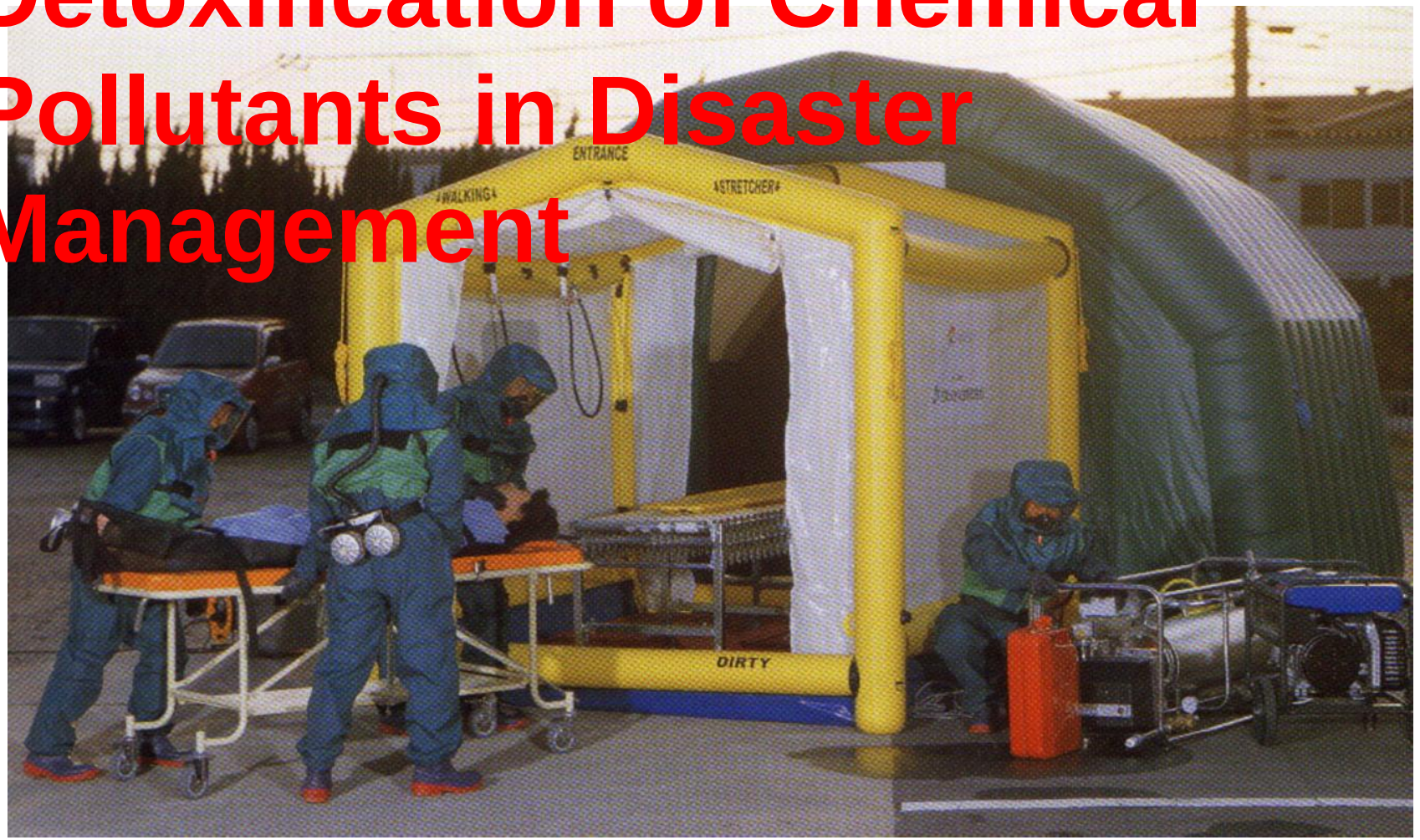
# Detoxification of Chemical Pollutants in Disaster Management




**Dr Mohd Idzwan bin Zakaria**
**Emergency Physician**
**University Malaya Medical Centre**

# Copyright Statement

- The content in this presentation is copyright of the speaker; Mohd Idzwan bin Zakaria and any other copyright as stated in this document.

# Disclaimer Statement

- THE USER ACKNOWLEDGES AND AGREES THAT ALL THE INFORMATION IN THIS PRESENTATION IS PROVIDED "AS IS".
  - The use of this information is only as part of materials provided in the SEMINAR ON “EFFECTIVE AND EFFICIENT DISASTER MANAGEMENT ” which was held on the 23 July 2008.
  - The organiser of the conference and the speaker(s) gives no warranty and accepts no responsibility or liability for the accuracy or the completeness of the information and materials provided here. No reliance should be made by any user on the information or material so posted; instead, the user should independently verify the accuracy and completeness of the information and/or materials with the originating or authorising institution.
  - The user acknowledges and agrees that the organiser of the conference and the speaker(s) shall not be held responsible or liable in any way for any and / or all consequences, including but not limited to damages for loss of profits, business interruption, or mis-information, that may arise, directly or indirectly as a result of using, or the inability to use, any materials or contents on this presentation, even if the the organiser of the conference and the speaker(s) has been advised of the possibility of such damages in advance; and no right of action will arise as a result of personal injury or property damage, howsoever arising or sustained as a result of reference to, or reliance upon, any information contained in, or omitted from, this presentation, whether through neglect or otherwise.

# Objectives

- Definitions
- Methods of mass decontamination
- Triage for decontamination
- Decontamination procedures



© Mohd Idzwan bin Zakaria

# Introduction

- Disaster:

*"An event where the destructive effects of natural or man-made forces overwhelm the ability of a given area or community to meet the demands for health care"*

*(American College of Emergency Physicians)*


© Mohd Idzwan bin Zakaria

# Introduction

- Disaster:

*"Sudden ecological phenomenon of sufficient magnitude to require external assistance"*

*(World Health Organization)*


© Mohd Idzwan bin Zakaria

# Mass Casualty Accident

Accident causing many victims, who are in a serious condition; due to single cause, happening in relatively short time, requiring external assistance in the shortest possible time

*"…..too much for the few people with inadequate facilities"*

*Zimmerman 1973*

# Major Incident

- ***Involvement of large numbers of people***
- ***Required treatment, rescue, transport***
- ***Large number of enquiries from public & media***
- ***Required > 3 emergency services***


© Mohd Idzwan bin Zakaria

# Chemical pollutants

- **Chemical pollutants include:**
- Oils, greases and detergents from roadways, commercial, industrial and domestic sites, and plant fertilizers, pesticides and chemicals from building sites, domestic sites, farms and gardens.

***Impacts on our Estuaries: Chemical Pollutants; 2006***


© Mohd Idzwan bin Zakaria

# History

- 1984: Bhopal, India
  - several thousand gallons of highly volatile methylisocyanate released over a three-hour period → poisonous gas → 5,000 perished
- 1995: Sarin gas (fluorinated phosphonate) attack in Tokyo subway, Japan
  - 5,510 victims, 12 were casualties that died, 17 were casualties that were considered critically ill, 37 were casualties that were considered seriously ill, and 984 were casualties that were considered moderately ill


© Mohd Idzwan bin Zakaria

# Act of terrorism: Weapons of Mass Destruction

- *Even small amounts (several droplets) of liquid nerve agent contacting the unprotected skin can be severely incapacitating or lethal if the victim or responder is not decontaminated rapidly (within minutes) and treated medically.*



