

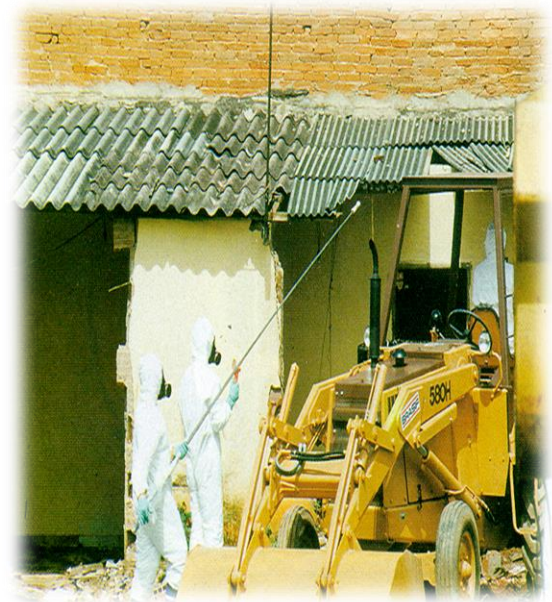
# Emergency Monitoring

IAEA-KINS Workshop on the Emergency Preparedness and Response to Nuclear and Radiological Emergencies

19 - 23 June 2023, Daejeon, Republic of Korea

# Introduction

- The primary purpose of emergency monitoring is to provide timely information on which first decisions on protective actions (primarily based on the accident classification) can be confirmed or revised
- This means detection of radioactive material, determination of its location and its nature
- Capability to provide rapid monitoring is essential



*Image courtesy IAEA*

# General Considerations

- A measurement result is useful only if it adequately represents the quantity under consideration
- Radioactive decay is a random process
- Due to the stochastic nature of this process, several measurements of a specified quantity are needed
- Evaluation of measured results is needed
  - To get appropriate estimate of the quantity under consideration and
  - on its associated degree of confidence

# Emergency Monitoring. General Goal

- To assist, confirm or revise decision-making regarding
  - WHETHER
  - WHEN
  - and
  - WHERE
  - to apply protective actions



