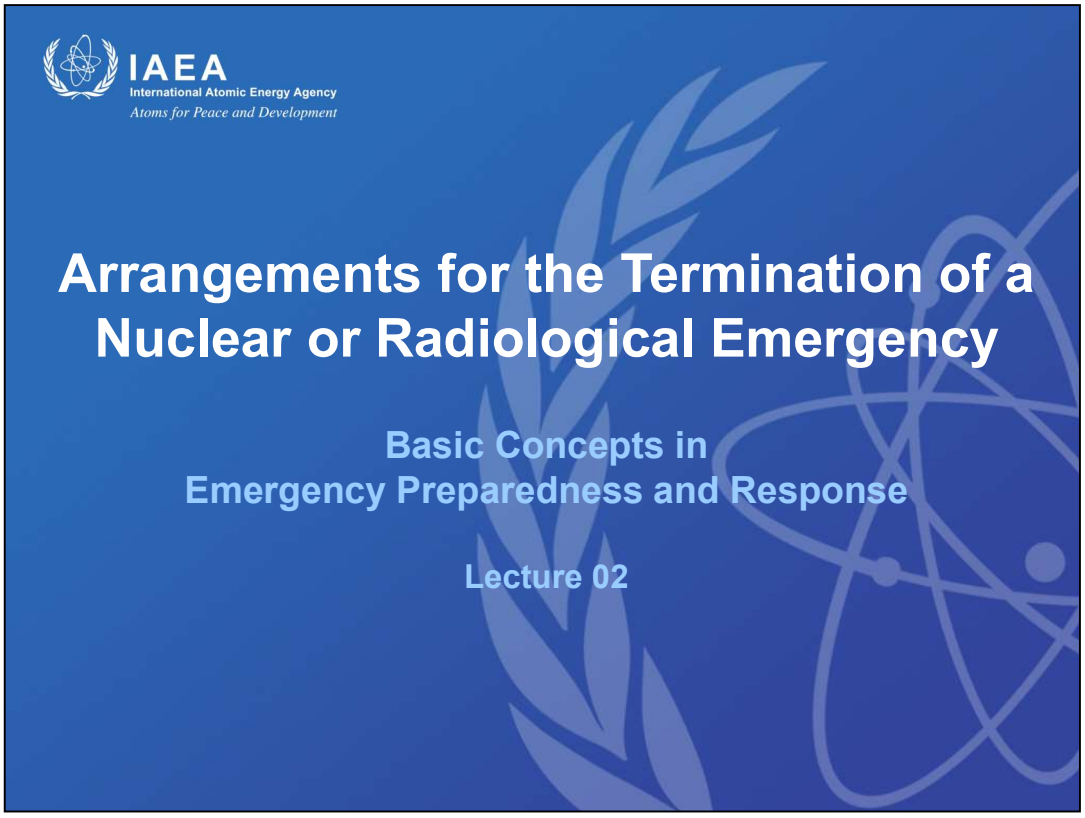
Arrangements for the Termination of a Nuclear or Radiological Emergency



Lecture: 02. Basic Concepts in Emergency Preparedness and Response

Purpose of the Presentation:

- Present the concepts addressed in IAEA Safety Standards Series No. GSG-11, particularly in relation to the transition phase
- Describe how these concepts derive and build upon those given in IAEA Safety Standards Series No. GSR Part 7 and other EPR related Safety Standards

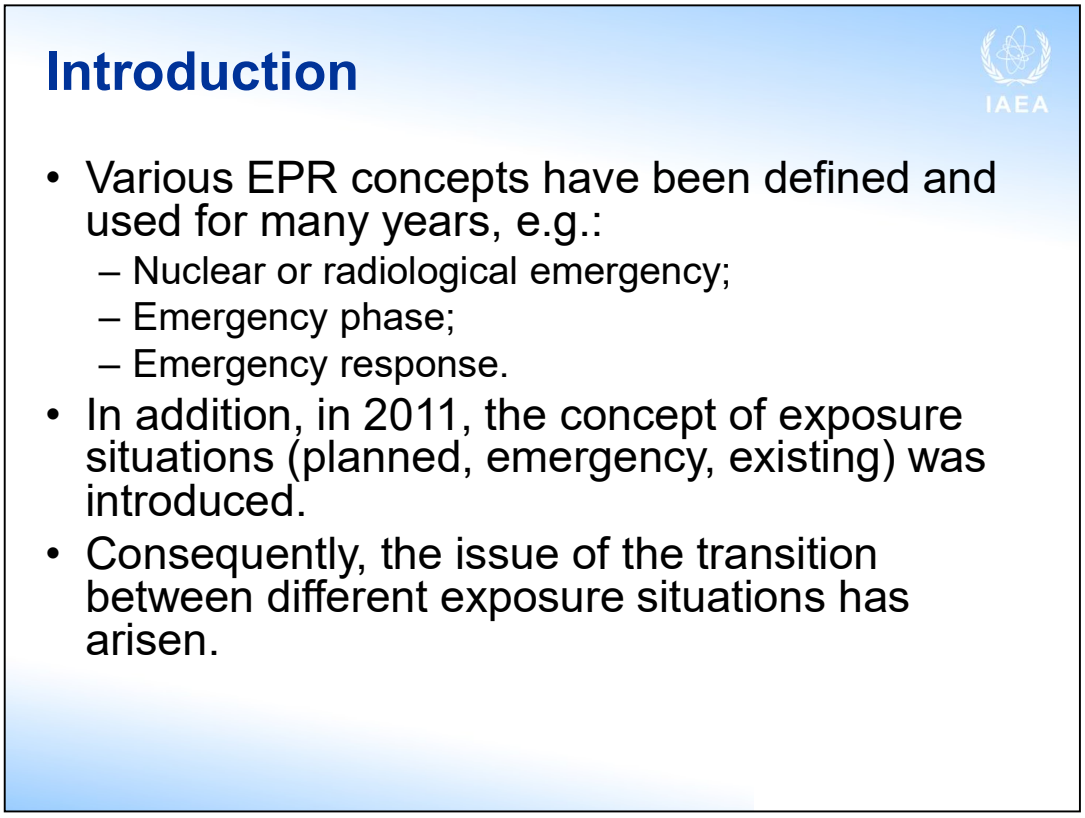
Learning Objectives:

- Differentiate between different exposure situations
- Differentiate between various phases of a nuclear or radiological emergency, with an understanding of the underlying principles of, and the objectives for, the delineation of these phases
- Recognize the implications of the termination of an emergency with regard to the management of the situation
- Identify the scope of IAEA Safety Standards Series No. GSG-11

Duration: 60 minutes

References:

1. International Atomic Energy Agency, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (2015).
2. International Atomic Energy Agency, Arrangements for the Termination of a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-11, IAEA, Vienna (2018).
3. International Atomic Energy Agency, Arrangements for Preparedness for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GS-G-2.1, IAEA, Vienna (2007).
4. International Atomic Energy Agency, Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-2, IAEA, Vienna (2011).



Lecture notes:

Various EPR concepts have been defined and used for many years. Examples include the concepts of nuclear or radiological emergency, emergency phase, emergency response etc., which have been part of EPR Safety Standards and national EPR frameworks for decades.

In 2011, with the publication of IAEA Safety Standards Series No. GSR Part 3 (Basic Safety Standards, BSS), the concept of exposure situations (planned, emergency, existing) was introduced in addition. However, no explanation was provided on the correlation of the exposure situations. With the introduction of the concept, it was evident that clarification would be required about when and how the transition between the different exposure situations was taking place.

Purpose

- Present the concepts addressed in IAEA Safety Standards Series No. GSG-11, particularly in relation to the transition phase;
- Describe how these concepts derive and build upon those provided in IAEA Safety Standards Series No. GSR Part 7 and other EPR related Safety Standards.

Learning objectives

- Differentiate between different exposure situations;
- Differentiate between various phases of a nuclear or radiological emergency, with an understanding of the underlying principles of, and the objectives for, the delineation of these phases;
- Recognize the implications of the termination of an emergency with regard to the management of the situation;
- Identify the scope of IAEA Safety Standards Series No. GSG-11.

Content

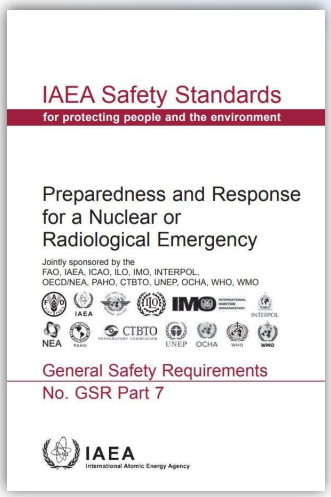
- Basic concepts and terminology:
  - Nuclear or radiological emergency
  - Situations of exposure (emergency, planned, existing)
  - Emergency response phase
  - Transition phase
- Transition to:
  - An existing exposure situation
  - A planned exposure situation
- Important considerations

Definition of Emergency

- ***Emergency***: A **non-routine situation or event that necessitates prompt action**, primarily to mitigate a hazard or adverse consequences for human life, health, property or the environment.

  Nuclear or radiological emergency: An *emergency* in which there is, or is perceived to be, a hazard due to:

  1) The energy resulting from a nuclear chain reaction or from the decay of the products of a chain reaction; or
  2) Radiation exposure.



