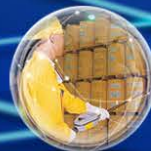


# ***IAEA-KINS Workshop on Radiation Safety and Emergency Response in the Medical or Industrial Use of Radiation***

## ***Radiological Emergency Response Management***



***June 12, 2019***



**한국원자력안전기술원**  
KOREA INSTITUTE OF NUCLEAR SAFETY

# Emergency Response Management Introduction



## ❑ ***Radiological emergencies can occur anywhere and include:***

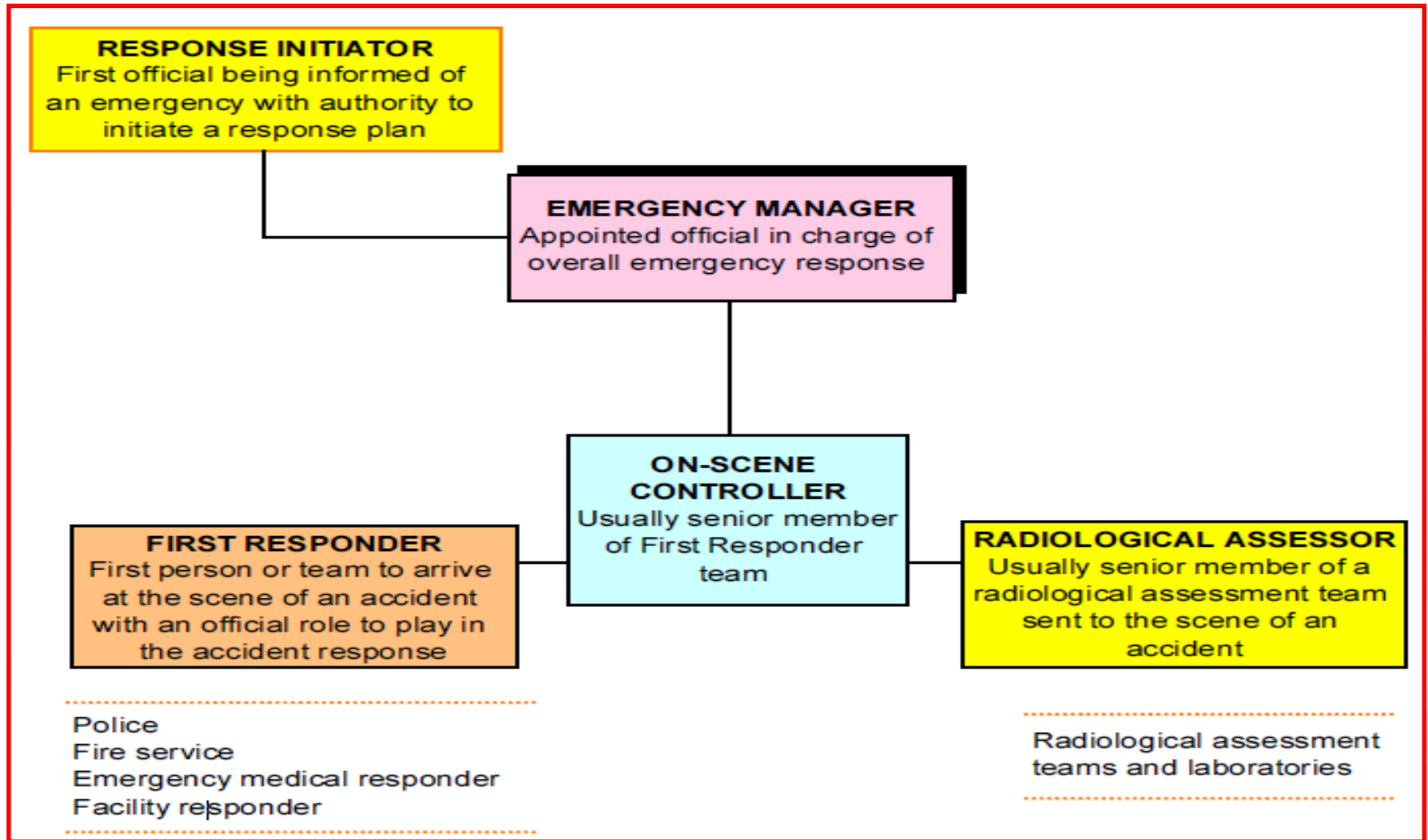
- Uncontrolled (abandoned, lost, stolen or found) dangerous sources
- Misuse of dangerous industrial and medical sources
- Public exposures and contamination from unknown origins
- Serious overexposures
- Malicious threats/acts
- Transport emergencies..

