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IAEA Training in Emergency Preparedness and Response

Radiation Emergencies – Common Features

Protecting Emergency Workers

Lecture
Introduction

- In radiation emergency, emergency workers will be or could be exposed to radiation
- Protection of emergency workers is based on principles of ICRP’s system of radiation protection and IAEA BSS
- Aim of this lecture is to present those principles and practical instructions for protection of emergency workers
Content

- Basic principles of radiation protection in an emergency
- Exposure pathways for emergency workers
- Personal dosimetry
- Personal protection guides and instructions
- Personal protective equipment and control point
- Summary
Overview

- **31 emergency workers** (on-site and off-site fire brigade) received lethal doses at Chernobyl
  - Did not monitor their dose
  - Were not trained
  - Did not have dose limits or guidelines

To prevent such tragedies in future, protection of emergency workers must be part of any emergency planning.
Basic Principles of Radiation Protection

- The principles of radiation protection and safety are presented in the *International Basic Standards for Protection against Ionizing Radiation and for the Safety of Radiation Sources* Safety Series No. 115, IAEA, Vienna (1996) BSS

- BSS lay out the principles of radiation protection when undertaking an intervention
Undertaking Intervention (BSS)

- Workers who undertake actions in which the dose may exceed the maximum single year dose limit (emergency workers):
  - shall be volunteers
  - shall be clearly and comprehensively informed in advance of the associated health risk, and
  - shall, to the extent feasible, be trained in the actions that may be required
Undertaking Intervention (1)

- All reasonable steps shall be taken
  - to provide appropriate protection during the emergency intervention, and
  - to assess and record the doses received by workers involved in emergency intervention

- When the intervention has ended, the doses received and the consequent health risk shall be communicated to the workers involved
Total Effective Dose Guidance (BSS)

- No worker undertaking an intervention shall be exposed in excess of the maximum single year dose limit for occupational exposure, except:
  - for the purpose of saving lives or prevent serious injury
  - if undertaking actions intended to avert a large collective dose, or
  - if undertaking actions to prevent the development of catastrophic conditions
Total Effective Dose Guidance (1)

- **Type 1 tasks** - below 500 mSv
  - Life saving actions
  - Prevention of core damage
  - Prevention of a large release
- **Type 2 tasks** - below 100 mSv
  - Prevent serious injury
  - Avert a large collective dose
  - Prevent the development of catastrophic conditions
  - Recovery of reactor safety system
  - Off-site ambient dose rate monitoring
Total Effective Dose Guidance (2)

- **Type 3 tasks - below 50 mSv**
  - Short term recovery operations
  - Implement urgent protective actions
  - Environmental sampling

- **Type 4 tasks - Occupational exposure guidance (BSS)**
  - Longer term recovery operations
  - Work not directly connected with an accident
Exposure Pathways for Emergency Workers

Release into environment

- cloud shine
- plume inhalation
- skin contamination
- ground shine
- inhalation of re-suspended material
- (ingestion)

Unsealed, damaged or leaking source

- radiation from the source
- inhalation
- skin contamination
- (ingestion)

Sealed source

- radiation from source
Two Types of Equipment

- **Measuring devices**
  - Active monitoring : Passive
  - Personal : Environmental
  - Fixed : Portable

- **Contamination control barriers**
  - Anti-contamination clothing
  - Respiratory protection
Personal Dosimeters

- **Types:**
  - **Passive:** TLD or film body badges
  - **Active:** Pocket ion chamber and electronic pocket dosimeters

- None of the above dosimeters can detect low energy beta emitters
- Passive dosimeters cannot be used for contamination surveys
- Alarms and turn back values
Thermo Luminescent Dosimeters - TLD

- Crystalline material
- Excited electrons remain in metastable state until heated
- Heating releases electrons
- Reusable but no permanent record
- Dose rate response curve is flat
- Dose response does not saturate
Thermo Luminescent Dosimeters - TLD

Filters

Chips
Electronic Personal Dosimeter

- Similar to PIC
- Reads dose or dose rate
- Alarms for dose or dose rate
- No permanent record
Personal Protection Guidance

- Emergency worker personal protection guidance is given in three areas:
  - general instructions
  - thyroid protection, and
  - emergency worker turn back guidance
General Instructions

- **ALWAYS** be aware of the hazards that you may encounter in the field and take the necessary precautions.

- **NEVER** attempt any field activities without the appropriate safety equipment; always know how to use it.