*Image courtesy IAEA*

# Emergency Monitoring. General Objectives



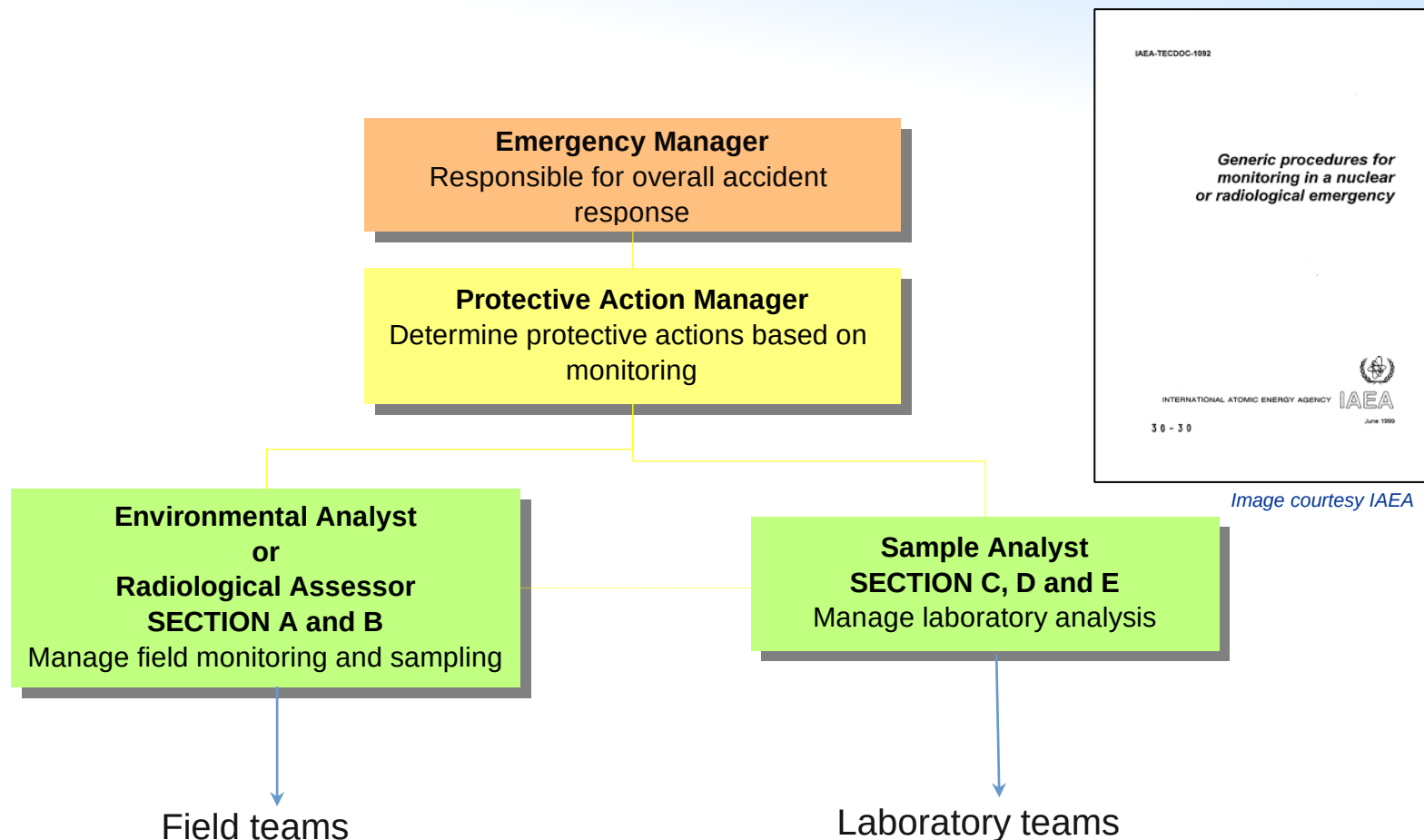
- The **objectives** of emergency monitoring in general are:
  - To help decision makers to assess the need for protective actions and interventions on the basis of operational intervention levels (OILs)
  - To assist in preventing the spread of contamination
  - To provide information for protection of emergency workers
  - To confirm **absence** of radiation/contamination

# Emergency Monitoring. General objectives (cont.)



- To provide accurate and timely data
  - On the level and degree of hazards resulting from a radiological emergency
- To determine the extent and duration of the hazard
- To provide details on the physical and chemical characteristics of the hazard and
- To confirm the efficiency of remedial measures
  - Such as decontamination procedures etc.