© Mohd Idzwan bin Zakaria

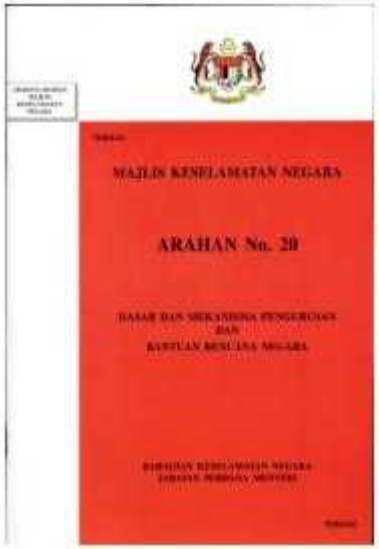

© Mohd Idzwan bin Zakaria



© Mohd Idzwan bin Zakaria

# PKTK

- Pos Kawalan Tempat Kejadian
- Incident Site Committee
- Commander -- Police (On Scene Commander)
- Deputy Commander -- JBPM (Forward Field Commander)
- Roles
  - Risk analysis
  - Development of action plan
  - Coordination of relief workers
  - Zone Management
  - Safety
  - Liason with Pusat Kawalan Operasi Bencana
  - Management of victims and public (law and order)
  - Forensic duties





© Mohd Idzwan bin Zakaria

# Decontamination

- *Decontamination is the process of reducing and preventing the spread of contaminants from a hazardous materials scene*
- *This process is accomplished by physical means or by chemical neutralization or detoxification*


© Mohd Idzwan bin Zakaria

# General principles to mass casualty decontamination

- Expect at least a 5:1 ratio of unaffected to affected casualties
- Decontaminate victims as soon as possible
- Disrobing (removing clothes) is decontamination; head to toe, more removal is better
- Water flushing generally is the best mass decontamination method
- After a known exposure to liquid chemical agent, emergency responders should be decontaminated as soon as possible to avoid serious effects.

***Guidelines for Mass Casualty Decontamination During a Terrorist Chemical Agent Incident: U.S. Army Soldier and Biological Chemical Command (SBCCOM), 2000***


© Mohd Idzwan bin Zakaria

# Do it fast, do it right

*the precise methods used to remove the agent are not nearly as important as the speed by which the agent is removed*

# Decontamination Process

- **Victims**
- **Environment**
- **Personnel**
- **Equipment**


© Mohd Idzwan bin Zakaria

# Personnel Protection Suit

1. Suit
2. Glove
3. Boots
4. Oxygen respirator
5. Suit cooling system
6. Sealed container
7. Goggles
8. Work Discipline and Culture


© Mohd Idzwan bin Zakaria

# Who is responsible?

- Fire and Rescue Department
  - hazardous materials (HAZMAT) teams
- Emergency Response Teams


© Mohd Idzwan bin Zakaria

# HAZMAT team in action


© Mohd Idzwan bin Zakaria

# Objectives of decontamination

- Remove the agent from the victim's skin and clothing, thereby reducing further possible agent exposure and further effects among victims
- Protect emergency responders and medical personnel from secondary transfer exposures
- Provide victims with psychological comfort at, or near, the incident site, so as to prevent them from spreading contamination over greater areas.

***Medical Management of Chemical Casualties Handbook; Sept 1995, Second Edition; United States Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, MD 21010*.**


© Mohd Idzwan bin Zakaria

# Rapid physical removal of agent from the victim

- Most important action
  - Scraping
  - Blotting off
  - Disrobing (adsorbents to soak up the agent)
  - Flushing or showering (water)

*Medical Management of Chemical Casualties Handbook; Sept 1995, Second Edition; United States Army Medical Research Institute of Chemical Defense, Aberdeen Proving Ground, MD 21010.*

# Mass decontamination

- *Due to the availability of large quantities of water that can be rapidly used, mass decontamination can be most readily and effectively accomplished with a water shower system*


© Mohd Idzwan bin Zakaria

# Water-based decontamination system

- Water alone
  - Force and dilution
- Soap (liquid) and water
  - Ionic degradation of chemical agent
  - Dissolve oily substances (mustard and blister agent)
  - Disadvantages:
    - Soap may hydrate skin → increase damage by blister agents
    - Delay in time to get adequate supply


© Mohd Idzwan bin Zakaria

# Water-based decontamination system

- Bleach (sodium hypochlorite) and water
  - Remove, hydrolyze, and neutralize chemicals
  - Not recommended in mass decontamination because of SPEED is the factor in such situation
    - Not readily available
    - Long skin contact time needed to be effective
    - Laboratory studies suggest that bleach solutions at the 0.5% level may not be better than flushing with water alone.
    - Medically, bleach solutions are not recommended for use near eyes or mucous membranes, or for those with abdominal, thoracic, or neural wounds.

*Hypochlorite Solution as a Decontaminant in Sulfur Mustard Contaminated Skin Defects in the Euthymic Hairless Guinea Pig; 1994; Gold, M.B., Woodard, Jr., C.L., Bongiovanni, R., Schraf, B.A., and Gresham, V.C.; Drug and Chemical Toxicology 17(4), 499-527.*

# Conclusion of water-based system

- **Recommends rapid use of water, with or without soap, for decontamination. However, the process should never be delayed to add soap or any other additive.**


© Mohd Idzwan bin Zakaria

# Decontamination procedures

- Disrobing
- Showering


© Mohd Idzwan bin Zakaria

# Decontamination procedures

- Disrobing
  - Should occur prior to showering for chemical agents
  - Decision made by the Incident Commander
  - Wetting down casualties as they start to disrobe is recommended
  - However, this process may:
  - Force chemical agents through the clothing if water pressure is too high
  - Decrease the potential efficacy of directly showering skin afforded by shear forces and dilution


© Mohd Idzwan bin Zakaria

# Decontamination procedures

- Disrobing
  - Recommends that victims remove clothing at least down to their undergarments prior to showering.
  - Proceeding from head to toe.
  - Victims unwilling to disrobe should shower clothed before leaving the decontamination area.


© Mohd Idzwan bin Zakaria

# Decontamination procedures

- Showering
  - Use a high volume of water delivered at a minimum of 60 pounds per square inch (psi) water (standard household shower pressure)
  - Showering time: incident specific decision: volume of casualties and water (2-3 minutes)
  - For emergency responders with Level A suits who becomes contaminated; high volume, low pressure water is recommended to prevent chemical agent through the victim’s clothing onto the skin.

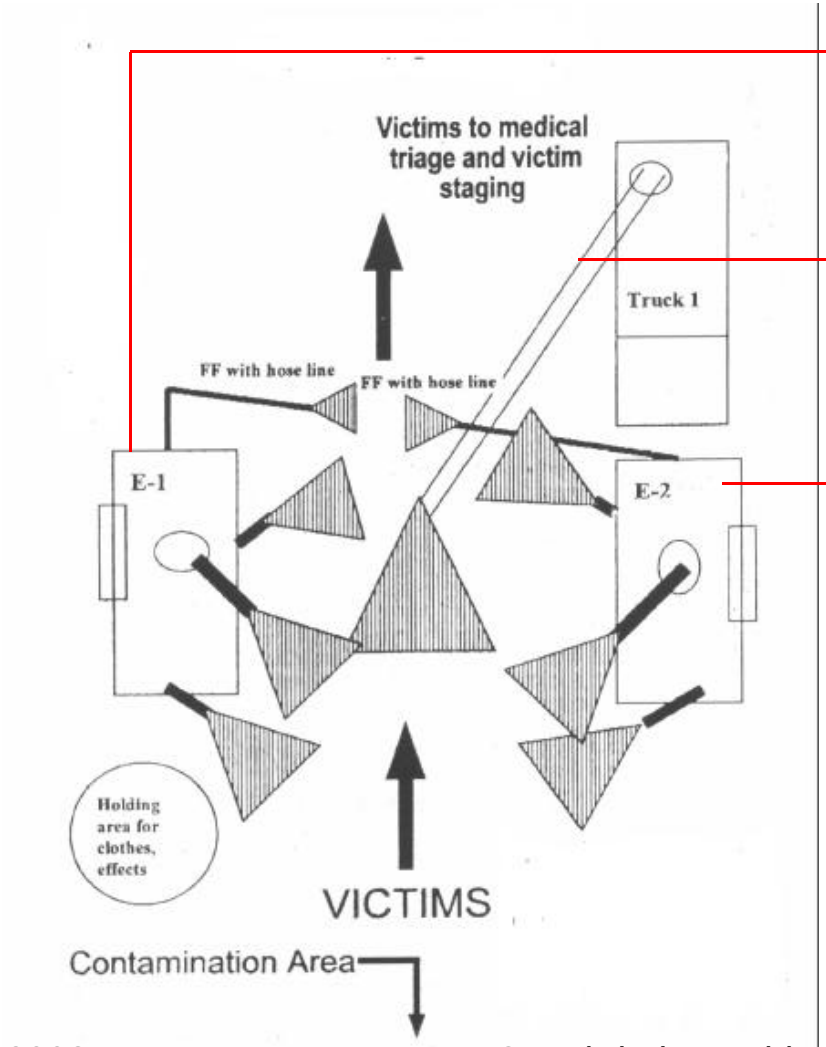

© Mohd Idzwan bin Zakaria

# Decontamination approaches

- Ladder-pipe decontamination system
  - provide a large capacity shower of high volume, low-pressure water spray
  - Creation of decon-corridor for casualties to go through
  - Multiple ladder-pipe system is used for larger casualties


