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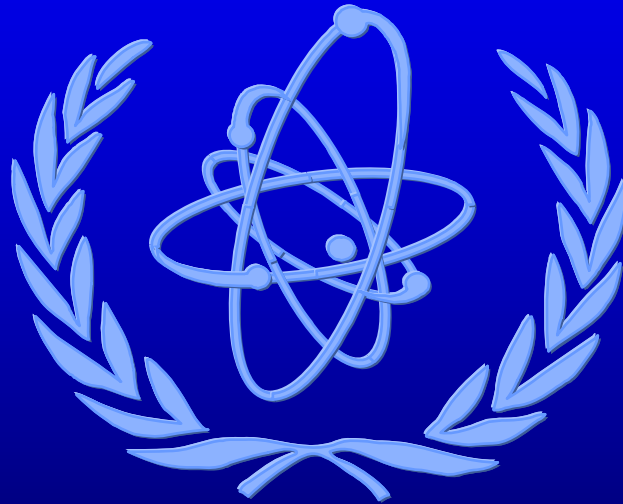
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# Radiation Emergencies – Common Features



## 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

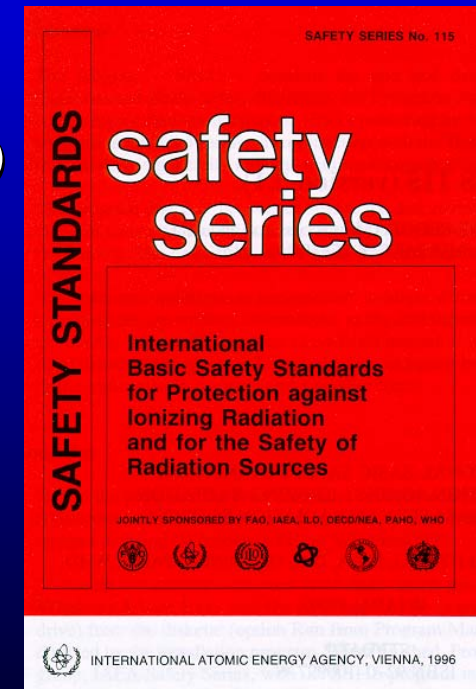
- **31 emergency workers** (on-site and off-site fire brigade) received lethal doses at Chernobyl
  - **Did not monitor their dose**
  - **Were not trained**
  - **Did not have dose limits or guidelines**



**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



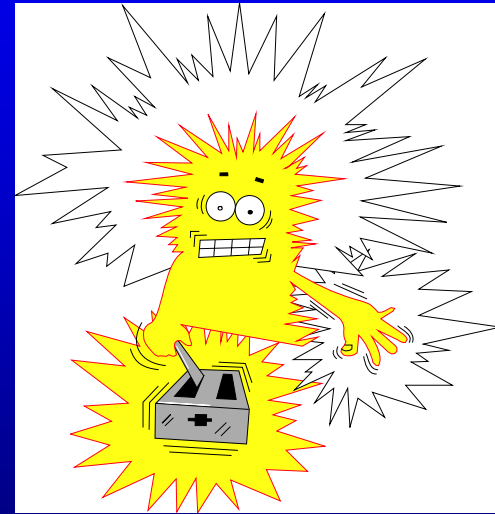
# Undertaking Intervention (BSS)

- **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

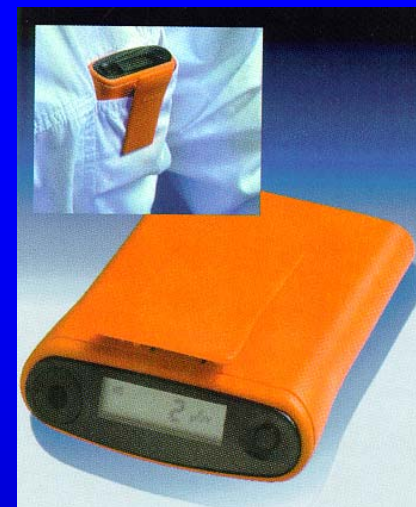


# Two Types of Equipment

- **Measuring devices**
  - **Active monitoring : Passive**
  - **Personal : Environmental**
  - **Fixed : Portable**
  
- **Contamination control barriers**
  - **Anti-contamination clothing**
  - **Respiratory protection**



