Unit 5.1

MISSION SPECIFIC:
Personal Protective Equipment

TERMINAL OBJECTIVE
Given scenarios involving hazardous materials/WMD incidents with known and unknown hazardous materials/WMD, the participant will be able to select the personal protective equipment required to support mission specific tasks at hazardous materials/WMD incidents based upon local procedures. (OPS-PPE 1.1)
EDUCATIONAL OBJECTIVES

Describe the types of personal protective equipment and EPA levels of protection. (OPS-PPE 1.1.1)

Identify the different designs of vapor-protective and splash-protective clothing. (OPS-PPE 1.1.1.1)

Identify the advantages and disadvantages of different types of heat exchange units. (OPS-PPE 1.1.1.2)

Describe personal protective equipment options for the following hazards:
- Thermal
- Radiological
- Asphyxiating
- Chemical
- Etiological/biological
- Mechanical (OPS-PPE 1.1.1.3)

Describe the following terms and explain their impact and significance on the selection of chemical-protective clothing:
- Degradation
- Penetration
- Permeation (OPS-PPE 1.1.1.4)

Identify at least three indications of material degradation of chemical-protective clothing. (OPS-PPE 1.1.1.6)

Identify the physiological and psychological stresses of using personal protective equipment. (OPS-PPE 1.1.2)

Given a scenario involving hazardous materials/WMD incidents and the emergency response plan and/or standard operating procedures, demonstrate the technical decontamination duties assigned in the incident action plan. (OPS-PPE 2.1)

Identify the safety procedures and emergency procedures for personnel wearing personal protective equipment. (OPS-PPE 2.1.1)

Demonstrate local procedures for going through the technical decontamination process. (OPS-PPE 2.1.2)

Describe the maintenance, testing, inspection, storage, and documentation procedures for personal protective equipment provided by the AHJ according to the manufacturer’s specifications and recommendations. (OPS-PPE 2.1.3)
Given a scenario involving a hazardous materials/WMD incident, identify and complete the reporting and documentation requirements consistent with the emergency response plan and/or standard operating procedures regarding personal protective equipment. (OPS-PPE 3.1)
UNIT TIMELINE

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<td>Respiratory Protection</td>
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<td>Garment Inspection and Testing</td>
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<td>Activity</td>
<td>PPE Operations</td>
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4 hrs 30 min. TOTAL

REQUIRED MATERIALS

- Visuals for Unit 5.1
- Personnel protective equipment that will be used by the participant as defined by their Employer’s Emergency Response Plan
  - SCBA, PAPR or APR
  - Protective ensembles NFPA 1991, 1992 or 1994 Class 2, 3 or 4 as defined
  - Sufficient gloves and supplies for the dress-out activity
- Fully encapsulated vapor protective garments, one for every two participants
- Vapor protective ensemble test equipment, one set for every two participants

ATTITUDES TO FOSTER
I) INTRODUCTION (5 MINUTES)

A) Goal

1) Upon completion of the program, the operations level responder will be able to select the appropriate personal protective equipment necessary to support mission specific tasks at hazardous materials/WMD incidents that are consistent with local policy and procedures.

B) Local policies and technician oversight requirement.

1) Use of PPE in the hazardous materials/WMD setting must be directed by organizational policies and procedures or, directed by the technical oversight of trained hazardous materials technicians.

C) Objectives

1) Describe the various levels and design considerations of personal protective equipment

2) Identify the hazards to be evaluated when conducting a risk based response

3) Identify the capabilities and limitations of personal protective equipment

4) Identify the national standards that address the selection, use, care and maintenance of PPE

D) Program organization

E) Evolutions

1) Evolutions will be based upon the personal protective equipment provided by the organization in conjunction with mission specific actives that are expected of the responder.
II) INTRODUCTION TO HAZARD BASED RESPONSE (20 MINUTES)

A) Definition

1) The process of developing personal protective measures designed to specifically address the hazards that are present at the scene in order to achieve an acceptable level of risk.