© Mohd Idzwan bin Zakaria

# Multiple ladder-pipe system




Fire-engine

Ladder

Fire-engine

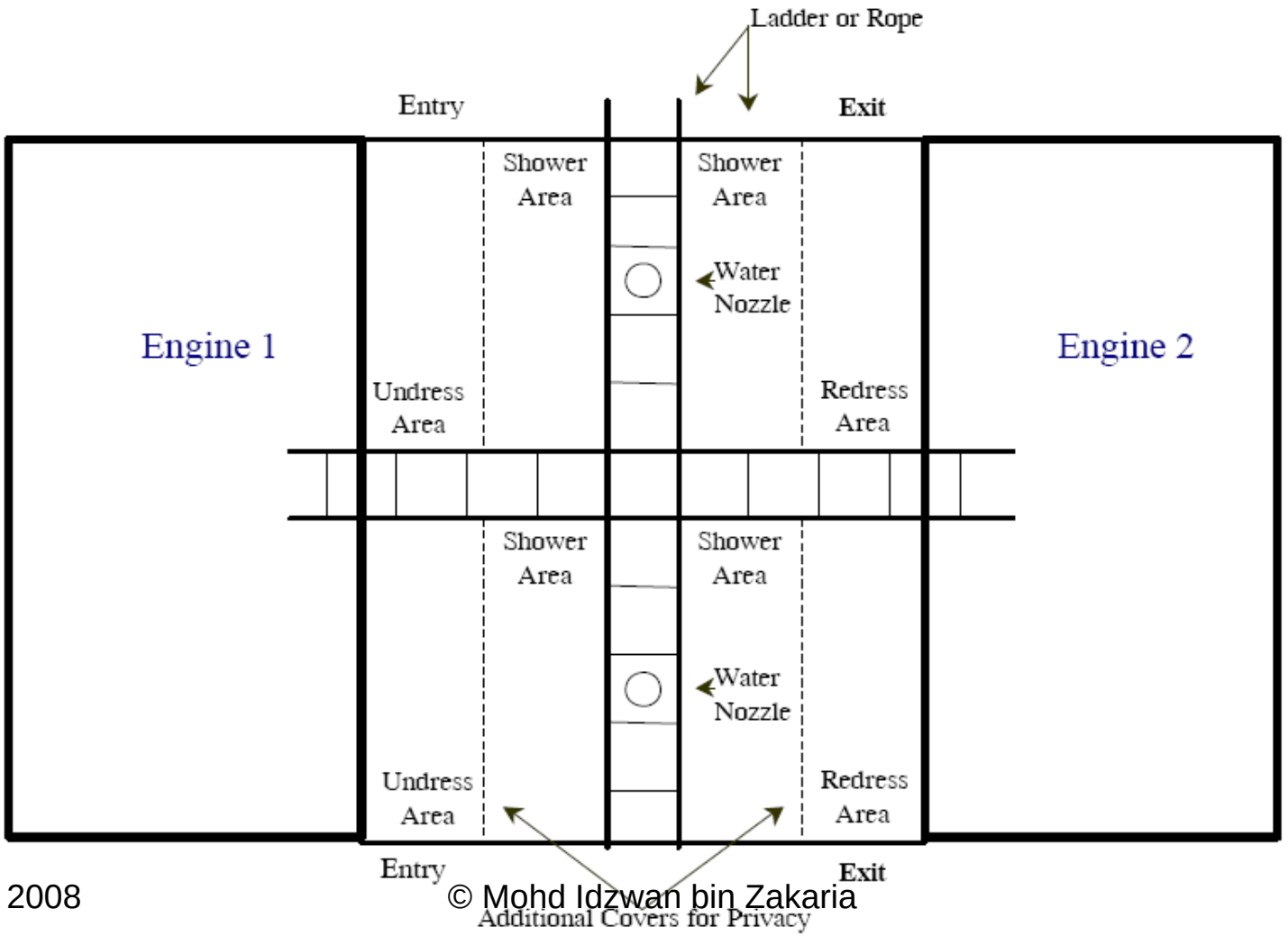

© Mohd Idzwan bin Zakaria

# Decontamination approaches

- **Emergency Decontamination Corridor System**
  - Covers to create a privacy barrier and corridors for decontaminating victims
  - Engines are stopped to prevent CO build up
  - Set up takes 15 minutes


© Mohd Idzwan bin Zakaria

# Emergency Decontamination Corridor System





© Mohd Idzwan bin Zakaria

# Decontamination approaches

- **Commercially Available Decontamination Systems.**
  - Set up at the incident site
  - Delay in setting up
  - Advantages:
    - Heated shower
    - Covered area
    - Can control run-off


© Mohd Idzwan bin Zakaria

# Decontamination approaches

- **Other Field-Expedient Water Decontamination Methods**
  - public fountains, chlorinated
  - swimming pools, swimming areas, etc
- **Non-Aqueous Methods**
  - dirt, flour, Fuller's earth, baking powder, sawdust, charcoal, ashes, activated carbon, alumina, silica gels, zeolites, clay materials, and tetracalcium aluminate
  - Oxidants, nucleophiles, and/or enzymes are bound to the polymeric backbone of the foams or gels, and when the chemical warfare agents contact the foam or gel, they encounter the reactive site and are detoxified
  - effective in removing spots of liquid chemical agent contamination
  - Not suitable for mass decontamination


© Mohd Idzwan bin Zakaria

# Estimation of victims

- Anticipates at least a 5:1 ratio of victims to actual casualties
  - For every casualty that actually is exposed to chemical agent, more than five victims who are not exposed to the chemical agent will be evaluated
- But, when the situation is severe enough and resources are overwhelmed, individuals who show no chemical agent contamination or symptoms, and who are not otherwise suspected of being contaminated, may be allowed to proceed to the Cold Zone.