# Personal Dosimeters



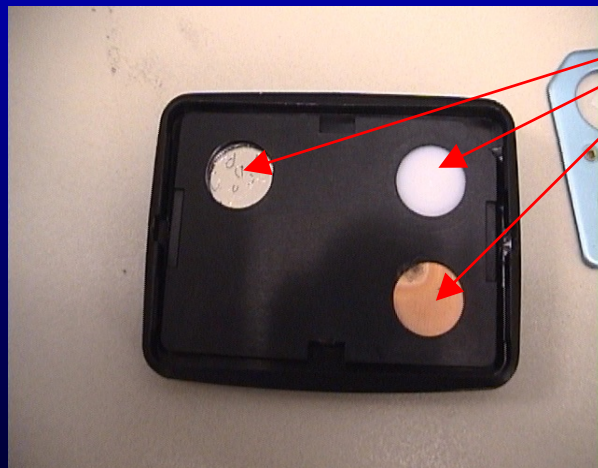
- **Types:**
  - **Passive:** TLD or film body badges
  - **Active:** Pocket ion chamber and electronic pocket dosimeters
- **None of the above dosimeters can detect low energy beta emitters**
- **Passive dosimeters cannot be used for contamination surveys**
- **Alarms and turn back values**



# 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**



**SMILE**

**In danger**



# 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



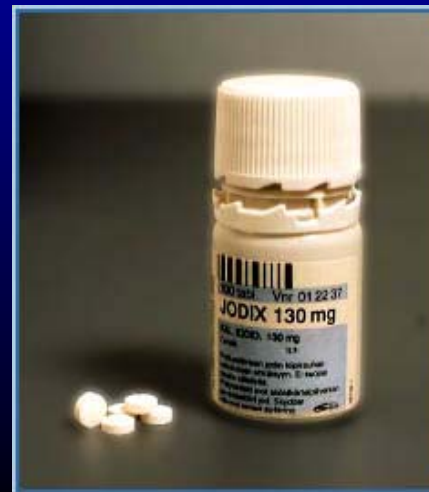
## General Instructions (2)