Definition of Emergency (Response) Phase

- ***Emergency response phase***: The period of time from the detection of conditions warranting an *emergency response* until the completion of all the actions taken in anticipation of or in response to the radiological conditions expected in the first few months of the *emergency*:
  - This phase typically ends when the situation is under *control*, the *off-site* radiological conditions have been characterized sufficiently well to identify where food restrictions and *temporary relocation* are *required*, and all *required* food restrictions and *temporary relocations* have been implemented.

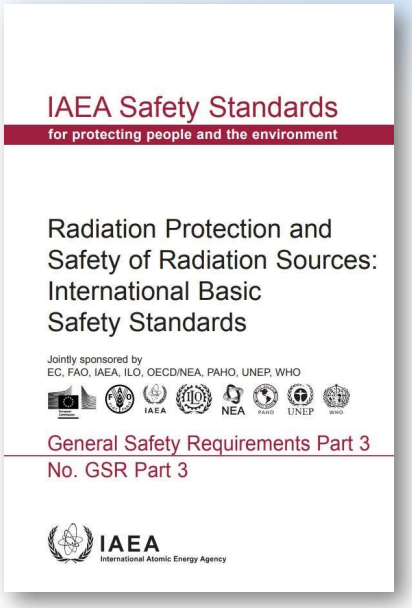
    = early protective actions have been implemented.

Lecture notes:

The emergency response phase was established before the term "early protective actions" was introduced in EPR related Safety Standards. Thus, relocation and food restrictions (both belonging to early protective actions) are mentioned in this definition. This means that the definition could be read that the emergency response phase ends when early protective actions are implemented.

Situations of exposure

- GSR Part 3, on the basis of ICRP 103 Recommendations, introduced three situations of exposure:
  - Planned exposure situation;
  - Emergency exposure situation;
  - Existing exposure situation.



Lecture notes:

ICRP 103 Recommendations refer to 2007 Recommendations of the International Commission on Radiological Protection (ICRP).

Reference:

1. International Commission on Radiological Protection, The 2007 Recommendations of the International Commission on Radiological Protection, ICRP publication 103. Ann ICRP. (2007).

Definition of emergency exposure situation

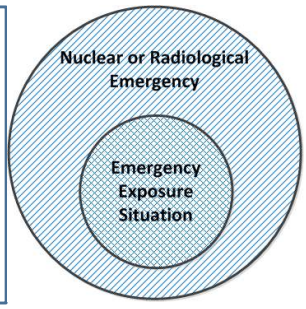
- A **situation of exposure** that arises as a result of an accident, a malicious act or other unexpected event, and **requires prompt action** in order to avoid or reduce adverse consequences.

Emergency: A **non-routine situation or event that necessitates prompt action**, primarily to mitigate a hazard or adverse consequences for human life, health, property or the environment.

Definition of emergency exposure situation (cont'd.)

- 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.

Nuclear or radiological emergency
≠
Emergency exposure situation



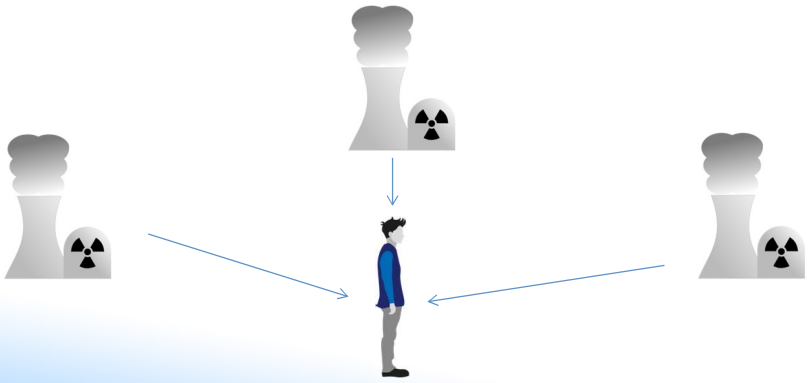
Lecture notes:

From the definitions it is evident that each emergency exposure situation is a nuclear or radiological emergency; but not necessarily each nuclear or radiological emergency is an emergency exposure situation. They are not synonyms.

For optimizing the protection and safety in an emergency exposure situation, reference levels are introduced that aim to help reducing doses to an individual to an optimum level under the circumstance which may not be the level with the lowest dose. The protection is associated with implementation of protective actions, individually or in combination, that are targeting directly either the individual or the exposure pathway(s).

Definition of planned exposure situation

- 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.



Lecture notes:

The planned exposure situation is associated with the planned use of radiation sources for certain purposes. Dose limits and dose constrains that are applied to optimize protection and safety during routine operations are imposed on the source with the aim of limiting the exposure to an individual from a number of sources.

Definition of existing exposure situation

- A situation of exposure that already exists when a decision on the need for control needs to be taken.

  (i) …*"exposure due to residual radioactive material deriving from a nuclear or radiological emergency* ***after an emergency has been declared to be ended****."*

Lecture notes:

The existing exposure situation relates to various situations of exposure that may be present in the environment and calls for a need for control (as opposite to a situation of exposure that is due to, for example, natural background that is always present and does not require control). Examples include radon exposure or a situation inherited after an emergency has been terminated; these situations still require control to be introduced or maintained even in long term.

In this workshop and in GSG-11, we use "existing exposure situation" only in relation to the situation of exposure that is inherited after an emergency has been terminated and a need for control still exists.

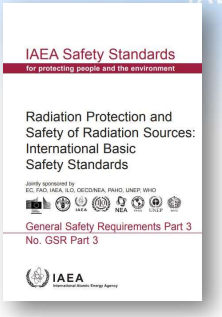
For optimizing protection and safety in an existing exposure situation, reference levels are also to be applied, but they are usually lower than those that will be applicable to an emergency exposure situation.

Reference:

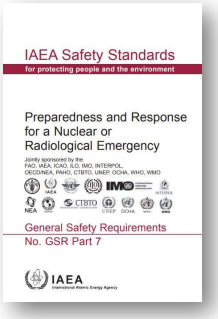
1. International Atomic Energy Agency, Arrangements for the Termination of a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSG-11, IAEA, Vienna (2018).

Transition between situations of exposure

- **Req. 46 of GSR Part 3**: Transition from an emergency exposure situation to an existing exposure situation



- **Req. 18 of GSR Part 7**: Termination of the emergency and transition to either an existing exposure situation or a planned exposure situation



Lecture notes:

Safety Requirements explicitly address the requirements for preparing arrangements for the transitioning from an emergency exposure situation to either an existing exposure situation or a planned exposure situation. GSR Part 7 embeds this concept in the concept of termination of an emergency, as it is addressed in GSG-11 and will be discussed throughout this workshop.

Discussion

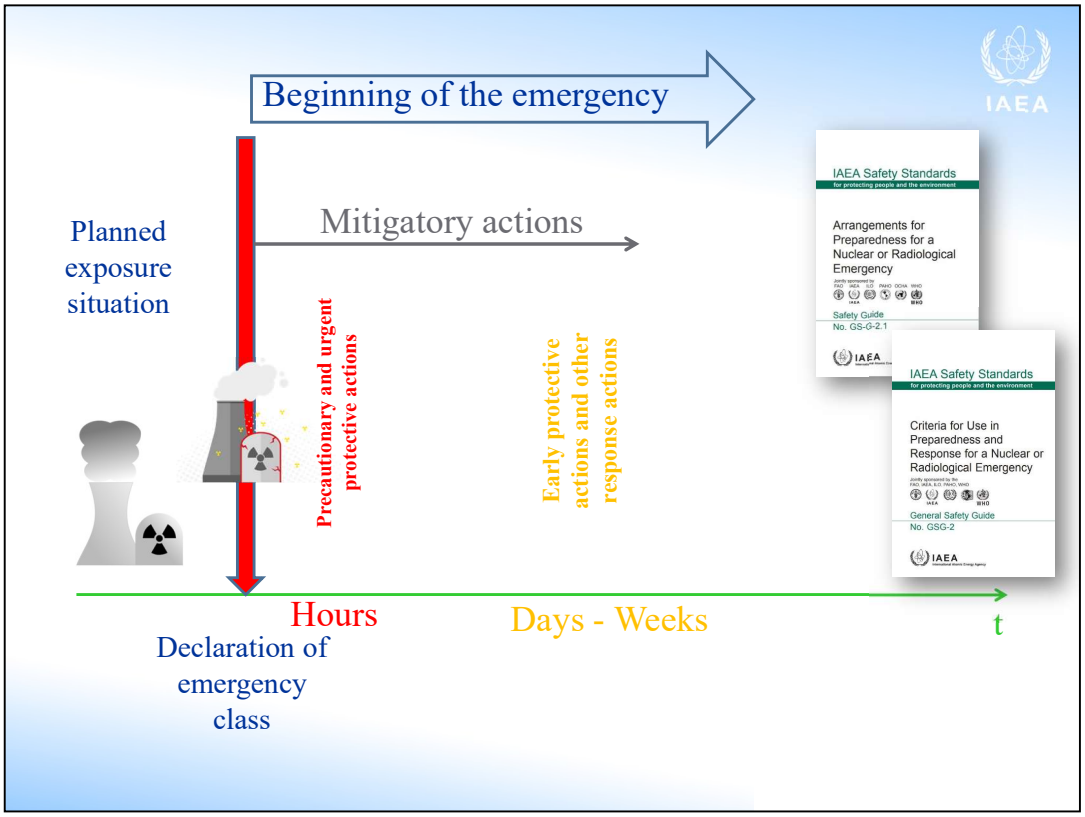
- Have you defined and used the three exposure situations at your national level?

