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

Intervention for Chronic and Emergency Exposure Situations

Assessment and Response during Radiological Emergency



Radiological Response

Lecture

Introduction

- The most important aspects of managing a radiological emergency:
  - The ability to promptly and adequately determine actions to protect members of the public and emergency workers
  - The ability to take those actions efficiently
- The objective of this lesson is to present major aspects of radiological assessment and response – the tasks of Radiological Assessor



Module X.5 • Assessment and Response during Radiological Emergency 2

Content

- Radiological Assessor
- Emergency radiological monitoring
- Radiation protection support
- Source recovery and decontamination
- Removal of radioactive wastes
- Summary



Module X.5 • Assessment and Response during Radiological Emergency 3

Accident Scenarios

- From an emergency management perspective, accident scenarios may be classified in the following categories:
  - Accidents with radiation sources or material
  - Accidents outside the country with trans-boundary effects, and
  - Nuclear powered satellite re-entry



Module 14 4

Generic Response Organization

RESPONSE INITIATOR
First official being informed of an emergency with authority to initiate a response plan

EMERGENCY MANAGER
Appointed official in charge of overall emergency response

FIRST RESPONDER
First person or team to arrive at the scene of an accident with an official role to play in the accident response

ON-SCENE CONTROLLER
Usually senior member of First Responder team

RADIOLOGICAL ASSESSOR
Usually senior member of a radiological assessment team sent to the scene of an accident

Radiological assessment teams and laboratories

Module X.5 • Assessment and Response during Radiological Emergency 5

Who is Radiological Assessor?

- Radiological professional (qualified expert) sent to the scene of an accident
- He/she may be alone or part of a team
- He/she advises the Emergency Manager on the radiological aspects of the situation



Module X.5 • Assessment and Response during Radiological Emergency 6

Generic Response Tasks

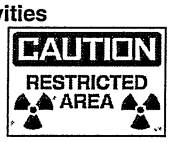
- He/She is responsible for
  - Surveys
  - Contamination control
  - Radiation protection support
  - Formulation of protective action recommendations
  - Setting turn back guidance
  - Estimating and recording the doses received

Generic Response Tasks (Cont'd)

- He/She is also responsible for
  - Source recovery, clean up and decontamination operations
  - Requesting additional radiological assessment resources
  - Carrying out specialized hazard and dose assessment tasks

Radiological Response

- Generic response steps can be divided into three phases:
  - On notification
  - At the scene
  - Post emergency activities



Emergency Radiological Monitoring

- To obtain the data or information required in an emergency
  - Different type of measurements can be performed
  - Different physical quantities can be measured
- The intended uses of the results should guide the choice of monitoring priorities

Objectives of Emergency Monitoring

- To provide information for emergency classification
- To make assessment of the level, degree, nature, extend and duration of the hazards
- To guide decision-makers on the need to take protective actions
- To make assessment of the efficiency of remedial actions

Relevant Monitoring Procedures

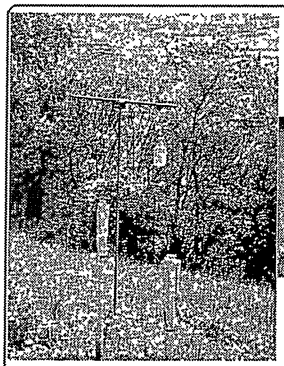
- Source monitoring
- Contamination survey
- Ground deposition survey
- Personal monitoring
- Air sampling
- Gross alpha and beta in air
- In-situ gamma spectrometry
- Sampling and laboratory analysis
- Plum survey
- Environmental dosimetry

Measurements in an Emergency

- Ambient dose rate and dose measurements
- Airborne radionuclide concentration measurements
- Environmental deposition measurements
- Food, water and environmental contamination measurements
- Individual dose measurements
- Object surface contamination measurements

