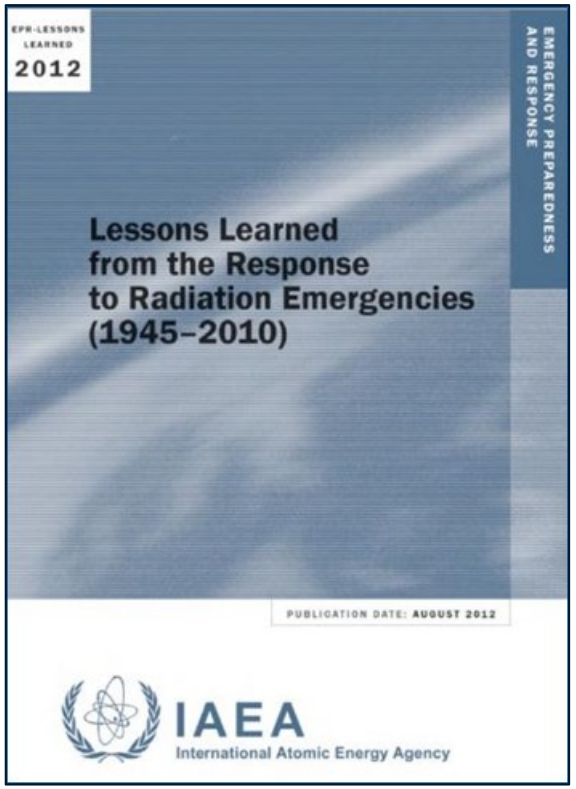


Image courtesy IAEA

EPR-Embarking (2012)

- The objectives of this publication are
  - To assist States that are considering embarking on a nuclear power programme to develop an adequate level of EPR prior to commissioning their first NPP and ensure the maintenance of the EPR programme throughout the lifetime of the facility.

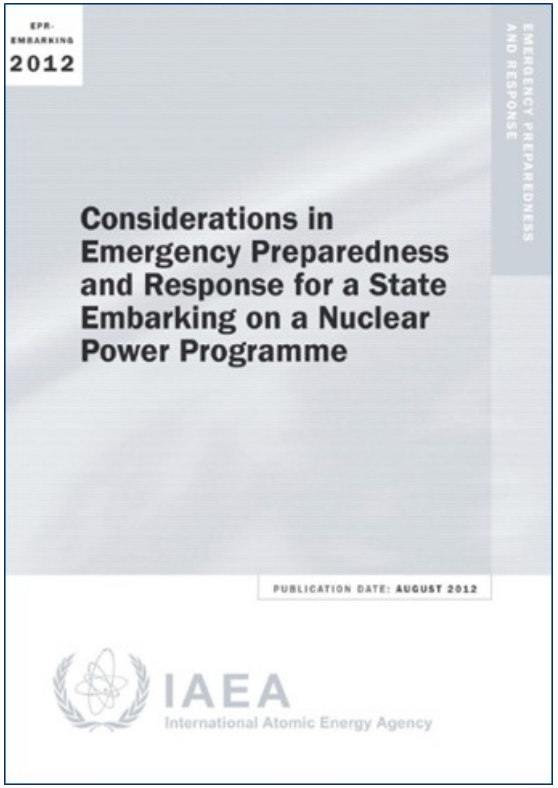
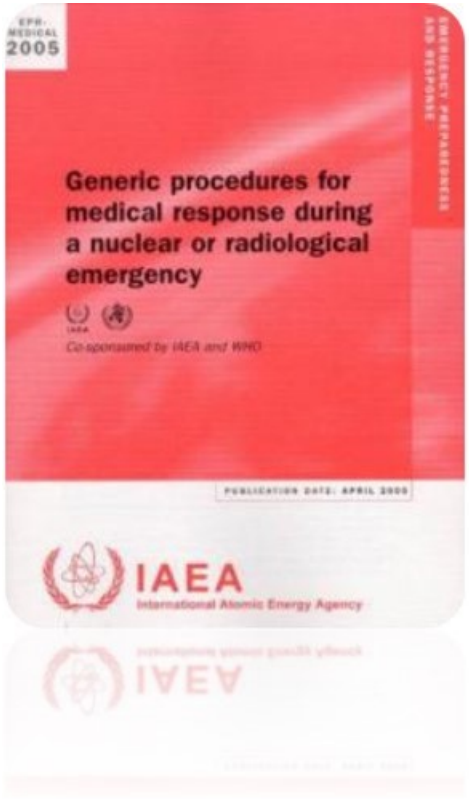
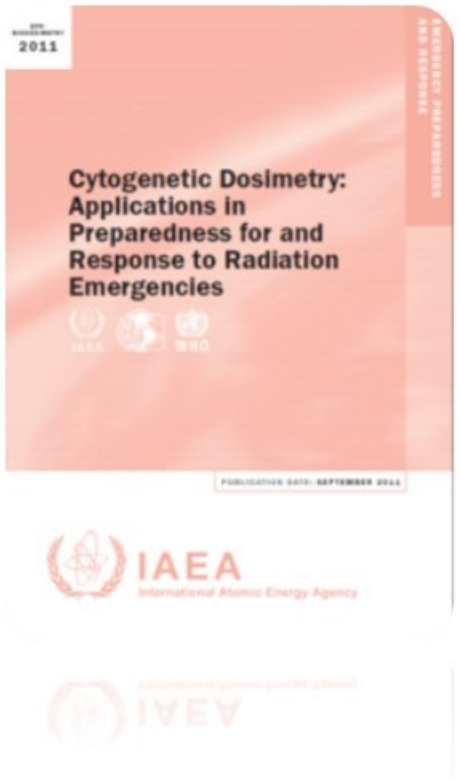