# Generic Monitoring Organization



# Generic Monitoring Organization (cont)

## Field teams

**Aerial Survey  
Team**

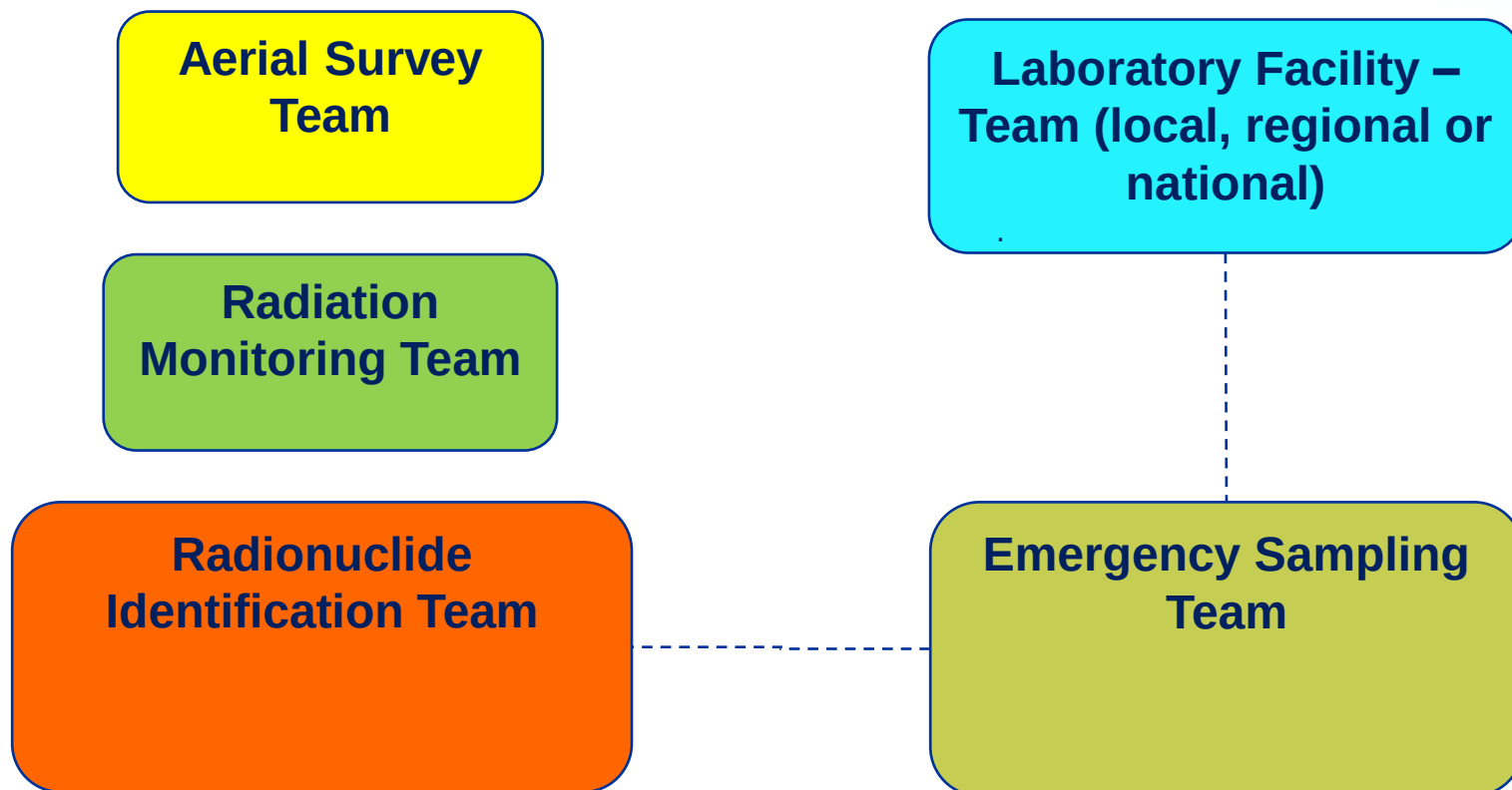
**Radiation  
Monitoring Team**

**Radionuclide  
Identification Team**

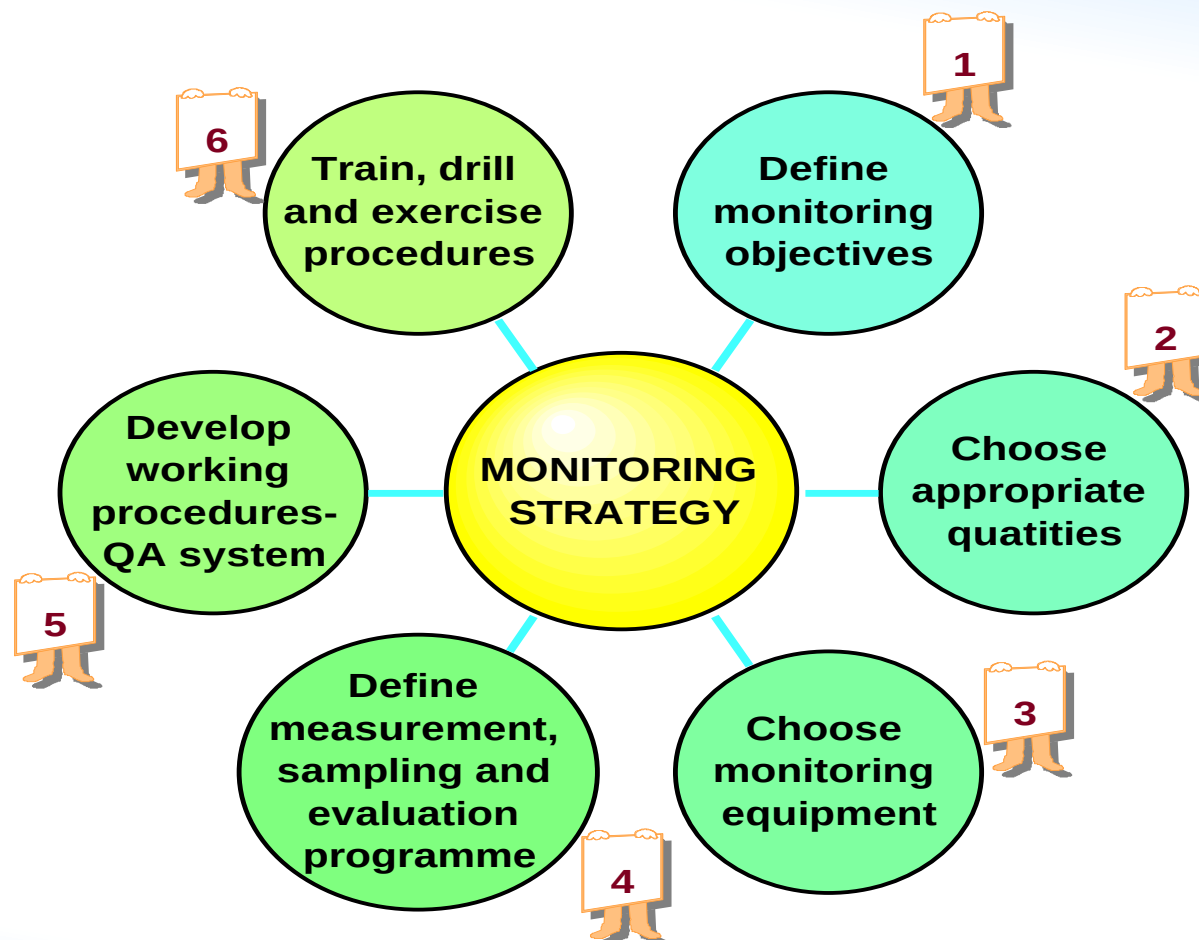