Lecture notes:

Ask the participants about their experiences with respect to situations of exposure, GSR Part 7 and GSR Part 3. Allow for about 3 mins. of discussion.

Lecture notes:

So, these are the various concepts that have existed prior to the publication of GSG-11, but it was not clear how they relate to each other. This will be shown in this presentation and the next slides.



Lecture notes:

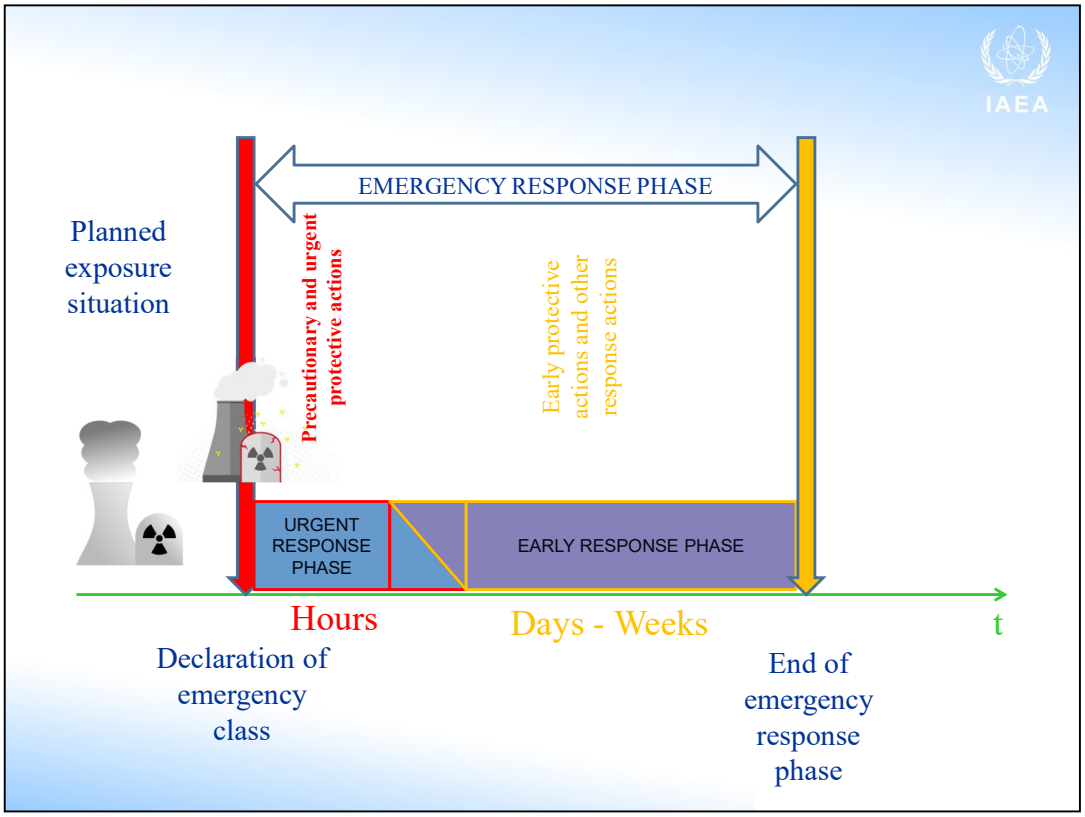
Planned exposure situation: a facility (e.g. nuclear power plant) in normal operation.

Something happens that triggers an emergency (e.g., in case of the Fukushima Daiichi accident, an earthquake followed by a tsunami and a station blackout). Based on conditions observed at the site (e.g. Emergency Action Levels, EALs) the emergency class is declared. This is the point in time when the emergency situation begins.

Early in the emergency, the response organizations focus their response actions on mitigating the potential consequences of the emergency so that the development of undesirable conditions is prevented or delayed, making it possible to take effective protective actions on the site and, as necessary, off the site. Such mitigatory actions are accompanied by protective actions and other response actions that are aimed at the potentially or actually affected individuals.

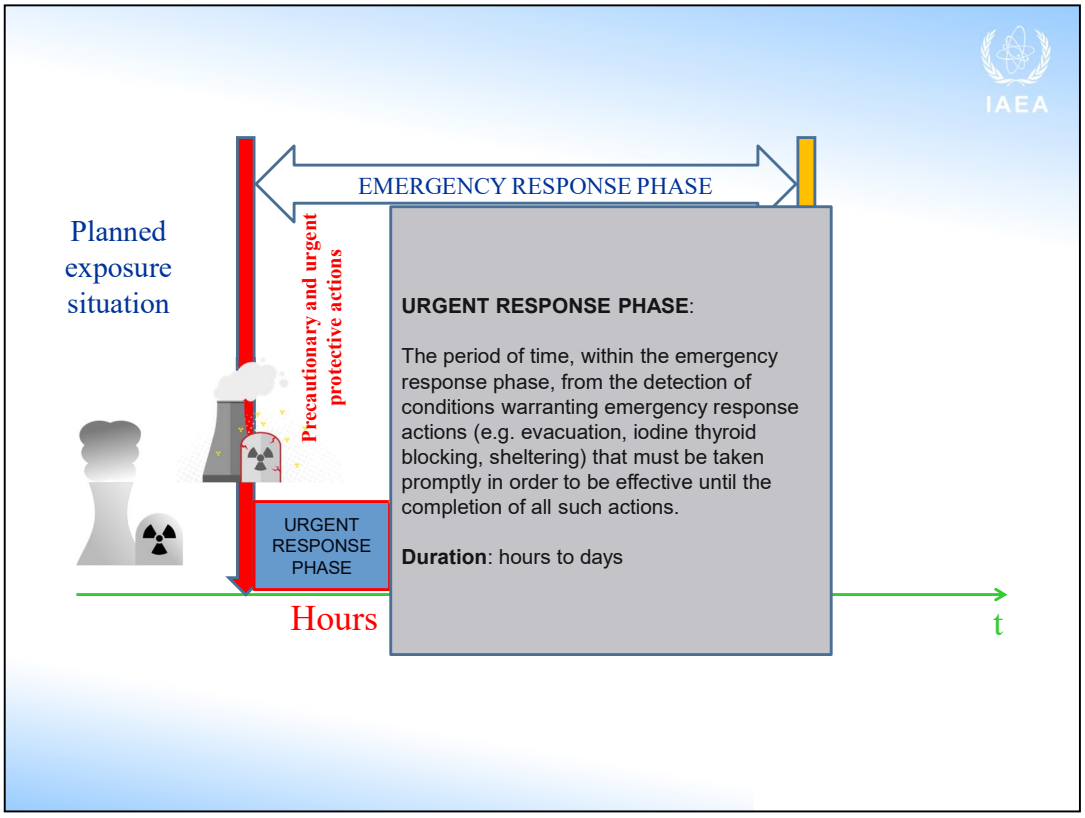
Lecture notes:

Most of these actions are taken as a matter of urgency (i.e. precautionary urgent protective actions, urgent protective actions and other response actions); however, some actions involve more detailed assessments, primarily based on monitoring, and can be taken within days or weeks and still be effective (i.e. early protective actions and other response actions).These aspects are addressed in detail in two IAEA Safety Guides on EPR (GS-G-2.1 and GSG-2).



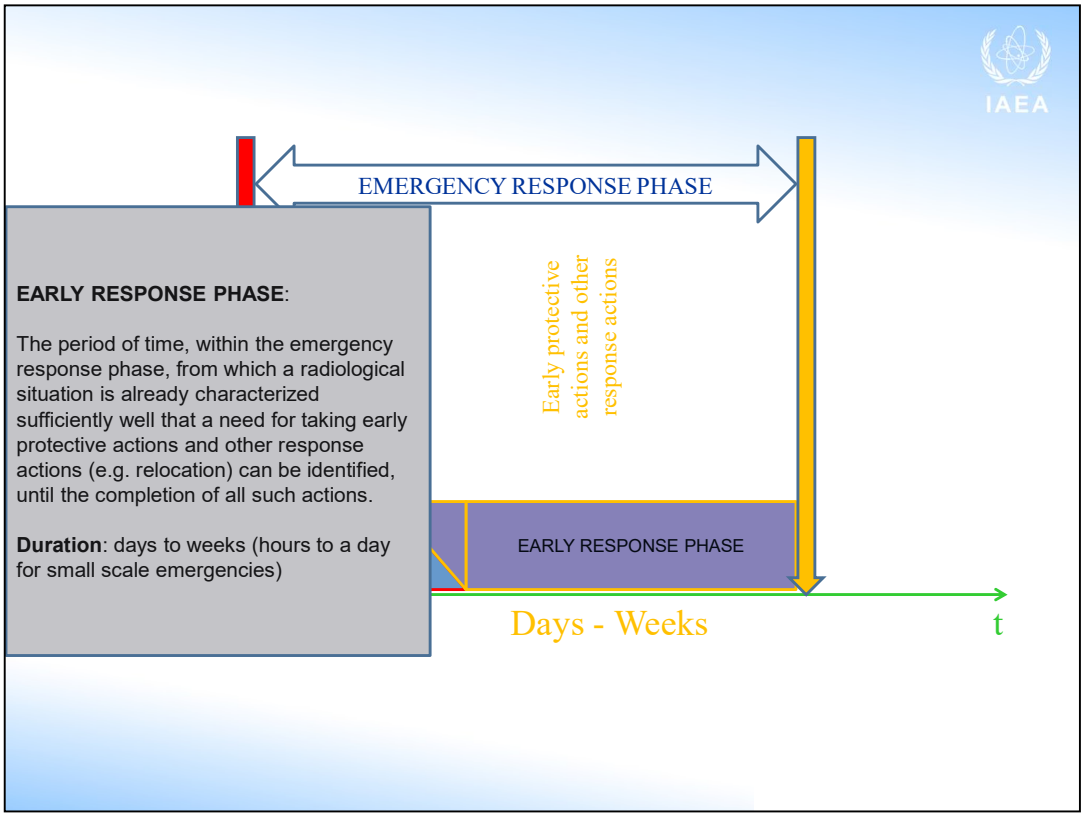
Lecture notes:

By definition, the declaration of the emergency up to the completion of the implementation of early protective actions encompasses the transition phase. In this phase, we can differentiate between two phases on the basis of the different time scales in which specific protective actions and other response actions are to be undertaken in order to achieve the goals of emergency response: the urgent response phase (associated with urgent protective actions) and the early response phase (associated with early protective actions).