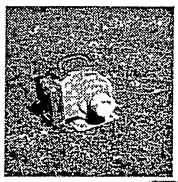
Ambient Dose Rate and Dose Measurements

- These measurements are generally used to support decisions concerning the implementation of various protective actions
- The physical quantity measured:
  - Ambient equivalent dose-rate or dose
- The units used:
  - µSv/h, mSv/h, etc. for external gamma dose-rates
  - µSv, mSv, etc. for integrated doses



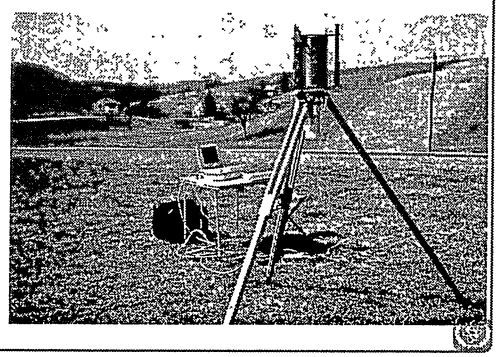
Airborne Radionuclide Concentration Measurements

- Measurements of airborne aerosols and gases are generally made to provide early warning of releases from unmonitored or as-yet unreported sources
- The physical quantity measured:
  - Activity concentration
  - The units used: Bq/m^3, µBq/m^3, mBq/m^3, etc.



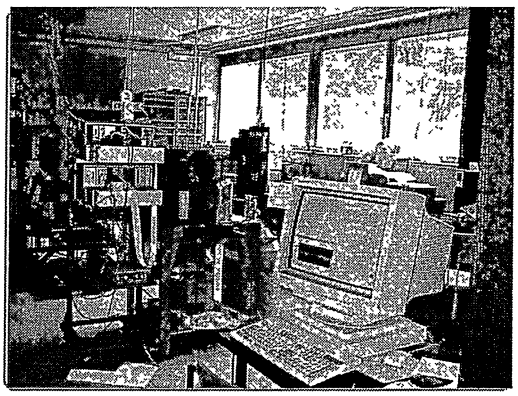
Environmental Deposition Measurements

- Environmental deposition measurements refer to the amount of radioactive material, which has been deposited on ground or surfaces
- The physical quantity measured:
  - Radionuclide specific surface activity
  - The units used: Bq/m^2
- They may also refer to the specific activity of soil, water, or plants; sampling is required
  - The units used: Bq/kg or Bq/l



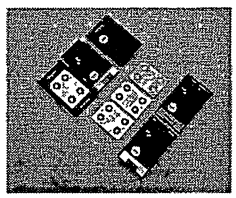
Food, Water and Environmental Contamination Measurements

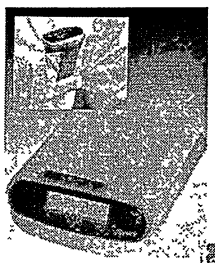
- They are performed to determine food and drinking water contamination
- Sampling and in many cases sample preparation is required
- The physical quantity measured:
  - Activity concentration
- The units used: Bq/kg or Bq/l



Individual Dose Measurements

- Individual doses may arise from
  - External irradiation
  - Intakes of radionuclides, primarily by ingestion or inhalation
- In general, doses to individuals cannot be measured directly
- The physical quantity measured:
  - Effective dose or equivalent dose (if low)
  - Absorbed dose (if high)
- The units used: Sv or Gy and equivalent





Object Surface Contamination Measurements

- To allow the selection of those objects, which should be decontaminated, disposed as waste, or treated, in some other controlled fashion
- The physical quantity measured:
  - Surface activity
- The units used: Bq/m^2 or equivalent



Exposure Pathways For Monitoring Teams

Release to the environment	Unsealed, damaged or leaking source	Sealed source
cloud shine plume inhalation skin contamination ground shine inhalation of re-suspended material (ingestion)	radiation from the source inhalation skin contamination (ingestion)	radiation from the source

