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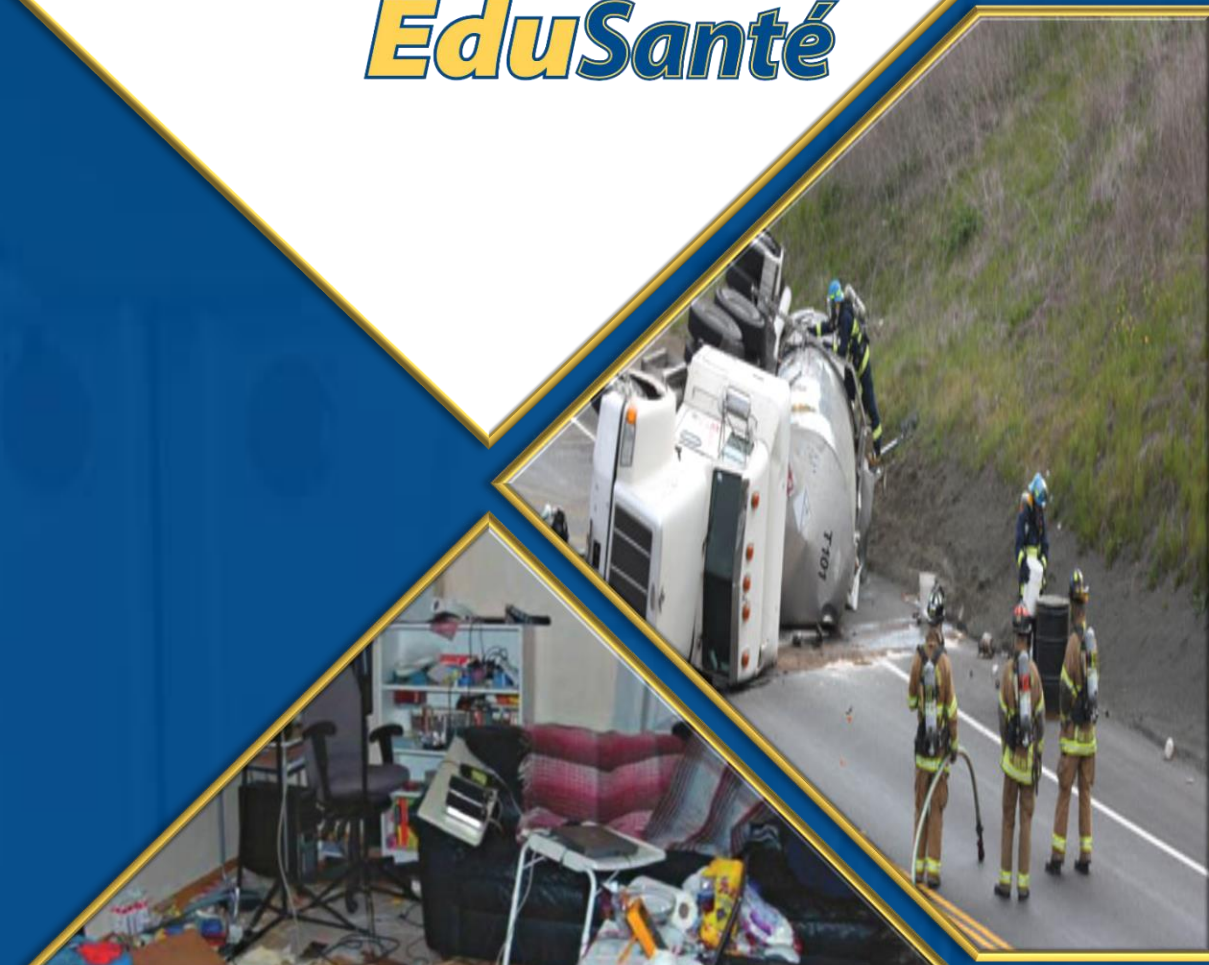
Hazardous Materials Incident

Primary Care Paramedicine



Module: 20

Section: 02b

Lecture Outline

- Role of the Paramedic
- Incident assessment
- Control zones
- Properties of hazardous materials
- Hazmat protection equipment
- Approaches to decontamination
- Medical monitoring and rehabilitation

Hazardous Material

- Any substance or material capable of posing an unreasonable risk to health, safety, and property
- A hazardous materials emergency can involve countless substances and occur in many situations

Hazardous Material

- More than 10 million tonnes of hazardous materials are made in Canada each year
- About 1 million tonnes are shipped within Canada
- From 1996 to 2010, the Canadian Government reports there were 125 hazmat transportation-related fatalities, roughly 31 per year
  - Of these, 105 deaths were on highways and 20 were rail-related

Hazardous Material

- Emergency responses to vehicular crashes are common
  - Potential for exposure to hazardous materials is great
  - Other possible causes of hazardous materials incidents
    - Mishaps in storage of materials and manufacturing operations
    - Illicit drug manufacturing (e.g. “meth labs”)
    - Acts of terrorism

Role of the Paramedic

- Scene and risk assessment
- Activation of the incident management system
- Coordinate with incident command
- Paramedics generally do not perform containment or control functions

Requirements and Standards

- Transport Canada
  - Developed Transport of Dangerous Goods Regulations
  - Adopted by all Provinces and Territories
- CANUTEC
  - Canadian Transport Emergency Centre
  - Emergency Response Guidebook
- NFPA Standard 473
  - American standard often referred to

Levels of Training

- Awareness level
  - Recognition
- EMS Level I (operations level)
  - Patient care in cold zone
- EMS Level II (technician level)
  - Patient care in warm zone

Incident Assessment

- Priorities for a hazmat incident are the same as for any other major incident.
  - Life safety
  - Incident stabilization
  - Property conservation

Incident Awareness

- Every emergency site has the potential to be a hazmat scene
- Awareness that a dangerous substance is present is critical
  - Transportation
  - Fixed facilities
  - Terrorism

Incident Awareness

- Do not rule out the presence of a hazardous material at an MVA just because you do not see a placard.