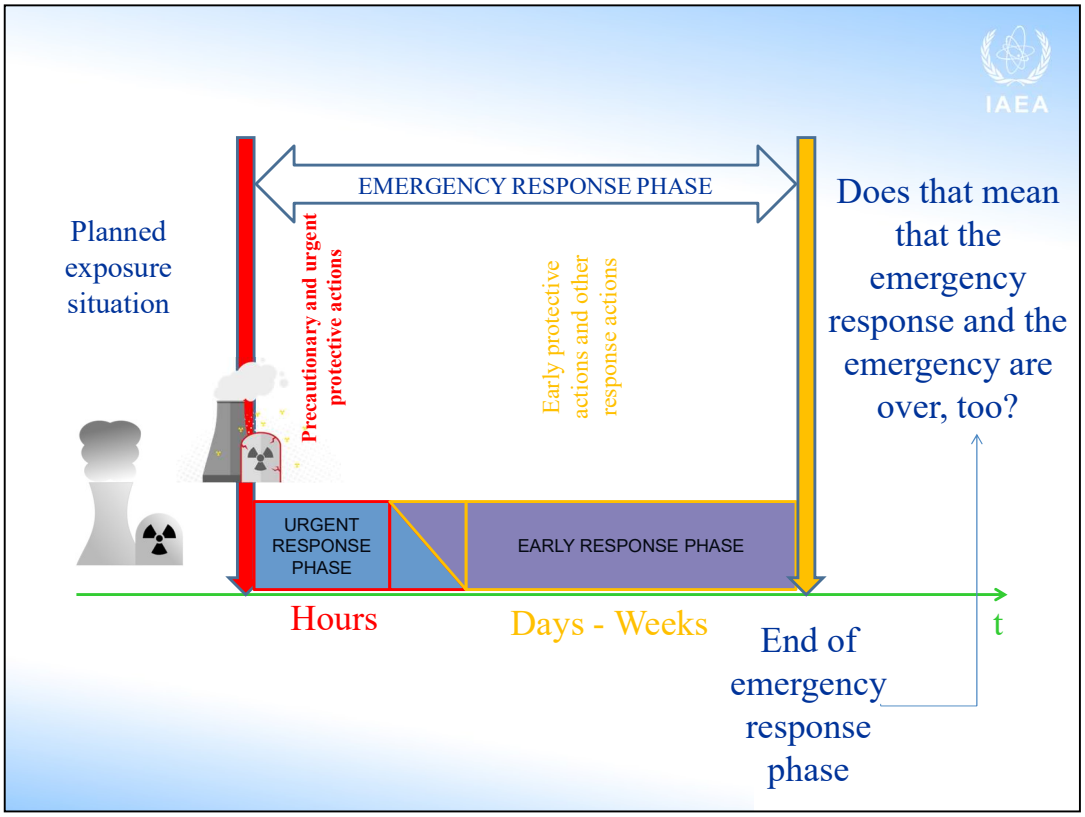
Lecture notes:

This slide defines urgent response phases and what its expected duration would be.



Lecture notes:

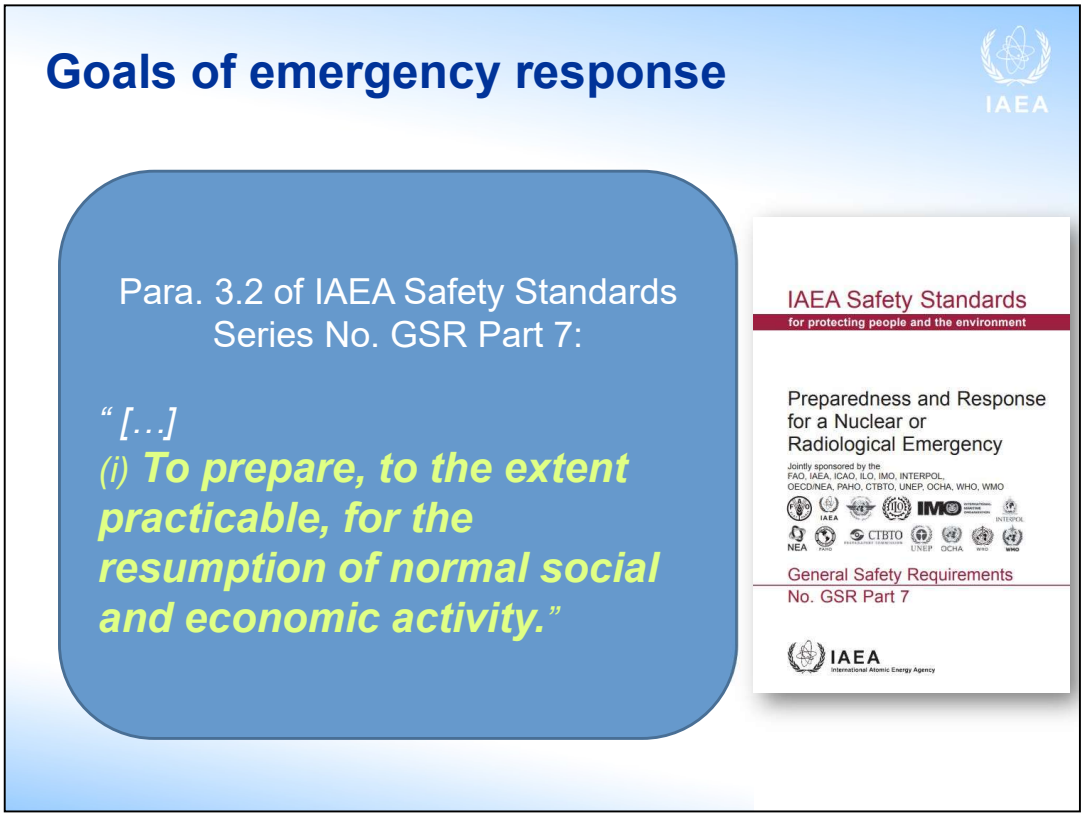
This slide defines early response phases and what its expected duration would be.



Lecture notes:

The question that arises now is: Does the end of the emergency response phase mean that the emergency response and the emergency are over, too?

Allow 5 mins of discussion among participants asking them also for the basis for their yes/no answer. Then move on to the next slides.



Lecture notes:

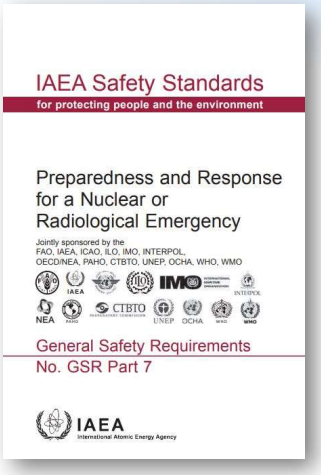
To answer this question, let's look at the goals of emergency response and the definition of "emergency response" in line with GSR Part 7.

Reference:

1. International Atomic Energy Agency, Preparedness and Response for a Nuclear or Radiological Emergency, IAEA Safety Standards Series No. GSR Part 7, IAEA, Vienna (2015).

