

## **EH Resident Competency 1.19**

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**Competency 1.19** EH Residents shall demonstrate a working level knowledge of the requirements for using personal protective equipment (PPE).

### **1. Supporting Knowledge and Skills**

- a. Describe the principles governing the selection, use, and limitations of the following:
  - Respirators
  - Protective clothing
  - Hearing protection devices
- b. Describe the various types of personal equipment (devices or clothing) worn to protect a worker from chemical exposure, radiological exposure, and physical injury.
- c. Given a work procedure and atmospheric conditions, identify the appropriate type of respiratory protection for the activity.
- d. Discuss the following terms as applied to the selection of respiratory equipment:
  - Time-weighted average
  - Short-term exposure limit
  - Threshold limit values
  - Immediately dangerous to life and health
  - Revised exposure limits
  - Protection factor
  - Derived air concentration
- e. Describe the four levels of protection defined by the Environmental Protection Agency for workers at hazardous waste sites or those workers conducting emergency response activities.

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### 2. Self-Study Activities (corresponding to the intent of the above competency)

Below are two web sites containing many of the references you may need.

Web Sites		
Organization	Site Location	Notes
Department of Energy	<a href="http://wastenot.inel.gov/cted/stdguido.html">http://wastenot.inel.gov/cted/stdguido.html</a>	DOE Standards, Guides, and Orders
OSHA	<a href="http://www.osha-slc.gov/">http://www.osha-slc.gov/</a>	OSHA documents and search engine
U.S. House of Representatives	<a href="http://law.house.gov/cfr.htm">http://law.house.gov/cfr.htm</a>	Searchable Code of Federal Regulations

**Read** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection.

EXERCISE 1.19-A Referring to 29 CFR 1910.120 (g), under what general circumstances would the personal protective equipment (PPE) be used as a control measure to reduce and maintain to or below the permissible exposure limits or dose limits?

**Read** Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*; **scan** Subpart I, "Personal Protective Equipment," of 29 CFR 1910, *Occupational Safety and Health Standards for General Industry*; and **read** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection, Appendix B, "General Description and Discussion of the Levels of Protection and Protective Gear."

EXERCISE 1.19-B Referring to paragraph (a) of Subpart I, 29 CFR 1910.132, when shall personal protective equipment be provided and used?

EXERCISE 1.19-C Referring to Chapter 8, "Personal Protective Equipment (PPE)," of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, what are the primary and secondary considerations when selecting protective clothing?

EXERCISE 1.19-D Describe the various types and intended purpose of personal

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protective equipment (PPE).

EXERCISE 1.19-E Referring to Chapter 8, Personal Protective Equipment (PPE), of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, in the following table, match (from the following list) the appropriate type of respiratory protection to the given limitation:

- Self-contained breathing apparatus (SCBA)
- Positive-pressure, supplied-air respirator (SAR)
- Air-purifying respirator
- Closed-circuit SCBA
- Escape-only SCBA

Matching Respiratory Protection with Limitation	
Limitation	Type of Respiratory Protection
At very cold temperatures, scrubber efficiency may be reduced and CO <sub>2</sub> breakthrough may occur.	
Can only be used against gas and vapor contaminants with adequate warning properties.	
Provides only 5 to 15 minutes of respiratory protection.	
Bulky, heavy, and may impair movement in confined spaces.	
Air line is vulnerable to damage, chemical contamination, and degradation.	

EXERCISE 1.19-F Describe the EPA levels of protection for workers at hazardous material sites, providing at least one condition for each level.

EXERCISE 1.19-G Describe two reasons for upgrading the PPE level of protection.

EXERCISE 1.19-H Based on EPA protective ensembles, complete the following table by giving at least two examples of recommended equipment for each level of protection.

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Levels of Protection Ensembles		
Level	Protection Provided	Recommended Equipment
A	The highest available level of respiratory, skin, and eye protection.	
B	Same level of respiratory protection but less skin protection than Level A. The minimum level recommended for initial site entries until the hazards have been identified.	
C	Same level of skin protection as Level B, but a lower level of respiratory protection.	
D	No respiratory protection. Minimal skin protection.	

**Read** paragraphs a through c of 29 CFR 1910.95, *Occupational Noise Exposure*, and the corresponding chapters in any comparable fundamentals of industrial hygiene text; **scan** Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*; **scan** Subpart I, “Personal Protective Equipment,” of 29 CFR 1910, *Occupational Safety and Health Standards for General Industry*; **scan** Appendix B, “Methods for Estimating the Adequacy of Hearing Protector Attenuation,” of 29 CFR 1910.95, *Occupational Noise Exposure*; and **scan** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection, Appendix B, “General Description and Discussion of the Levels of Protection and Protective Gear.”