# Prioritizing Casualties for Decontamination

- Decontamination prioritization
- Triage is the medical process of prioritizing treatment urgency within a large group of victims.
- Medical triage and decontamination priotization are done simultaneously


© Mohd Idzwan bin Zakaria

# Triage principal in mass casualty incident

- Responders, therefore, must prioritize victims for receiving decontamination, treatment, and medical evacuation, while providing the greatest benefit for the greatest number
- *Do the **most for the most***


© Mohd Idzwan bin Zakaria

# SIMPLE TRIAGE AND RAPID TREATMENT (START)

- Design for first responder during disaster situation
- Established in 1983 & updated 1994
- Required rescuer with basic first aid skill
- Assess 3 parameters – respiration, perfusion and mental status.
- System to identify which patients should be transport immediately, which can wait and with patients are unsalvageable

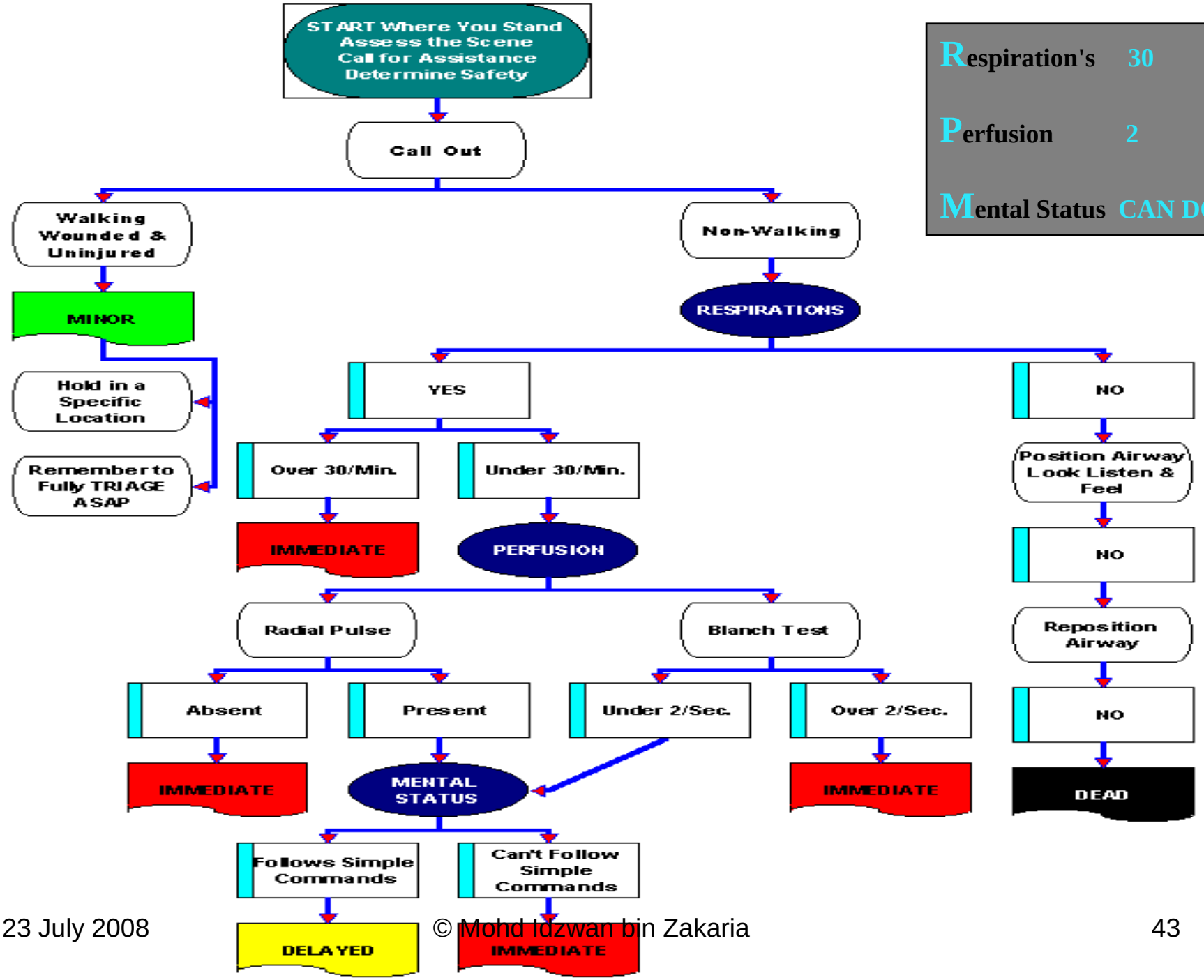

© Mohd Idzwan bin Zakaria

# START

| Triage Definitions |
| --- |
| • **Ambulatory Casualties:** Victims able to understand directions, talk, and walk unassisted. Most ambulatory victims are triaged as minimal (green tag/ribbon or Priority 3) unless severe signs/symptoms are present.<br>• **Non-Ambulatory Casualties:** Victims who are unconscious, unresponsive, or unable to move unassisted. |

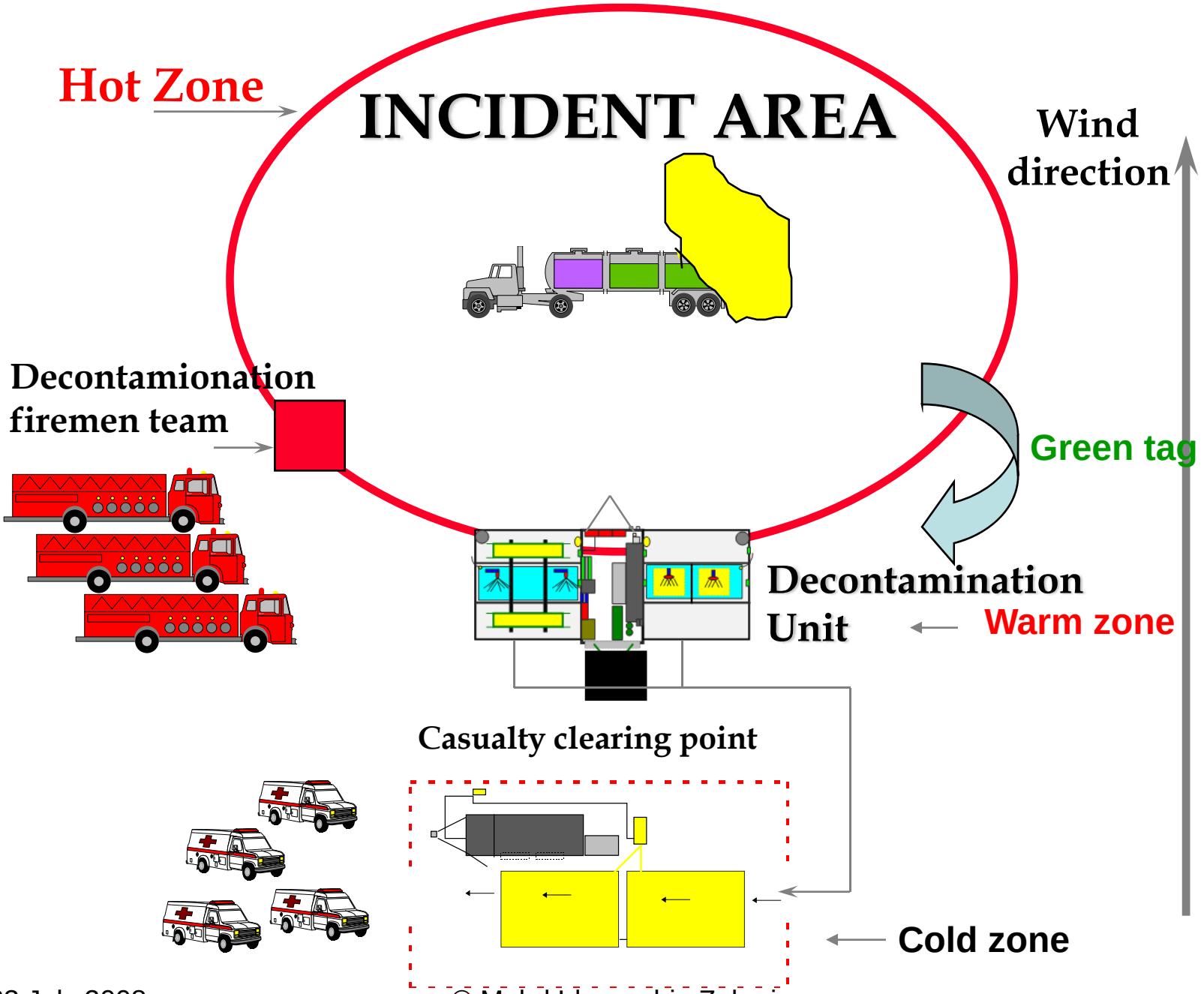
If resources are available, 2 mass decontamination units can be established