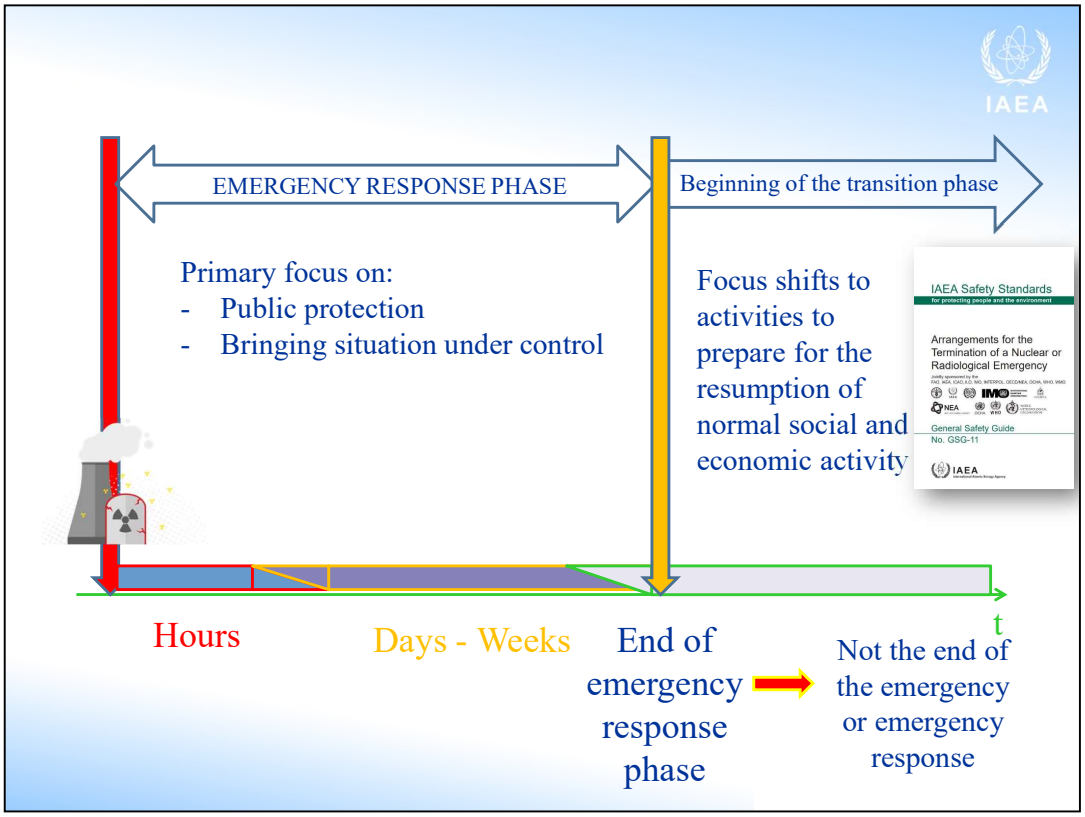
Definition of emergency response

- The performance of actions to mitigate the consequences of an emergency for human life, health, property and the environment:
  - *The emergency response also provides a basis for the resumption of normal social and economic activity.*



Lecture notes:

Based on this, the emergency and emergency response extend beyond the emergency response phase until the completion of preparations for the resumption of normal social and economic activity.

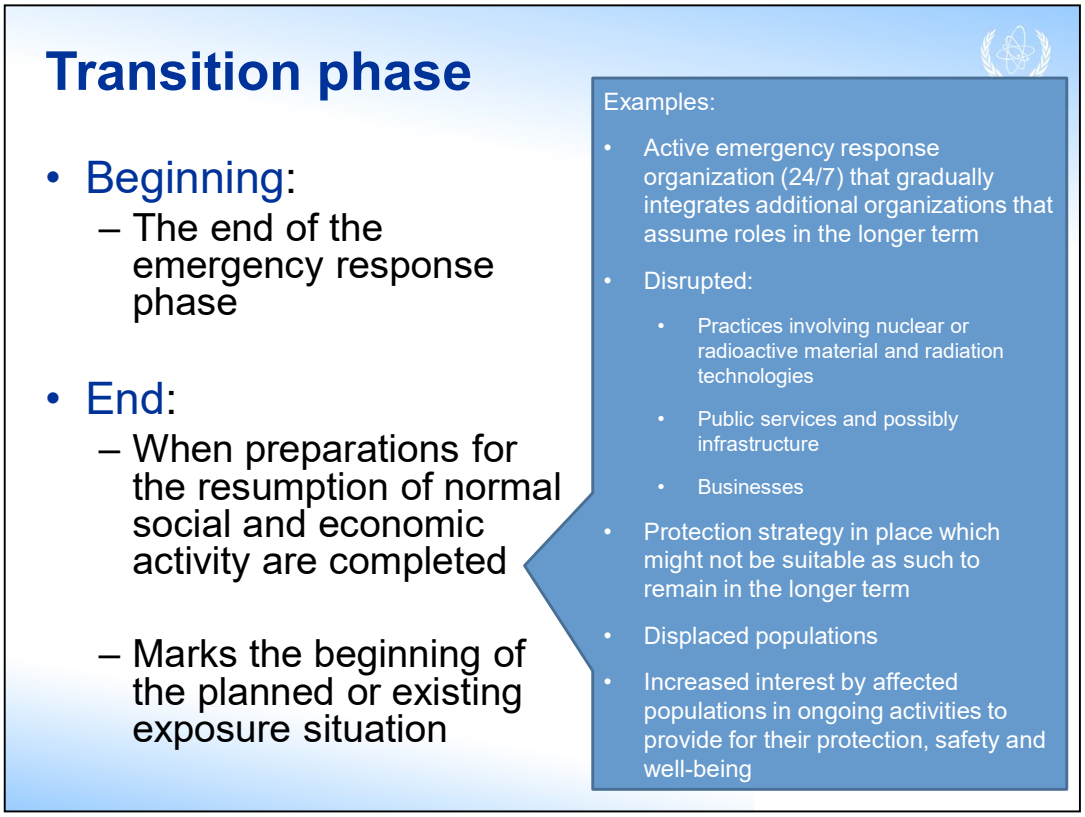


Lecture notes:

Thus, the end of the emergency response phase denotes the beginning of a phase in which these preparations take place. This is the period of time within the scope of GSG-11 that is referred to as “transition phase”.

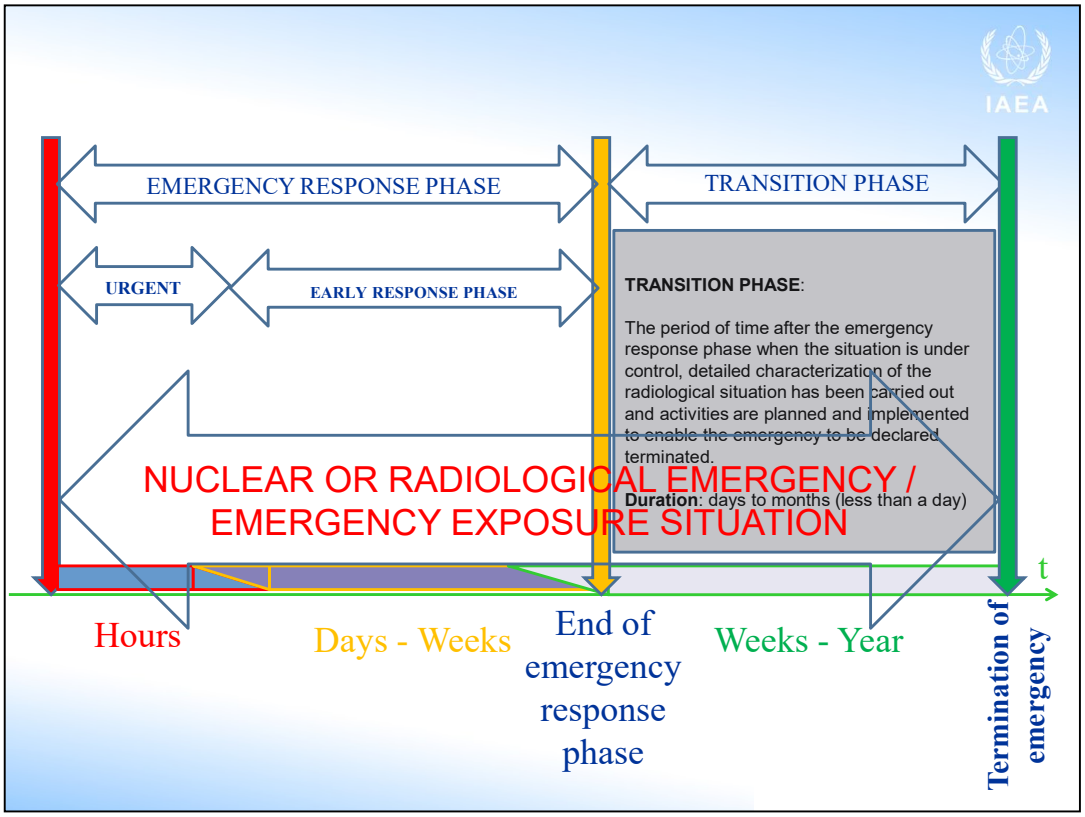
The change of focus of the emergency response efforts from the emergency response phase to the transition phase is presented here.

Once these preparations have been completed, the emergency can be formally ended; this also denotes the end of the transition phase. It may last from weeks to a year, notwithstanding that for small scale emergency it may take hours to days.