EXERCISE 1.19-I What are the four pathways by which sound can reach the inner ear when hearing-protective devices are worn?

EXERCISE 1.19-J Based on OSHA hearing-protection standards, complete the following table listing types (or examples), recommended use, and limitations for the four general categories of hearing-protective devices.

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Use and Limitations of Hearing-Protective Devices			
Category	Types or Examples	Recommended Use	Limitations
Enclosures			
Aural inserts			
Superaural protectors			
Circumaural protectors			

EXERCISE 1.19-K What are the primary considerations when selecting the appropriate hearing-protective device?

**Read** 29 CFR 1910.146 (a and b), *Permit-Required Confined Spaces*, and **scan** NIOSH Pub. No. 80-106, *Criteria for Recommended Standard: Working in Confined Spaces*, and ANSI Z88.2-1980, *Practices for Respiratory Protection*.

**Review** DOE Order 232.1, *Occurrence Reporting and Processing of Operations Information*; DOE 5500.2, *Emergency Categories, Classes, and Notification and Reporting Requirements*; and pages 1 through 9 in the Guidance for Event Classification and Emergency Action Levels in Office of Emergency Planning and Operations, *Emergency Management Guide*.

**Read** the following scenario (adapted from article in *Occupational Safety Observer*, July-August 1994 issue) and **answer** the questions posed in the exercises.

A subcontractor worker at a federal facility was inspecting a section of storm drain pipe and entered an underground vault that was connected to the piping. The vault contained about six inches of stagnant, bacteria- and algae-laden water. The worker collapsed after being in the vault for about 10 minutes. An hour later, two passersby climbed into the vault to rescue the worker. They, too, collapsed. Two paramedics, who arrived at the scene, entered the vault and then had to be helped out. Finally, firefighters wearing appropriate breathing apparatus retrieved the dead worker and first rescuer, and resuscitated the second rescuer, who needed to be hospitalized.

EXERCISE 1.19-L What was the likely cause of death for the worker and the rescuer?

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EXERCISE 1.19-M What type of breathing apparatus did the firefighters use, and why?

EXERCISE 1.19-N How could this incident have been prevented?

EXERCISE 1.19-O What is the proper classification of this incident, and why?

**Read** Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*; **scan** Subpart I, “Personal Protective Equipment,” of 29 CFR 1910, *Occupational Safety and Health Standards for General Industry*, and **read** 29 CFR 1910.120 (g), Engineering controls, work practices, and personal protective equipment for employee protection, Appendix B, “General Description and Discussion of the Levels of Protection and Protective Gear.”

EXERCISE 1.19-P Briefly define the following terms related to respiratory protection.

- Threshold limit values
- Time-weighted average
- Short-term exposure limit
- Recommended exposure limit
- Immediately dangerous to life and health
- Protection factor
- Derived air concentration

### 3. Summary

**(From NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*)**

Use of PPE is required by Occupational Safety and Health Administration (OSHA) regulations in 29 CFR 1910 and 1926 and reinforced by U.S. Environmental Protection Agency (EPA) regulations in 40 CFR 300, all of which include requirements for all private contractors working on Superfund, construction, industrial, and government sites to conform to applicable OSHA provisions and any other federal or state safety requirements deemed necessary by the lead agency overseeing the activities. All supervisors should check the applicable regulations to ensure worker safety and health, and compliance with PPE requirements for various hazards and work activities.

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No single combination of protective equipment and clothing is capable of protecting against all hazards. Thus PPE should be used in conjunction with other protective methods. The use of PPE can itself create significant worker hazards, such as heat stress, physical and psychological stress, and impaired vision, mobility, and communication. In general, the greater the level of PPE protection, the greater the associated risks. For any given situation, equipment and clothing should be selected that provide an adequate level of protection. Overprotection as well as underprotection can be hazardous and should be avoided.

### 4. Exercise Solutions

EXERCISE 1.19-A Referring to 29 CFR 1910.120 (g), under what general circumstances would the personal protective equipment (PPE) be used as a control measure to reduce and maintain to or below the permissible exposure limits or dose limits?

ANSWER 1.19-A Whenever engineering controls and work practices are not feasible or not required, or when contaminant levels have not been reduced using engineering or administrative controls.

EXERCISE 1.19-B Referring to paragraph (a) of Subpart I, 29 CFR 1910.132, when shall personal protective equipment be provided and used?

ANSWER 1.19-B (Any reasonable paraphrase of the following:) “Whenever it is necessary by reason of hazards of processes or environment, chemical hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact.”

