IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Arrangements for the Termination of a Nuclear or Radiological Emergency

Case Study Part 1:
The Nuclear Incident in the Paks Nuclear Power Plant in Hungary and the Radiological Accident in Goiânia, Brazil

Purpose

- To present and discuss the emergency response to the nuclear incident in the Paks NPP in 2003 in Hungary and to the radiological accident in 1987 in Goiânia, Brazil.
- To analyze these events in the context of transitioning to a planned and an existing exposure situation.

*The Case Study is **not** an assessment of the emergency response to these events but an opportunity to illustrate transitioning from an emergency exposure situation to either a planned or an existing exposure situation in the context of IAEA Safety Standards Series No. GSG-11.*

Learning objectives

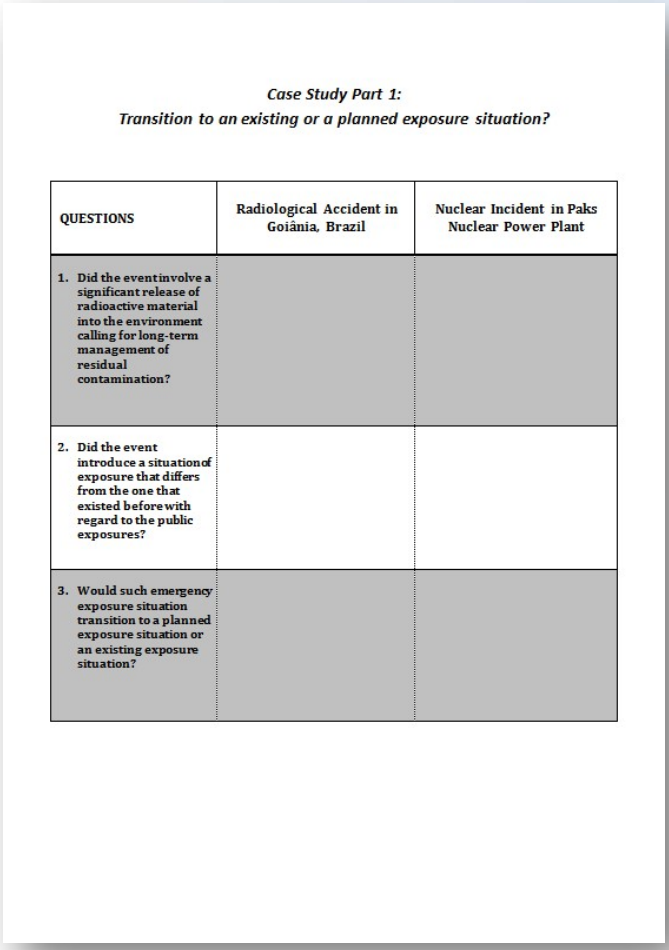
– In the context of past experience, to differentiate between:
  - Different situations of exposure;
  - Transition to a planned exposure situation and transition to an existing exposure situation.

Contents

- Nuclear incident in Paks Nuclear Power Plant in 2003
- Radiological accident in Goiânia, Brazil, in 1987
- Discussion and feedback session

Expectations from participants

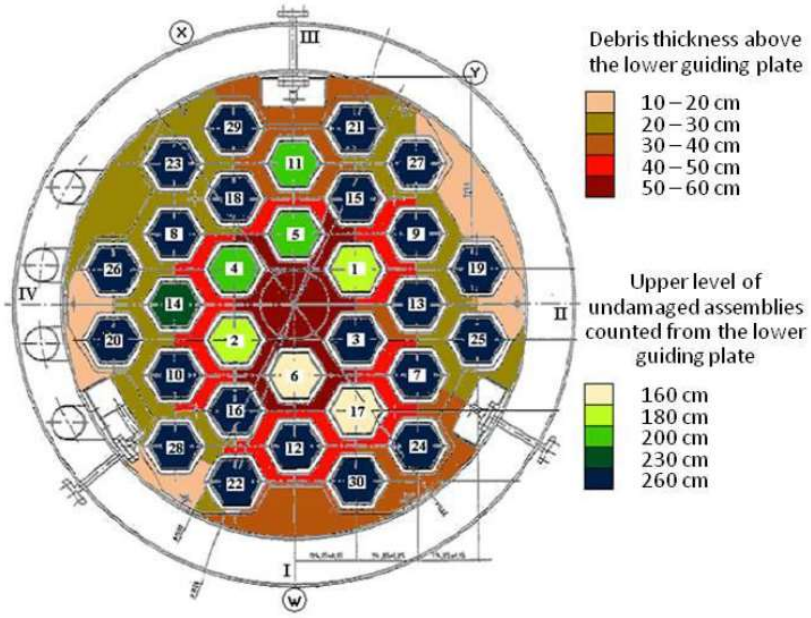
- Following the presentation, participants are expected to discuss past emergencies within their working groups and to answer the questions provided in *Case Study Part 1: Transition to an existing or a planned exposure situation?*



Case Study Part 1:
Transition to an existing or a planned exposure situation?