## ❑ ***This Lecture***

- provides **generic procedures** needed for **initial response to a non-reactor radiological emergency.**
- is consistent with the **IAEA Safety Requirements No. GS-R-2 (2002), IAEA-TECDOC-1162 (2000), IAEA-EPR-First responders(2006)**

# Response Organization

$$E = mc^2$$



# General Initial Response Procedure

$$E = mc^2$$



## Notification

- obtains initial information
- decides if it is a radiological one
- initiates the response by alerting/activating the emergency manager

## Hazard Assessment

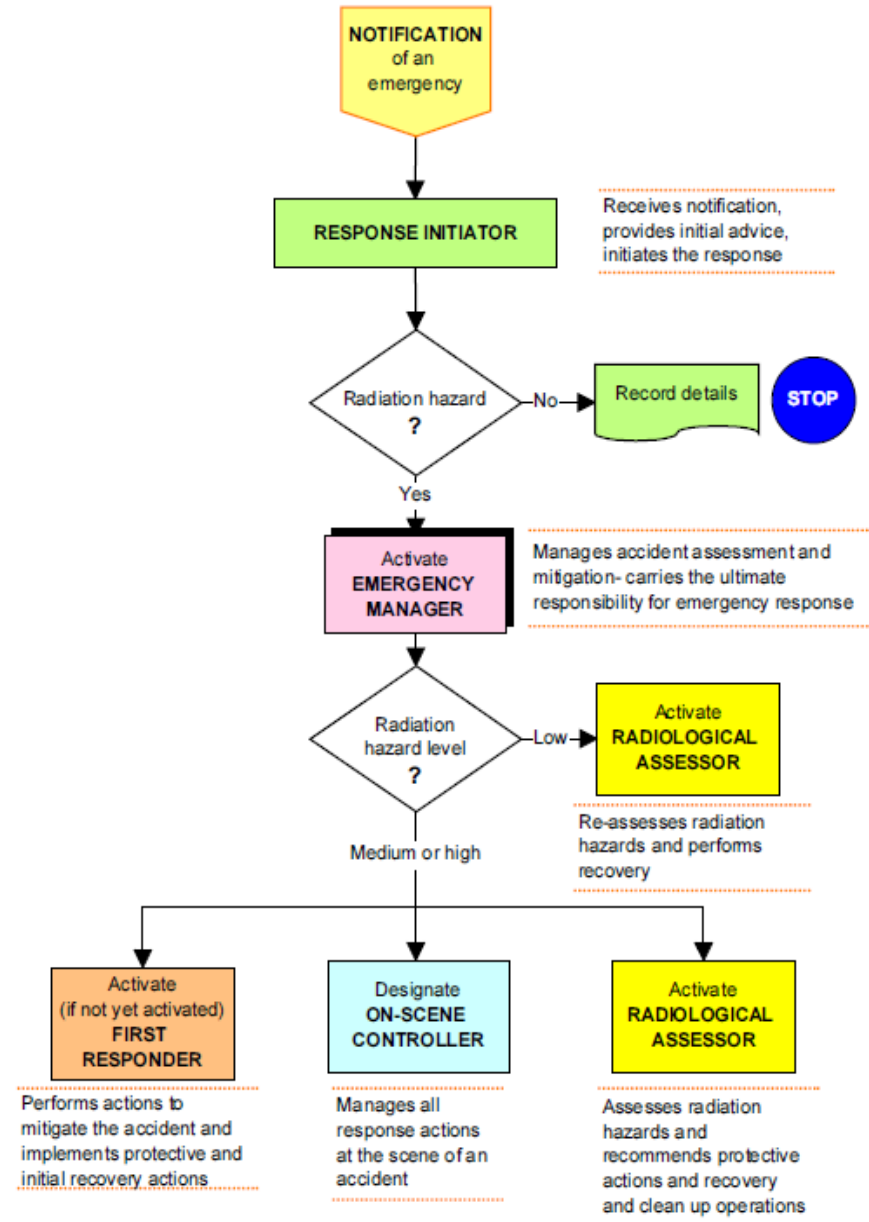
- assesses the level of the present or suspected hazard

## Local/national response organization

- determines whether the emergency is serious enough
- has a sufficient public interest to warrant sending a national level

## Providing Information

- overall response must cater for providing information to the media and the public.