Image courtesy IAEA

EPR Series - Medical





Images courtesy IAEA

EPR-Medical (2005)

- Generic procedures for medical response during a nuclear or radiological emergency
  - Provides generic response procedures for medical personnel responding to different types of radiation emergencies

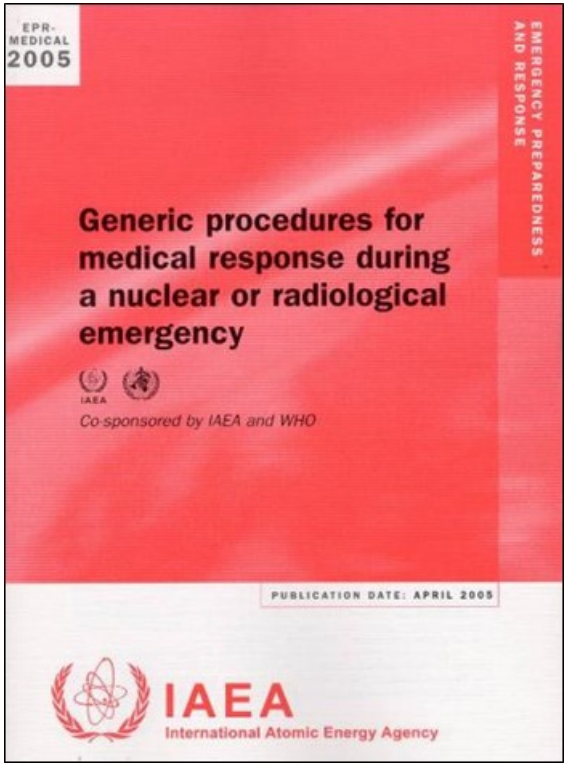


Image courtesy IAEA

EPR-Biodosimetry (2011)

- The primary objective of this publication is
  - To provide technical information for selecting and implementing, in a standardized manner, the appropriate cytogenetic technique to ensure comparable dose assessment following accidental exposure to ionizing radiation.