QUESTIONS	Radiological Accident in Goiânia, Brazil	Nuclear Incident in Paks Nuclear Power Plant
1. Did the event involve a significant release of radioactive material into the environment calling for long-term management of residual contamination?		
2. Did the event introduce a situation of exposure that differs from the one that existed before with regard to the public exposures?		
3. Would such emergency exposure situation transition to a planned exposure situation or an existing exposure situation?		

THE NUCLEAR INCIDENT AT THE PAKS NUCLEAR POWER PLANT, HUNGARY



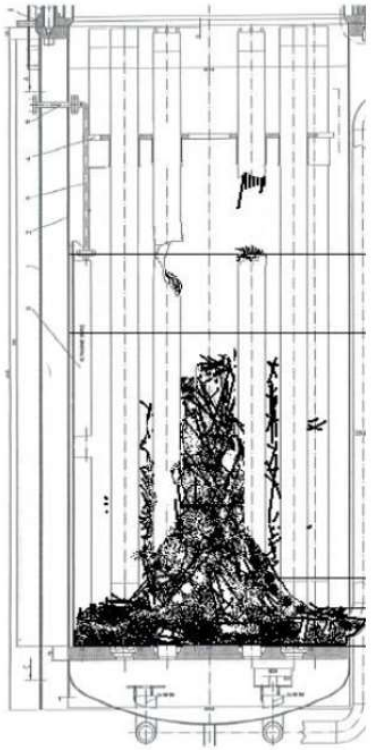


Image courtesy of the HAEA and Paks NPP

10 April 2003
The event sequence

- 30 fuel assemblies of Unit 2 reactor of Paks NPP were being cleaned in a fuel cleaning tank adjacent to the fuel pool:
  - The aim was to remove magnetite deposition on fuel cladding.
- At 21:53 UTC, the noble gas monitors in the reactor hall indicated that the emergency level had been reached.

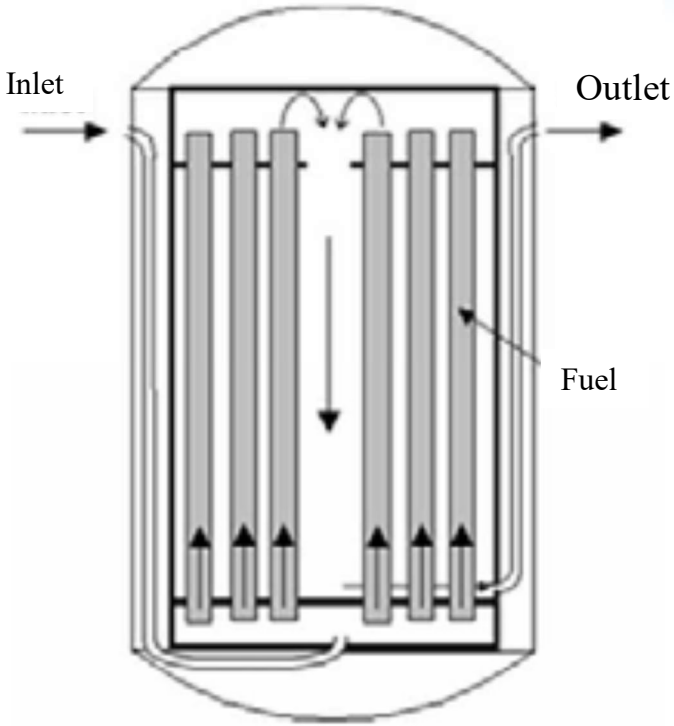


Image reproduced from OECD/IAEA, Paks Fuel Project: Final Report, IAEA, Vienna (2010)

10-11 April 2003
The event sequence

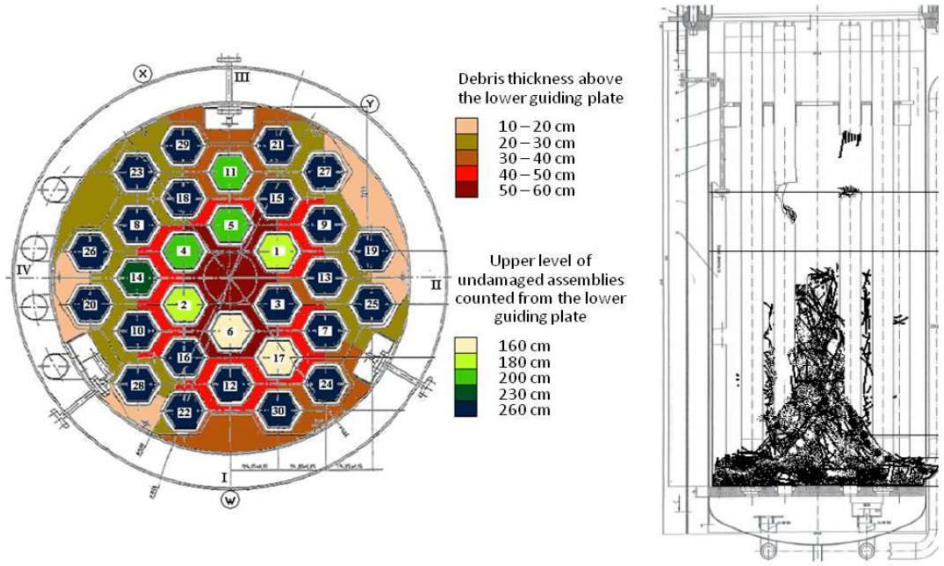
- Plant shift supervisor ordered workers to evacuate from the area and initiated evaluation of the situation:
  - Assessed low significance in terms of health impacts;
  - Noted decreasing tendency noted in the discharge of noble gases into the environment (below discharge limits);
  - Consulted the Site Emergency Response Plan (SERP).