B) Acceptable risks

1) Risks exist in everything we do, whether in our day to day lives or during emergency response.

2) It is impossible to eliminate all risks.

3) The objective must be to reduce the risks to responders to a level that is acceptable based upon the benefits to be gained.

   (a) We will risk more to achieve more (e.g., life saving rescues)

   (b) We will risk little to achieve little (e.g., body recovery, fighting a “no-win” situation)

4) The perception of “acceptability” may vary from individual to individual.

   (a) Knowledge, training and job experience contributes to a better understanding.

   (b) This is why the IC must designate a knowledgeable Safety Officer.

C) “Hazards Based Response” Step One: Identify the hazards that are present

1) There are seven mechanisms of harm.

2) If we evaluate the scene for all of the possible mechanisms of harm that are present, we can then develop a hazard
based response which reduces the level of risk to each of the hazards.

3) The mechanism “TEAM CPR”
   (a) Thermal
   (b) Etiological
   (c) Asphyxiation
   (d) Mechanical
   (e) Chemical
   (f) Psychological
   (g) Radiological

D) “Hazards Based Response” Step 2: Develop measures to reduce each hazard present to an acceptable level of risk

1) **Thermal** protective measures might include:
   (a) Proper PPE
   (b) Suppression of flammable vapors with foam
   (c) Elimination of ignition sources
   (d) Use of protective hose lines
   (e) Cooling of exposed containers

2) **Etiological** protective measures might include body substance precautions such as:
   (a) Respiratory protection
   (b) Gowns
   (c) Gloves
   (d) Avoiding sharp objects
3) **Asphyxiation** protective measures will be based upon whether the material is a simple or chemical asphyxiating.

Reinforce the difference between simple and chemical asphyxiation. Simple asphyxiation is easily controlled through ventilation practices and the use of positive pressure SCBA. Chemical asphyxiation protective measures are based upon protecting the route of exposure by which the chemical can enter the body.

4) **Mechanical** hazard protective measures include:

   (a) Stabilizing
   (b) Shoring
   (c) Preventing trips and falls
   (d) Wearing puncture resistant clothing (e.g., steel toes, steel shank boot)
   (e) Wearing protective work gloves, helmets and eye protection

5) **Chemical** hazard protective measures

   (a) Heed the recommendations of the NAERG with regards to firefighter protective clothing
   (b) Protect the route of exposure

   - If *inhalation*: PP/SCBA
   - If *dermal contact*: Avoid contact
   - If *absorption*: Avoid Contact
   - If *ingestion*: No hand to mouth activities and good decontamination
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- If injection: Avoid sharp objects

  (c) Avoid areas of high vapor concentration

  • Approach from up-wind up high
  • Stay out of enclosed, confined or low lying areas

  (d) Avoid direct product contact

  (e) Always use appropriate protective clothing

- Know your PPE's capabilities and limitations

6) Psychological hazard protective measures

  (a) Always know your own capabilities and limitations

  (b) Never try to over extend yourself

  (c) Recognize the need for Critical Incident Stress De-briefing (CISD)

7) Radiological hazard protective measures

  (a) Time: Exposure is directly proportional to time.

  (b) Distance: Exposure is inversely proportional to the square of the distance from the source.

  • If you double your distance from the source, you reduce your exposure to 1/4 the original rate.

  • If you triple your distance, your exposure is reduced to 1/9 the original.
(c) Shielding: The greater the mass between you and the source, the greater the protection

III) PROTECTION & STANDARDS (5 MINUTES)

A) OSHA 29 CFR 1910.120 defines minimum level of protection.

1) Full turnout gear and PP/SCBA

2) Level must be maintained until atmosphere is quantified

It is the Incident Commander's responsibility to insure that all personnel operating within the hazard area are wearing the appropriate level of protection. The MINIMUM level of protection that MUST be worn during an emergency response is full firefighter protective clothing with PP/SCBA. Only after the Incident Commander has thoroughly evaluated the hazards through proper air monitoring, can that level of protection be reduced. THIS IS NOT NEGOTIABLE.