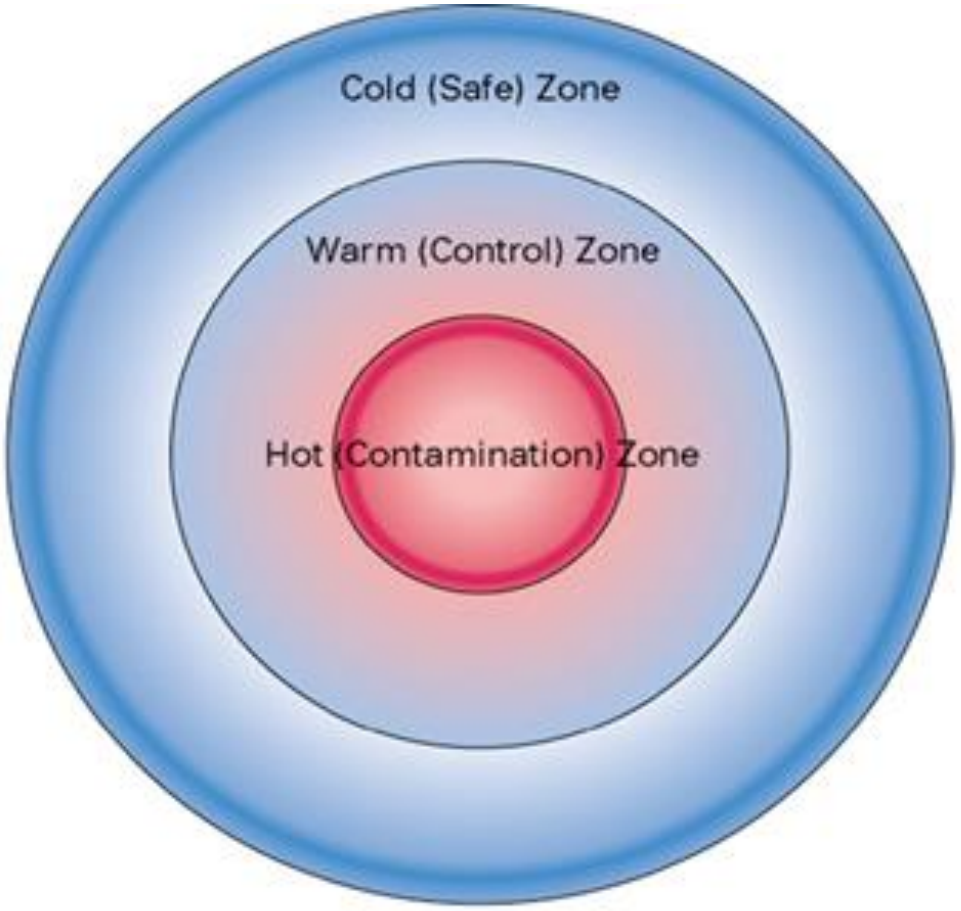
Hazardous Materials Control Zones

- Incident control system designed to assure scene safety and control
- Keep a bad situation from getting worse
  - Set up an incident command
  - Evacuate uncontaminated people from the area around the incident
- System is utilized in rescue or extended duration situations.