© Mohd Idzwan bin Zakaria





© Mohd Idzwan bin Zakaria





© Mohd Idzwan bin Zakaria

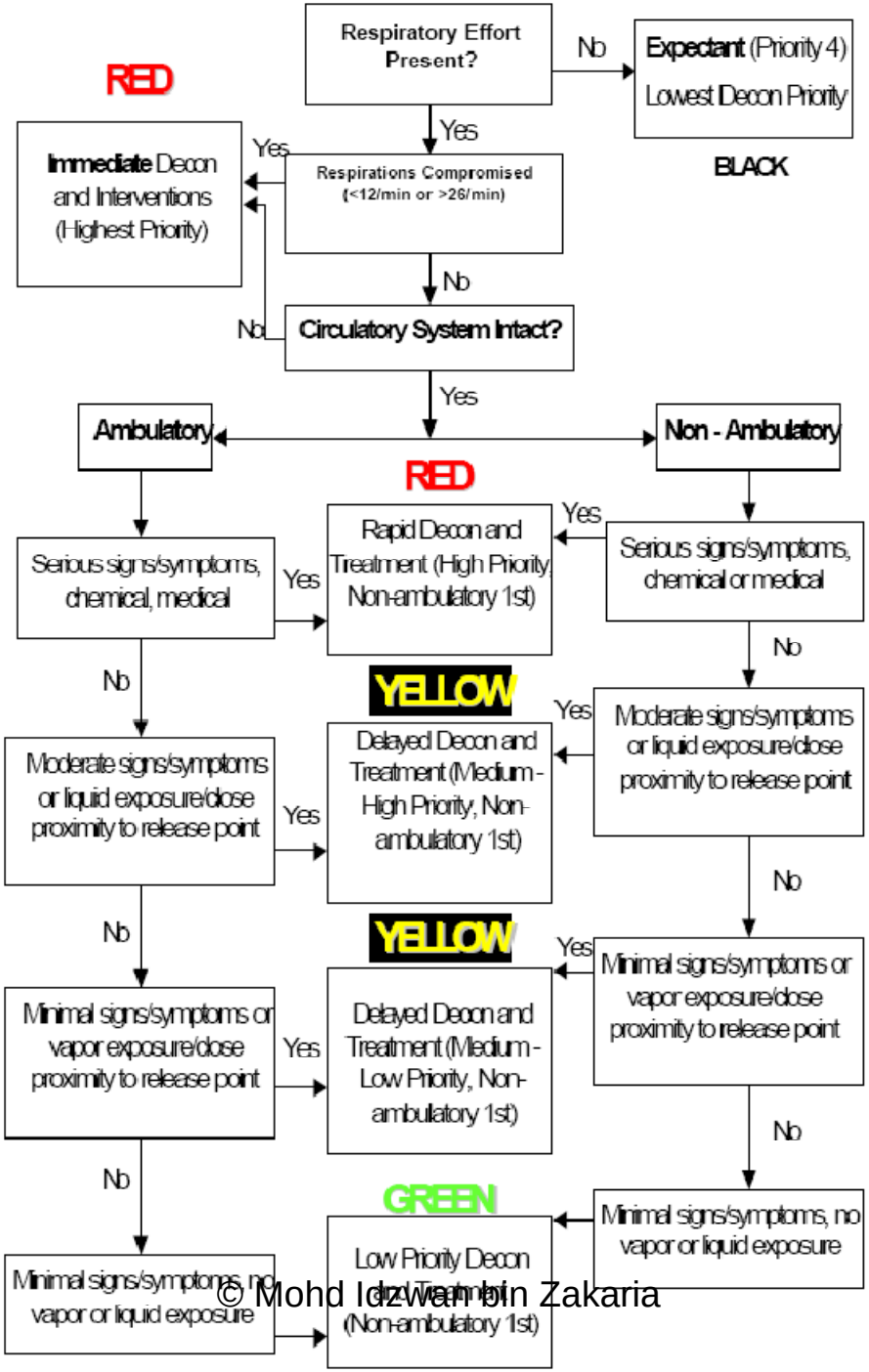
| Factors That Determine Highest Priority for Ambulatory Victim Decontamination |
| --- |
| • Casualties closest to the point of release<br>• Casualties reporting exposure to vapor or aerosol<br>• Casualties with evidence of liquid deposition on clothing or skin<br>• Casualties with serious medical symptoms (shortness of breath, chest tightness, etc)<br>• Casualties with conventional injuries |

# Four S.T.A.R.T. Categories

| S.T.A.R.T. Category | Decon Priority | Classic Observations | Chemical Agent Observations |
|---|---|---|---|
| IMMEDIATE Red Tag | 1 | Respiration is present only after repositioning the airway. Applies to victims with respiratory rate >30. Capillary refill delayed more than 2 seconds. Significantly altered level of consciousness. | • Serious signs/symptoms<br>• Known liquid agent contamination<br>In need of antidote or ventilation<br>The only group needs Rx in Hot zone |
| DELAYED Yellow Tag | 2 | Victim displaying injuries that can be controlled/treated for a limited time in the field. | • Moderate to minimal signs/symptoms<br>• Known or suspected liquid agent contamination<br>• Known aerosol contamination<br>• Close to point of release |
| MINOR Green Tag | 3 | Ambulatory, with or without minor traumatic injuries that do not require immediate or significant treatment. | • Minimal signs/symptoms<br>• No known or suspected exposure to liquid, aerosol, or vapor |
| DECEASED/ EXPECTANT Black Tag | 4 | No spontaneous effective respiration present after an attempt to reposition the airway. | • Very serious signs/symptoms<br>• Grossly contaminated with liquid nerve agent<br>• Unresponsive to autoinjections<br>Delay autoinjection or decon more than 5 minutes |

# Autoinjection of atropine or oxime


© Mohd Idzwan bin Zakaria





© Mohd Idzwan bin Zakaria

# Decontamination priotization

- Immediate decontamination may only involve removal of clothing
- Ambulatory victims should be placed in a separate collection area in the upwind area of the Hot Zone for secondary triage.
- Should a second decontamination system be placed in operation at the same site, ambulatory victims may be assigned to the second station, leaving the initial station for the non-ambulatory victims.
- It is recommended that all non-ambulatory victims who are exhibiting serious chemical signs and symptoms receive highest priority for decontamination.

