IAEA
International Atomic Energy Agency
Atoms for Peace and Development

Emergency Monitoring

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

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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

Emergency Manager
Responsible for overall accident response

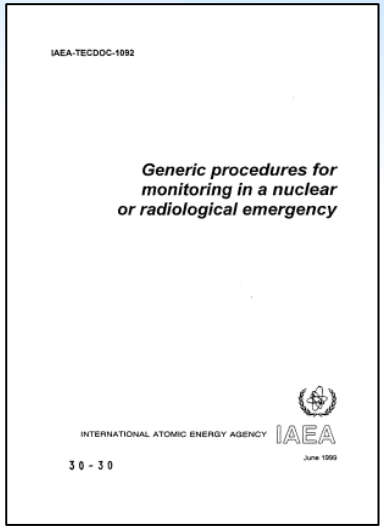
Protective Action Manager
Determine protective actions based on monitoring

Environmental Analyst
or
Radiological Assessor
SECTION A and B
Manage field monitoring and sampling

Sample Analyst
SECTION C, D and E
Manage laboratory analysis

Field teams

Laboratory teams



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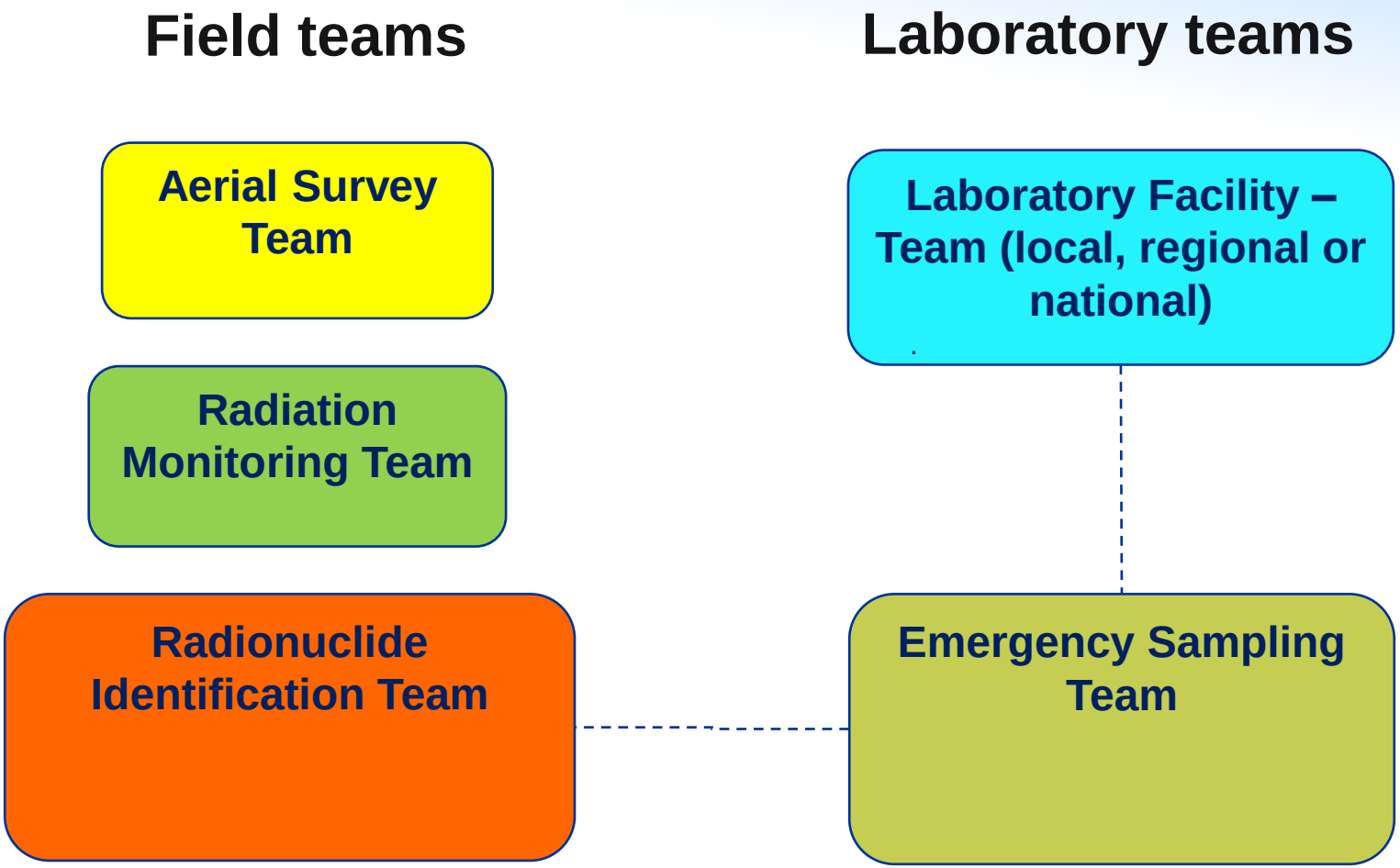
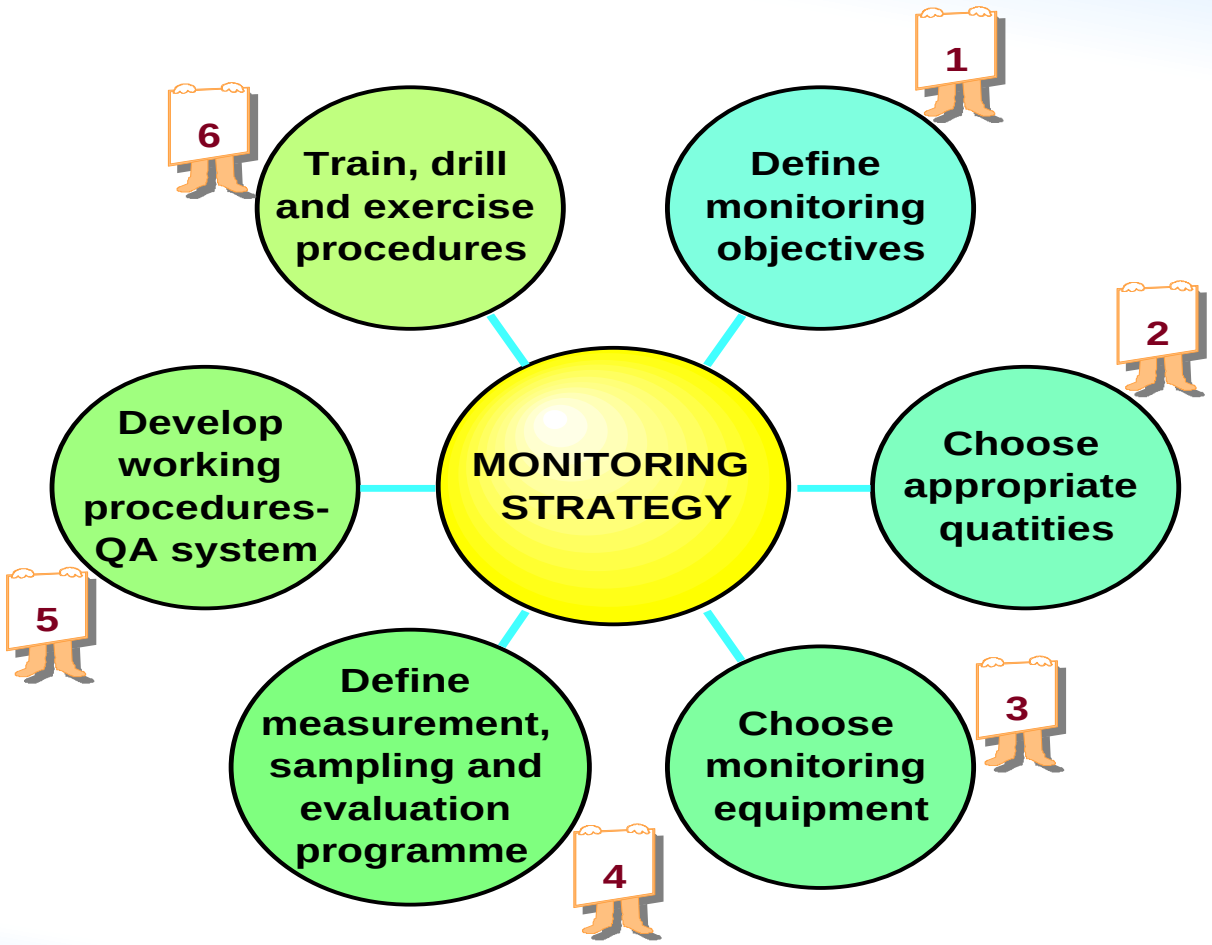
Generic Monitoring Organization (cont)