- All activities **SHALL BE** conducted so that exposures are maintained as low as reasonably achievable.
General Instructions (1)

- **BE AWARE** of turn back levels

- **DO NOT** linger in areas where the dose rate is **1 mSv/h** or greater

- **DO NOT** proceed to areas where the dose rate is greater than **10 mSv/h** unless otherwise directed by the Radiological Assessor or Environmental Analyst.
General Instructions (2)

- You **SHALL NOT** proceed to areas in which the dose rates exceed **100 mSv/h** unless otherwise directed.
- **USE** time, distance and shielding to protect yourself.
- **PRE-PLAN** entry into high dose rate areas in conjunction with your supervisor.
- **DO NOT** take unnecessary risks.
- **WHEN** in doubt seek advice from your team leader or coordinator.
Thyroid Protection

- Take a stable iodine tablet when instructed to do so by your field controller/supervisor (tablets should be provided in your kit)
- Record the fact that you have taken a tablet in your personal dose record form
- If exposure is ongoing over several days, take a further tablet when instructed to do so
Caution

- For iodine prophylaxis to be effective, the dose should be administered prior to exposure or within a few hours (around four) of exposure.
- Administration of stable iodine more than eight hours after exposure is ineffective and can be counterproductive.

Effectiveness of thyroid blocking afforded by 100 mg of iodine (130 mg of KI)
Emergency Worker Turn Back Guidance

- Emergency worker turn back guidance values are given as an integrated external dose on a self reading dosimeter
  - Emergency workers should take all reasonable efforts not to exceed these values

- Emergency worker turn back doses are to serve as guidance and not limits; judgment must be used in their application
### Default Values

<table>
<thead>
<tr>
<th>TASKS</th>
<th>EWG [mSv]</th>
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<tr>
<td>Life saving actions</td>
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<td>Prevention of core damage or of a large release</td>
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<td>Prevent a serious injury</td>
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<td>Avert a large collective dose</td>
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<td>Prevent the development of catastrophic conditions</td>
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<td>Recovery of reactor safety systems</td>
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<td>Off-site ambient dose rate monitoring (gamma)</td>
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<td>Short term recovery operations</td>
<td>&lt; 25</td>
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<td>Implement urgent protective actions</td>
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<td>Environmental sampling</td>
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<td>Longer term recovery operations</td>
<td></td>
</tr>
<tr>
<td>Work not directly connected with an accident</td>
<td>Occup. exp. guidance</td>
</tr>
</tbody>
</table>

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Contamination Control

- Emergency personnel entering accident area where spill or airborne release has occurred need to be checked on leaving contaminated area for personal skin and protective clothing contamination.
- Their equipment and vehicles should also be checked.
- Contamination limits:
  - General beta/gamma emitters: 4 Bq/cm²
  - Less toxic alpha emitters: 4 Bq/cm²
  - More toxic alpha emitters: 0.4 Bq/cm²
Contamination Control Barriers

- **External barriers**
  - prevents contamination of skin
  - helps minimize spread of contamination
  - does not provide protection against external exposure

- **Internal barriers**
  - prevents contamination from entering the body
  - requires specialized equipment
External Barriers = Anti-Cs

- Cotton Gloves
- Overalls
- Shoe Covers
- Vinyl Gloves
- Hood
- Foul weather gear
Internal Barriers = Respirators

- Dust filters
- Half-face respirator
- Full-face respirator
- Self contained breathing apparatus
- Air Supplied Hoods
Control/Check Point

On-Scene Response

- Safety Perimeter at 100 uSv/h
- Outer cordoned area
- Inner cordoned area
- Decontamination area
- Medical response base
- Vehicle marshalling area
- Reception Area for Response Personnel
- Media Reception Area
- Command Post
- Staging Area
- Receiving Area for Response Personnel
- Media Reception Area
- Vehicle marshalling area
- Radiological Assessor base
- Control/Check Point
- Control/Check Point
- On-Scene Response

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Control/Check Point

HAZMAT PROCEDURE

Disposal of equipment
Shower
Undressing/Dressing (gloves & overshoes)
Undressing (LAYER-3)
Undressing (LAYER-2)
Final Check (LAYER-1)

Air Supply

STATION 1
STATION 2
STATION 3
STATION 4
STATION 5
STATION 6
STATION 7

CLEAN LINE
DIRTY LINE
Protection From Non Radiological Hazards

- **Fire fighting protective equipment:**
  - appropriate protective clothing
  - breathing masks
  - self air set

- **Water flow personal protection:**
  - waterproof suits
  - impermeable boots

- **Protection in building destruction action**
  - crash helmets
Summary

- BSS lay out the principles of radiation protection when undertaking an intervention

- Personal protection equipment (PPE) provide barriers to protect emergency worker from external and internal contamination

- Emergency workers should be trained in radiation protection and they should understand the risks they face
Where to Get More Information

- See references on cover page of this lecture