IAEA Post Graduate Educational Course in Radiation Protection and Safety of Radiation Sources

Intervention for Chronic and Emergency Exposure Situations

Monitoring in a Nuclear or Radiological Emergency

Emergency Monitoring Overview

Lecture

Introduction

- This lecture presents an overview of the IAEA technical document *Generic procedures for monitoring in a nuclear or radiological emergency* (IAEA-TECDOC-1092)
- It covers strategy, manpower and equipment needed in environmental, source, personal and equipment monitoring during a nuclear or radiological emergency

Content

- Objectives of emergency monitoring
- Generic monitoring organization
- Emergency monitoring strategy
- Emergency staff
- Instrumentation
- Basic survey methods
- Quality assurance system
- Summary

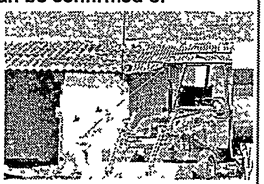


Overview

- One of the most important aspects of managing a radiological emergency is the ability to promptly and adequately assess the need for protective actions
- Protective action accident management must make use of the key relevant information available
- Emergency monitoring is one of the main sources for obtaining the needed information

Purpose

- The primary purpose of emergency monitoring is to provide timely information on which decisions on protective actions can be confirmed or revised
- This requires detection of radioactive material, determination of its location and its nature



General Goal

- To assist, confirm or revise decision-making regarding

WHETHER
WHEN
and
WHERE



to apply protective actions

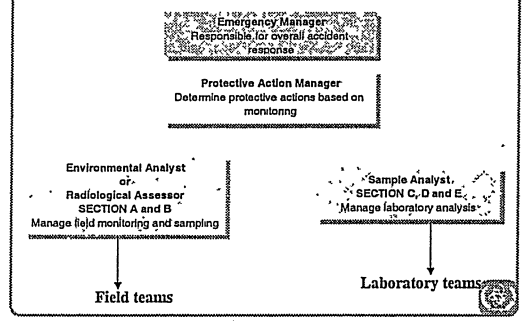
General Objectives

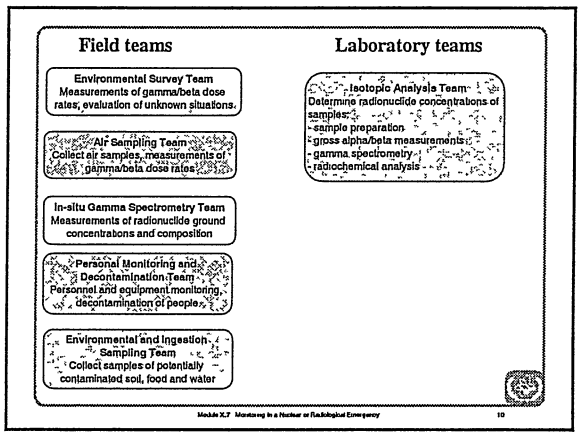
- The objectives of emergency monitoring in general are:
  - To provide information for accident classification
  - To help decision makers to assess the need for protective actions and interventions on the basis of operational intervention levels (OILs)
  - To assist in preventing the spread of contamination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

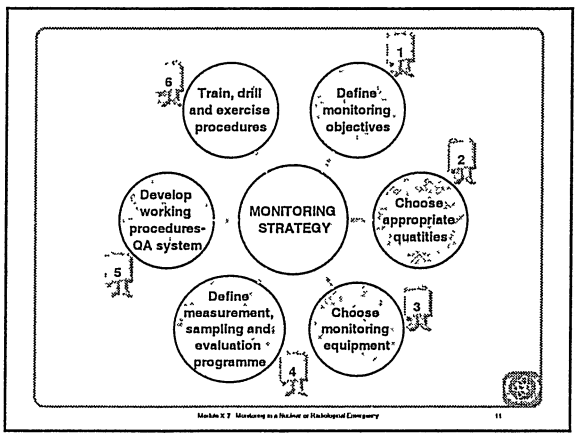
General Objectives – Cont'd

- 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 detail 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