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

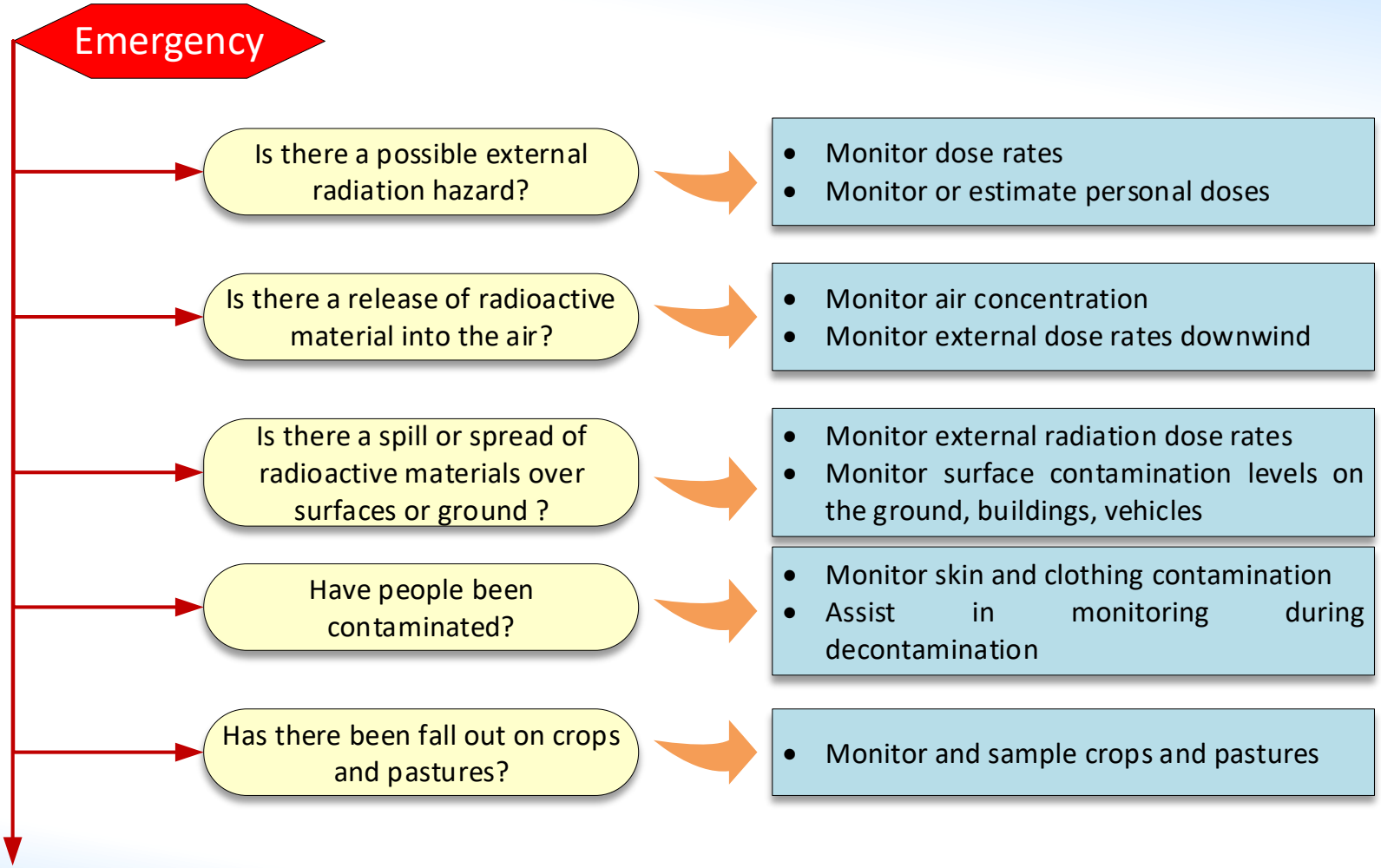
Image courtesy IAEA

General Priorities in Designing Emergency Monitoring