Hazardous Materials Control Zones

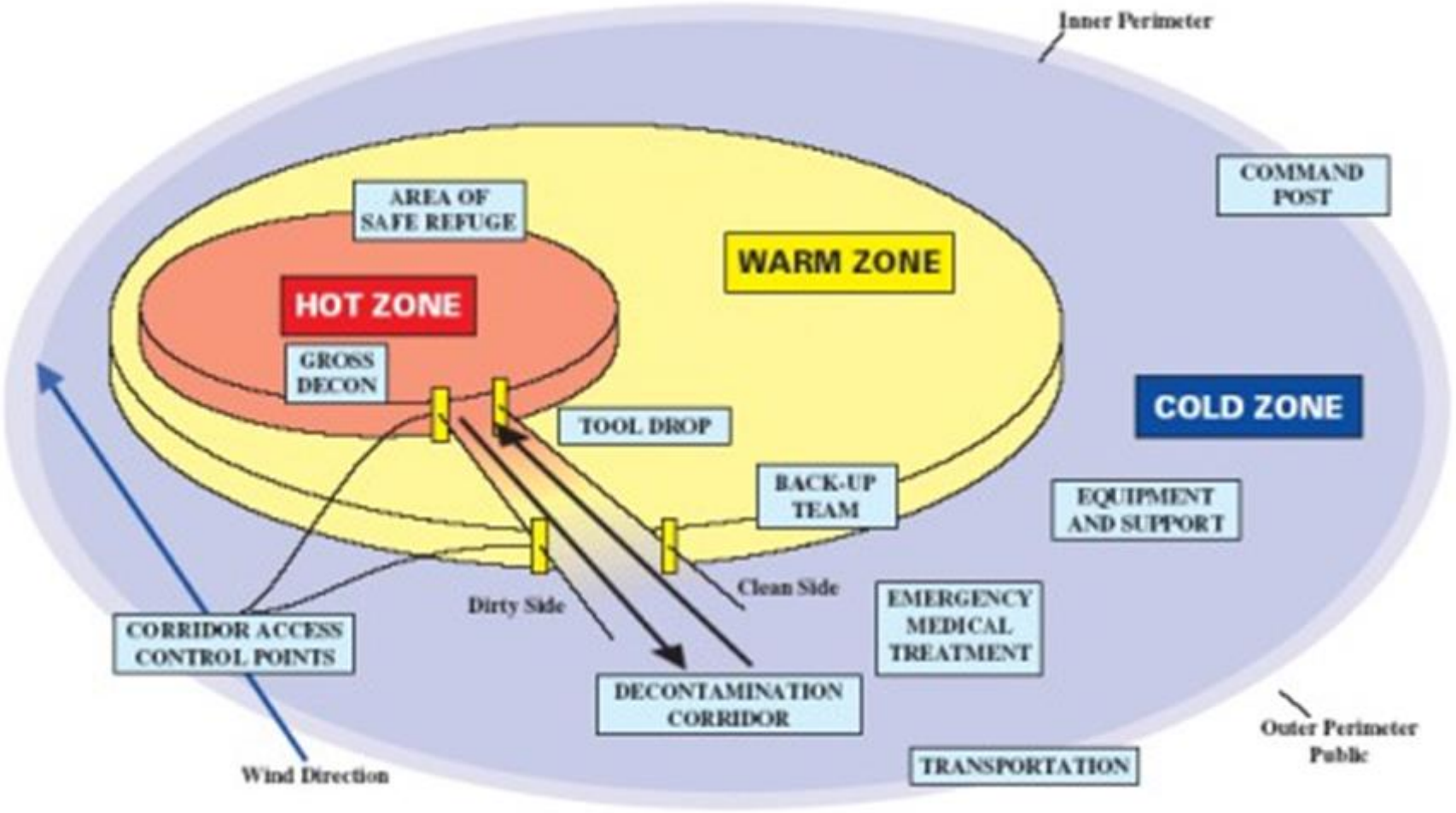
- Hot (red) zone
  - Site of contamination
  - Must have appropriate high level PPE
- Warm (yellow) zone
  - Buffer zone
  - Decontamination corridor
- Cold (green) zone
  - Safe zone where incident operations take place