→ No need for further response actions on-site or off-site or for activation of the Site Emergency Response Organization (SERO)

Nevertheless, in order to provide continuous control and evaluation of the situation, SERO was partially activated until 16:00 on 13 April 2003.

16 April 2003
New insights

- Removal of the tank lid revealed extent of damage to the fuel assemblies within the tank.



- SERO activated until 20 April 2003 in partial response mode:
  - Assessment of situation;
  - Communication and coordination with authorities;
  - Increased readiness for full activation.

Image courtesy of the HAEA and Paks NPP

Major challenge faced by operator

- Inability to fully understand the situation and the nature of release at the time.
- No specific plan and procedures for dealing with such situations.

Off-site response

- Monitoring initiated in areas surrounding the Paks NPP as of 11 April 2003:
  - The results from the survey covering the period from 11 to 26 April 2003 confirmed that no significant release had occurred warranting public protective actions.
- Dose assessment initiated as of 16 April 2003:
  - Doses assessed to be less than the dose to the public from the exposure to natural background for one day.
- Provision of public information and issuing of press releases initiated as of 11 April 2003;

On-site response efforts

- Determination of the radiological situation in the reactor hall and ensuring stability;
- Measures for protection of on-site workers:
  - Within the requirements and dose limits for occupational exposure during normal operation.
- Planning for recovery operations:
  - 17 April 2003: Continuous cooling of the cleaning tank ensured;
  - Professional teams involving specialists from various fields of expertise were formed to identify alternatives for recovery:
    - An autonomous cooling system and an emergency boron system for the service pool were established during the first half of 2004.

On-site recovery operations

- The licensing documentation for the planned recovery submitted to HAEA (Hungarian Atomic Energy Agency) in November 2004:
  - A license for recovery operations in the service pool was issued in July 2005.
- Manufacturing licences for cases and containers for the storage of the damaged fuel assemblies and solid radioactive waste issued in March 2006;
- Authorization for the removal of damaged fuel granted in September 2006;
- Recovery operations completed by the end of 2007;

Additional activities

- Independent investigations (national and international) during 2003:
  - Operator, HAEA, Parliamentary Committee;
  - IAEA to assess the results of HAEA investigation.
- Deficiencies in various areas in EPR identified and action plan developed following the IAEA mission in June 2003:
  - Action plan approved by HAEA and improvements (e.g. emergency classification, drills and exercises, training etc.) implemented by 2006.

Discussion

Based on this information, please discuss and answer the questions distributed for this Case Study (*Case Study Part 1: Transition to an existing or a planned exposure situation?*) within your working group.

– Time allocated: **5 mins**

THE RADIOLOGICAL ACCIDENT IN GOIÂNIA, BRAZIL

Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

13 September 1987
The initial event

- Person A and Person B dismantled a teletherapy unit found in an abandoned clinic in Goiânia, a small city located in central Brazil.

Images reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

13 September 1987
Removal of the source

- These two persons removed the source rotating assembly and carried it to Person A's house in a wheel barrow.
- In the evening, they both began to vomit.

Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

14 – 15 September 1987
Initial medical symptoms

- Person B suffered from diarrhoea, felt dizzy and one of his hands was swollen (oedema), but his symptoms were diagnosed as being caused by an allergy.

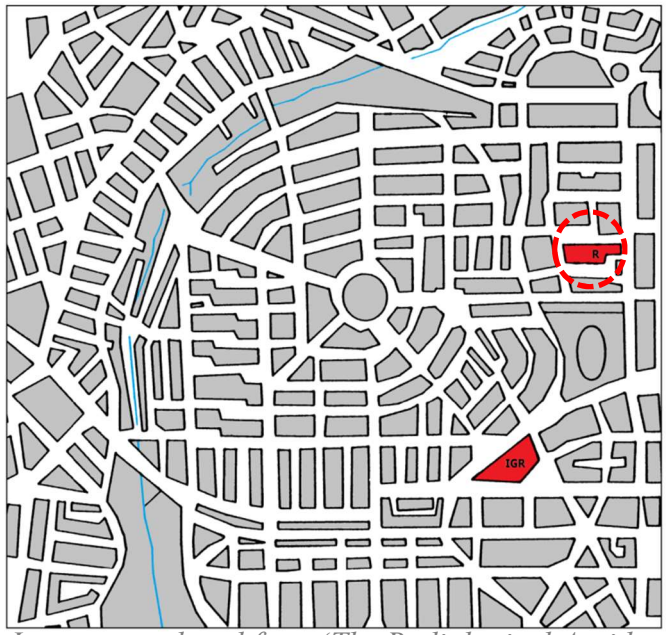


Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

18 September 1987
Source damage

- In his garden, Person A worked to remove the source wheel from the rotating shutter, accidentally punctured the source capsule with a screwdriver and removed some of the material.