1) Training

2) Selection and use

3) Fitness

4) Fit testing

C) Ensemble concept

1) Ensembles are considered to be all of the components of a personal protective system.

   (a) Components

      • Respiratory protective component
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- Dermal protective component (garment)
- Footwear
- Hand protection

(b) Respiratory options

- Protection provided against IDLH concentrations
- Protection from concentrations below IDLH

(c) Dermal options

- Gas and vapor protective, high concentration
- Gas and vapor protection low concentration
- Liquid with low vapor pressure
- Particulates

2) Third party test requirements

(a) Certified ensembles must be tested by third party testing facilities.

(b) All ensembles are tested as a system.

IV) STANDARDS DEVELOPMENT ORGANIZATIONS (10 MINUTES)

A) National Fire Protection Association (NFPA)

1) Standard 1991 — Vapor Protective Garment

(a) Protection from high levels of vapor concentration
(b) With or without a flash fire protection option

NFPA 1991 defines the highest level of protection for hazardous material emergencies. NFPA 1991 ensembles are intended for severe chemical exposure skin hazards. The suits are designed to provide protection from gases, vapors, liquids, and particulates. Level A ensembles should not be used without extensive training. Use considerations are provided in OSHA Title 29 CFR Sections 1910.120 and 1910.132, and NFPA 1500, Standard on Fire Department Occupational Safety and Health Program.

2) Standard 1992 — Splash Protective Garments

(a) Liquid splash protection

(b) Optional flash fire resistance

NFPA 1992 addresses the second tier of hazardous materials response protection. This standard establishes the requirements for chemical liquid splash protection where the chemical vapors that exist during a hazardous material response are no longer a hazard. The liquid splash-protective ensembles are intended for situations where the primary form of chemical exposure is short-term, intermittent contact with liquid chemicals that do not produce skin-toxic or carcinogenic vapors. NFPA 1992 further permits the individual certification of garments, gloves, and footwear, which may not be part of an overall ensemble. The primary purpose of NFPA 1992 is to establish requirements for clothing that keeps liquids from contacting the wearer's skin.


(a) Class 2 — Vapor or liquid hazards at or above IDLH
NFPA 1994 Class 2 requirements consist of a full body one- or multi-piece garment, gloves, footwear, and CBRN Self-Contained Breathing Apparatus (SCBA). Note that the certification applies to a specific set of elements identified by make/model (garment, gloves, boots, SCBA) and the ensemble certification is void unless the specified elements are used (e.g., it is not permissible to substitute boots or a respirator that have not been certified as part of the ensemble).

- Similar in function to what has been referred to as Level B but offers vapor protection from those chemicals are that not aggressively injurious to the skin
- For use in IDLH respiratory environments
- Used in gases, vapors, aerosols and particulate environments

(b) Class 3 — Liquid splash, vapor non-IDLH

(c) Class 4 — Particulate/biological

B) National Institute of Justice

1) Law enforcement specific protective ensembles

2) Same chemical protective capabilities as NFPA 1994

3) Specific capabilities for the unique law enforcement functions

(a) LERL 1 — IDLH and flash fire

(b) LERL 2 — IDLH no fire

(c) LERL 3 — Non-IDLH respiratory hazard
V) RESPIRATORY PROTECTION (20 MINUTES)

A) Six types

The instructor will discuss various types of protective equipment for the purpose of informing the responders of the types of equipment that are available so that they can make an educated decision as to when to call for technician level assistance. This lecture is not intended to condone the use of specialized equipment by operations level responders.

1) Particulate filter
   
   (a) Filters particulates out of the air
   
   • Works by numerous mechanisms
   • Entrainment
   • Impaction
   • Electrostatic
   
   (b) Most common are rated at 95% and 100% (99.97%) efficient at removing particulates 0.1 micron or greater in size.
   