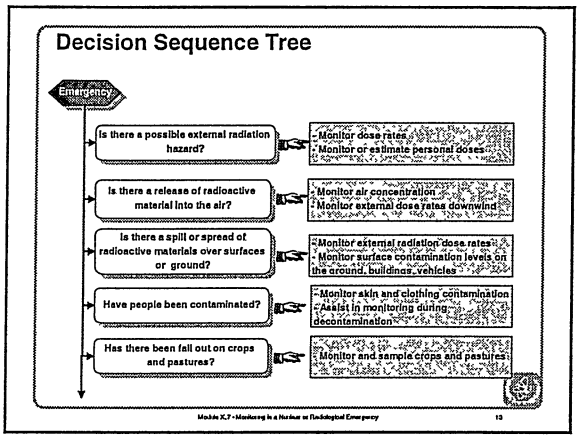


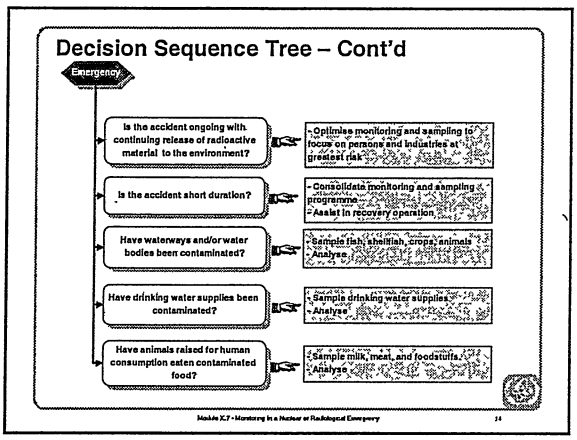


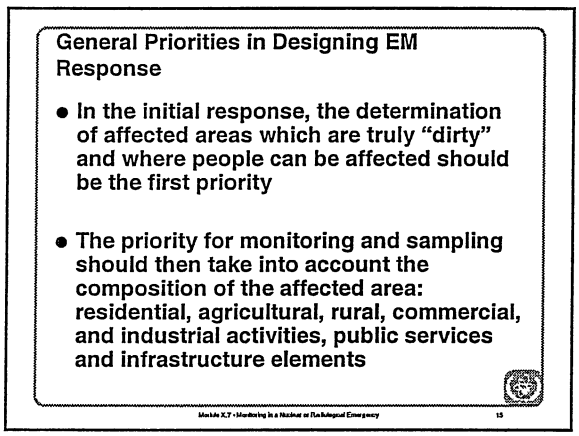


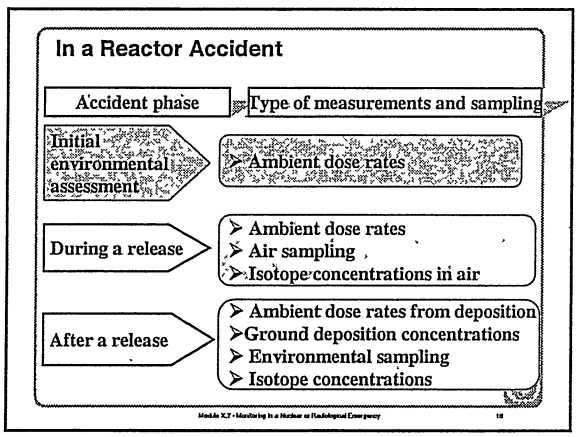
Design of EM Programme

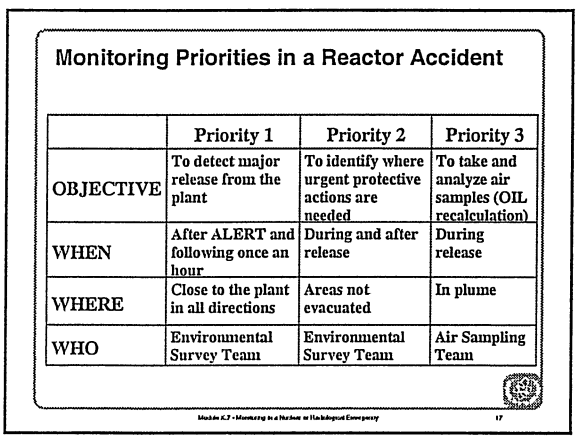
- The design of the emergency monitoring and sampling programme will be determined:
  - By the primary objectives for which it has been established
  - By the scale of the accident envisaged and
  - The availability of qualified teams to respond to radiological emergency