## ☐ Indications of a **possible radiological emergency(hazard)**:

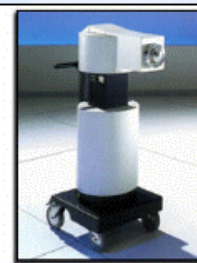
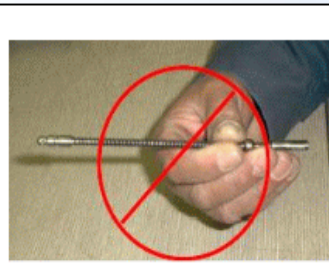
- Credible threats or threatening messages.
- Device that appears intended to spread contamination.
- Signs of possible contamination (e.g. spill).
- Gamma dose rates:  $> 100 \mu\text{Sv/h}$  at 1 m from object or at 1m above the ground.
- Medical symptoms of radiation injuries (such as burns without an apparent cause).
- Building / area marked with the **radiation symbol**
- Results of assessment of a radiological assessor.
- Neutron radiation.
- Dangerous source that is lost, stolen, damaged, in a fire, leaking, or potentially involved in a terrorist act or explosion.





## ☐ Indications of a **dangerous source**:

- A heavy container with the radiation symbol
- Item with labels of packages.
- Item with transport UN numbers or markings.
- Device used for cancer treatment (teletherapy or brachytherapy).
- Radiography cameras or sources.
- Well logging sources used in drilling operations.
- Dangerous quantity of material (> D-value), as assessed by a radiological assessor.

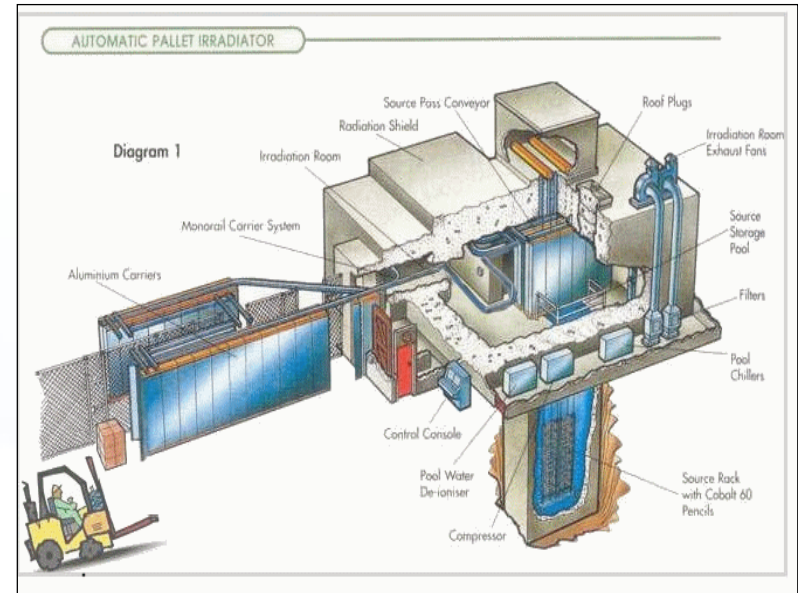


# Hazard Assessment

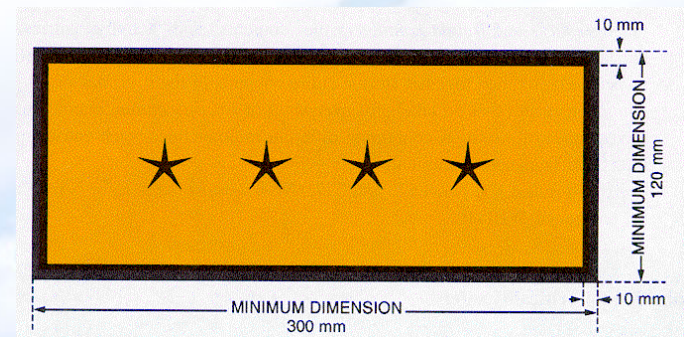
$$E = mc^2$$



## ☐ Indications of a **dangerous source**:



UN Number marking	Possible other marking	Hazard
2908, 2909, 2910, 2911	None	<b>Not dangerous</b>
2912, 2913, 3321, 3322, 3324, 3325, 3326	Type IP-1, Type IP-2, LSA, SCO	<b>Possibly dangerous</b> if material is inhaled or ingested
2915, 3327, 3332, 3333	Type A	<b>Possibly dangerous</b>
2916, 2917, 3328, 3329	Type B(U), Type B (M)	
3323, 3330	Type C	