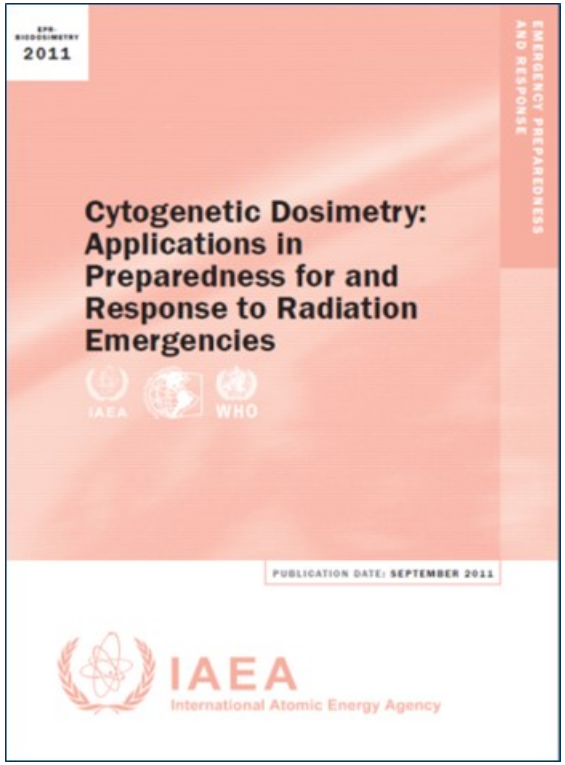


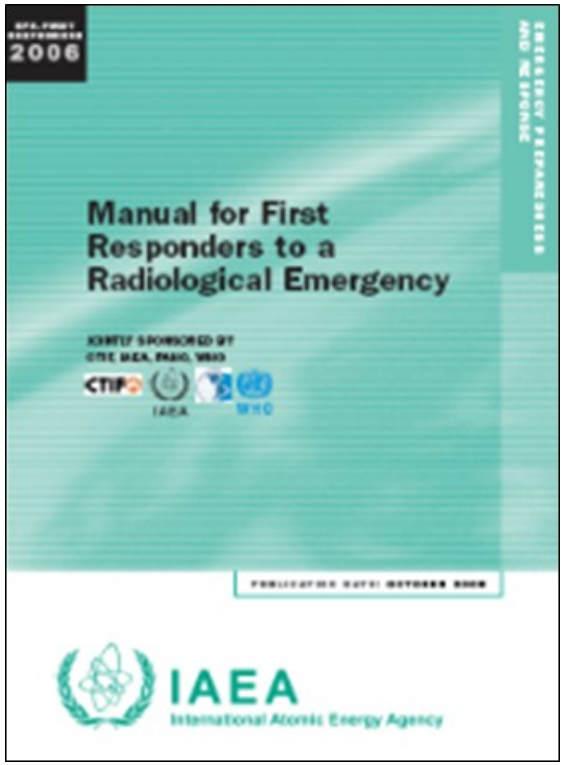
Image courtesy IAEA

EPR Series - Operational

Images courtesy IAEA

EPR-First Responders (2006)

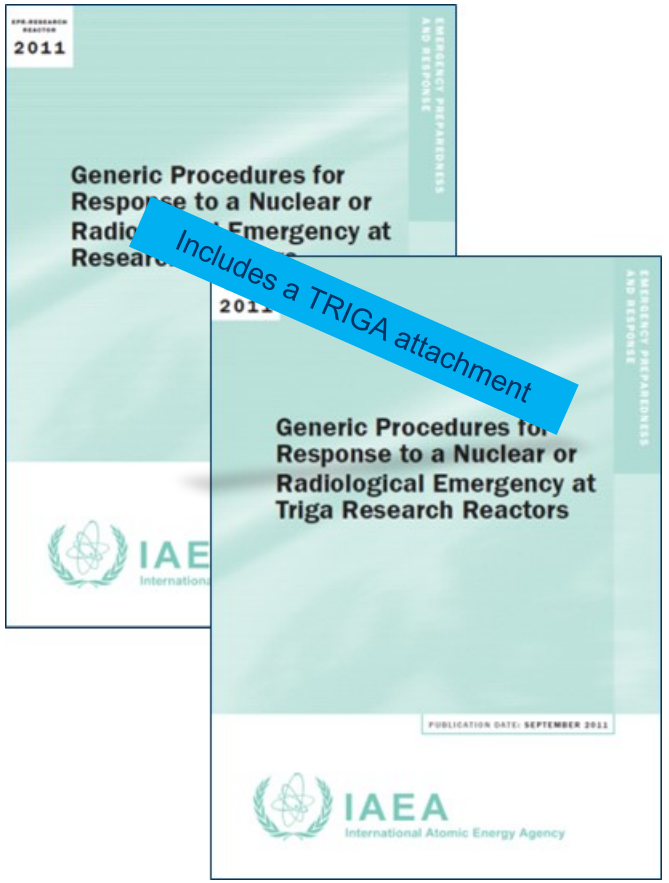
- Guidance for first responders and for national officials who would support this early response
  - Action guides, instructions, data



Images courtesy IAEA

EPR-Research Reactor (2011)

- Objectives of this publication are
  - To describe appropriate responses to a range of emergencies at Hazard Category II and III research reactor sites
  - To describe the on-site organization needed to respond to these emergencies
  - To provide tools to organize the emergency response actions at these reactor sites



Images courtesy IAEA

EPR-Public Communications (2012)

- The objectives of this publication are
  - To provide practical guidance to those responsible for keeping the public and media informed and coordinating all sources of official information to ensure a consistent message is being provided to the public.