- 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



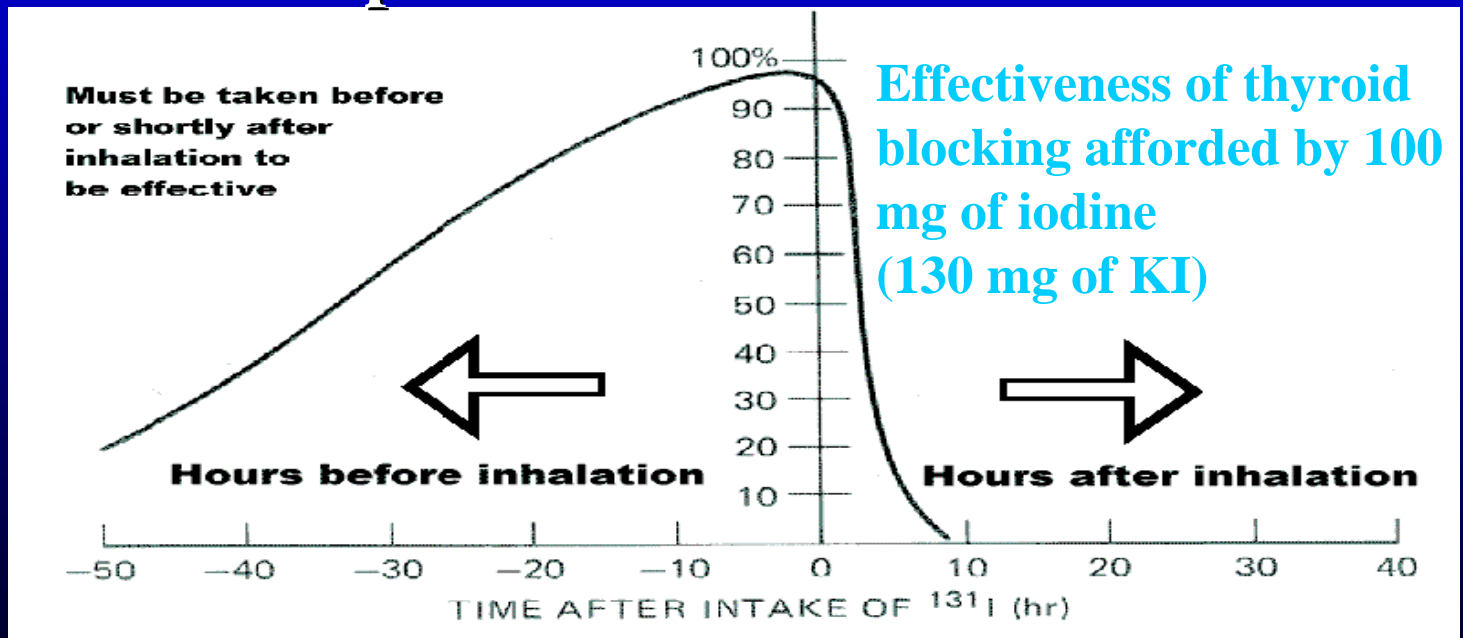
# Thyroid Protection

- **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



# 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

TASKS	EWG [mSv]
<b>Life saving actions</b> <b>Prevention of core damage or of a large release</b>	<b>250</b>
<b>Prevent a serious injury</b> <b>Avert a large collective dose</b> <b>Prevent the development of catastrophic conditions</b> <b>Recovery of reactor safety systems</b> <b>Off-site ambient dose rate monitoring (gamma)</b>	<b>&lt; 50</b>
<b>Short term recovery operations</b> <b>Implement urgent protective actions</b> <b>Environmental sampling</b>	<b>&lt; 25</b>
<b>Longer term recovery operations</b> <b>Work not directly connected with an accident</b>	<b>Occup. exp. guidance</b>



# 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/cm<sup>2</sup>**
  - **Less toxic alpha emitters: 4 Bq/cm<sup>2</sup>**
  - **More toxic alpha emitters: 0.4 Bq/cm<sup>2</sup>**