- Person A sold the pieces of the rotating assembly to Person C, the owner of a junkyard (JY I).

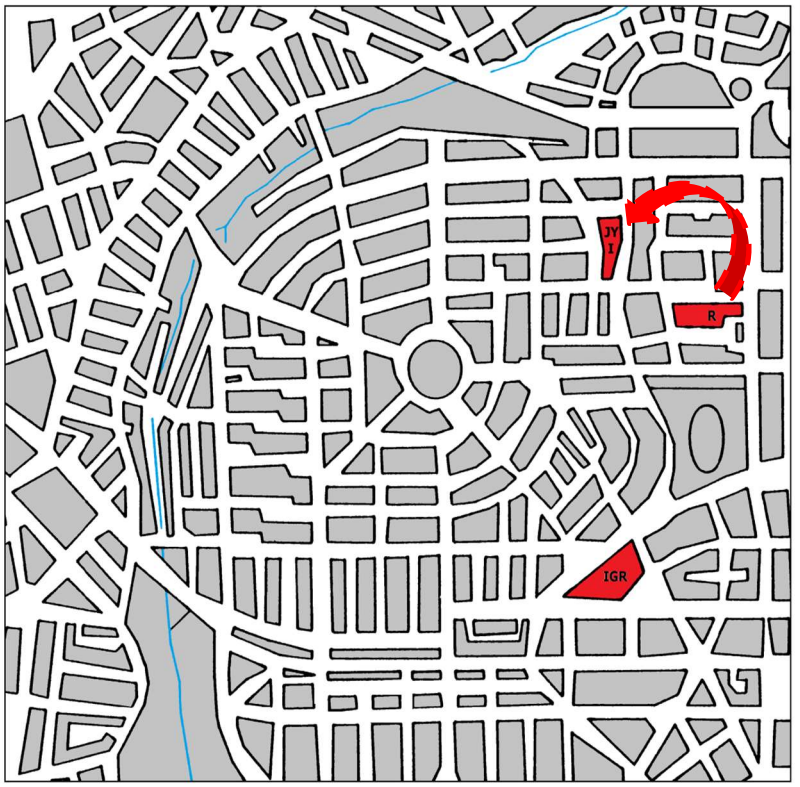


Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

18 September 1987
Wider distribution of fragments

- Person C took the capsule into his house and invited neighbors, relatives and acquaintances to see the glowing blue light.

- He distributed fragments of the source to several families.

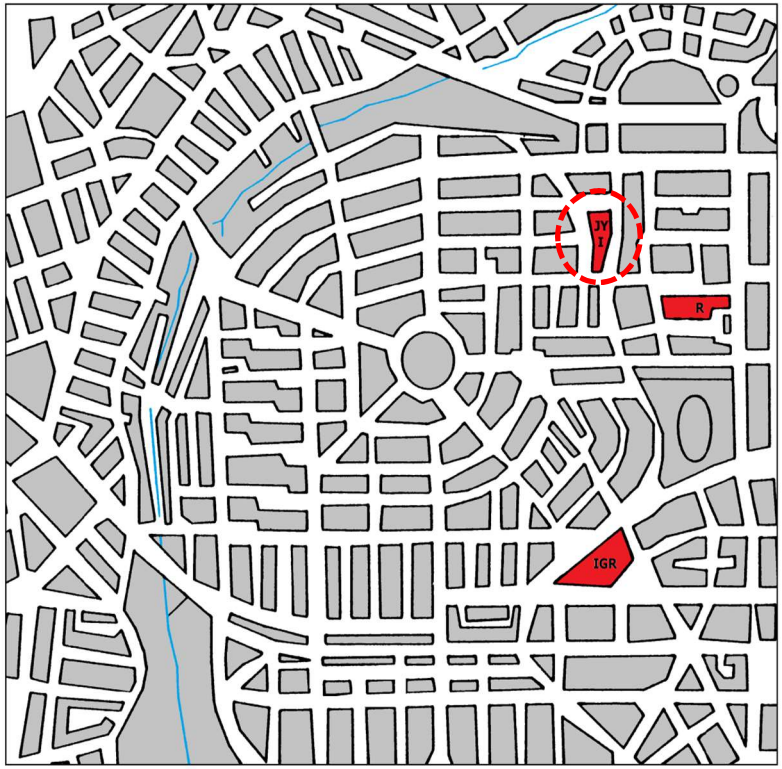


Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

24 September 1987
Wider distribution of fragments (cont'd)

- Person C's brother took some fragments to his home, located next to another junkyard (JY II).
- Most of the material remained at Person C's house.