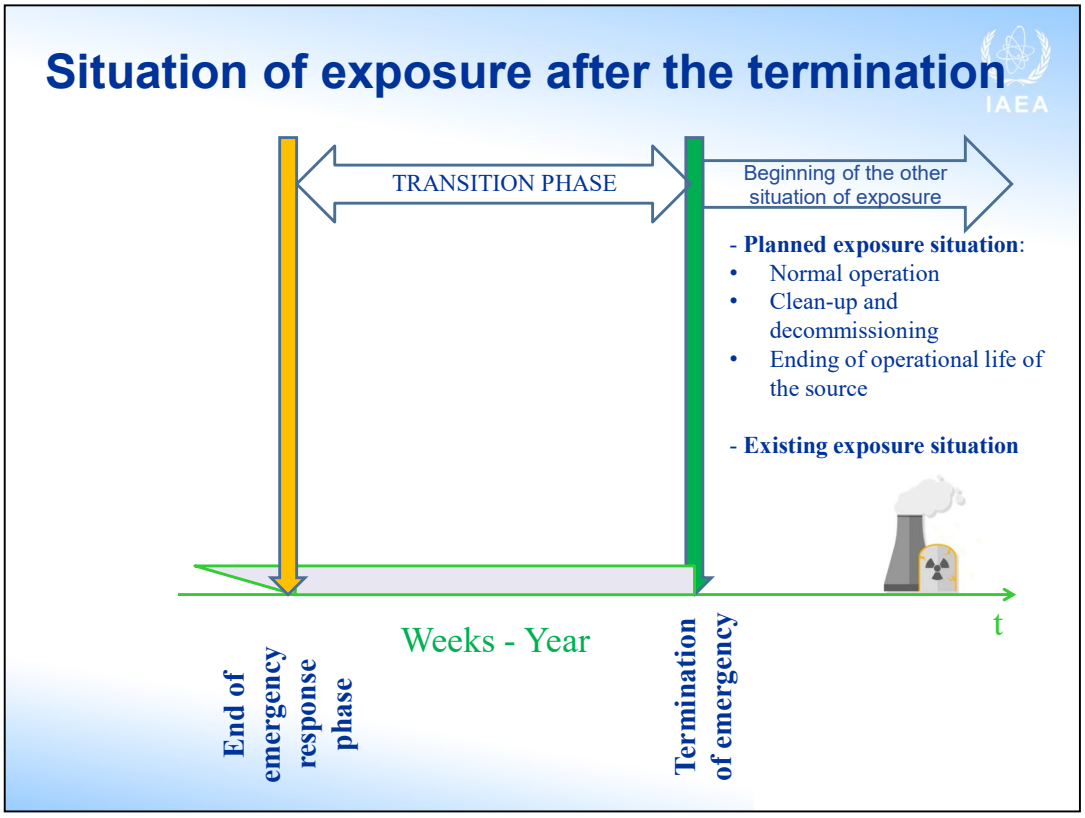
Lecture notes:

The end of the emergency marks the beginning of a planned or existing exposure situation. Example conditions that authorities may need to deal with during the transition phase are listed here.



Lecture notes:

This slide shows how the transition phase is defined in GSG-11, explaining that the end of the emergency is at the end of the transition phase.



Lecture notes:

The new exposure situation to which the emergency exposure situation transits can be:

- **Planned exposure situation**, associated with:
  - Normal operation;
  - Clean-up and decommissioning;
  - Ending of the operational life of the source.
- **Existing exposure situation.**

Discussion

- Can you explain some differences between a transition to a planned exposure situation and a transition to an existing exposure situation?
- Can you provide examples of emergencies that may transition to a planned or to an existing exposure situation?

Lecture notes:

Ask the participants for their experience and opinion. Examples of past emergencies in the context of transitioning to a planned and an existing exposure situation can be found in the notes on the next two slides. Allow for about 3 mins. of discussion.

Transition to an existing exposure situation

- Emergencies involving significant releases of radioactive material into the environment:
  - Result in an emergency exposure situation;
  - Public exposures in the longer term due to residual radioactive material are eventually to be managed as an existing exposure situation;
  - Termination of the emergency will mark entering into the existing exposure situation with regard to public exposures;
  - The facility, the activity or the source involved in the emergency will undergo clean-up, decommissioning or ending of the operational life of the source (all subject to the requirements for a planned exposure situation).

Lecture notes:

An emergency involving a significant release of radioactive material to the environment (e.g. the Chernobyl nuclear power plant accident, the Fukushima Daiichi accident, the Goiânia radiological accident) will result in an emergency exposure situation. In such emergencies, the public may be exposed in the longer term because of the presence of residual radioactive material in the environment. Such situations are eventually managed as existing exposure situations. The termination of such emergencies is possible after a period of time that allows for the transition to an existing exposure situation. The decision to terminate an emergency of this type also means entering into an existing exposure situation. In such cases, the phrase ‘transition to an existing exposure situation’ is used.

The facility, the activity or the source involved in an emergency of this extent will undergo clean-up, decommissioning or the ending of the operational life of the source. All of these are subject to requirements for a planned exposure situation.

Transition to a planned exposure situation

- Emergencies that do not involve significant releases of radioactive material into the environment:
  - Do not introduce a situation of exposure to the public that differs from the one that existed before the emergency;
  - May not necessarily result in an emergency exposure situation;
  - Termination of the emergency will mark the beginning of a planned exposure situation associated with normal operation, clean-up, decommissioning or ending of the operational life of the source (all subject to requirements for a planned exposure situation).

Lecture notes:

An emergency that does not involve a significant release of radioactive material to the environment, and thus does not result in exposure of the public in the longer term due to residual radioactive material (e.g. the fuel damage incident at Paks nuclear power plant, the accidental overexposures in Panama and the radiological accident in Nueva Aldea), may not necessarily result in an emergency exposure situation. Such emergencies can be terminated in a way in which the facility, the activity and the source can ultimately be managed as a planned exposure situation. The planned exposure situation may be associated with normal operation, with cleanup and decommissioning, or with the ending of the operational life of the source. In terms of public exposure, such emergencies are not expected to result in an exposure situation that is different from the one that existed before the emergency. The decision to terminate an emergency of this type also delineates the beginning of a planned exposure situation. In such cases, the phrase 'transition to a planned exposure situation' is used.

Important considerations

- The concept of 'transition phase' is introduced to provide clarity about the scope of GSG-11 regarding the period after the emergency it addresses:
  - Depending on the type of emergency, this period may last from hours to months.
- Various phases of the emergency are distinguished on the basis of the different timescales in which specific protective actions and other response actions are to be undertaken in order to achieve the goals of emergency response.

Lecture notes:

This distinction between various phases may appear theoretical. It is very helpful for planning purposes, but, in reality, drawing a clear border between them is often not easy.

For example, the monitoring strategy implemented during the early phase supports both decision making on early protective actions and the assessment of the radiological situation to determine how protection strategies will have to be adapted in the transition phase to allow for the termination of the emergency. Thus, one may conclude that the transition phase overlaps to some extent with the early response phase.

Important considerations (cont'd.)

- Various phases are intended to support the planning efforts for each phase at the preparedness stage:
  - These efforts depend on the characteristics of each phase, including the information available and the specific activities to be carried out to achieve the relevant goals of the emergency response.
- Response to a nuclear or radiological emergency is a continuous effort:
  - During the response, it is not intended that a distinction be made between the various phases .

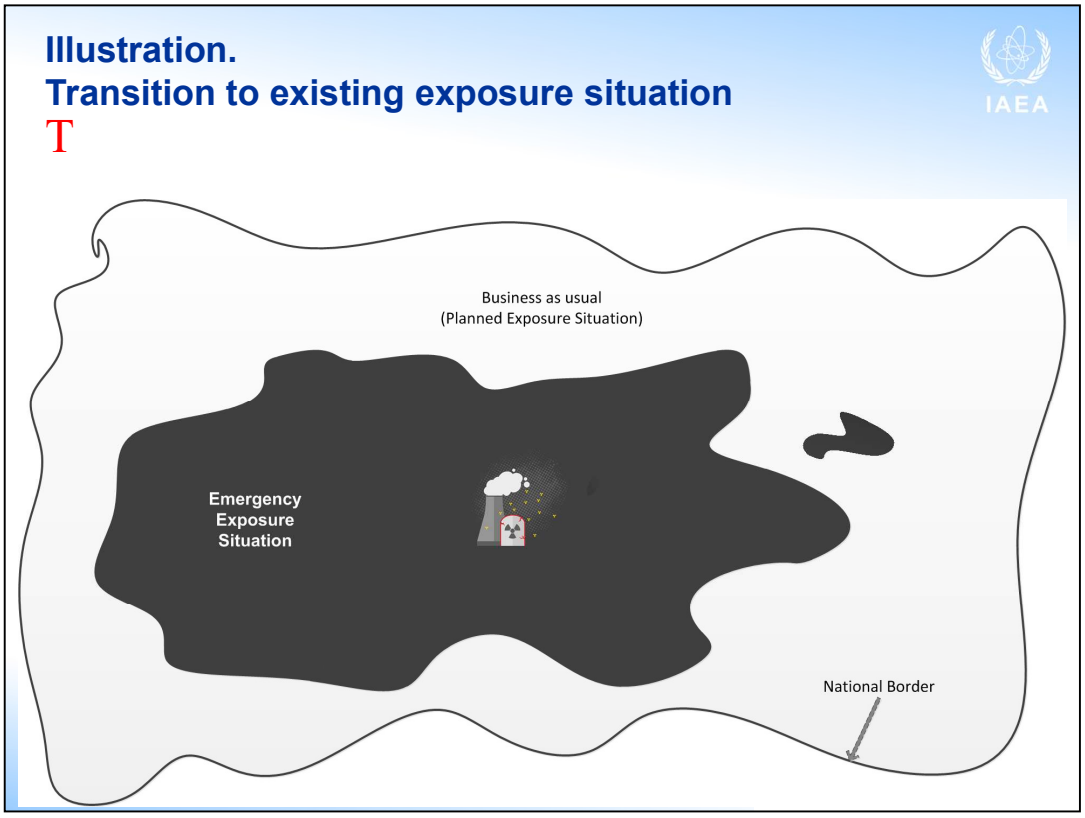
Lecture notes:

The distinction between the various phases of a nuclear or radiological emergency is intended to support the planning efforts for each phase at the preparedness stage, as well as to facilitate communication and a common understanding among those involved in the planning. These efforts depend on the characteristics of each phase, including the information available and the specific activities to be carried out.

The response to a nuclear or radiological emergency is a continuous effort; therefore, during the response it is not intended that a distinction be made between the various phases of the emergency.