   (c) Also designated as “P” of oil proof against oil aerosols and “N” as non oil proof
   
   (d) Light weight
   
   (e) Limited length of use
   
   (f) Does not provide protection from chemical or asphyxiation hazards

2) Air purifying respirators (APR)
(a) Pre-treats ambient air through use of chemical specific cartridges

(b) Advantages

- Light weight
- Extended work periods
- Stress reduction
- Matches protection to actual hazard

(c) Limitations

- Less protective
- Protection factor 100:1 max
- Not to be used in IDLH atmosphere
- Not applicable for firefighting
- Cannot be used in oxygen deficient atmospheres
- Chemical specific
- Must have known chemical and known concentration
- Develops negative pressure on inhalation

Discuss the use of APRs in decontamination. Explain that the likelihood of high concentrations is very low because responders are dealing only in small amounts and they are being diluted. However, to use APRs, responders must be properly fit tested. Additionally, this protective measure must not be utilized without expert technical recommendation.
3) PAPR

(a) Fan draws air into system and forces it through filters like APR

(b) Advantages

- Positive pressure — higher protection
- Cooling effect
- Much the same as APR
- Stacked filters

(c) Disadvantages

- Requires battery
- Cannot be used in IDLH environments
- Must have at least 19.5% oxygen

4) Supplied Air Breathing Apparatus (SABA)

(a) Air is supplied to user from known source through tether line

(b) Advantages

- Reduced weight
- Extended operational periods
- Less physical stress, greater mobility
- Some are positive pressure
- Protection factor 10,000:1 if positive pressure

(c) Limitations
• Air source has potential for failure so emergency egress must be maintained

• Tether length limited to 300 feet

• Contamination or damage to tether

5) Positive Pressure, Self-Contained Breathing Apparatus (PP/SCBA)

(a) Air supply worn on wearer’s back

(b) Advantages

• Readily available
• 30 to 60 min. duration
• Freedom of movement
• Greatest protection
• Protection factor 10,000:1

(c) Disadvantages

• Duration
• Weight
• Physical stress

6) Closed Circuit

(a) Advantages

• High level of protection
• Longer duration up to 4hrs

(b) Disadvantages

• Air supplied is heated
• Not rated for firefighting or CBRNE
• Cold temp may impede scrubber
• May be difficult to decontaminate

B) Determining work mission duration

1) Low pressure alarm during normal firefighting operations
   (a) Provides a safety period to allow emergency egress
   (b) Decontamination is generally not required during firefighting.

2) During hazmat in which time may not be sufficient
   (a) Safety factor of 25 – 30% of bottle life
   (b) Travel time to and from site
   (c) Decontamination time
   (d) Workload expected
   (e) Environmental <85 = 0 min., 85 – 90 = 5 min., >90 = 10 min.

Show the calculations for allowed work time in the hot zone adding all the factors. Explain why short duration work missions are needed.

VI) DERMAL PROTECTION (15 MINUTES)

A) Minimum level of protection is full turnout gear and PP/SCBA.

B) Any higher protection requires specialized training.
C) Support garment may be worn
   1) In support roles where an exposure is not anticipated
   2) Examples: aprons, eye protection

D) Special fire protective clothing can also be utilized.
   1) Must be defensive operations
   2) Garment includes
      (a) Proximity clothing
      (b) Entry clothing
      (c) Structural firefighting clothing

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Explain the difference in various types of firefighting gear and their intended purpose.

E) Skin contact hazards
   1) Vapors and gases
   2) Vapors from liquids
   3) Solids

F) Dermal protective suits
   1) Turnout gear has extreme protective limitations
   2) Two types of protection
      (a) Vapor
      (b) Splash
   3) These, combined with the different types of respiratory, give us four levels of protection.

G) Splash protective garments
1) Provides protection from incidental splashes

2) No vapor protection

3) Cannot be used:
   (a) In IDLH concentrations
   (b) Where there is potential for gross contamination with products absorbed through skin
   (c) In potential fire areas
   (d) Where large volumes of vapors are expected
   (e) Because it creates heat stress since moisture cannot evaporate from the skin

4) Are well suited for:
   (a) Decontamination operations in well established systems
   (b) Dealing with non-sublimating solids
   (c) Perimeter operations quantified safe
   (d) Caring for patients that no longer pose significant risk of secondary contamination

VII) OSHA DEFINED “LEVELS OF PROTECTION” (10 MINUTES)

A) The levels do not accurately reflect the protective capabilities of ensembles.