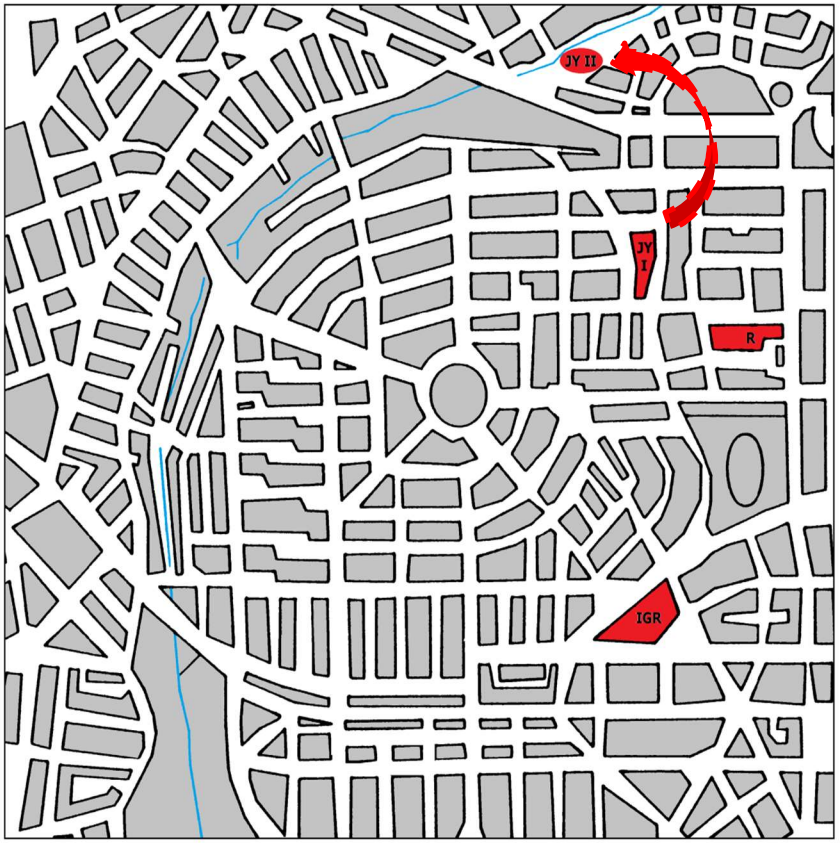


Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

25 September 1987
Wider distribution of fragments (cont'd)

- Person C sold the lead shielding and the remnants of the source assembly to a third junkyard (JY III).

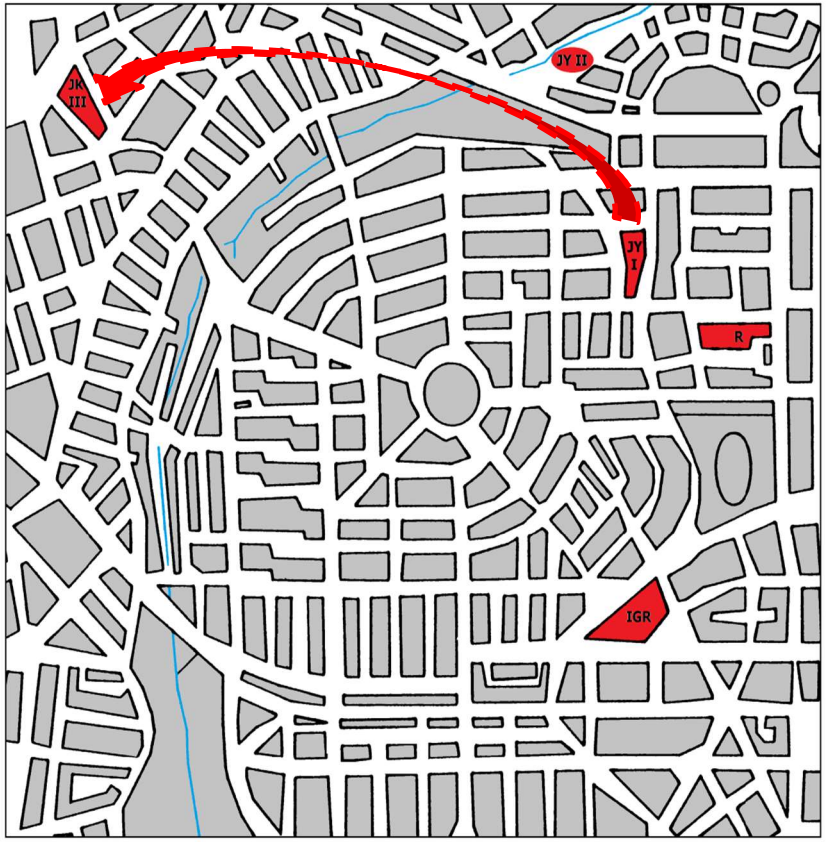


Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

28 September 1987
Identification of a problem

- Person C's wife, suspecting the glowing powder to be the cause of the sickness of those who had had contact, reclaimed the materials from junkyard III and transported it in a bag, by bus, to the Vigilância Sanitária.