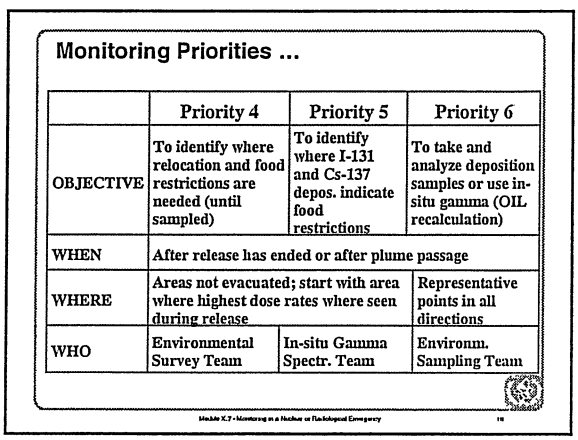






Monitoring Priorities in a Reactor Accident

	Priority 1	Priority 2	Priority 3
OBJECTIVE	To detect major release from the plant	To identify where urgent protective actions are needed	To take and analyze air samples (OIL recalculation)
WHEN	After ALERT and following once an hour	During and after release	During release
WHERE	Close to the plant in all directions	Areas not evacuated	In plume
WHO	Environmental Survey Team	Environmental Survey Team	Air Sampling Team



Monitoring Priorities ...

	Priority 4	Priority 5	Priority 6
OBJECTIVE	To identify where relocation and food restrictions are needed (until sampled)	To identify where I-131 and Cs-137 depos. indicate food restrictions	To take and analyze deposition samples or use in-situ gamma (OIL recalculation)
WHEN	After release has ended or after plume passage		
WHERE	Areas not evacuated; start with area where highest dose rates where seen during release		Representative points in all directions
WHO	Environmental Survey Team	In-situ Gamma Spectr. Team	Environm. Sampling Team

Monitoring Priorities ....

	Priority 7
OBJECTIVE	To take and analyze food, water and milk samples and identify if OILs in food are exceeded and restrictions on ingestion are warranted
WHEN	After release has ended
WHERE	Start where OILs for I-131 and Cs-137 were exceeded, but ensure that all areas where deposition could result in food restrictions will be evaluated
WHO	Environmental and Ingestion Sampling Team

Emergency Staff - General Guidance

- Use persons who are skilled and experienced
- Persons performing routine monitoring and sampling should receive specific training for non-routine and emergency monitoring and sampling
- Teams should be well trained and properly equipped with personal protective equipment and be acquainted with turn back guidance

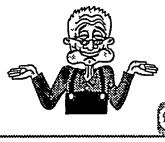
Emergency Manager

- Emergency manager is the person who will be in overall charge of an emergency and carry the ultimate responsibility for the emergency response
- He might simply be
  - The most senior member of staff of the premises where an accident has occurred
  - A senior police officer, or
  - A local or senior government official



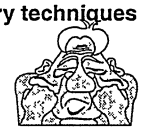
Protective Action Manager

- The Protective Action Manager is the officer responsible for determining protective actions based on accident classification and environmental monitoring and is normally a professional health physicist



Environmental Analyst / Radiological Assessor

- Most likely a professional operational or environmental health physicist knowledgeable and experienced in monitoring techniques and in the use of OILs but not necessarily highly skilled in specific analytical laboratory techniques