## Laboratory teams

**Laboratory Facility –  
Team (local, regional or  
national)**

**Emergency Sampling  
Team**



# Monitoring Strategy



# Design of Emergency Monitoring Program



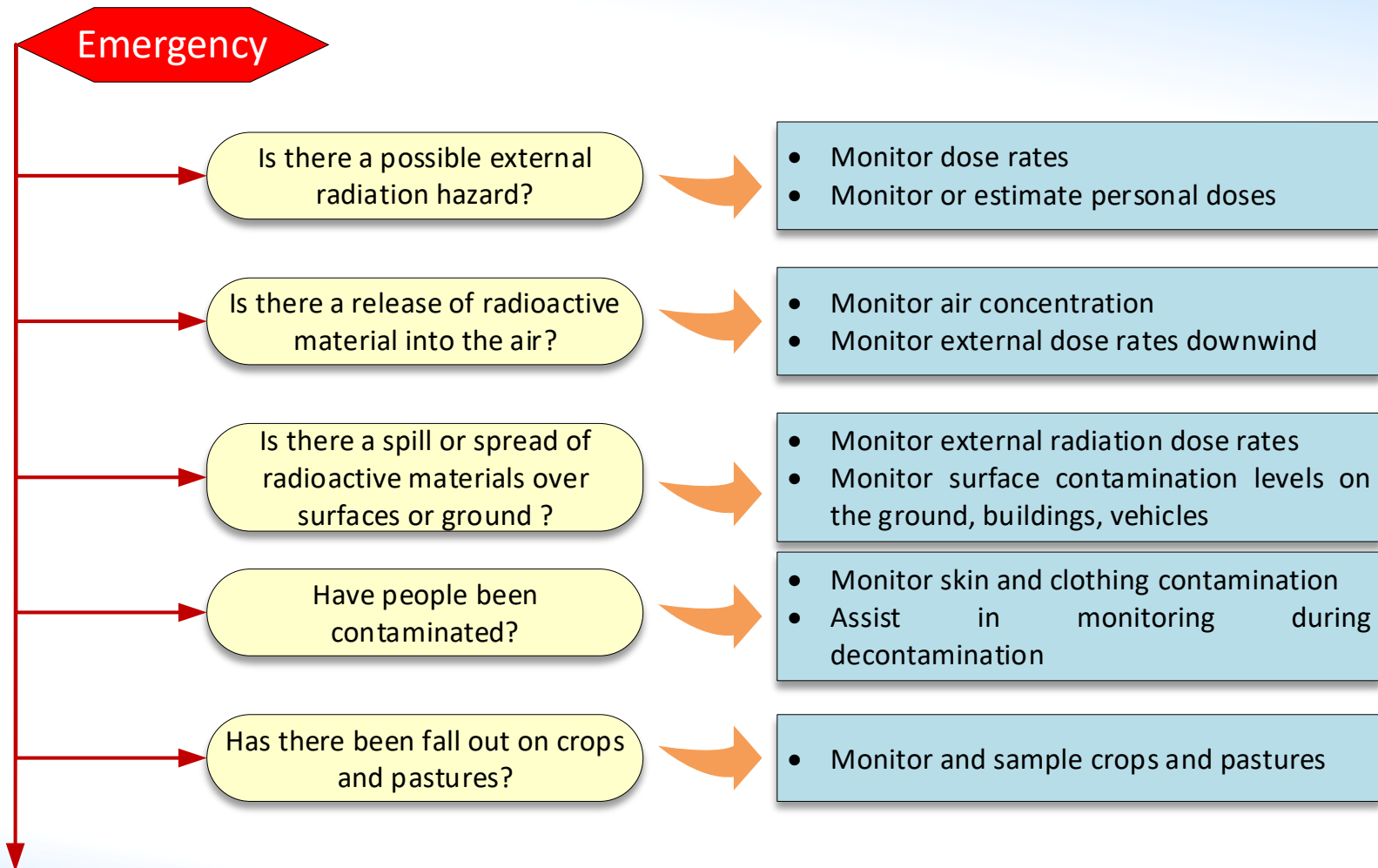
- The design of the emergency monitoring and sampling programme will be determined:
  - By the primary objectives for which it has been established
  - By the scale of the accident envisaged and
  - By the availability of qualified teams to respond to radiological emergency