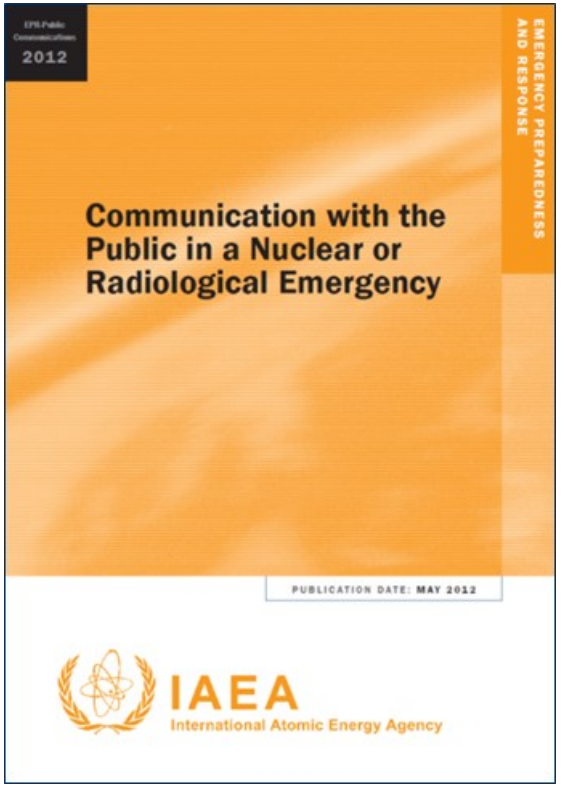


Image courtesy IAEA

EPR-PPA NPP (2013)

- The objective of this publication is
  - To provide an understanding of the actions necessary to protect the public for those responsible for making and for acting on decisions in the event of an emergency (LWR or spent fuel pool)

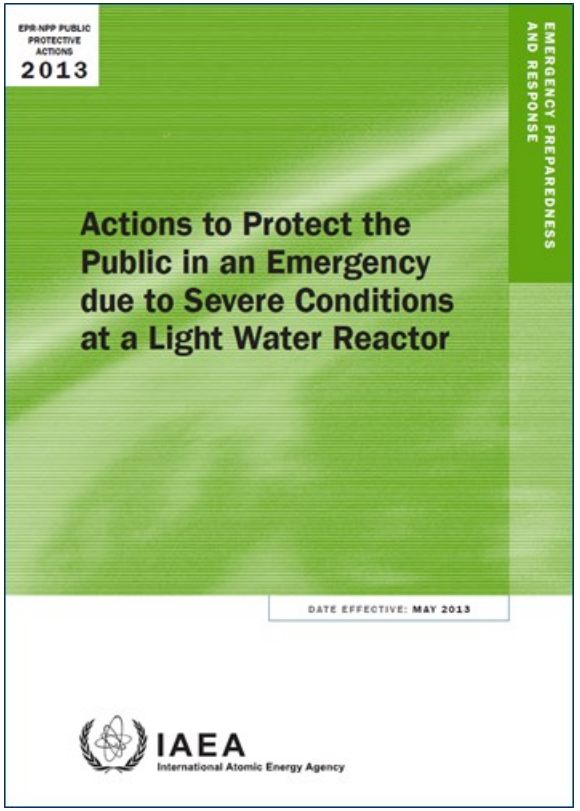


Image courtesy IAEA

Available IAEA Guidance

1. Safety standards
2. EPR series
3. **Training materials**
4. Accident reports

EPR Training Material

- Standard material based on EPR-series or standards.
- Available on-line as Powerpoint presentations
- Options to use it during training events:
  - In projects
  - Supporting specific national needs (when feasible)
  - As part of national on-going activities