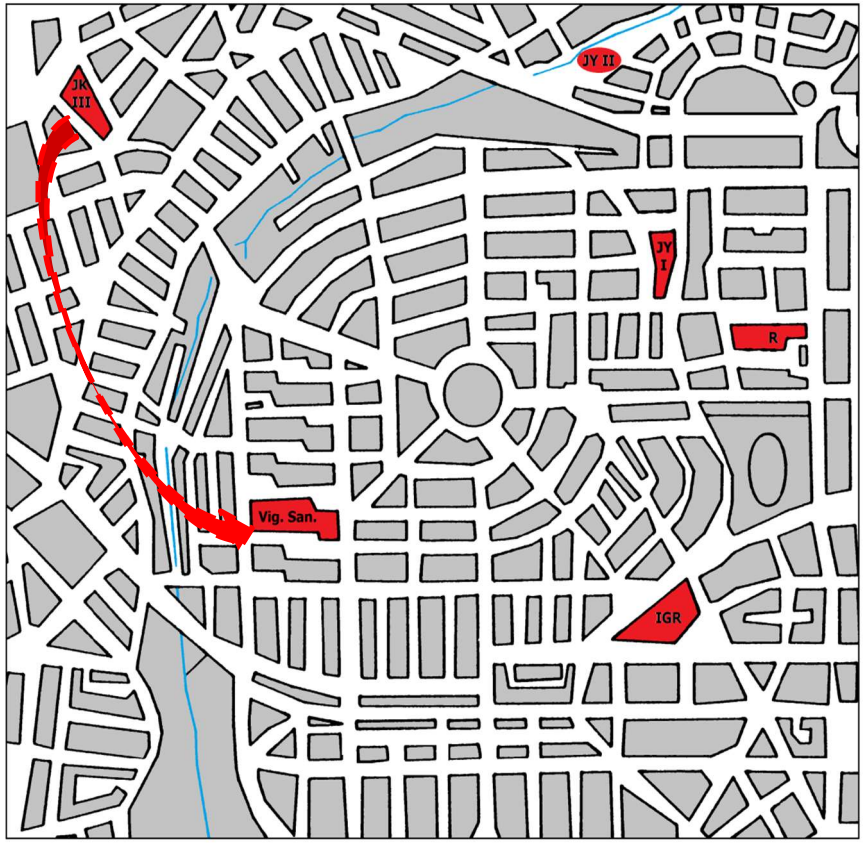


Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

29 September 1987
Identification of a problem (cont'd)

- A visiting medical physicist identified the presence of a radioactive source.
- He evacuated the building and informed the Goiás State authorities and the Brazilian National Nuclear Energy Commission (CNEN) in Rio de Janeiro.

Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

29 September 1987
Declaration of emergency & protective actions

- The Goiás State authorities were informed at 13:00.
- The Director of the Department of Nuclear Installations of CNEN was notified by phone at 15:00.

Emergency declared

Actions taken:

- Gathering more information about the source;
- Surveying the suspected areas;
- Alerting the police, fire brigades, ambulances and hospitals;
- Preparing for receiving contaminated people at the city stadium.

Image reproduced from 'The Radiological Accident in Goiânia', IAEA , Vienna (1988)

30 September 1987
Further protective actions

- The first team of the CNEN arrived from Rio de Janeiro and São Paulo at 00:30 UTC.

Actions taken:

- Survey of the suspected areas;
- Evacuation of residents from areas > 2.5 μSv/h;
- Control of contamination
- Decontamination (shower, changing of clothes) and medical follow-up;
- Isolation of the source;
- Gathering more technical and human resources.

Image reproduced from 'The Radiological Accident in Goiânia', IAEA, Vienna (1988)

3 October 1987
The situation brought under control

- The situation under control:
  - The source had been isolated;
  - The most contaminated sites had been identified and evacuated;
  - The potentially exposed persons had been identified.
- The main concerns:
  - Further treatment of the injured individuals;
  - Improvement of the conditions at the sites of contamination;
  - Clean-up operations;
  - Waste management.

As of 3 October 1987

- Plans and strategies for the recovery were prepared:
  - Resource needs (expertise, manpower, equipment and material) were assessed and resources were mobilized.
  - The logistic support (transport, housing, etc.) was organized in accordance with the expected increase of resources.
  - The dose criteria were re-evaluated and set up.
  - Further radiological surveys were conducted to build a comprehensive cartography of the contamination.
  - An environmental monitoring programme was organized.
  - Decontamination plans and procedures were developed, including waste packaging and storage.
  - A communication strategy was defined.

As of 16 October 1987

- Medical response organized:
  - Measures to protect the medical staff from contamination;
  - Follow-up studies on the contaminated persons;
  - Prussian Blue administered to speed up excretion of ^{137}Cs.
- Clean-up operations taken:
  - Houses cleaned up or demolished;
  - Public places and vehicles decontaminated;
  - Fruits and soil also removed on the basis of soil profile measurements;
  - Waste segregated, classified and treated.
- Environmental monitoring implemented:
  - A car borne monitoring programme to monitor areas outside the main focuses of contamination, decontamination and follow-up surveys;
  - Samples of soil, vegetation (leaves, branches and fruits), water (from the nearby river, wells and public water supply), rainwater and air were collected and measured.