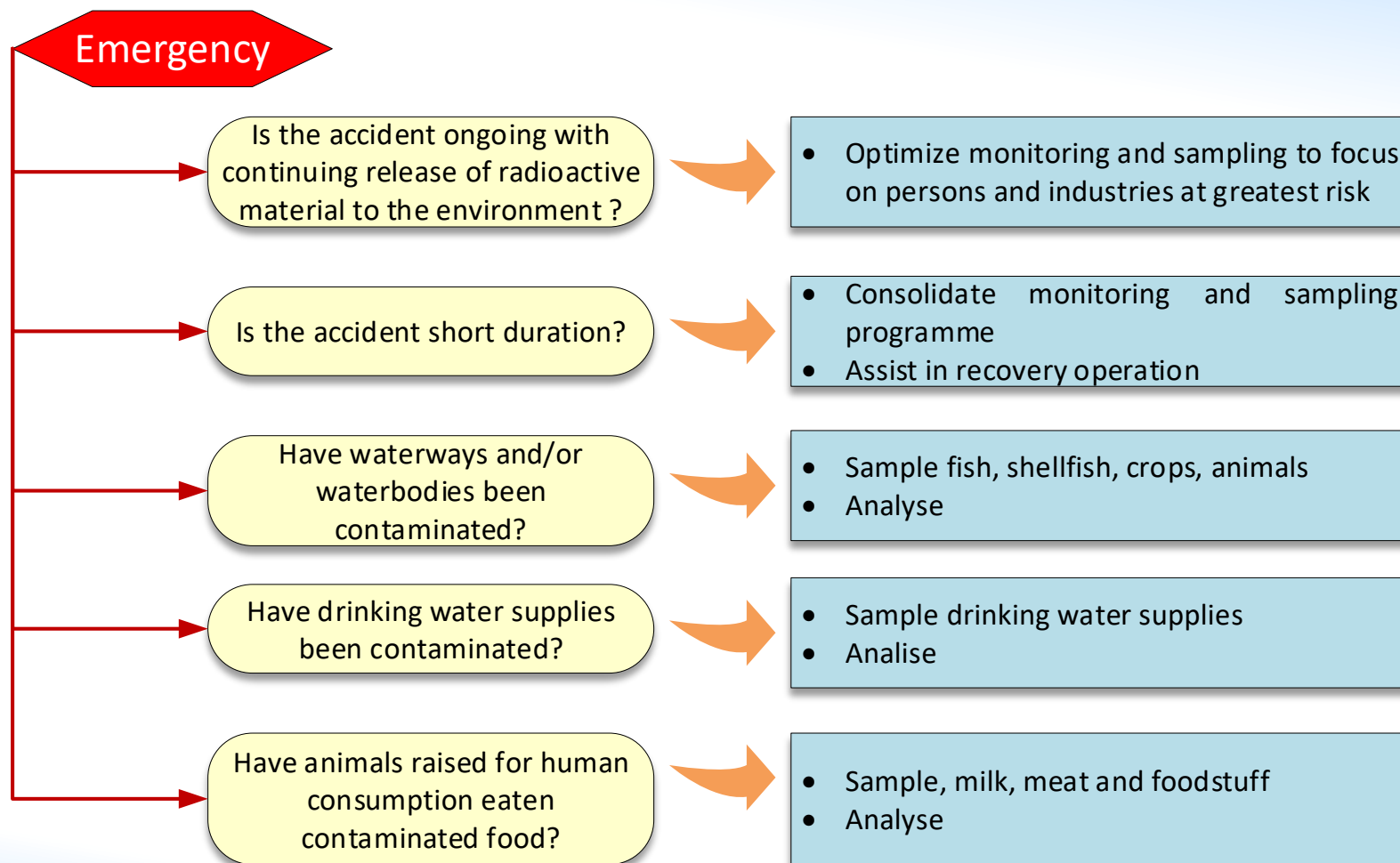
# General Priorities in Designing Emergency Monitoring

- In the initial response, the determination of affected areas should be the first priority
  - Which are truly “dirty” and
  - Where people can be affected
- The priority for monitoring and sampling should take into account
  - The composition of the affected area:
    - Residential, agricultural, rural, commercial
    - Industrial activities
    - Public services
    - Infrastructure elements

# Decision Sequence Tree



# Decision Sequence Tree (cont.)



# Suggested Number of Monitoring Teams

| Emergency preparedness category | Aerial Survey Team | Radiation monitoring team | Radionuclide Identification Team | Laboratory Facility – Team | Emergency Sampling Team |
|---------------------------------|--------------------|---------------------------|----------------------------------|----------------------------|-------------------------|
| I                               | 1                  | 6                         | 3                                | 2                          | 6                       |
| II                              | 1                  | 3                         | 1                                | 2                          | 2                       |
| III                             |                    | 1                         | 1                                | 1                          | 1                       |
| IV                              |                    | 1                         | 1                                | 1                          | 1                       |
| V                               |                    | 1                         | 2                                | 1                          | 3                       |