# Single decontamination

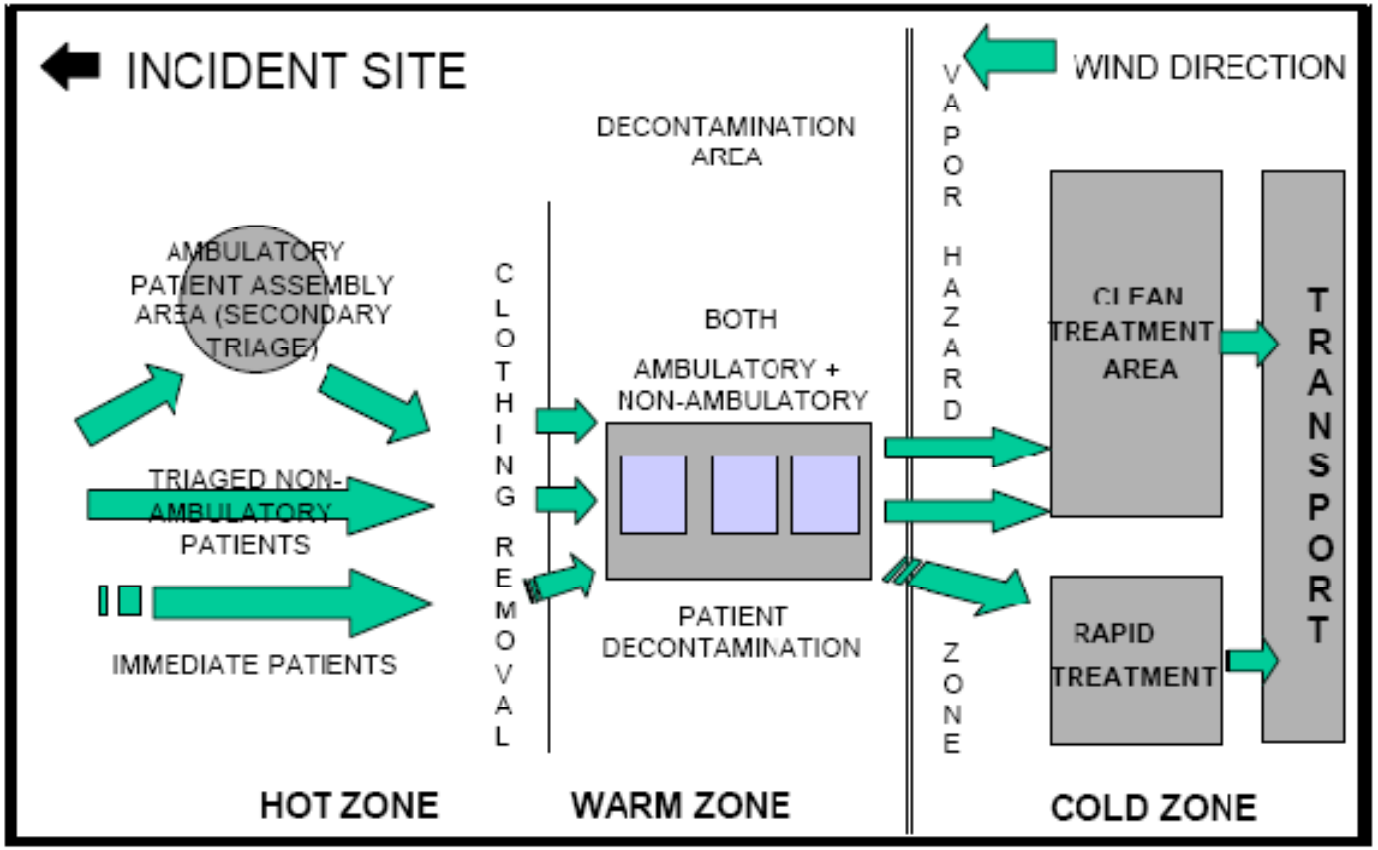
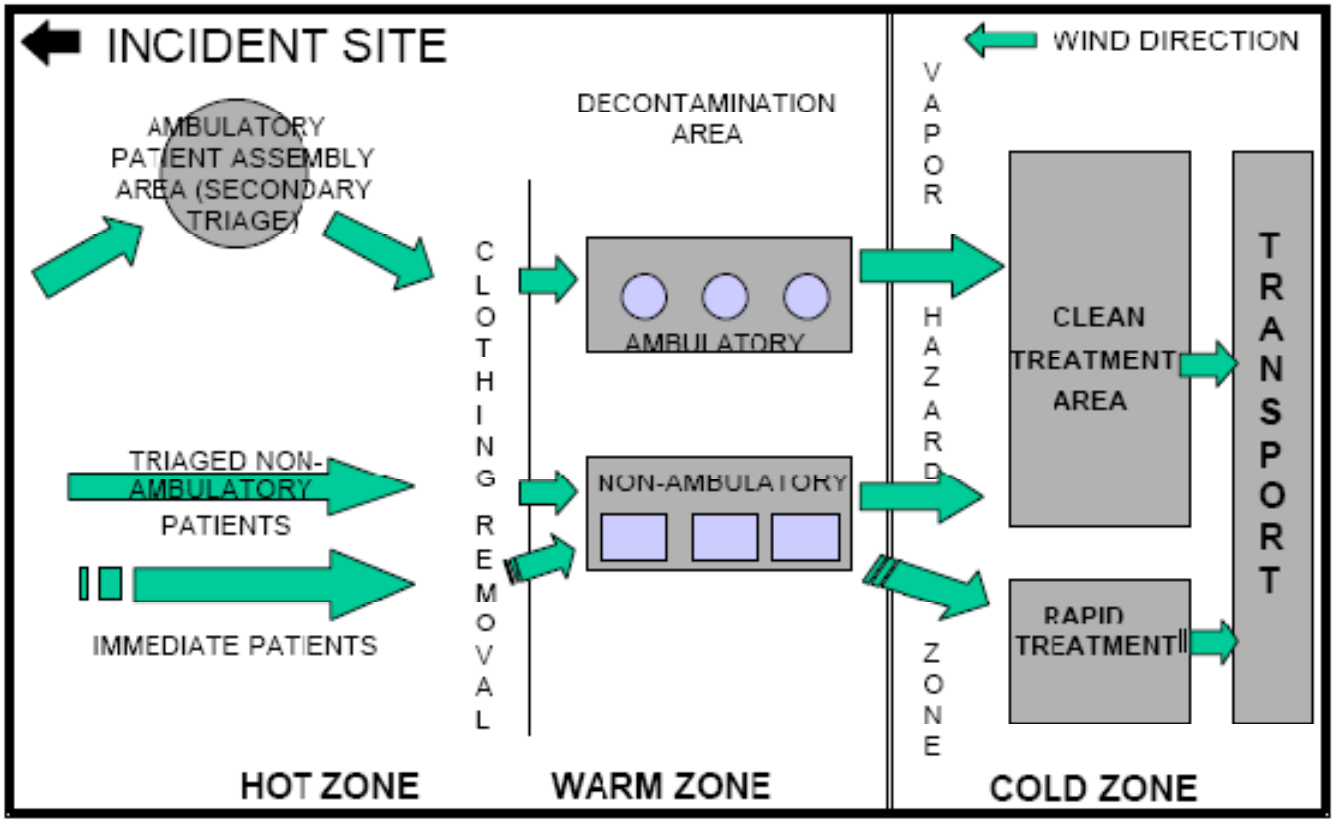



Figure 4-12. Emergency Decontamination Corridor System (1 Corridor)


© Mohd Idzwan bin Zakaria

# Double decontamination





© Mohd Idzwan bin Zakaria

# Process of decontamination

- Ambulatory victims should be instructed by the responders to remove their clothing in the Hot zone and move to Warm zone
- Contact lenses removed and flush skin, eyes and hair with water
- If casualties overwhelmed the decontamination process, ambulatory victims (priority 3) without any sign and symptoms may be transferred immediately to the Cold (support) Zone [some risks may be accepted in attempts to expedite the decontamination process so that more lives can be saved]