   1) However, the terminology is widely ingrained and commonly used.
   2) Certified ensembles such as NFPA and NIJ defined systems are much more accurate.
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B) Level C

1) Splash suit + APR

2) Splash protection with lower level of respiratory protection

3) Must know chemical and concentration

C) Level B

1) Splash suit + PP/SCBA

2) Provides splash protection with highest level or respiratory protection

D) Level A (vapor protection)

1) Protection from outside through full encapsulation

2) Designed for area of high concentrations of vapors and repeated contact or accidental immersion in product

3) Limitations

   (a) No thermal protection

   (b) Limited dexterity and sight

   (c) Limited communications

   (d) Physical stress

      • 100% humidity

      • Temperature inside can be as much as thirteen degrees higher than outside

   (e) Specialized training and maintenance

4) Level “A” vapor protective suit and PP/SCBA
5) Offers the highest level of protection and also, the greatest risk of physical stress

<table>
<thead>
<tr>
<th>BASIC LEVELS OF PROTECTION</th>
<th>Equipment/Level</th>
<th>Level D</th>
<th>Level C</th>
<th>Level B</th>
<th>Level A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garment Type</td>
<td>None</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bunker gear</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bunker gear w/ CBRN Option</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical Splash</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vapor Protective</td>
<td>X</td>
<td></td>
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</table>

**Respiratory Protection**

| None                  | X       |         |         |         |         |
| Air Purifying         | X       |         |         |         |         |
| Positive Pressure     | X       | X       |         |         |         |
| Supply air or SCBA    |         |         |         |         |         |

Note: Full firefighter protective clothing provides a high level of respiratory protection but a low level of skin protection; therefore, it is classified as level “D” but has limited applications in the hazard area.

E) Comparison of EPA/OSHA Levels A, B & C with NFPA standard Ensembles

<table>
<thead>
<tr>
<th>Ensemble Description Using Performance-Based Standard(s)</th>
<th>OSHA/OSHA Level</th>
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<tbody>
<tr>
<td>NFPA 1991, worn with NIOSH CBRN SCBA</td>
<td>A</td>
</tr>
<tr>
<td>NFPA 1994 Class 2 worn with NIOSH CBRN SCBA</td>
<td>A or B</td>
</tr>
<tr>
<td>NFPA 1994 Class 2 worn with NIOSH CBRN APR</td>
<td>C</td>
</tr>
<tr>
<td>NFPA 1994 Class 3 worn with NIOSH CBRN SCBA</td>
<td>B</td>
</tr>
<tr>
<td>NFPA 1994 Class 3 worn with NIOSH CBRN APR</td>
<td>C</td>
</tr>
</tbody>
</table>

Source: DMS Interagency Board

VIII) PPE AND WMD (5 MINUTES)

A) Radiological

1) Radiological materials are particulates

2) Respiratory protection prevents inhalation and ingestion

3) Particulate protective garments will enhance the ability to decontaminate

4) NFPA 1994 Class 4 ensembles with PAPR
B) Nerve agents

1) Nerve agents are mostly low volatility liquids

2) Positive pressure SCBA is selected in IDLH environments

3) In low vapor concentrations, NFPA 1994 Class 2 ensembles are indicated

C) Blister agents

1) Blister agents also are low volatility liquids

2) Positive pressure SCBA is selected in IDLH environments

3) In low vapor concentrations, NFPA 1994 Class 2 ensembles are indicated

D) Biological agents

1) Biological materials are particulates

2) Particulate respiratory protection

3) Particulate protective garment found in NFPA 1994 Class 4

   (a) Storage

   (b) Testing procedures and frequency

   (c) Must be in accordance with manufacture’s recommendations

   (d) Should also cover emergency procedures

Employers should define emergency evacuation procedures for entry operations. This should include what the employee should do if he or she experiences an in-suit emergency or what to do when the emergency evacuation signal is sounded.
Discuss the concept that no one suit is good for all chemicals. The manufacturer will supply their department with a list of chemicals their suit has been tested against. They will also list the breakthrough time of each. They will need to pick the garment that offers the longest time.