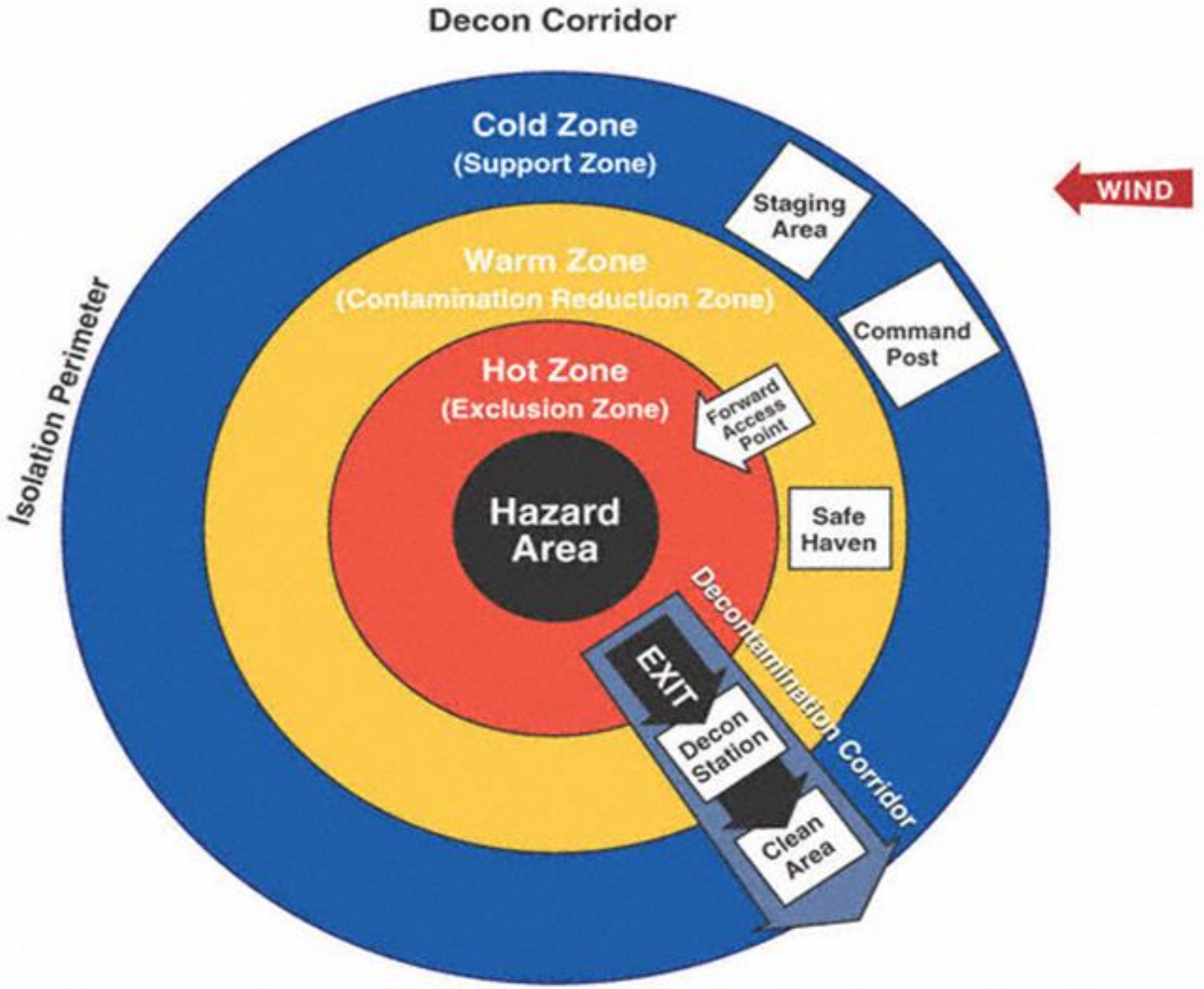
Hazardous Materials Control Zones



- Hot (Contamination) Zone
  - Contamination is actually present
  - Personnel must wear appropriate protective gear
  - Number of rescuers limited to those absolutely necessary
  - Bystanders never allowed
- Warm (Control) Zone
  - Area surrounding the contamination zone
  - Vital to preventing spread of contamination
  - Personnel must wear appropriate protective gear
  - Life-saving emergency care is performed
- Cold (Safe) Zone
  - Normal triage, stabilization, and treatment are performed
  - Rescuers must shed contaminated gear before entering the cold zone

Typical Hazmat Setup




Decon Corridor
Cold Zone
(Support Zone)
Staging Area
WIND
Warm Zone
(Contamination Reduction Zone)
Command Post
Isolation Perimeter
Hot Zone
(Exclusion Zone)
Forward Access Point
Hazard Area
Safe Haven
Decontamination Corridor
EXIT
Decon Station
Clean Area

Hot Zone

- The control zone immediately surrounding a hazardous materials incident extending far enough to prevent adverse effects from hazardous materials release to personnel outside the zone.
- Personnel may also refer to this as the inner perimeter.
  - Only for essential personnel
  - Logs are maintained for entry and exit
  - Sampling, cleanup, spill control, rescue
  - Clear boundaries
  - Proper PPE at all times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Warm Zone

- Area where personnel and equipment are decontaminated and hot zone support takes place.
  - Decontamination and support,
  - Secondary contamination is a strong possibility
  - Severity of contamination decreases moving from Hot to Warm
  - PPE is left in the warm zone
  - One decontamination corridor for personnel, one for equipment

Cold Zone

- Area with the incident command post (ICP) and other support functions necessary to control the incident.
- Is where all support functions other than decontaminated is located
  - Support functions include
  - ICP, site security, medical, reserve equipment, field Lab etc.


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Staging

- The designated location where emergency response equipment and personnel are assigned and remain available until they are needed.
- The staging area should be clearly identified through the use of signs, color-codes flags or lights, or other suitable means.

Incident Command

- The individual responsible for the management of on-scene emergency response operations.
- The IC must be thoroughly trained to assume these responsibilities and is not automatically authorized to perform these activities by virtue of his/her position within the organization.


COMMAND
UNIT

Properties of Hazardous Materials

- A Hazmat emergency is an uncontrolled or unexpected release of a Hazardous material.
- Depending on the situation, you may be faced with explosions spreading clouds of debris and chemicals as well as blunt and penetrating trauma.

Properties of Hazardous Materials

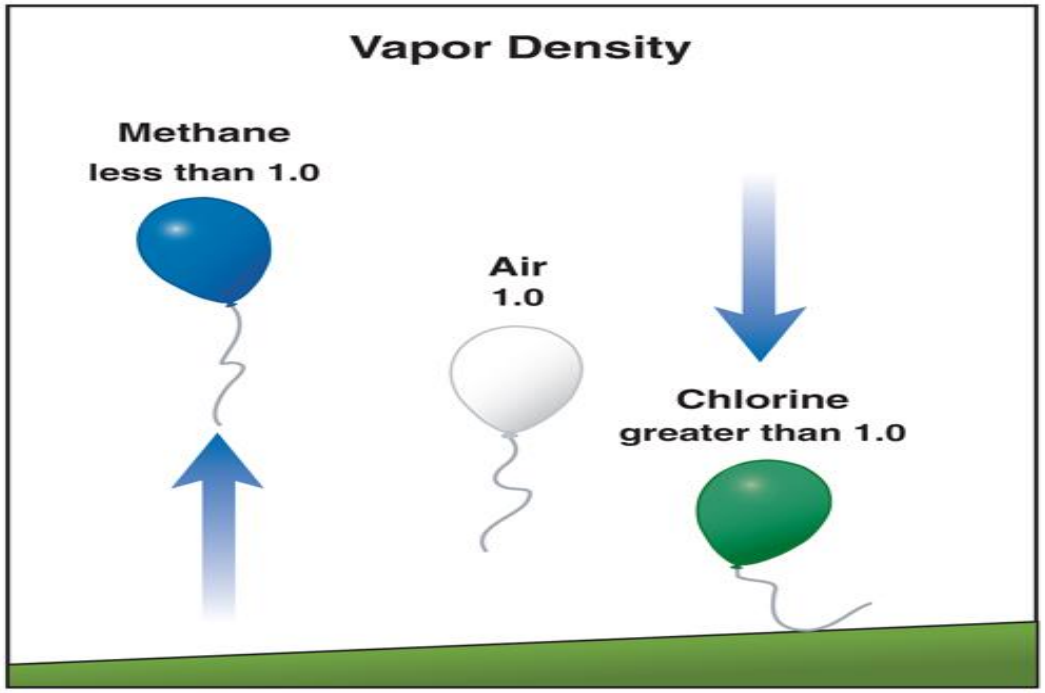
- Hazardous materials may be found as a solid, liquid or gas.
- A substance that may not be considered a hazard in 1 state (gas, solid, liquid) can be very dangerous in another.