# Aerial Survey Team

- Aerial monitoring can be regarded as an appropriate method for a rapid survey
  - To provide information on large area surface contamination (ground contamination survey) or
  - To search, detect localize and identify gamma-emitting source(s) over large areas in order to render the source safe



# Environmental Survey Team

- Environmental Survey Team should be technical personnel trained in:
  - Radiation dose rate measurements
  - Surface contamination measurements
- Team should be regularly exercised in emergency response scenarios



# Personal Monitoring and Decontamination Team

- Members need to be skilled in the use of contamination monitors
  - To assess contamination
  - To prevent the spread of contamination
  - To monitor the efficiency of decontamination of people and surfaces
- All such persons should receive regular refresher training in monitoring techniques



*Image courtesy IAEA*

# In-situ Gamma Spectrometry Team

- A specialist team skilled in the use of gamma spectrometers in field situations
- From environmental laboratories
- Geological surveyors skilled in radiometric assessments of the Earth's surfaces



# Air Sampling Team

- Air Sampling Team should be skilled at
  - Taking air samples
  - External dose rate measurements
  - Contamination monitoring
- Training required
  - in field assessment of air samples
  - Using portable radiation monitoring instruments
  - And placing the sample in a suitable sealed and labeled container



*Image courtesy IAEA*

# Environmental and Ingestion Sampling Team

- Team members should be experienced in environmental sampling
- Teams may also need to be experienced in
  - Radiological assessment techniques to monitor their own safety and
  - Provide field radiological data if requested to do so



# Laboratory Facility – Team

- It is composed of persons well trained in
  - Sample preparation
  - Gamma spectrometry
  - Other radionuclide analyses techniques
- Such persons should be routinely engaged in:
  - Analyses with well-calibrated equipment
  - Utilizing recognized and validated analytical techniques



# Mobile Radiological Laboratories

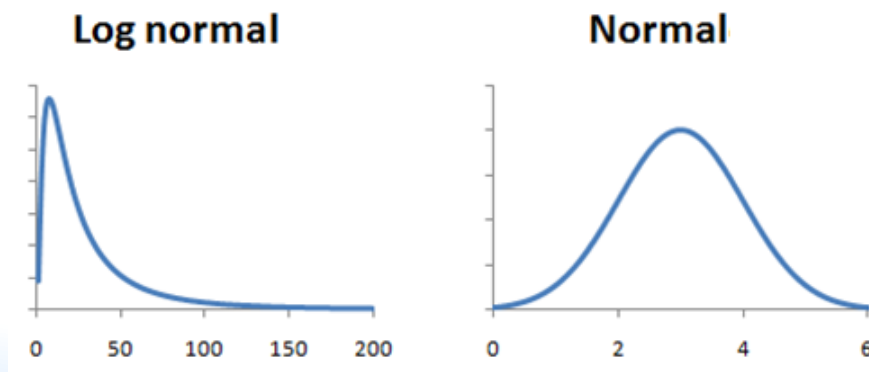
- To perform rapid analyses
  - Best solution at or near an emergency site
  - If properly equipped



*Image courtesy IAEA*

# Radionuclide Concentration Data Evaluation

- In most cases several samples are analyzed to get a representative value of the radionuclide concentration in the environment, foodstuff, etc.
- Independently measured activities have statistical fluctuations in values
- The frequency distribution of such set of measured values usually follows log-normal distribution



# Statistical Uncertainty

- The uncertainty of a value  $C$  (with mean value  $\bar{C}$ ) is calculated using the expression:

$$\sigma = \frac{1}{m} \sqrt{\sum_{j=1}^m (\bar{C} - C_j)^2}$$

- $\sigma$  - represents the uncertainty of a single measurement
- $m$  – total number of measurements