Discussion

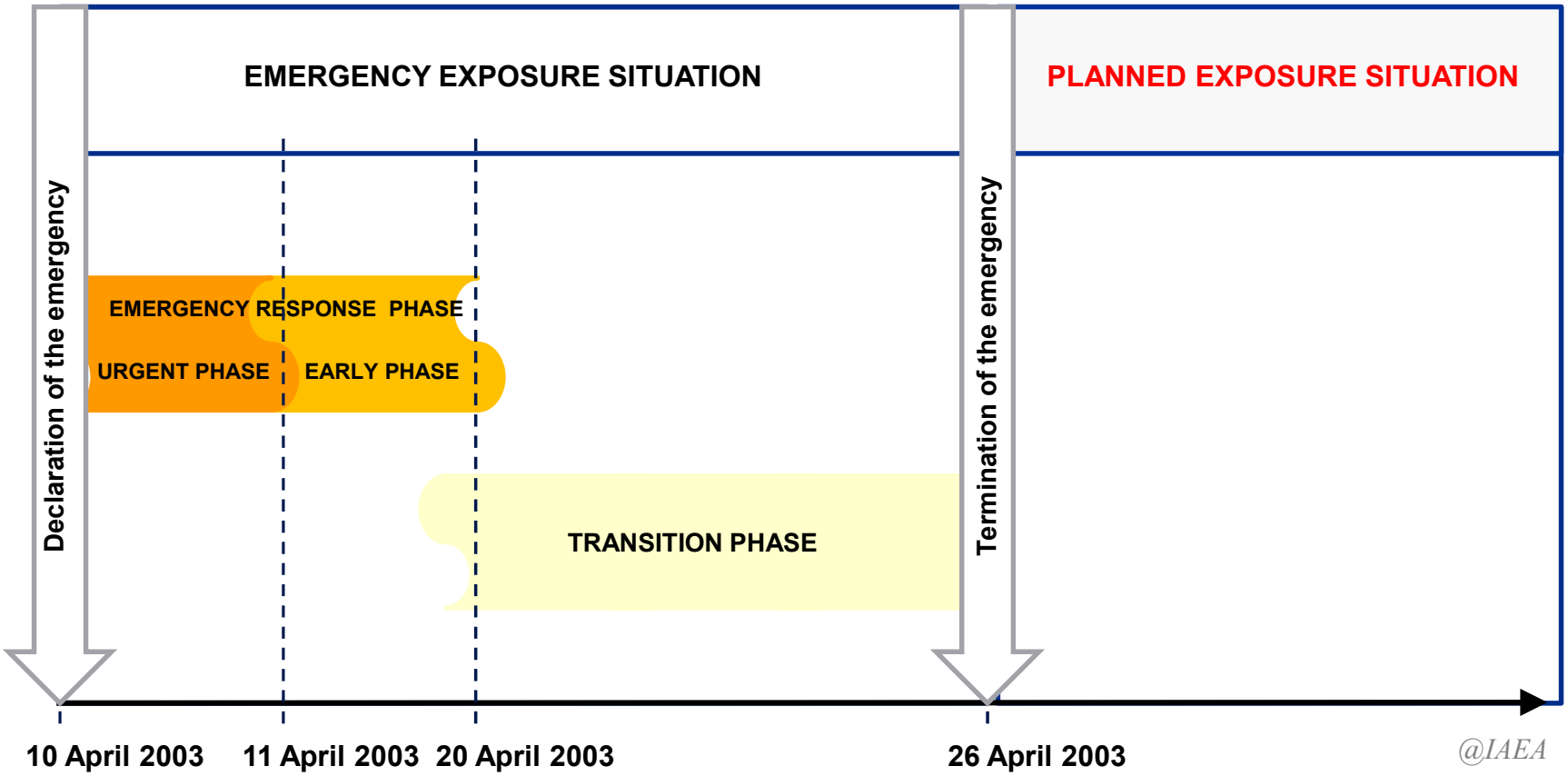
- Based on this information, please discuss and answer the questions distributed for this Case Study (*Case Study Part 1: Transition to an existing or a planned exposure situation?*) within your working group.
  - Time allocated: **5 mins**

Let's discuss:

- Did these events involve a significant release of radioactive material into the environment calling for longer term management of residual contamination?
- Did these events introduce a situation of exposure that differed from the one that had existed before with regard to the public exposure?
- How will such emergency exposure situations transition (to a planned exposure situation or an existing exposure situation)?