Common Hazmat Terminology

- Vapor Pressure: pressure produced by vapors given off by an evaporating liquid or subliming solid.
- Vapor Concentration: the measurement of the amount of vapor released from a solid or liquid.

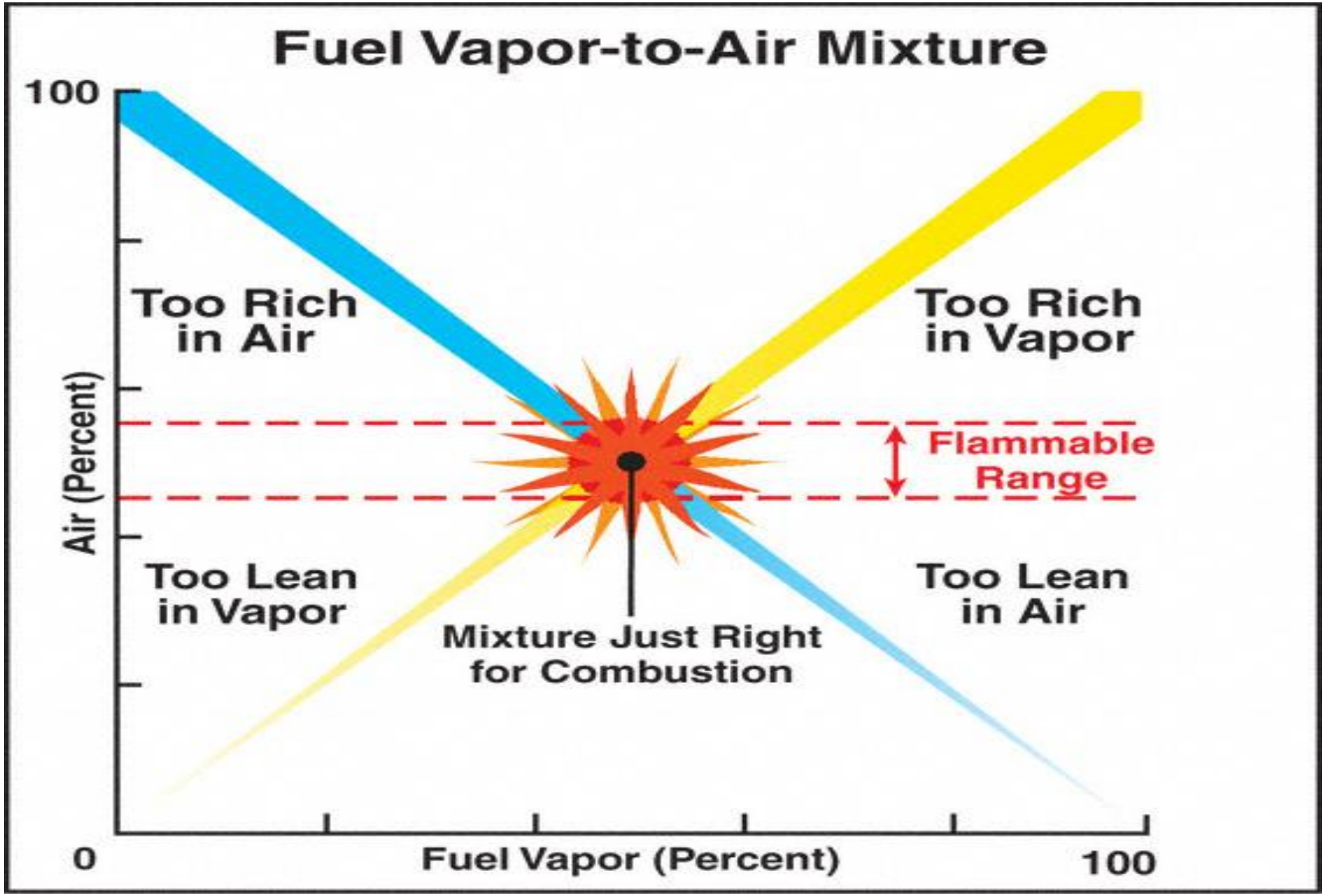
Vapor Density

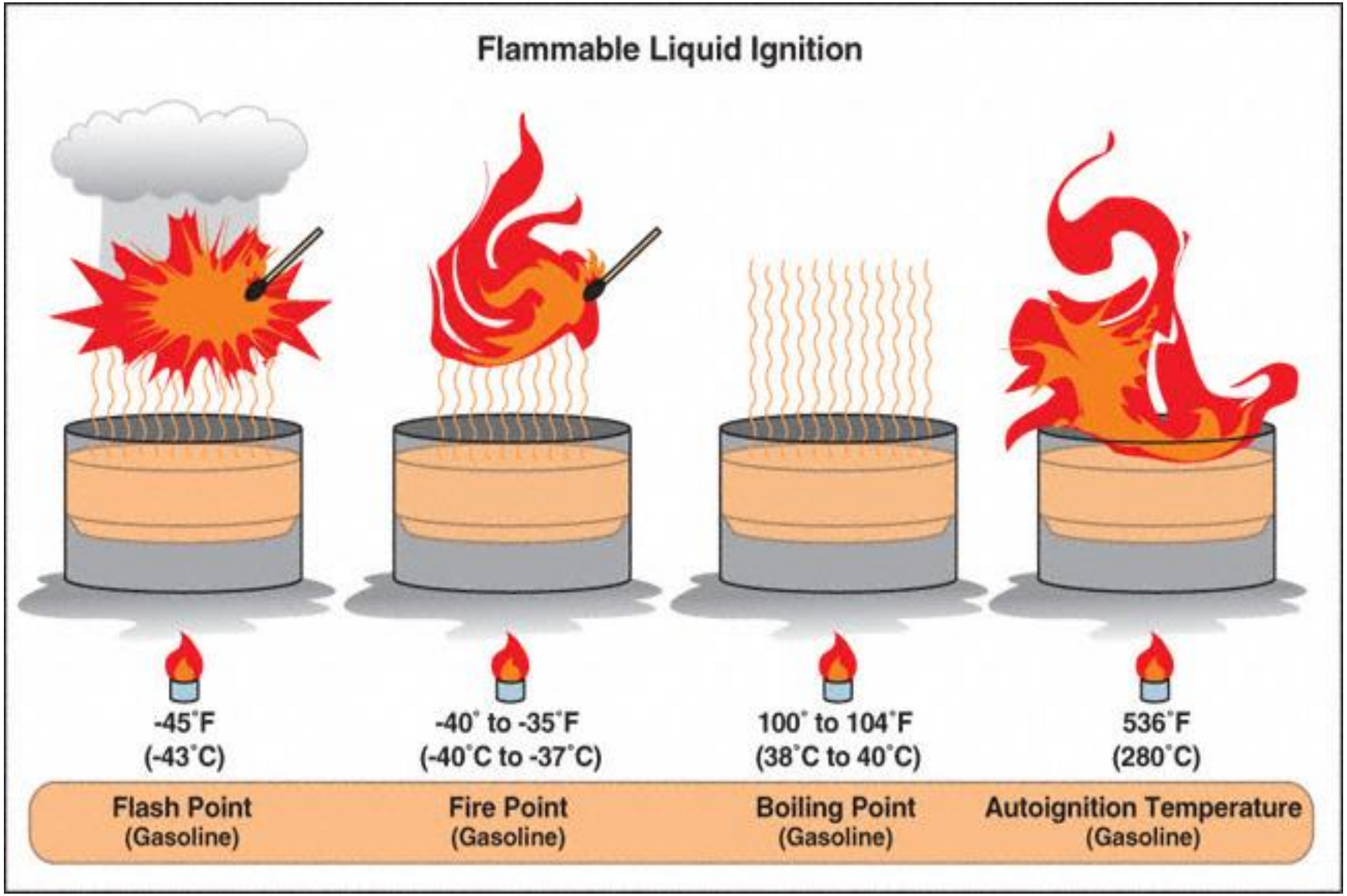
- The weight of a pure vapor or gas compared with the weight of an equal volume of dry air at the same temperature and pressure.
- The molecular weight of air is 29.