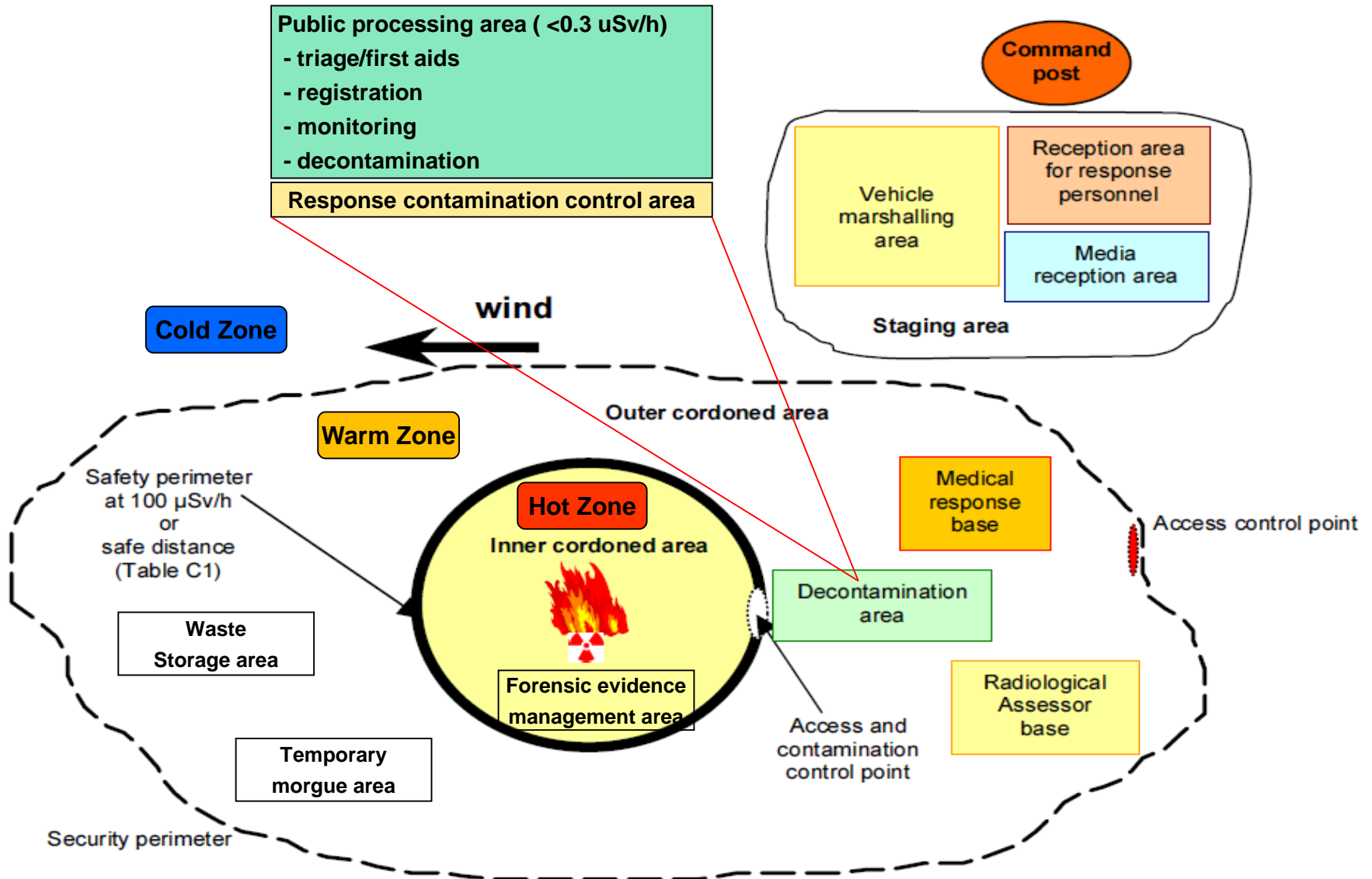


# Establishment of Cordoned Area etc.

$$E = mc^2$$



## Generic layout of the response facilities and locations within areas





# Establishment of Cordoned Area etc.

$$E = mc^2$$



## ❑ Generic layout of the response facilities and locations within areas

Area/location/facility	Description/Functions
Inner cordoned area	Area around a dangerous radioactive source where precautions should be taken to protect responders and the public from potential external exposure and contamination. <i>safety perimeter.</i>
Outer cordoned area	Secured area around the inner cordoned area. <i>security perimeter.</i>
Incident command post (ICP)	Location of the IC and other members of the unified command and support staff.
Forensic evidence management area	Location for the supervised processing, recording, examination and photography of items and evidence recovered from the scene
Public information center (PIC)	Location for the coordination of all official information released to the media concerning the emergency.
Public processing area	Location for processing and registering the public evacuated from the inner cordoned area; - medical triage, first aid and preparation of victims for transport - monitoring and decontamination of the public evacuated
Response contamination control area	Location for the control of contamination from response personnel entering and leaving
Staging area	Location used to collect and organize additional resources in the vicinity of the emergency.
Temporary morgue area	Location for the dignified storage of deceased victims - may be contaminated or have not been released by the forensic team.
Waste storage area	Location where potentially contaminated items (e.g. clothing) are stored.

# Establishment of Cordoned Area etc.

$$E = mc^2$$



## ❑ Suggested radius of inner cordoned area

Situation	Initial inner cordoned area (safety perimeter)
Initial determination — outside	
Unshielded or damaged potentially dangerous source	30 m around
Major spill from a potentially dangerous source	100 m around
Fire, explosion or fumes involving a potentially dangerous source	300 m radius
Suspected bomb (potential RDD) exploded or unexploded	400 m radius or more to protect against an explosion
Initial determination — inside a building	
Damage, loss of shielding or spill involving a potentially dangerous source	Affected and adjacent areas (including floors above and below)
Fires or other event involving a potentially dangerous source that can spread materials throughout the building (e.g. through the ventilation system)	Entire building and appropriate outside distance as indicated above
Expansion based on radiological monitoring	
Ambient dose rate of 100 $\mu\text{Sv/h}$ Beta/gamma surface contamination of 1,000Bq/cm <sup>2</sup> Alpha surface contamination of 100Bq/cm <sup>2</sup>	Wherever these levels are measured

# Personnel Protection Guidelines

$$E = mc^2$$