Radiation Protection Support

Tasks	Total effective dose guidance [mSv]
Type 1	< 500
Type 2	< 100
Type 3	< 50
Type 4	Occupational exposure guidance

Safety First

- All the field teams may be faced with high external radiation levels, inhalation hazards and problems of surface contamination
- Therefore teams should be well trained and properly equipped with personal protective equipment and be acquainted with turn back guidance



Emergency Worker Basic Instructions

- BE AWARE of turn back guidance
- DO NOT linger in areas where the dose rate is 1mSv/h or greater
- BE CAUTIOUS proceeding to areas where the dose rate is greater than 10mSv/h
- You SHALL NOT proceed to areas in which the dose rates exceed 100mSv/h unless otherwise directed by the Radiological Assessor

Turn Back Guidance

- Emergency worker dose:

  external + inhalation

- Dosimeters can only measure external

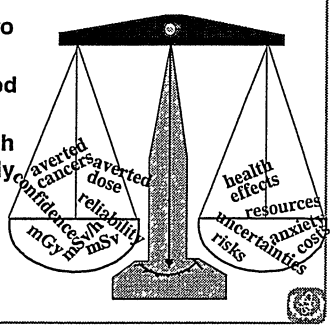


In danger

- An integrated dose reading on a self reading dosimeter indicating that an emergency worker dose guidance has been exceeded and that the emergency worker should leave the areas where further significant dose is possible

Protective Actions

- To justify and to balance
  - Do more good than harm
  - Save as much as reasonably achievable



Source Recovery

- Information needed:
  - Characterization of the scene
  - Identification and quantification of the radioactive material(s) involved
- Output to be achieved:
  - Definition of safety precautions
  - Inventory of required resources
  - Prescribed recovery steps

The Key Factors

- The key factors that determine the scope and feasibility of recovery activities
  - The nature of the accident
  - Physical size and activity level of the source, and
  - The appropriateness of available resources

Recovery Procedure

- Confirm that that all necessary protective actions have been implemented and the location has been stabilized and secured
- Review all available information on the radioactive materials involved
- Confirm the physical state of the radioactive material
- Determine whether available local resources are adequate to assure the safe recovery and packaging of the source

Recovery Procedure (Cont'd)

- Determine whether immediate removal of the source or radioactive materials is necessary or advisable
- Radioactive source container remains intact: determine the size, shape and weight of the container
- Containment is damaged or breached: estimate the quantity of material that must be removed

Recovery Procedure (Cont'd)

- Identify an approved location or repository and ensure that any such location is capable of providing secure storage for the material
- Determine what type of equipment and other resources are required
- Determine allowable dose rates for emergency workers
- Ascertain whether personnel protective equipment appropriate to the hazard is available
- Assure the availability of proper containers, shielding, etc.

Recovery Procedure (Cont'd)

- Assess whether contained materials (sealed sources or waste in un-breached containers) can be safely recovered with existing resources
- Ask on-scene authorities what types of equipment are readily available for recovery activities
- Select the mitigation process

What to Do?
Alternatives

- Remove the source materials and attempt to decontaminate the area
  - Example: a radiopharmaceutical spill
- Remove the largest concentrations of contaminated material and seal the site, leaving the remainder in place to decay
  - Example: accident in a remote area
- Remove amounts of contaminated material until activity levels in the area are at or near background
  - Example: contaminated environment in populated area, migration in soils or ground water possible

Recovery Procedure (Cont'd)

- Develop a step-by-step procedure for initiating the cleanup operations
- Instruct workers at the scene regarding the proper protocols for handling the radioactive elements
- Ensure that radiological monitoring capability is in place for constant survey
- Record all information as it is gathered

Recovery Procedure (Cont'd)

- Ensure that all packages containing radioactive materials are properly labelled and identified
- Conduct another survey of the area to ensure that no portions of the site continue to exhibit readings above the prescribed clearance levels