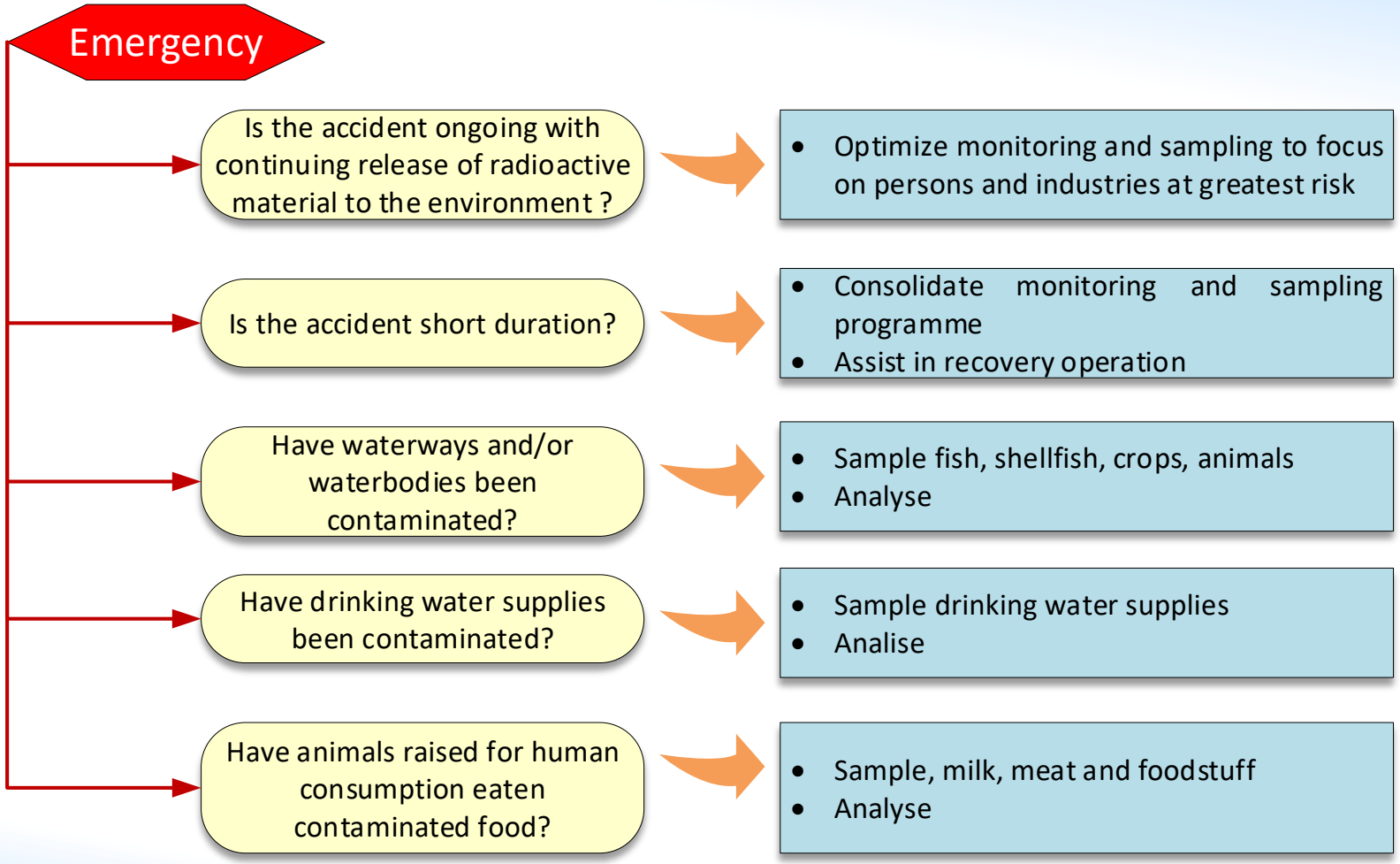
- In the initial response, the determination of affected areas should be the first priority
  - Which are truly “dirty” and
  - Where people can be affected