  – Time allocated: **15 mins**

Nuclear incident at Paks NPP: An example for transition to a planned exposure situation

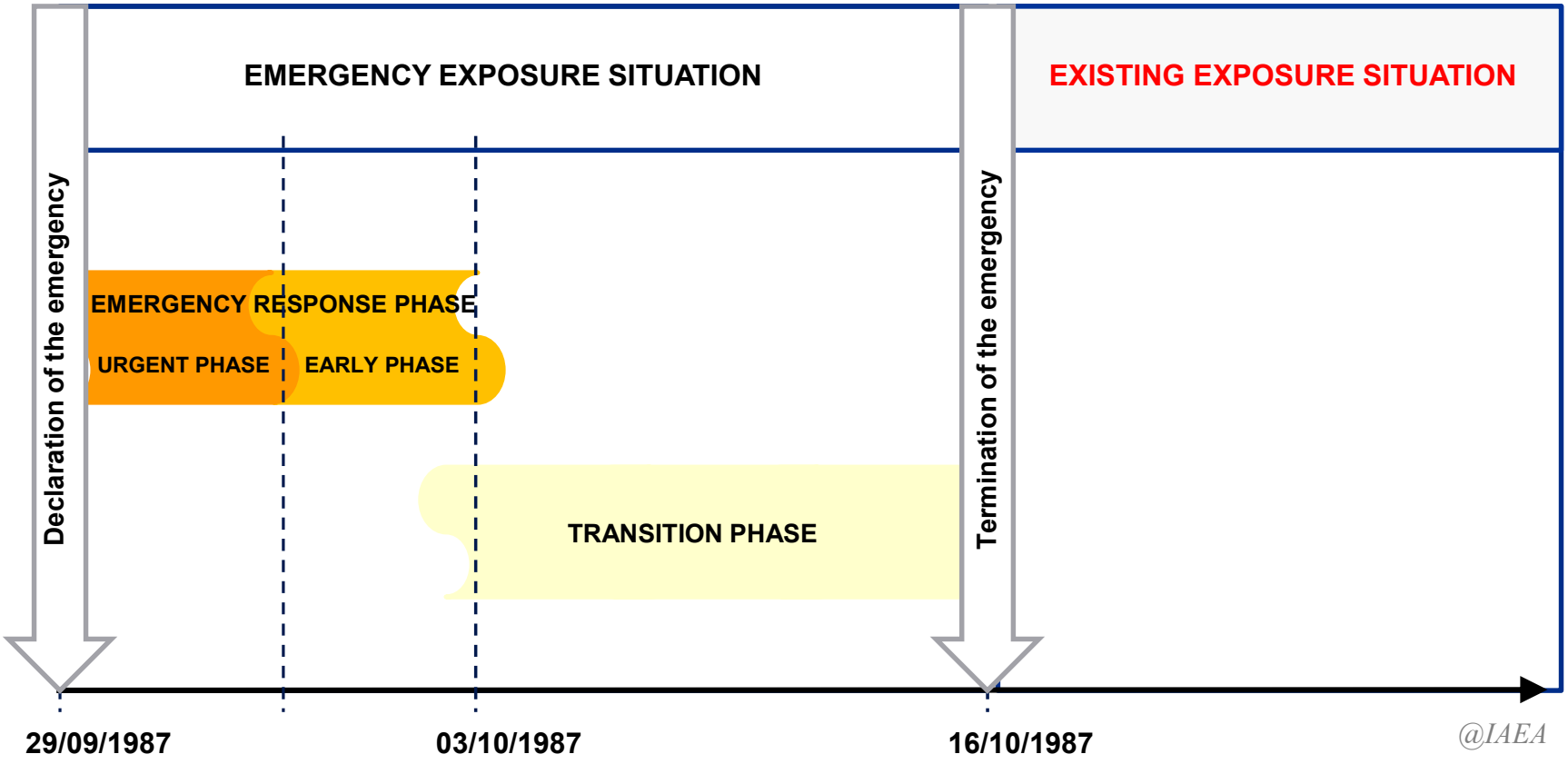


Retrospective sequencing and milestones of the nuclear incident at Paks NPP

Basis for the milestones in the Paks fuel damage incident

- The incident was identified on 10 April 2003, when limited urgent protective actions on the site were implemented for worker protection (urgent response phase).
- The emergency phase continued until 20 April 2003, when efforts focused on assessing the situation and on the effects of continuous cooling and monitoring to confirm the stability of the situation (early response phase).
- The damaged fuel was brought under control by 26 April 2003, and the consequences on-site and off-site were being assessed (transition phase).
- Further planning for recovery continued, and normal operation resumed in the second half of 2005 (planned exposure situation).

Goiânia radiological accident: An example for transition to an existing exposure situation



Retrospective sequencing and milestones of the radiological accident in Goiânia

Basis for the milestones in the radiological accident in Goiânia

- Emergency declaration on 29 September 1987 with the notification to the CNEN;
- The emergency response phase lasted until 3 October 1987, during which period:
  - The source had been isolated;
  - Contaminated areas had been evacuated and cordoned off;
  - Exposed people had been identified and dealt with.
- The transition phase lasted from 3 to16 October 1987, during which period a general strategy was established for recovery operations, including a decision for a temporary waste storage site.
- The recovery phase, aiming to restore normal living conditions, continued until March 1988.

Case studies

- Detailed in Annex I of IAEA Safety Standards Series No. GSG-11 for further information

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Thank you!