Decontamination of People and Equipment

- Basic on-scene decontamination:
  - It reduces the potential for continuing individual exposure from contamination
  - Limits the potential for the spread of contamination beyond the scene
  - Allows for the reuse of response equipment for other emergencies

General Rule

- Detectable contamination levels greater than twice background indicate decontamination should be attempted
- Two types
  - Simple decontamination
  - Impounded decontamination

Needed Information

- Radiological Assessor needs
  - Information regarding the type and activity level of the radioactive material involved
  - Results of monitoring surveys of people, essential equipment and vehicles

to prepare guidance on decontamination activities

Removal of Radioactive Wastes

- Radioactive wastes might be generated as a result of an emergency situation
- Such wastes may include
  - Sources whose ownership cannot be determined
  - Unconfined radioactive material, and
  - Environmental material or material contaminated during the response to a radiation accident

General Considerations

- The removal methodology, required recovery equipment, and transport mechanisms must be determined in relationship to
  - The quantity of radioactive material involved
  - Its activity levels, and
  - The availability of either interim or long-term storage facilities within the jurisdiction in which the waste is generated

Needed Information

- Radiological Assessor needs information on
  - Quantification and inventory of the wastes involved by category
  - The availability of safe transport means, proper packaging, and storage options

to make recommendations for removal

The Process

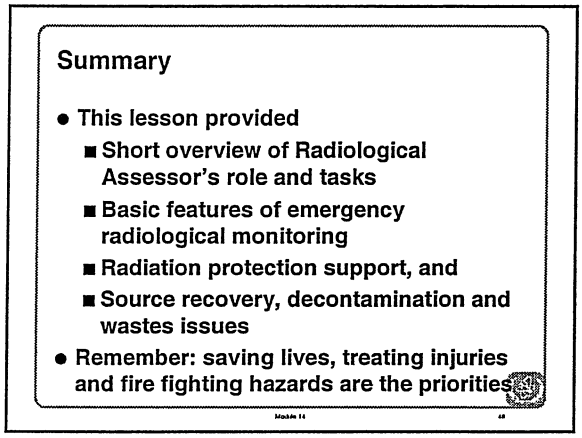
- Assess the need for removal of waste materials; categorise wastes by type, level of activity, and volume
- Determine the availability of appropriate disposal or storage facilities for each category of waste material (in consultation with the Emergency Manager)

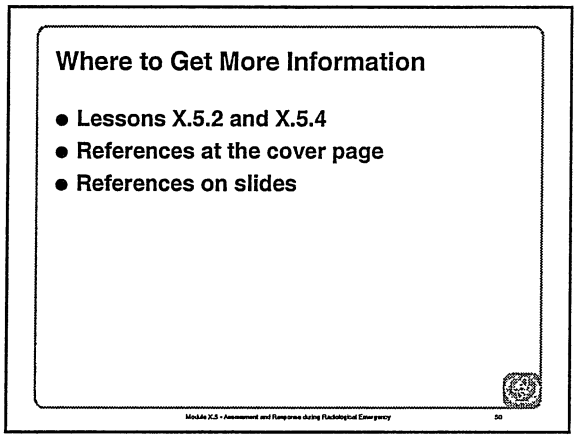
The Process (Cont'd)

- Identify the requirements for packaging each category or type of waste for transport from the emergency scene, and determine whether such packaging is readily available or can be reasonably obtained
- Determine the appropriate means to transport the wastes from the emergency scene to the designated storage or disposal site

The Process (Cont'd)

- Document information about each packaged quantity of waste material prior to shipment
- Resurvey the area and catalogue any remaining areas where activity levels exceed normal background; such areas should be secured to prevent unauthorised access


Summary
This lesson provided
Short overview of Radiological Assessor's role and tasks
Basic features of emergency radiological monitoring
Radiation protection support, and
Source recovery, decontamination and wastes issues
Remember: saving lives, treating injuries and fire fighting hazards are the priorities


Where to Get More Information
Lessons X.5.2 and X.5.4
References at the cover page
References on slides