IX) SUPPORT REQUIREMENTS FOR ENTERING THE ISOLATION AREA (5 MINUTES)

A) OSHA 29 CFR 1910.120 requires support functions be in place for personnel entering into isolation zones caused by hazardous materials

1) Use of a buddy system
2) Use of RIC
3) EMS on scene dedicated to responders
4) Decontamination in place
5) Proper level of PPE
6) Proper training

X) MAINTENANCE AND TESTING (15 MINUTES)

A) PPE maintenance

1) Employer must have defined PPE policy

(a) Define inspection procedures and frequency
   - Permeation
   - Penetration
   - Degradation

(b) Cleaning, disinfection or disposal procedures

B) Must be maintained according to manufacturer’s recommendations
C) Enforced by Employers SOP’s

D) Cleaned and disinfected according to manufacturer’s recommendations

E) Visual Garment Inspection

1) All garments should be visually inspected before use and testing

2) Inspect the garment thoroughly, head to toes, front to back to look for signs of

   (a) Missing exhaust vents

   (b) Physical damage

   (c) Signs of degradation
       - Discoloration
       - Delamination
       - Imbrittlement or softening of the garment fabric

F) Testing full Encapsulating Vapor Garments (Level A)

1) Garment testing is defined by the manufacturer

2) Most common means is by inflation testing

   (a) Visual inspection is performed (as defined earlier

   (b) Garment is inflated with air to pre-test expansion pressure of not less than 3 inches of water for 1 minute to allow for expansion

   (c) Pressure is then reduced to 2 inches of water and held for not less than 3 minutes

   (d) After 3 minutes, no greater than 20% (0.4 inches) can be lost
(e) If excessive pressure is lost then soap water can be used to locate the leak

(f) Repairs can be made in accordance with manufacturer recommendations and the suit can be re-tested

(g) All tests must be recorded and log

Activity 5.1 A (If Applicable) (30 Minutes)

Working in teams of two, have participants conduct pressure testing of totally encapsulating vapor protective ensemble equipment provided by the AHJ in accordance with the manufacture’s recommendations.

XI) GARMENT DONNING, DOFFING AND USE

During this discussion, the instructor should have one or all of the participants engage in the donning and doffing process in a unified manner as lead by the instructor.

A) Agency Standard Operating Procedures should be used in the donning, doffing and use of PPE

B) Florida SERC Model Procedure

Activity 5.1.B (30 Minutes)

Have the participants don or doff the protective ensembles in accordance with their Employers Standard Operating Procedures or the SERC Model Procedure for Personal Protective Equipment.

XII) SUMMARY (10 MINUTES)

A) Hazards based response

1) Identify the hazards present using TEAM CPR
2) Develop protective measures necessary to bring each of the identified hazards to an acceptable level of risk

3) If the risk remains unacceptable, get help

B) Personal protective equipment

1) Minimum level of protection is PP/SCBA and full firefighter protective clothing until proven otherwise. No exceptions.

2) Levels of respiratory protection
   
   (a) APR's and Positive SABA or SCBA
   
   (b) APRs not applicable to the operations level responder without fit testing and expert evaluation

3) Levels of dermal protection
   
   (a) Bunker gear
   
   (b) Splash resistant
   
   (c) Vapor protective

4) Level of PPE ensembles

Activity 5.1 C (30 Minutes)
Selection and Use of PPE

Activity 5.1 D (60 Minutes)
PPE Operations
Participants should don PPE and perform an entry operation. Give the participants tasks to complete. Then have them go through technical decontamination.