- Example: anhydrous ammonia has a molecular weight of 17 and a vapor density of 0.59.



Common Hazmat Terminology

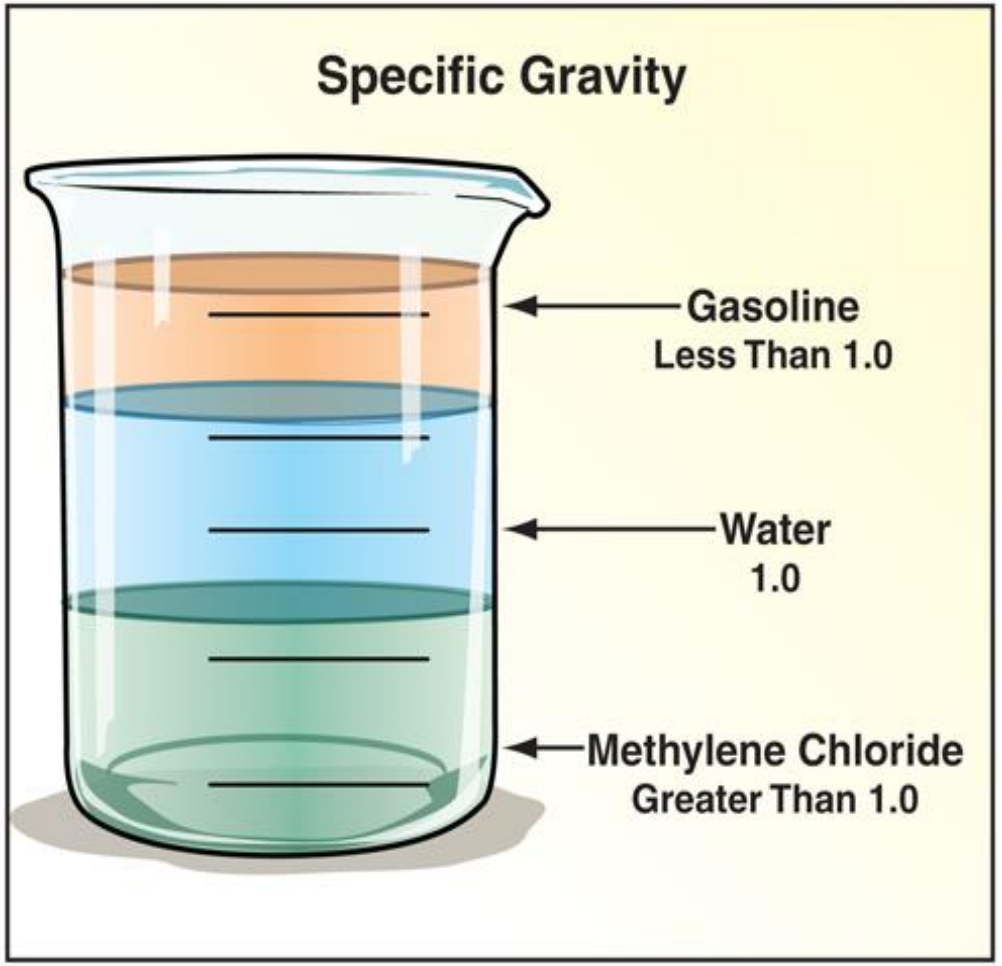
- Flammable/explosive limits
  - LEL: Lower explosive limit
    - The lowest concentration of the material in the air that can be detonated by spark, fire or shock.
  - UEL: Upper Explosive Limit
    - The highest concentration of the material in the air that can be detonated by spark, fire or shock
- Flash point
  - The temperature when a material evaporates fast enough to form a ignitable vapor.