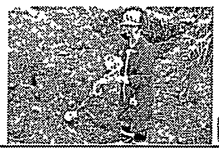
Sample Analyst

- He/she is a specialist in environmental monitoring data interpretation and is most likely an environmental health physicist or a specialist in sample analyses for radionuclide content



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
- They may also be trained in aerial survey methods

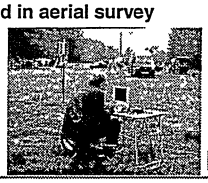


Air Sampling Team

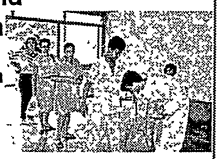
- Air Sampling Team should be skilled:
  - at taking air samples
  - external dose rate measurements
  - contamination monitoring
- It may also require training in field assessment of air samples using portable radiation monitoring instruments prior to placing the sample in a suitable sealed and labeled container

In-situ Gamma Spectrometry Team

- In-situ Gamma Spectrometry Team is a specialist team skilled in the use of gamma spectrometers in field situations
- Such persons may be drawn from environmental laboratories or geological surveyors skilled in radiometric assessments of the Earth's surfaces
- Team may also be trained in aerial survey procedures



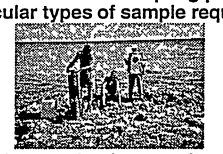
Personal Monitoring and Decontamination Team



- 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 re-familiarization training in such techniques

Environmental and Ingestion Sampling Team

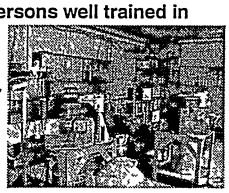
- Team members need to be experienced environmental sampling personnel or personnel well instructed in correct sampling procedures for the particular types of sample required



- Teams may also need to be experienced in radiological assessment techniques to monitor their own safety and to provide field radiological data if requested to do so

Isotopic Analysis Team

- Team is composed of persons well trained in
  - sample preparation
  - gamma spectrometry
  - other radionuclide
  - analyses techniques



- Such persons should be routinely engaged in such analyses, with well-calibrated equipment and utilizing recognized and validated analytical techniques

Suggested Number of Teams for Reactor Accident Response

Environmental Survey Team	Air Sampling Team	In-situ Gamma Spectrometry Team	Personnel Monitoring and Decontamination Team	In Plant Survey Team
5-10	2	2	2-5	2

Environmental/ Ingestion Sampling Team	Isotopic Analysis Team	Initial Treatment Team	Local Response Control Team	National or Regional Response Control Team
2-5	1	1	1	1

Instrumentation - General Guidance

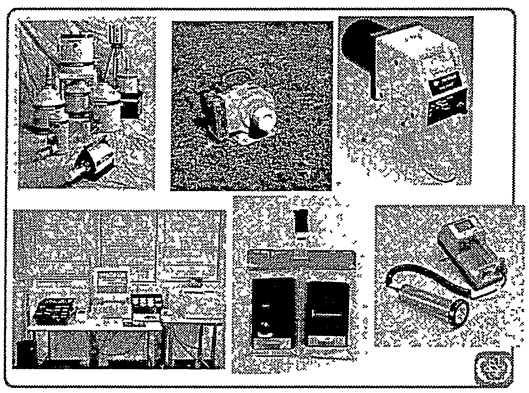
- Choose appropriate equipment
- Properly calibrate equipment
- Maintain equipment readiness





Types of instrumentation

- Radiation monitoring equipment
- Contamination monitors
- Air samplers
- Dosimeters
- Gamma spectrometers
- Gross alpha/beta counting
- Laboratory analytical equipment



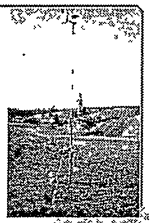
Basic Survey Methods

- Ground survey
- Aerial survey
- Personal monitoring
- Sampling and sample analysis



Ground Survey

- Plume survey
- Ground deposition survey
- Environmental dosimetry
- Source monitoring
- Surface contamination survey