Important considerations (cont'd.)

- The complexity of the radiological situation may vary greatly within an affected area after a large scale emergency and may be transient in nature:
  - Different phases and different exposure situations will coexist geographically and temporally;
  - Transition will occur gradually in specific areas within the entire affected area:
    - In such case, the transition phase will end when the final area that was in an emergency exposure situation has transitioned to an existing exposure situation;
    - The transition of this final area to an existing exposure situation will also denote the overall termination of the emergency.

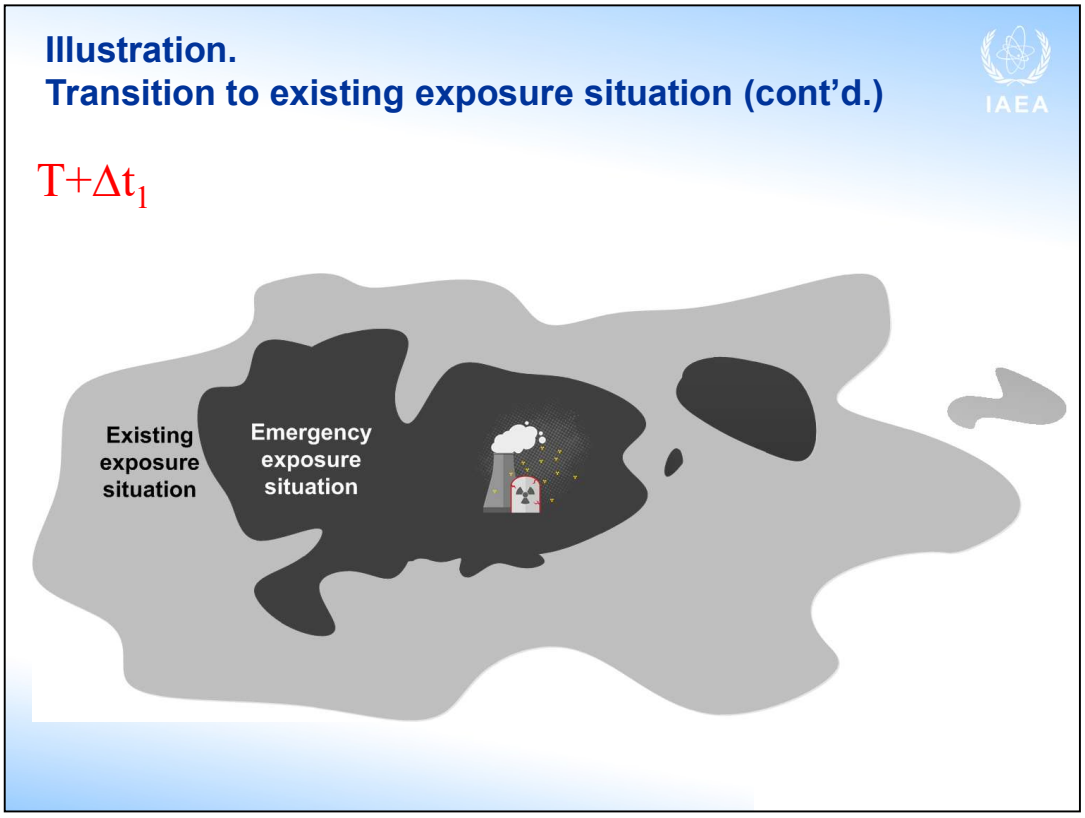


Lecture notes:

The following slides illustrate the evolution of the situation with regard to transition in the case of a large scale emergency involving a significant release of radioactive material to the environment.

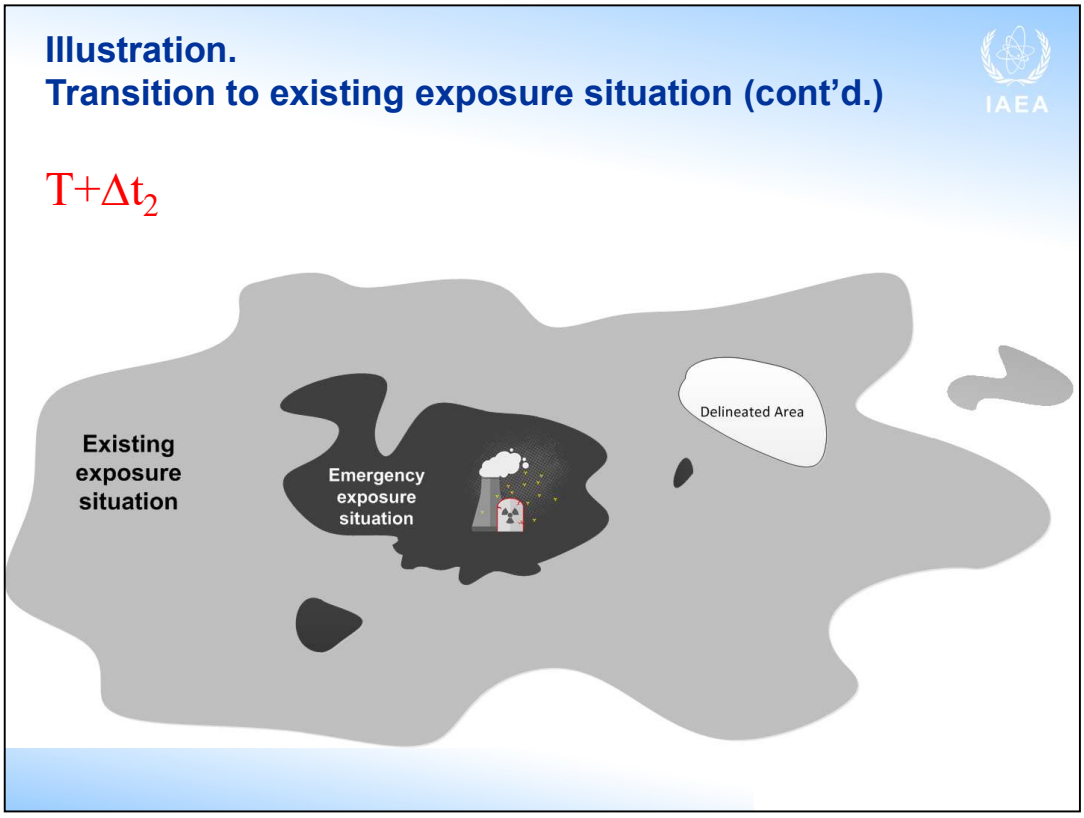
The white area, ‘business as usual’, is the area of the Accident State that is not impacted by the radiological consequences of the emergency. The planned exposure situation in this context relates to how radiation sources and nuclear/radiation facilities that are present in this area are regulated.

The black area around the nuclear facility is in an emergency exposure situation.



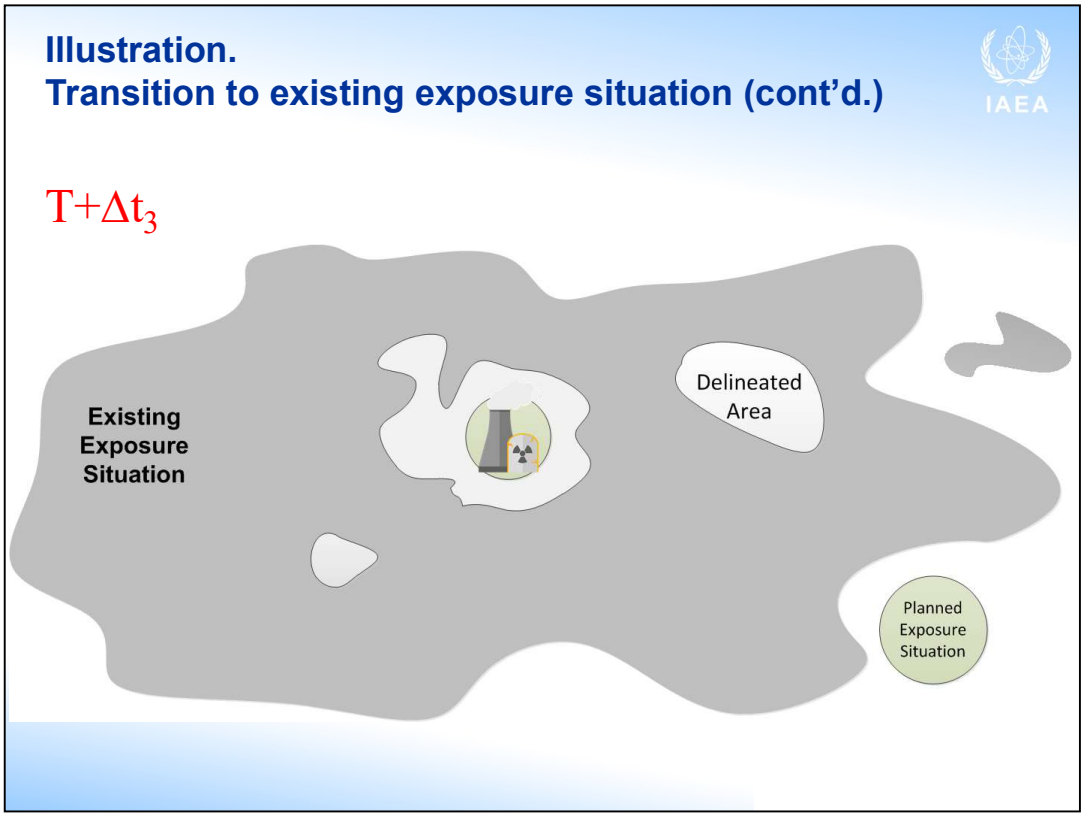
Lecture notes:

As progress is made in preparing certain areas to resume normal social and economic activity after the emergency, they can transition to an existing exposure situation (grey area). This transition will take place in different areas at different times. With time, the balance between areas managed as an emergency exposure situation and areas that are managed as an existing exposure situation will change (grey area increasing and black area decreasing).