Fuel Vapor-to-Air Mixture
100
Too Rich
in Air
Too Rich
in Vapor
Air (Percent)
Flammable
Range
Too Lean
in Vapor
Too Lean
in Air
Mixture Just Right
for Combustion
0
Fuel Vapor (Percent)
100


Flammable Liquid Ignition
-45˚F
(-43˚C)
-40˚ to -35˚F
(-40˚C to -37˚C)
100˚ to 104˚F
(38˚C to 40˚C)
536˚F
(280˚C)
Flash Point
(Gasoline)
Fire Point
(Gasoline)
Boiling Point
(Gasoline)
Autoignition Temperature
(Gasoline)

Specific Gravity

- Is the weight of the material as compared with the weight of an equal volume of water.
  - Water has the value of 1.0
  - Gasoline SG 000.9
  - Mercury SG 13.5
  - Toluene SG 000.87



Common Hazmat Terminology

- Substance water solubility depends on the chemicals polarity.
- Materials that are completely soluble are polar substances (acetone, isopropyl alcohol)
- Non-water soluble materials are nonpolar substances (hydrocarbons, oils)

Common Hazmat Terminology

- Oxygen enriched atmospheres
  - Oxygen concentration greater than 23.5%. May lead to uncontrolled combustion.
- Oxygen Deficient Atmospheres
  - Concentration less than 19.5%. May occur with inert or asphyxiant gasses, common in confined spaces

Corrosive Chemicals

- A material that causes visible destruction of, or irreversible alterations to, living tissue by chemical action at the point of contact.
- Scale table 0 to 14, with 7 as neutral.
- The measurement of the hydrogen ion concentration in solution is called the pH (power of hydrogen) of the compound in solution.

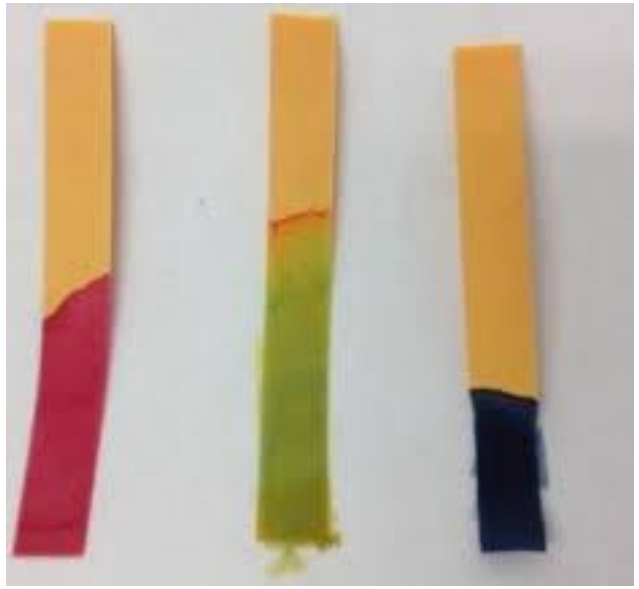
Corrosive Chemicals

Acids

- pH < 7 will turn pH paper red
- pH < 2.0 strong acid

Caustics

- pH > 7 will turn pH paper blue
- pH > 12 strong base



Chemical Reactivity

- A process involving the bonding, un-bonding or re-bonding of atoms, that can chemically change substances into other substances.
- Air Reactive - are those which react when exposed to air.
- Water Reactive - the materials that will react with water and release flammable gas or present a health hazard.

Exposure

- Is the process where people, equipment, animals and/or environment are subjected to or come in contact with a hazardous material.
- People may be exposed to a hazardous material through any route of entry (e.g. direct contact, inhalation, absorption, ingestion or direct contact).

Contamination

- Is the presence of a minor and unwanted contaminant.
- This process of transferring a hazardous material from its source to people, animals, the environment, or equipment, which may act as a carrier.

Secondary Contamination

- The process by which a contaminant is carried out of the hot zone on equipment, clothing or people in sufficient quantities, and contaminates other people, animals, the environment or equipment outside the hot zone.