© Mohd Idzwan bin Zakaria

# Process of decontamination

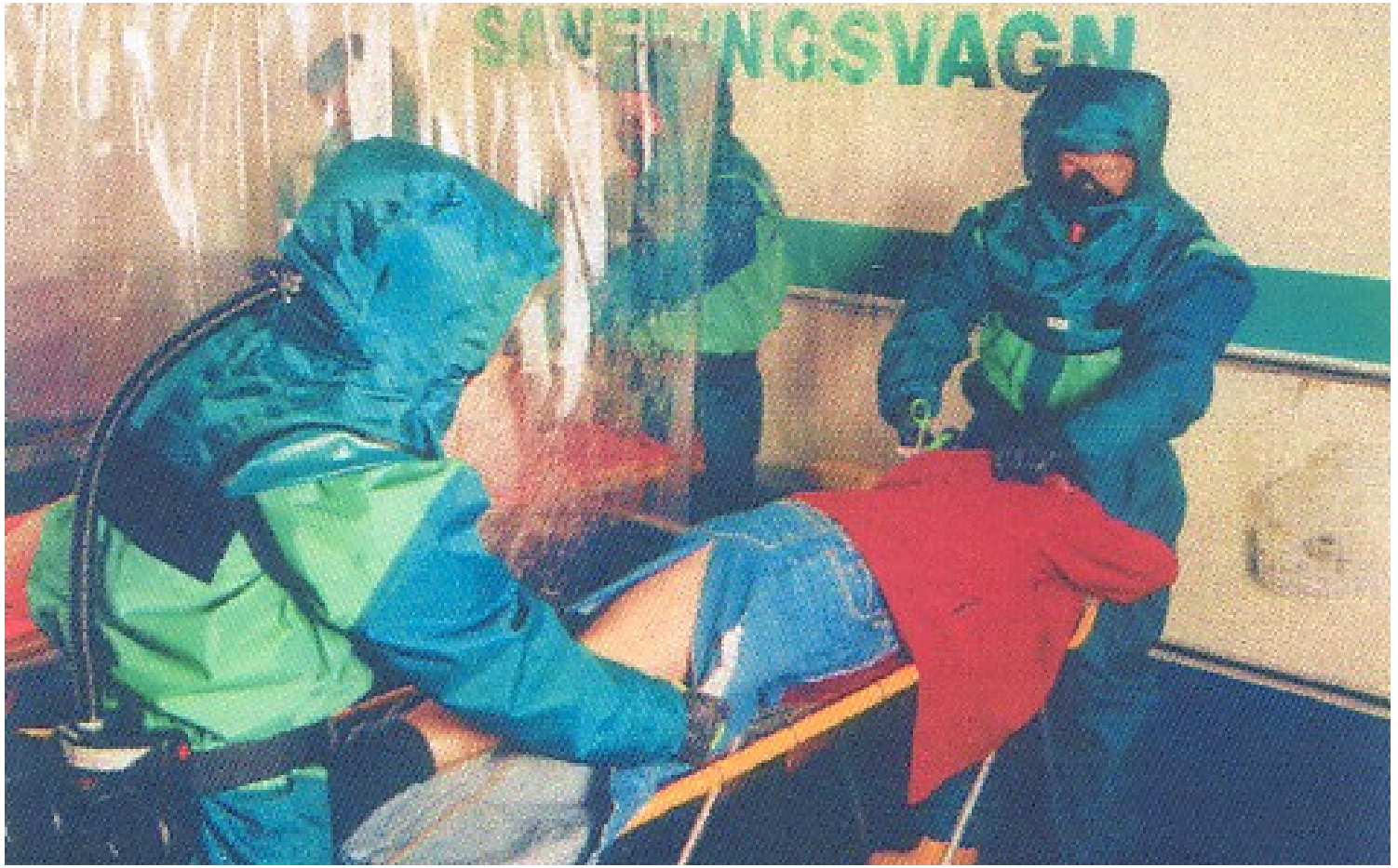
- Non-ambulatory victims will be assisted to remove their clothes in the Hot zone before transporting to the backboard
- All contaminated clothing and personal belongings have to be left in the hot zone