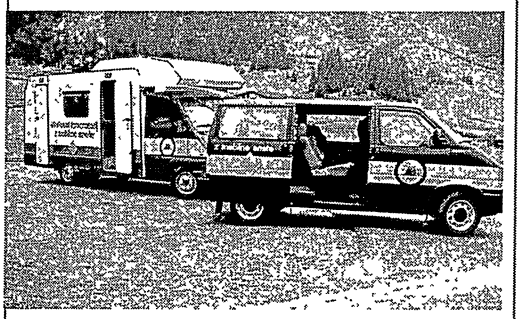




- Ground survey can be performed:
  - with automatic measuring stations
  - on foot with hand held instruments
  - from an adequately equipped vehicle - mobile radiological laboratory

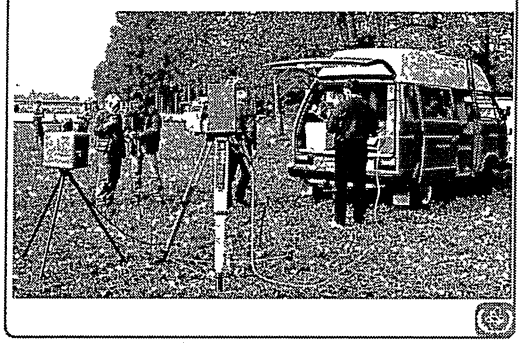
Mobile Radiological Laboratories

- To perform rapid analyses at or near an emergency site an appropriate equipped mobile radiation laboratory can be the best solution
- Vehicles range in size from van or lorry based to commercial semi-trailer or articulated lorry



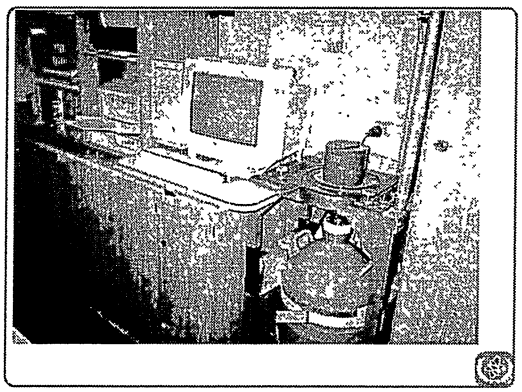
Use of the MRL

- Mobile laboratories are set up for a specific purpose:
  - to provide rapid analyses following radiation accident
  - to provide analyses for routine environmental studies
  - to provide survey in
    - lost source events
    - events where the source material is not known
    - nuclear weapons accidents, and
    - incidents of nuclear terrorism



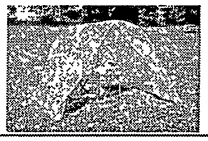
Equipment

- Common equipment placed inside mobile laboratories:
  - gamma spectrometers
  - gross alpha/beta counters
  - liquid scintillation systems
  - other detection equipment
- The choice of equipment for a mobile laboratory is crucial to ensure that samples can pass through the laboratory quickly



Sample preparation capability

- Simple sample preparation is called for in an emergency
- It is recommended that sample preparation is not performed in the mobile laboratory
- Either a sample preparation capability should be built into another vehicle, or be set up in whatever space or facilities are available locally



Sample preparation laboratory

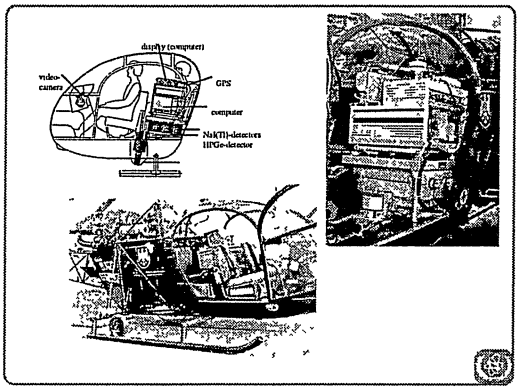
- **Placement of the sample preparation laboratory relative to the mobile laboratory in the field is important**
- **The mobile laboratory should be away from sample preparation area by a good distance, and the mobile laboratory must be much further from sample control (where samples are initially received before processing starts)**