EXERCISE 1.19-C Referring to Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, what are the primary and secondary considerations when selecting protective clothing?

ANSWER 1.19-C Primary:

- permeation
- degradation
- penetration
- heat transfer

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Secondary:

- durability
- flexibility
- temperature effects
- ease of decontamination
- compatibility with other personal protective equipment
- duration of use

EXERCISE 1.19-D Describe the various types and intended purpose of personal protective equipment (PPE).

ANSWER 1.19-D

Types and Purpose of Personal Protective Equipment (PPE)		
Body Part Protected	PPE	Purpose
Eyes and face	Face shield	Protects against chemical splashes.
	Splash hood	Protects against chemical splashes.
	Safety glasses	Protect eyes against large particles and projectiles.
	Goggles	Can protect against vaporized chemicals, splashes, large particles, and projectiles.
	Sweat bands	Prevents sweat-induced eye irritation and vision impairment.
Respiratory	Self-contained breathing apparatus	Provides the highest available level of protection against airborne contaminants and oxygen deficiency.
	Supplied-air respirators	Protect against most airborne contaminants.
	Air-purifying respirators	Protect against specific chemicals and up to specific concentrations.
Hands and arms	Gloves and sleeves	Protect hands and arms from chemical contact.

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Types and Purpose of Personal Protective Equipment (PPE)		
Body Part Protected	PPE	Purpose
Feet	Safety boots	Protect feet from contact with chemicals and from compression, crushing, or puncture by falling, moving, or sharp objects.
	Disposable shoe or boot covers	Protect safety shoes or boots from contamination.
Head	Safety helmet	Protects head from blows.
	Hood	Protects against chemical splashes, particulates, and rain.
	Protective hair covering	Protects hair against chemical contamination, entanglement in machinery or equipment, or from interfering with vision and with the functioning of respiratory devices.
Full body	Fully encapsulating suit	Protects against splashes, dust, gases, and vapors.
	Nonencapsulating suit	Protects against splashes, dust, and other materials, but not against gases and vapors.
	Aprons, leggings, and sleeve protectors	Provides additional splash protection of chest, forearms, and legs.

EXERCISE 1.19-E Referring to Chapter 8, “Personal Protective Equipment (PPE),” of NIOSH/OSHA/USCG/EPA, *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, in the following table, match (from the following list) the appropriate type of respiratory protection to the given limitation:

- Self-contained breathing apparatus (SCBA)
- Positive-pressure, supplied-air respirator (SAR)
- Air-purifying respirator
- Closed-circuit SCBA
- Escape-only SCBA

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ANSWER 1.19-E

<b>Matching Respiratory Protection with Condition</b>	
<b>Limitation</b>	<b>Type of Respiratory Protection</b>
At very cold temperatures, scrubber efficiency may be reduced and CO <sub>2</sub> breakthrough may occur.	Closed-circuit SCBA
Can only be used against gas, vapor, and particulate contaminants with adequate warning properties.	Air-purifying
Provides only 5 to 15 minutes of respiratory protection.	Escape-only SCBA
Bulky, heavy, and may impair movement in confined spaces.	Self-contained breathing apparatus
Air line is vulnerable to damage, chemical contamination, and degradation.	Positive-pressure, supplied-air respirator

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EXERCISE 1.19-F Describe the EPA levels of protection for workers at hazardous material sites, providing at least one condition for each level.

ANSWER 1.19-F

EPA Levels of Protection for Workers	
Level	Condition
A	<ul style="list-style-type: none"><li>• The hazardous substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system based on either the measured or potential for high concentration.</li><li>• Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible.</li><li>• Operations are being conducted in confined, poorly ventilated areas, and the absence of conditions requiring Level A have not yet been determined.</li></ul>
B	<ul style="list-style-type: none"><li>• The type and atmospheric concentration of substances have been identified and require the highest level of respiratory protection, but less skin protection.</li><li>• The atmosphere contains less than 19.5 percent oxygen.</li><li>• The presence of incompletely identified vapors or gases is indicated by a direct-reading organic vapor-detection instrument, but vapors and gases are not suspected of containing high levels of chemicals harmful to skin or capable of being absorbed through the skin.</li></ul>
C	<ul style="list-style-type: none"><li>• The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin.</li><li>• The types of air contaminants have been identified, concentrations have been measured, and an air-purifying respirator is available that can remove the contaminants.</li><li>• All criteria for the use of air-purifying respirators are met.</li></ul>
D	<ul style="list-style-type: none"><li>• The atmosphere contains no known hazard.</li><li>• Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.</li></ul>

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EXERCISE 1.19-G Describe two reasons for upgrading the PPE level of protection.