Lecture notes:

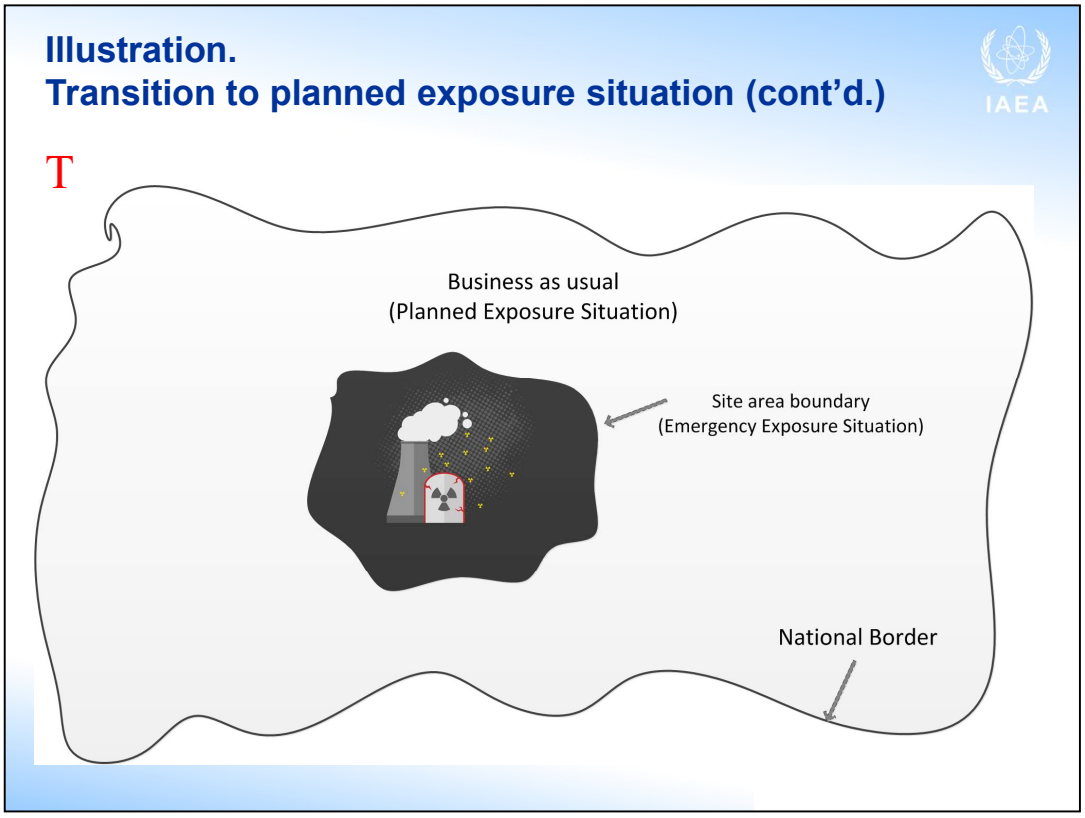
The areas that will be identified at some point in time as not being open for the return of people and the sustenance of normal social and economic activity within a reasonable timeframe will be delineated (e.g. might be called exclusion zone – light grey area).



Lecture notes:

This lasts until the final areas under an emergency exposure situation transition to an existing exposure situation and all areas that cannot be inhabited and sustain normal social and economic activities have been delineated.

The facility involved in emergencies will be subject to clean-up and decommissioning, which is supposed to take place under the framework established for the planned exposure situation.

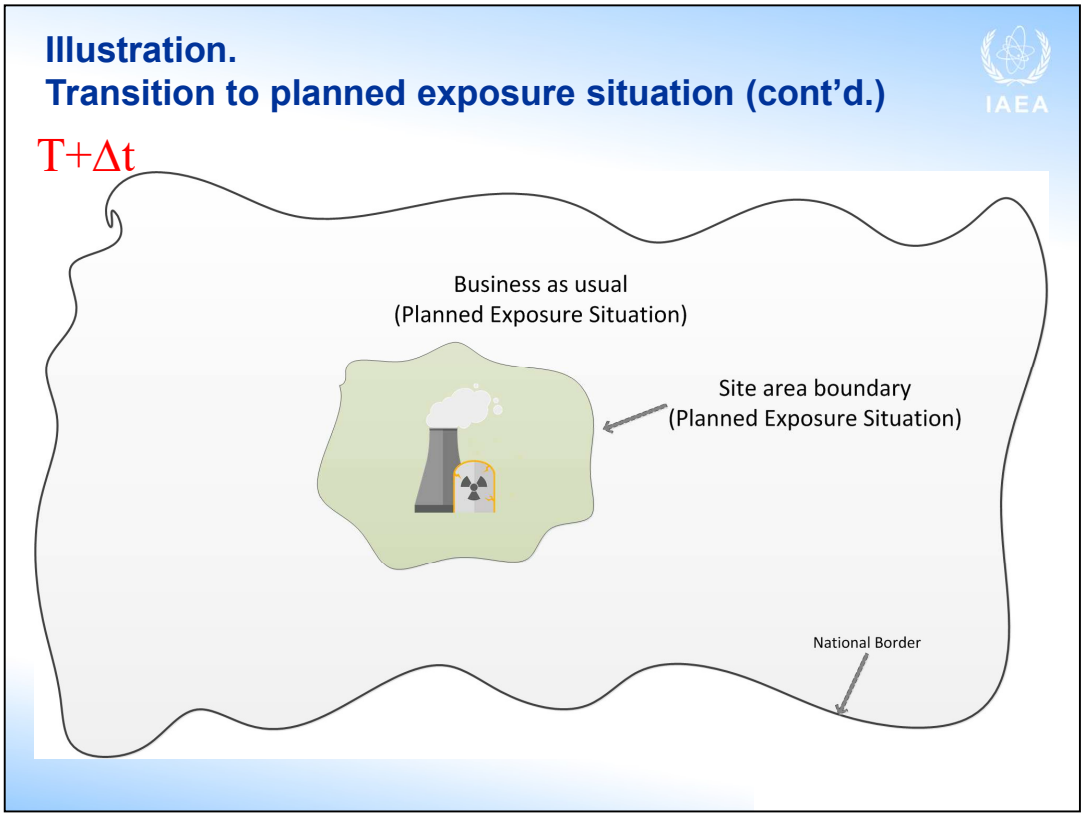


Lecture notes:

The following slides illustrate the evolution of the situation with regard to transition in the case of a small scale emergency that does not involve significant release of radioactive material to the environment.

The white area, 'business as usual', is the area of the Accident State that is not impacted by the radiological consequences of the emergency. The planned exposure situation in this context relates to how radiation sources and nuclear/radiation facilities that are present in this area are regulated.

The black area around the nuclear facility is in an emergency exposure situation, which is contained in this case within the site boundary.

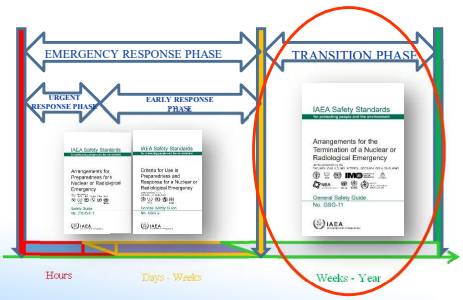


Lecture notes:

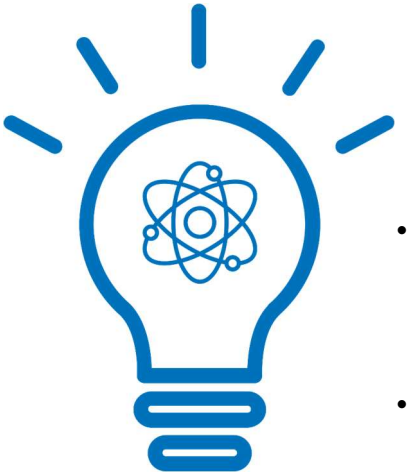
Once the situation has been brought under control and conditions to resume with normal social and economic activity have been fulfilled, the emergency exposure situation transitions to a planned exposure situation. This planned exposure situation relates to how the facility/activity or source that was involved in the emergency is managed.

Finally…

- GSG-11, which is the basis of this workshop:
  - Addresses the transition phase in terms of how we can prepare for the timely resumption of normal social and economic activity after an emergency and what needs to be fulfilled to be able to end the emergency;
  - Complements GS-G-2.1 and GSG-2, providing for integrated and coordinated EPR from the emergency onset until its termination;
  - Facilitates planning for long term recovery.



Summary



- Various concepts and terms in emergency preparedness and response are in use. Some are inherited from earlier versions of the Safety Standards, and others, such as different situations of exposure, are newly introduced. They all relate to each other.
- Depending on the severity of the emergency and its consequences, an emergency may be terminated and transition to either a planned or an existing exposure situation.
- The transition will occur gradually at different times in different areas, posing challenges to both management and communication with the public.

Lecture notes:

Summarize the three key points from the presentation.

Lecture notes:

Thank you!