EPR Training Material

Images courtesy IAEA

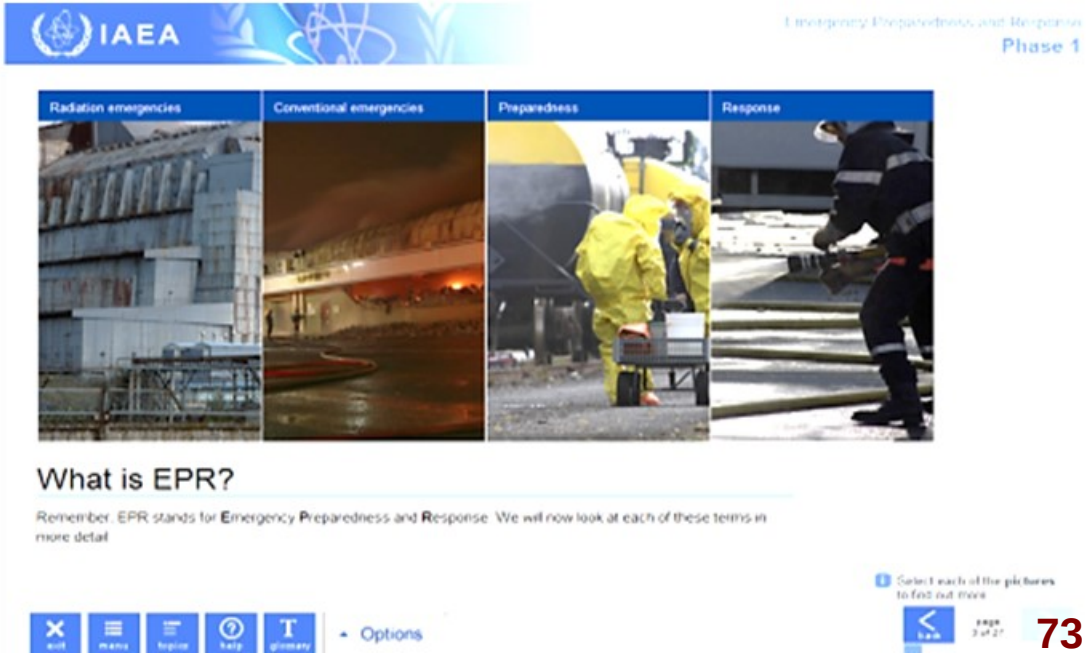
EPR Training Material

Images courtesy IAEA

E-learning

←First responders

Embarking →



Images courtesy IAEA

Available IAEA Guidance

1. Safety standards
2. EPR series
3. Training materials
4. **Accident reports**

Accident Reports

- Capture past experiences and lessons to be learned

Image courtesy IAEA

The Fukushima Daiichi Accident Report (2015)

IAEA Accident Reports

- The Radiological Accident in Goiânia (1988)
- The Radiological Accident in San Salvador (1990)
- The Radiological Accident in Soreq (1993)
- The Radiological Accident at the Irradiation Facility in Nesvizh (1996)
- An Electron Accelerator Accident in Hanoi, Viet Nam (1996)
- Accidental Overexposure of Radiotherapy Patients in San Jose, Costa Rica (1998)
- The Radiological Accident in the Reprocessing Plant at Tomsk (1998)
- The Radiological Accident in Tammiku (1998)
- The Radiological Accident in Istanbul (2000)
- The Radiological Accident in Yanango (2000)
- The Radiological Accident in Lilo (2000)
- The Criticality Accident in Sarov (2001)
- The Radiological Accident in Gilan (2002)
- The Radiological Accident in Samut Pakarn (2002)
- The Radiological Accident in Cochabamba (2004)
- Accidental Overexposure of Radiotherapy Patients in Bialystok (2004)
- The Radiological Accident in Nueva Aldea (2009)
- The Radiological Accident in Lia, Georgia (2014)

Images courtesy IAEA

Putting it all together with training

Spotlight on the IAEA School of Radiation Emergency Management: Training on Nuclear or Radiological Emergency Preparedness and Response