High Risk	Low Risk
Asbestos	Carbon Monoxide
Pesticide	Weak Acids
PCB’s	Gasoline

Workplace Exposure Limits

- Threshold limit value
  - Airborne concentrations that workers can be exposed to daily without adverse effects.
- Threshold limit value/time weighted average (TLV/TWA)
  - Exposure concentrations for 40hr work week at 8hr days.
- Threshold limit value/short-term exposure limit (TLV/STEL)
  - 15 min exposure for substances thought to have chronic health effects and may have acute short term effects

Workplace Exposure Limits

- Threshold limit value/ceiling level (TLV/CL)
  - Concentration that should not be exceeded during any part of the day.
- Lethal concentration/lethal doses (LCt/LD)
  - Dose of a substance that will kill 50% of a research population.
- Immediately dangerous to life and health (IDLH)
  - Maximum environmental concentration for exposure up to 30 min without irreversible effects

Workplace Exposure Limits

- Recommended Exposure limit
  - Time weighted average of a substance that all workers can be exposed without adverse effects.
- Permissible Exposure limit
  - Allowed TWA for a substance in the workplace for 40 hr work week at 8 hr days.

Decontamination

- Decontamination typically takes place in the warm zone of the incident through a decontamination corridor.
- Consists of 4 methods depending on the substance:
  - Dilution
  - Absorption
  - Neutralization
  - Isolation

Dilution

- Application of large quantities of water to the person.
- Water is the universal decontamination solution (polar substances).
- Water may be aided by soap (non-polar).
- Remember polar and nonpolar substances react differently with water

Absorption

- Use of pads or towels to blot up the hazardous material
- Usually applied after lavage
- More commonly used during environmental cleanup

Neutralization

- Almost never used by EMS personnel
- A substance reduces or eliminates the toxicity of another substance
- Some substances may react violently with neutralization.
- Refer to MSDS sheets or specific protocols before using neutralizers

Isolation

- Involves separating the patient or equipment from the hazardous substance.
- Zones are established to prevent further contamination.

Decontamination Decision Making

- Fast-break decision making
  - Immediate action needed to prevent contamination and handle life threats
- Long-term decision making
  - Takes place at extended events with hazmat teams

Field Decontamination

- When dealing with unknowns, do not attempt to neutralize.
- Brush off dry chemicals. Be aware of the respiratory or contact exposure potential.
- Apply large quantities of water with soap if available.

Two-Step Process

- Usually a fast-break method.
- Remove patient's clothing and jewelry.
- Wash and rinse the patient two times.
- Be aware of run off and environmental exposure for the patient.

Eight-Step Process

- Rescuers enter the decontamination area at hot end of corridor and mechanically remove contaminants.
- Rescuers drop equipment in a tool-drop area, and remove outer gloves.
- Decontamination personnel shower and scrub all victims and rescuers using gross decontamination. Victims can be moved to step 6 or step 7.
- Rescuers remove and isolate their SCBA.

Eight-Step Process

- Rescuers remove all protective clothing. Victims who are still clothed have their clothes removed.
- Rescuers remove all personal clothing.
- Rescuers and victims receive a full-body washing.
- Patients receive rapid assessment and stabilization before transport.

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Field Decontamination

Level A Ensemble

- Fully encapsulating garment and respiratory protection
- Protects against only brief flash fire exposure
- Alpha radiation protection

Level B Ensemble

- Common level of protection, often chosen for its versatility
- Chemical protective:
  - Clothing
  - Boots
  - Gloves
  - SCBA

Level B Ensemble

- High level of respiratory protection
- Less skin protection
- Little or no flash fire protection

Level C Ensemble

- Appropriate when airborne contaminant is known
- Worn in long-duration, low-hazard situations
- Consists of:
  - Standard work clothing
  - Chemical-protective clothing
  - Chemical-resistant gloves
  - Respiratory protection other than SCBA/SAR

Level D Ensemble

- Work uniform that includes coveralls
- Provides minimal protection

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Protection

The level of protection needed depends on the chemical or substance involved.

Medical Management of Hazmat Patients

- Who was exposed?
  - Fixed or mobile site and number of potential patients.
- What was the material?
  - Single or multiple releases, physical state of the substance.
- Where did the incident occur?
  - Location and substance can give clues to the eventual scope of the situation.
- When did the incident occur?
  - Day, night, weather
- Why or How?
  - Crash, explosion, spill

Medical Management of Hazmat Patients

- Decontamination
- Primary survey and resuscitation
- Poisoning treatment paradigm:
  - A: Alter absorption, administer antidote
  - B: Basic supportive care
  - C: Change catabolism
  - D: Distribute differently
  - E: Enhance elimination

Entry Readiness

- Hazmat team members are assessed for readiness and the following checked and documented:
  - Blood pressure
  - Pulse
  - Respiratory rate
  - Temperature
  - Body weight
  - ECG
  - Mental/neurological status

After Exit “Rehab”

- The team completes decontamination and reports to rehab.
- Measure and document the same parameters as during entry readiness.
- Rehydrate the members of the team.
- Team members are not allowed to reenter the hot zone until their parameters are within normal limits.

Heat Stress Factors

- Take into account:
  - Temperature and humidity
  - Prior hydration status
  - Duration and degree of activity
  - Level of protective suit used

Summary

- Role of the Paramedic
- Incident assessment
- Control zones
- Properties of hazardous materials
- Hazmat protection equipment
- Approaches to decontamination
- Medical monitoring and rehabilitation