## □ 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.
- BE AWARE of turn back levels. Emergency worker turn back doses are to serve as guidance and not limits. Judgement must be used in their application.
- 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 100 mSv/h unless otherwise directed by the radiological assessor.
- USE time, distance and shielding to protect yourself.
- PRE-PLAN entry into high dose rate areas in conjunction with your supervisor.
- DO NOT eat, drink, or smoke in any contaminated areas.
- WHEN in doubt seek advice from your team leader or coordinator.

# Personnel Protection Guidelines

$$E = mc^2$$



## ❑ When gamma dose rate is known:

- Follow general personnel protection guidelines
- If ambient dose rate in a particular area is greater than 100 mSv/h:
  - Perform only life saving actions, Limit total time of staying there to < 30 minutes
- Do not proceed into area with an ambient dose rate of greater than 1000 mSv/h unless directed by radiological assessor

## ❑ When self-reading dosimeters are being used

- Make all reasonable efforts not to exceed [emergency worker turn-back dose guidance](#).

***Caution:** Self-reading dosimeters do not measure the dose from inhalation, ingestion or skin contamination; consequently responders must also follow all [general personnel protection guidelines](#) to limit the dose from these pathways.*

## ❑ Thyroid protection

- Take a stable iodine tablet when instructed to do so by your field controller/supervisor

*Some accidents may involve the release of radioactive iodine. In such cases, thyroid is the critical organ and stable iodine can be used to block the uptake of radioactive iodine.*



# Personnel Protection Guidelines

$$E = mc^2$$



## ❑ EMERGENCY WORKER TURN BACK DOSE GUIDANCE

Task	EWG[mSv)*
<b>Life saving actions</b> <ul style="list-style-type: none"><li>• rescue from immediate threats to life;</li><li>• provision of first aid for life threatening injuries;</li><li>• prevention/mitigation of conditions that could be life threatening.</li></ul>	1000
<b>Actions to prevent severe health effects or injuries</b> <ul style="list-style-type: none"><li>• evacuation/protection of the public;</li><li>• environmental monitoring of populated areas to identify where evacuation, sheltering or food restriction are warranted;</li><li>• rescue from potential threats of serious injury;</li><li>• immediate treatment of serious injuries;</li><li>• urgent decontamination of people.</li></ul> <b>Actions to prevent the development of catastrophic conditions</b> <ul style="list-style-type: none"><li>• prevention or mitigation of fires, etc;</li><li>• apprehension of terrorist suspects.</li></ul>	500
<b>Actions to avert a large collective dose</b> <ul style="list-style-type: none"><li>• environmental sample collection and analysis for environmental monitoring of populated areas;</li><li>• localized decontamination if required to protect the public.</li></ul>	50