- 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

Image courtesy IAEA

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

Image courtesy IAEA

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

Image courtesy IAEA

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

Image courtesy IAEA

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

Image courtesy IAEA

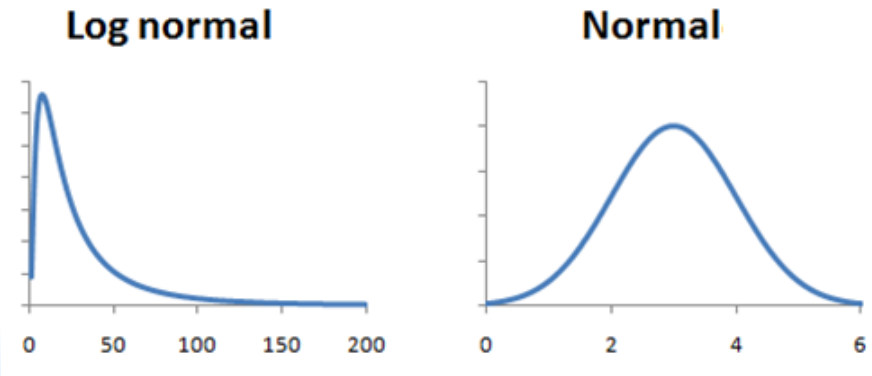
Mobile Radiological Laboratories

- 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



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Statistical Uncertainty

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

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

- σ - represents the f 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

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

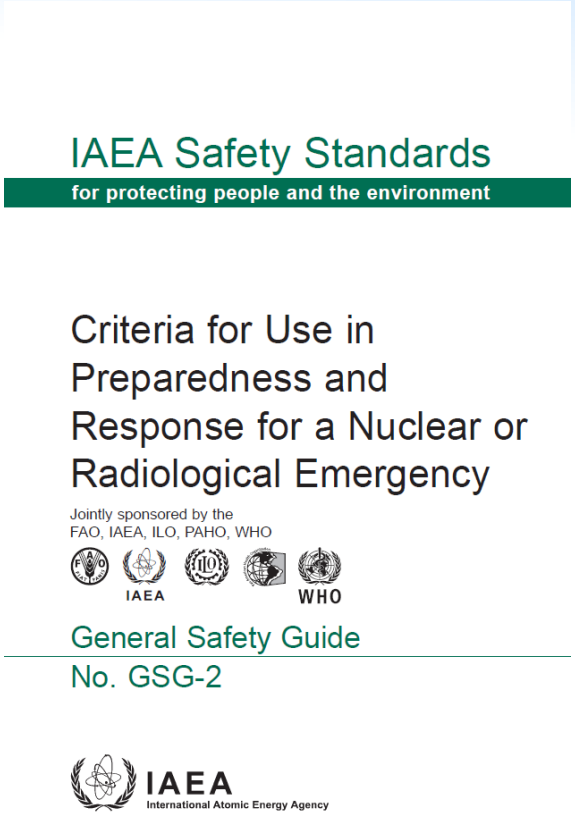
- where n is generally 2 or 3

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



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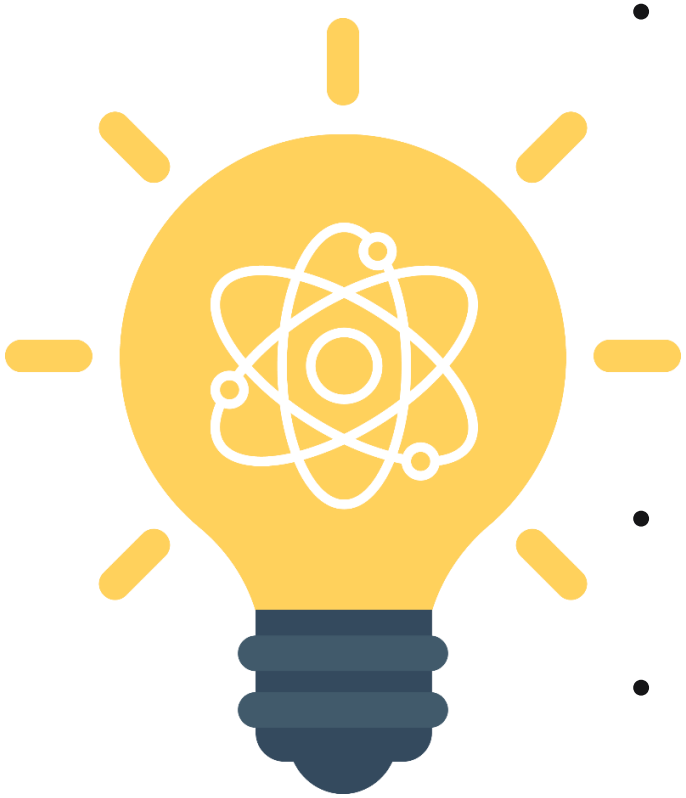
Link to the Operational Intervention Levels (cont.)

OIL 1, 2 and 3	• Gamma (γ) dose rate at 1 m from surface or source • Direct beta and alpha surface contamination measurement (counts/s)
OIL 4	• Gamma (γ) 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)

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Thank you!

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