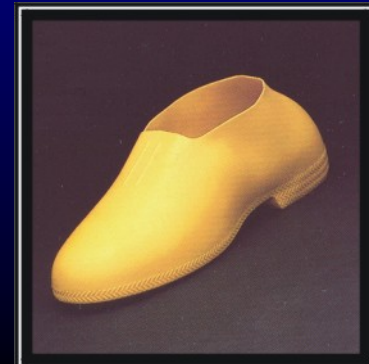
# Contamination Control Barriers

- **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**



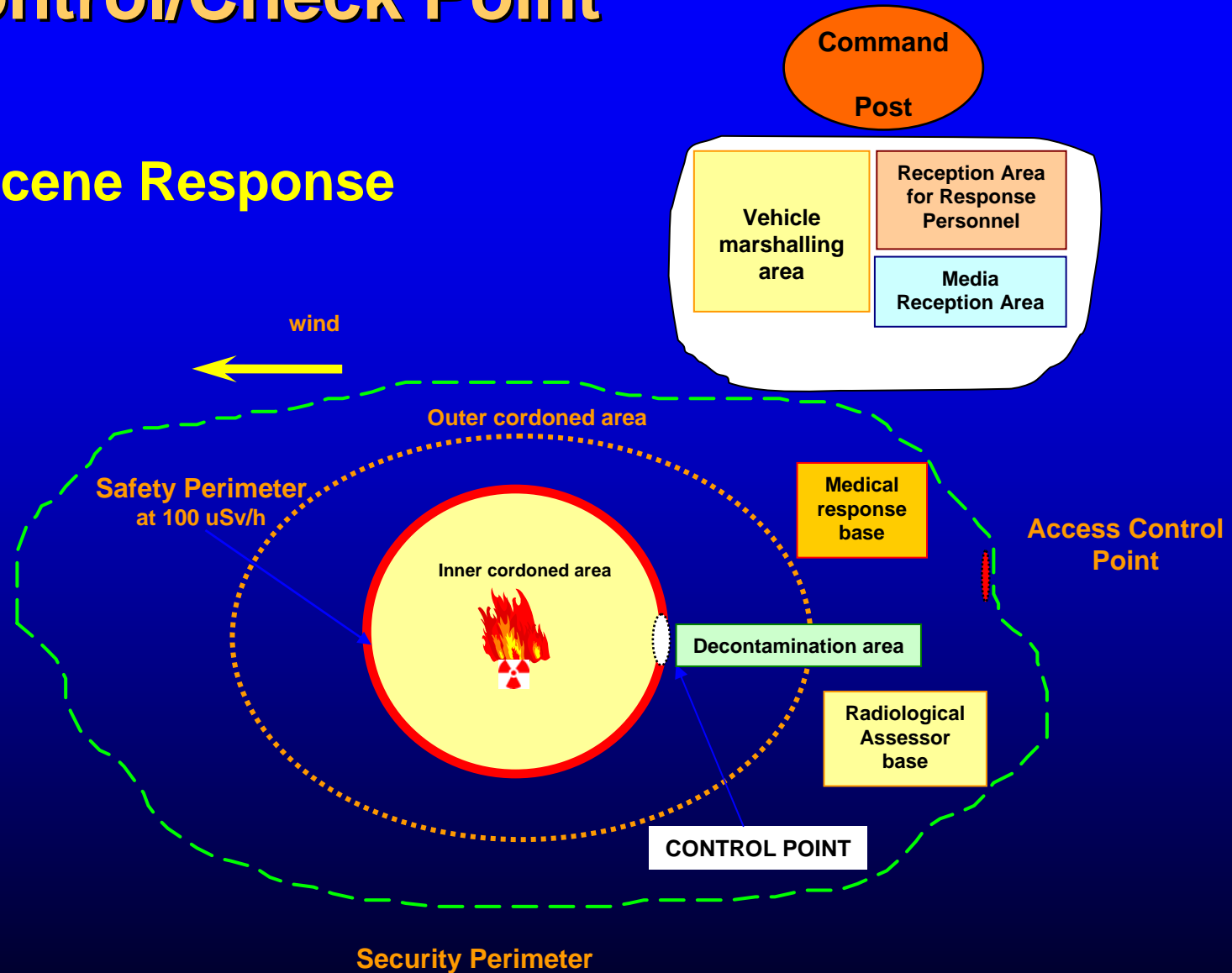




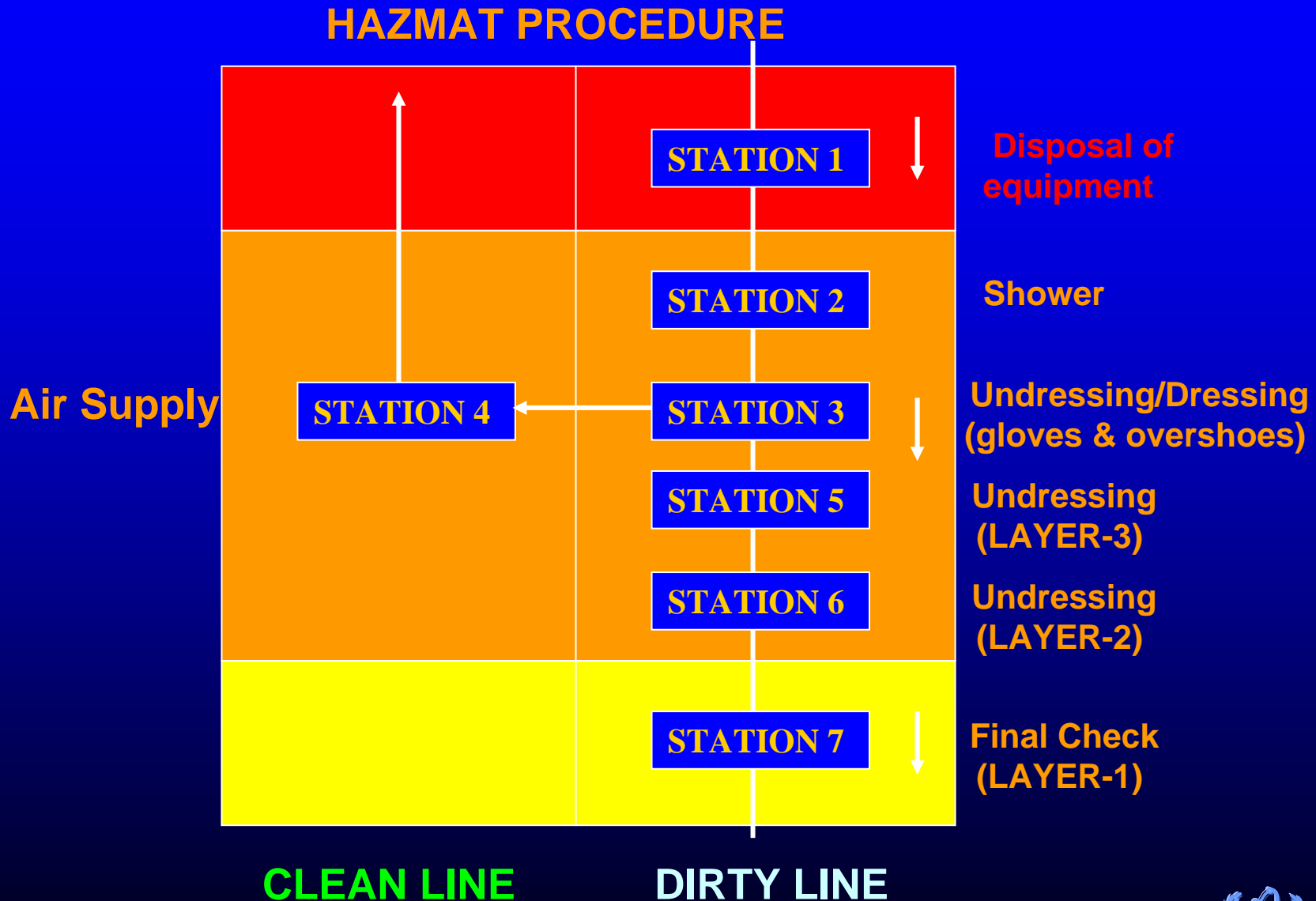


# Control/Check Point

## On-Scene Response



# Control/Check Point





# 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**