# Decontamination process



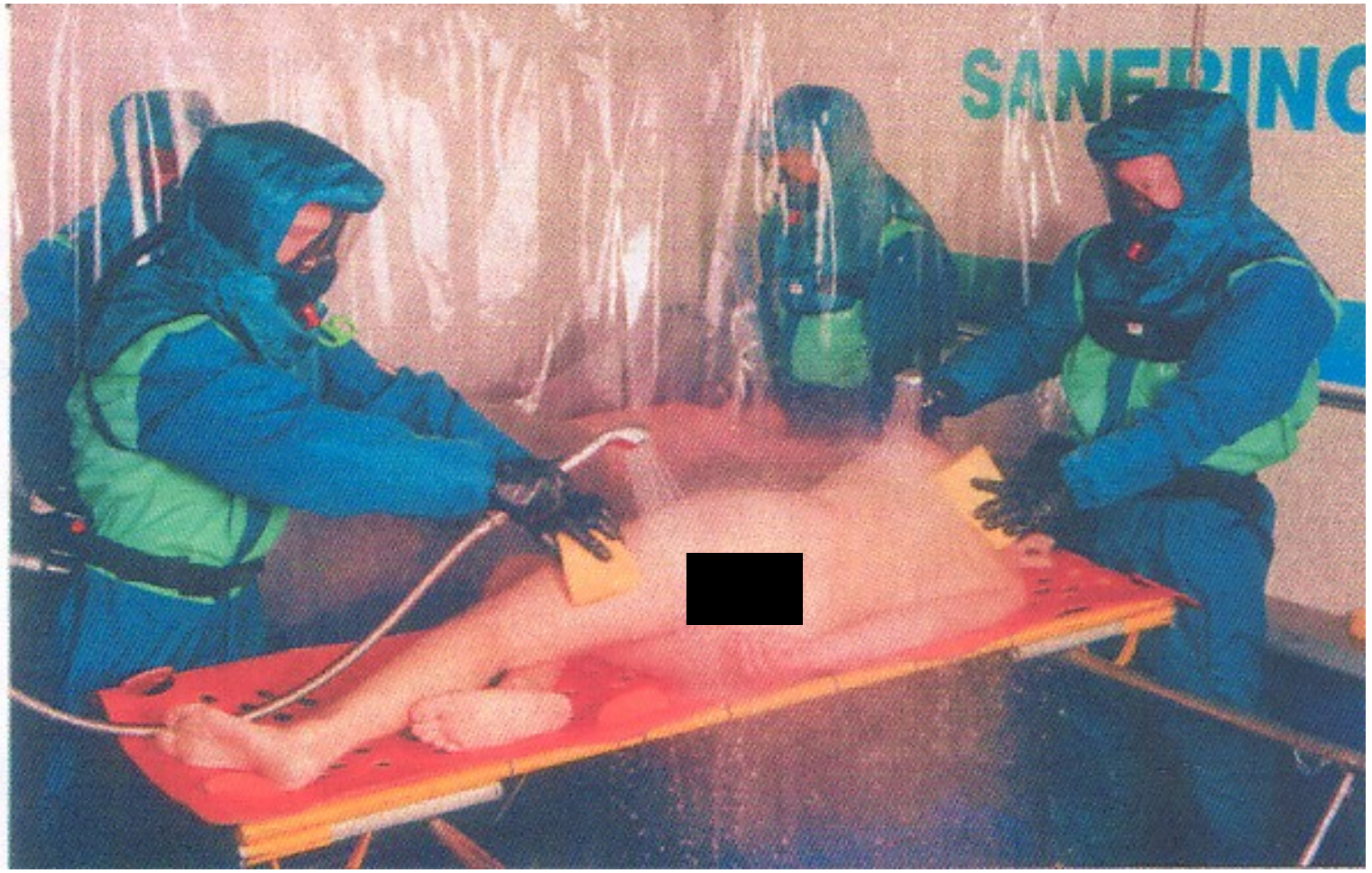
© Mohd Idzwan bin Zakaria

# Decontamination process




© Mohd Idzwan bin Zakaria

# Decontamination process

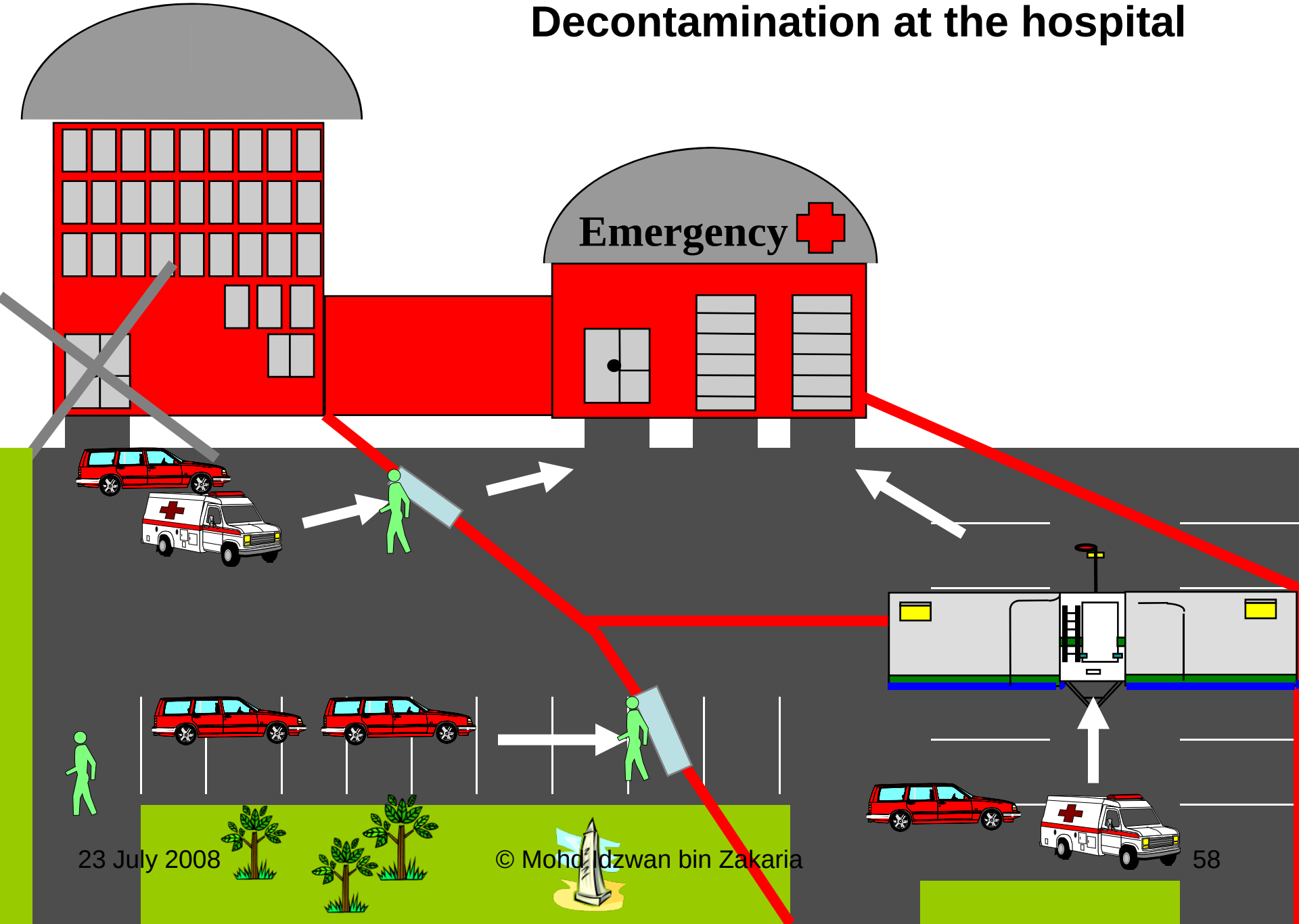


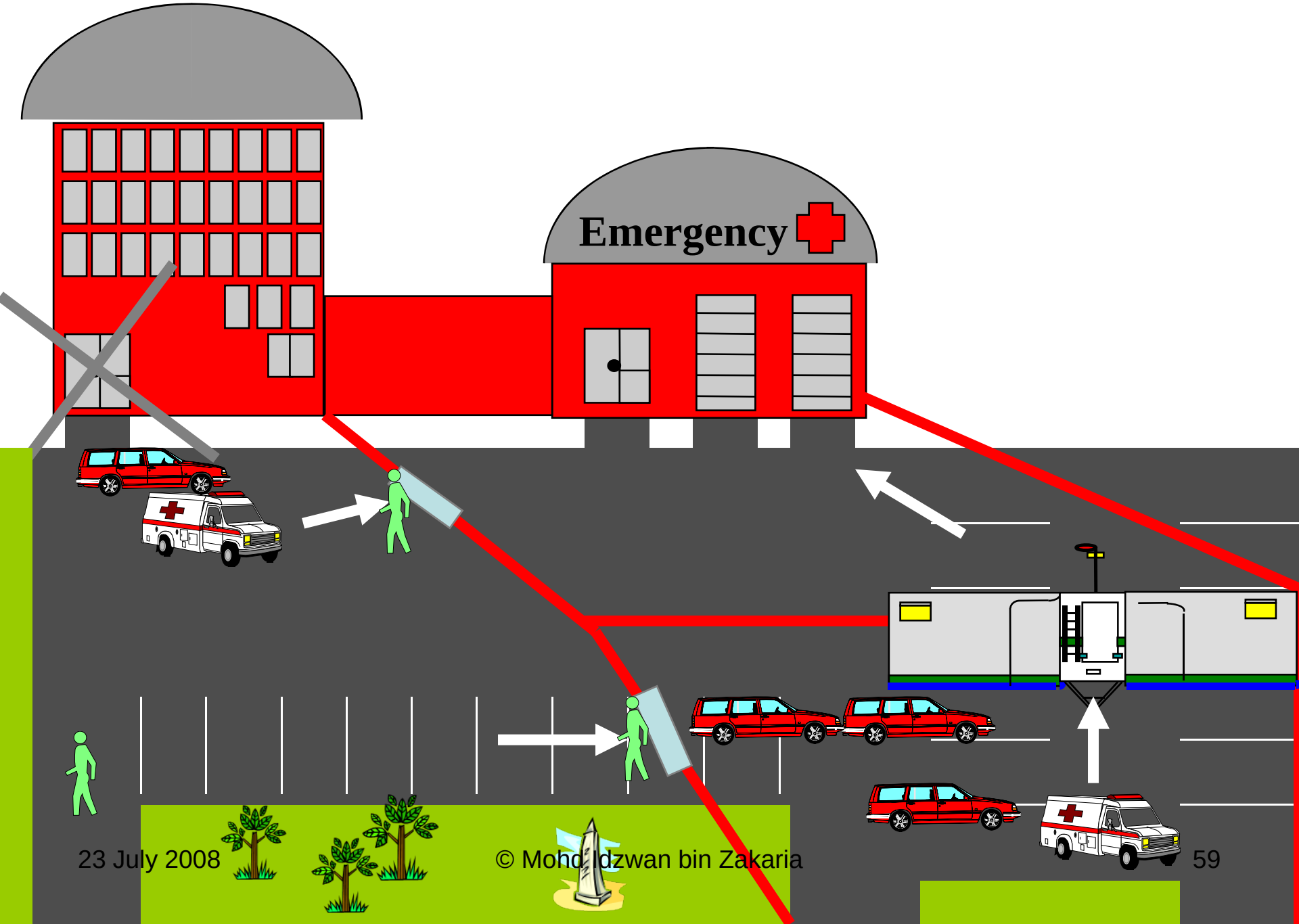
# Process of decontamination

- The triage personnel positioned at the entrance of the Cold (support) Zone must be certain that victims have either undergone basic decontamination or are not suspected of having been contaminated, before leaving the Warm Zone
- The first 25 meters of the Cold Zone should be treated as a vapor hazard zone where only victims and responders in transit should be allowed in the area.


© Mohd Idzwan bin Zakaria

# Decontamination at the hospital







© Mohd Idzwan bin Zakaria

# Issues on the environment

- *“Contaminated runoff should be avoided whenever possible, but should not impede necessary and appropriate actions to protect human life and health.”*


© Mohd Idzwan bin Zakaria

# Run-off containment



© Mohd Idzwan bin Zakaria

# Conclusions

- Showering with water at 60psi is an effective decontamination in a mass casualty decontamination
- START triage system is used in decontamination priotization
- Medical triage and decontamination triage are done simultaneously
- Zoning is required to effectively managed a mass casualty incident involving chemical pollutants


© Mohd Idzwan bin Zakaria

# References


- ***Guidelines for Mass Casualty Decontamination During a Terrorist Chemical Agent Incident: U.S. Army Soldier and Biological Chemical Command (SBCCOM), 2000***
- ***Bioterrorism, a global threat by Prof Dato' Abu Hassan Asaari Abdullah : Presentation at the Seminar on Toxicology 2002 Universiti Sains Malaysia***

# Any questions?