Aerial Survey

- **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**

Equipment

- **For aerial surveys high HPGe detectors or Na(I) detectors are the favorite detectors**
- **Systems based on pressurized ionization chambers, proportional counters, GM detectors or other suitable dose rate meters may be also used**



Personal Monitoring

- **To control personal exposure and contamination of response personnel and in particular field monitoring teams**
- **To monitor persons from the accident area for skin and clothing contamination before, during and after decontamination**
- **To monitor thyroid for radioiodine uptake**



Sampling - General Guidance

- Take representative samples to enable the level and extent of contamination of air, ground, water, foodstuffs, vegetation etc. to be accurately and rapidly determined
- Sampling techniques should be consistent between sampling teams
- Samples should be taken at locations representative for the area and where contamination is more likely rather than at the most accessible sampling sites

Sample Analysis

- Samples can either be assessed in the field or returned to a specialist laboratory
- Standard analytical procedures may need to be replaced by rapid methods to cater for larger numbers of samples and the need for results as soon as possible
- Sample screening techniques may be employed

Confidence in the Monitoring Results

- Confidence in the monitoring results and international acceptability can be achieved only by implementing effective quality assurance system
- The system basically consists of
  - quality assurance (QA) programme
  - quality controls (QC) and
  - audits / appraisals

Procedures

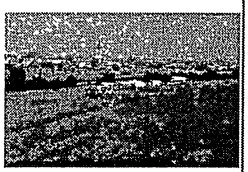
- Measuring procedures
- Calibration procedures
- Evaluation procedures
- QA and QC procedures



Field measurements and sampling

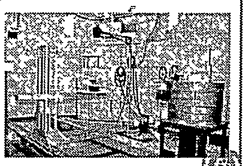
- Techniques
- Preparation and storage of samples
- Coding and record keeping

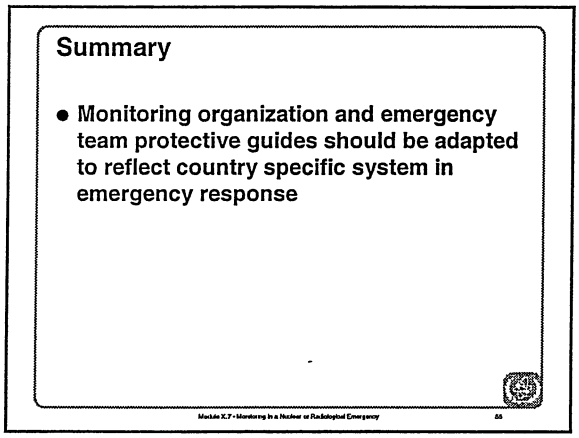


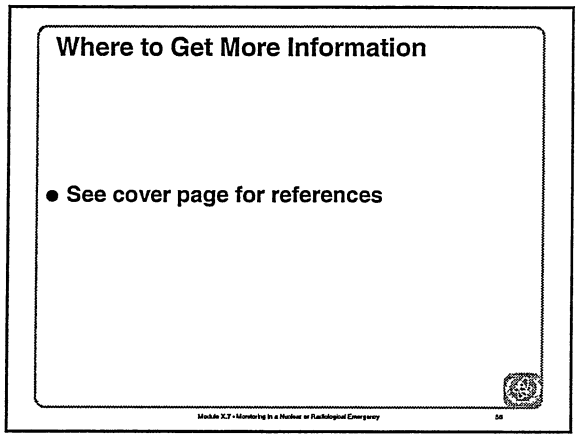


Instrumental Analyses

- Instruments
- Calibrations
- Background evaluations
- Checks of the stability of the instruments
- Field and laboratory records
- Data reporting




Summary
• Monitoring organization and emergency team protective guides should be adapted to reflect country specific system in emergency response


Where to Get More Information
• See cover page for references