# Radionuclide Concentration Data Evaluation

- The result of repeated measurements should be recorded/presented as

$$\overline{C} \pm \sigma$$

or

$$\overline{C} \pm n\sigma$$

- where n is generally 2 or 3

# Mapping

- Mapping of monitoring data is one of many techniques to present data in a “readable” way
- Mapping can be:
  - Performed manually
  - Computerized, using appropriate software
- Mapping is performed by Environmental Analyst or Radiological Assessor
- In IAEA TECDOC-955 worksheets are prepared for simple manual mapping

# Link to the Operational Intervention Levels



- Representative and best estimate values of monitoring data are needed
  - For competent decision making on protective actions which are based on OILs
- Default OIL values are calculated under certain assumptions

## IAEA Safety Standards

for protecting people and the environment

### Criteria for Use in Preparedness and Response for a Nuclear or Radiological Emergency

Jointly sponsored by the  
FAO, IAEA, ILO, PAHO, WHO



### General Safety Guide

No. GSG-2



*Image courtesy IAEA*

# Link to the Operational Intervention Levels (cont.)

## OIL 1, 2 and 3

- Gamma ( $\gamma$ ) dose rate at 1 m from surface or source
- Direct beta and alpha surface contamination measurement (counts/s)

## OIL 4

- Gamma ( $\gamma$ ) dose rate at 10 cm from the skin
- Direct beta and alpha skin contamination measurement (counts/s)

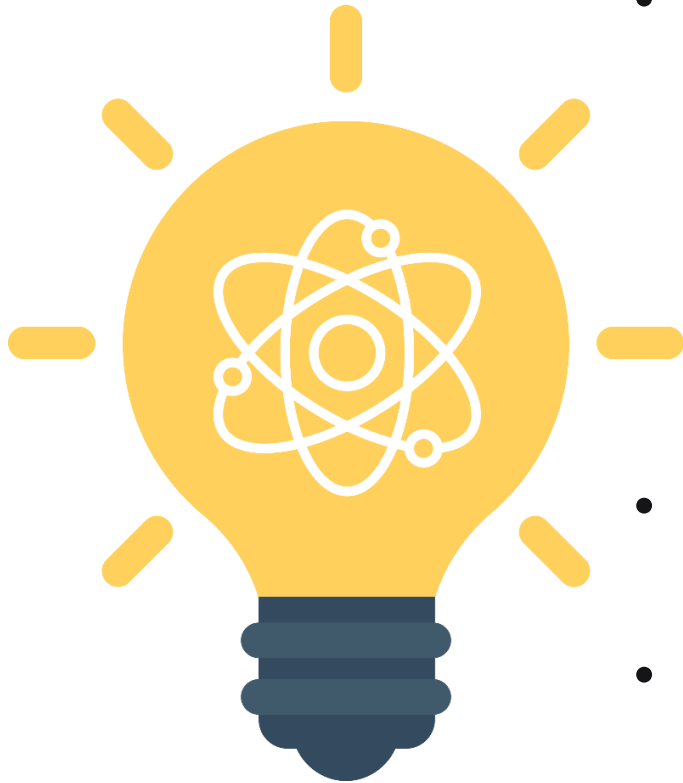
## OIL 5

- Gross beta or gross alpha (Bq/kg) activity concentration

## OIL 6

- Default radionuclide specific OILs for food, milk and water concentrations from laboratory analysis

# Key Points



- Emergency monitoring will provide the data for:
  - Identify the affected areas
  - Assessing the radiation exposure and/or contamination in an emergency
- Hazard assessment provides basis for an emergency monitoring strategy
- An emergency monitoring organization should be set up and maintained
  - Trained and exercised

# Where to Get More Information

- IAEA TECDOC-1092 (1999)
- IAEA EPR-Method (2003)

**iec.iaea.org**  
**iec-information@iaea.org**  
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*Thank you!*

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