# Personnel Protection Guidelines

$$E = mc^2$$



## □ Guidance for occupational exposure

Task	Dose guidance value
<b>Rescue operations*</b> <ul style="list-style-type: none"><li>• Saving life, preventing serious injury, or actions to prevent the development of catastrophic conditions</li></ul>	<p>In principle, no dose restrictions are recommended if, and ONLY IF, the benefit to others clearly outweighs the rescuers own risk. Otherwise, every effort should be made to avoid deterministic effects on health</p> <ul style="list-style-type: none"><li>- effective doses below 1000 mSv should avoid serious deterministic health effects</li><li>- below ten times the maximum single year dose limit should avoid other deterministic health effects</li></ul>
<ul style="list-style-type: none"><li>• Other immediate and urgent actions to prevent injuries or large doses to many people</li></ul>	<p>All reasonable efforts should be made to keep doses below twice the maximum single year limits</p>
<b>Other operations, including recovery and restoration operations</b>	<p>Normal occupational dose limits apply; i.e.:</p> <ul style="list-style-type: none"><li>• a limit on effective dose of 100 mSv in 5 years (average 20mSv/y) and should not exceed 50 mSv in any single year</li><li>• the equivalent dose should not exceed<ul style="list-style-type: none"><li>- 150 mSv for the lens of the eye,</li><li>- 500 mSv for the skin (average dose over 1 cm<sup>2</sup> )</li><li>- 500 mSv for the hands and feet</li></ul></li></ul>

# Public Protection Guidelines

$$E = mc^2$$

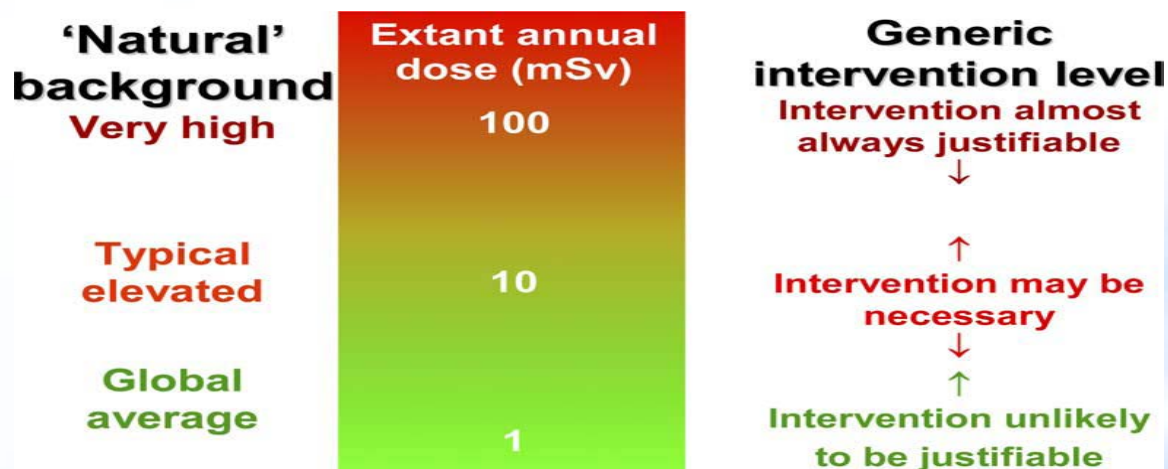


## ☐ Recommended avertable doses for undertaking countermeasures

Countermeasure	Avertable dose
Sheltering	~10 mSv in 2 days (of effective dose)
Temporary evacuation	~50 mSv in 1 week (of effective dose)
Iodine prophylaxis (if radioiodine is present)	~100 mSv (of equivalent dose to the thyroid)
Relocation	~1000 mSv or ~100 mSv first year (of effective dose)

ICRP 96 Protecting people against radiation exposure in the event of a radiological attack