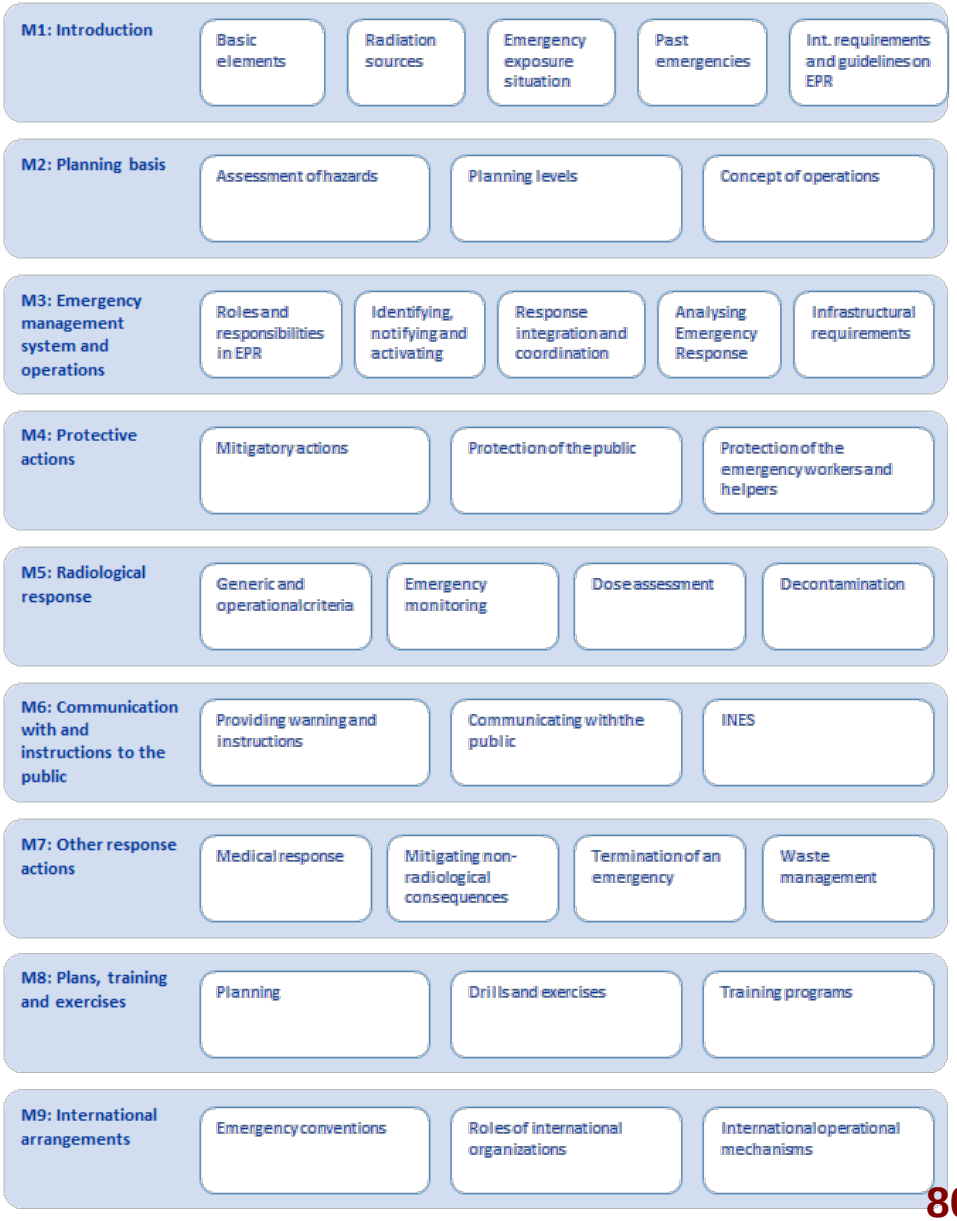
TRAINING (SREM)

School of Radiation Emergency Management

- **Purpose:** To provide participants with an understanding of the international principles, requirements and guidelines on EPR, based mainly on IAEA's safety standards on EPR and technical tools
- **Duration:** Three weeks
- **What:** To ensure that an adequate capability is in place within the operating organization and at local, regional and national levels and, where appropriate, at the international level, for an effective response
    - To **regain control** of the situation and to mitigate consequences
    - To **save lives**
    - To avoid or to minimize severe **deterministic effects**
    - To render first aid, to provide **critical medical treatment** and to manage the treatment of radiation injuries
    - To reduce the risk of **stochastic effects**
    - To keep the **public informed** and to maintain public trust
    - To mitigate, to the extent practicable, **non-radiological consequences**
    - 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**

Modular Format for Training

- The School of Radiation Emergency Management has adopted a modular approach to training, which allows us to adapt training to fit specific needs an goals



Thank You