## ☐ Recommended generic criteria for intervention in prolonged exposure situations



ICRP 82 Protection of the public in situations of prolonged radiation exposure

# *Recovery/Removal of Radioactive Material*



## **□ GENERAL INSTRUCTIONS**

- Before recovery, confirm that that all necessary protective actions have been implemented and the location has been stabilized and secured
- Review all available information on the identity, quantity, and physical properties of the radioactive materials
- Identify an approved location or repository to which the source material is to be sent
- determine what type of equipment and other resources are required (e.g. shovels, bucket loader, dump truck, barrels etc.)
- Develop a step-by-step procedure and proper protocol for handling RM
- Ensure that radiological monitoring capability is in place
- Ensure that all packages containing radioactive materials are properly labelled and identified
- Once removing RM, conduct another survey of the area to ensure that no portions of the site continue to exhibit readings above the prescribed clearance levels.



# *Recovery/Removal of Radioactive Material*



## ❑ Recovery Video of Orphan Source(Sr-90) in Georgia



# Public decontamination

$$E = mc^2$$



## **Caution:**

*Do not delay transport of seriously injured victims because of decontamination procedures. Perform the following to prevent the spread of contamination*

*: remove their outer clothing, wrap them in a blanket and tag as possibly contaminated. If decontamination area can not be promptly established, the public should be reminded to shower and change clothing as soon as possible and to listen for official instructions and then should be sent home (released).*

## **❑ Instructions for performing immediate decontamination**

- Wear gloves and protective clothing as available, changing gloves regularly. Periodically get monitored. If contaminated to levels  $>1 \mu\text{Sv/h}$ , get decontaminated
- Keep families together and ask adults to assist children or others (if possible)
- Instruct the people as follows depending on the level of decontamination being performed:
  - **Field decontamination**
  - **Full decontamination**



# *Public decontamination*

$$E = mc^2$$



## **☐ Instructions for performing immediate decontamination**

- Fill out a registration form
- Provide people with information on where to get further instructions once released
- Issue a receipt for contaminated clothing and personal items and release the person
- Treat monitoring results, registration forms and contaminated clothing as evidence
- Move bags with potentially contaminated items to an isolated and secure location regularly
- When relieved from your monitoring duties, do not leave until decontaminated at the response contamination control area

# *Response contamination control*

$$E = mc^2$$



- ❑ **Establish a response contamination control area at the boundary of the inner cordoned area.**
- ❑ **When entering the inner cordoned area:**
  - Cover instruments with plastic bags
  - Log in (keep account of those in area)
  - Limit taking additional tools going into the area if possible (use tools already in the area)
- ❑ **When leaving the inner cordoned area:**
  - Remove plastic cover from the instruments
  - Leave instruments and equipment used inside of the inner cordoned area for further use
  - Receive monitoring using instructions for monitoring of the public and responders
  - Receive field decontamination, Before leaving the scene get a full decontamination
  - Log out



# Criteria for Monitoring & Decontamination



## ❑ Criteria for decontamination of people (skin or clothing)

### Personal survey measurements of gamma dose rate at 10 cm from body surface (clothes):

< 1 $\mu\text{Sv/h}^*$	> 1 $\mu\text{Sv/h}$
Remind those monitored to: <ul style="list-style-type: none"><li>– shower and change clothing ASAP</li><li>– listen for official instructions.</li></ul> Send them home (release).	Send those monitored for immediate decontamination If immediate decontamination is not available, remind them to <ul style="list-style-type: none"><li>– shower and change clothing as soon as possible;</li><li>– listen for official instructions.</li></ul> Send them home (release).

\* Related criteria (for use by radiological assessor only): > 10000 Bq/cm<sup>2</sup> beta/gamma, > 1000 Bq/cm<sup>2</sup> for alpha

## ❑ Criteria for monitoring/decontamination of equipment

If ambient dose rate at 10 cm is:	Perform the action:
> 1 $\mu\text{Sv/h}$ and <10 $\mu\text{Sv/h}$	Use for response activities only.
> 10 $\mu\text{Sv/h}$ and <100 $\mu\text{Sv/h}$	Use for critical response activities only - e.g. needed for transport of injured
> 100 $\mu\text{Sv/h}$	Isolate and use only with radiological assessor approval.

## ❑ Criteria for isolation

- any objects with an ambient dose rate > 100  $\mu\text{Sv/h}$  at 1 m are identified and isolated

Always we keep watching  
our Atomic Power



Thank You



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