ANSWER 1.19-G (Any two of the following:)

- Known or suspected presence of dermal hazards
- Occurrence or likely occurrence of gas or vapor emission
- Change in work task that will increase contact or potential contact with hazardous materials
- Request of the individual performing the task
- Oxygen-deficient atmosphere

EXERCISE 1.19-H Based on EPA protective ensembles, complete the following table by giving at least two examples of recommended equipment for each level of protection.

ANSWER 1.19-H

<b>Levels of Protection Ensembles</b>		
<b>Level</b>	<b>Protection Provided</b>	<b>Recommended Equipment</b>
A	The highest available level of respiratory, skin, and eye protection.	<ul style="list-style-type: none"> <li>• Positive-pressure, full face-piece, self-contained breathing apparatus, or positive-pressure, supplied-air respirator with escape SCBA</li> <li>• Totally encapsulating chemical protective suit</li> </ul>
B	Same level of respiratory protection but less skin protection than Level A. The minimum level recommended for initial site entries until the hazards have been identified.	<ul style="list-style-type: none"> <li>• Positive-pressure, full face-piece, self-contained breathing apparatus, or positive-pressure, supplied-air respirator with escape SCBA</li> <li>• Hooded, chemical-resistant clothing</li> </ul>
C	Same level of skin protection as Level B, but a lower level of respiratory protection.	<ul style="list-style-type: none"> <li>• Full-face or half-mask air-purifying respirators</li> <li>• Hooded, chemical-resistant clothing</li> </ul>
D	No respiratory protection. Minimal skin protection.	<ul style="list-style-type: none"> <li>• Coveralls</li> <li>• Chemical-resistant, steel toe and shank boots/shoes</li> </ul>

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EXERCISE 1.19-I What are the four pathways by which sound can reach the inner ear when hearing-protective devices are worn?

- ANSWER 1.19-I
1. Seal leaks
  2. Material leaks
  3. Hearing-protective device vibration
  4. Bone conduction

EXERCISE 1.19-J Based on OSHA hearing protection standards, complete the following table listing types (or examples), recommended use, and limitations for the four general categories of hearing-protective devices.

Use and Limitations of Hearing-Protective Devices			
Category	Types or Examples	Recommended Use	Limitations
Enclosures			
Aural inserts			
Superaural protectors			
Circumaural protectors			

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### ANSWER 1.19-J

Use and Limitations of Hearing-Protective Devices			
Category	Types or Examples	Recommended Use	Limitations
Enclosures	<ul style="list-style-type: none"> <li>Helmets</li> </ul>	Enveloping the entire head, this device can accommodate earmuffs and other aural protectors.	Cost, bulk, and practical only in very special applications.
Aural inserts	<ul style="list-style-type: none"> <li>Formable</li> <li>Custom-molded</li> <li>Premolded</li> </ul>	<ul style="list-style-type: none"> <li>Rolled into cone and inserted into ear.</li> <li>Custom-molded to shape of ear.</li> <li>Require proper fitting by trained person.</li> </ul>	<ul style="list-style-type: none"> <li>Can be pushed too far into ear canal, and can come loose.</li> <li>Can come loose.</li> <li>Performance falls with irregularly-shaped ear canals; also can shrink and become hard from contact with ear wax</li> </ul>
Superaural protectors	<ul style="list-style-type: none"> <li>Devices that seal the external opening of the ear canal</li> </ul>	Held in place by a light band or head suspension.	Can come loose.
Circumaural protectors	<ul style="list-style-type: none"> <li>Earmuffs</li> </ul>	The attenuation is increased with an increase in force applied; a good seal is dependent upon the width of the contact surface and the material used in the cushion.	Perspiration causes stiffening of the seals.

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EXERCISE 1.19-K What are the primary considerations when selecting the appropriate hearing-protective device?

ANSWER 1.19-K (Any three of the following.)

- Attenuation characteristics of the hearing protector (given in the manufacturer's noise reduction rating)
- The individual's work area
- The use of other personal protective equipment
- The frequency of exposure to excessive noise

EXERCISE 1.19-L What was the likely cause of death for the worker and the rescuer?

ANSWER 1.19-L Asphyxiation from lack of oxygen. Bacteria growth and algae decay in the stagnant water produced carbon dioxide that likely displaced the oxygen in the vault.

EXERCISE 1.19-M What type of breathing apparatus did the firefighters use, and why?

ANSWER 1.19-M Self-contained breathing apparatus (SCBA) with full face-piece because the hazardous atmosphere was unknown and the SCBA offers the highest level protection in a confined space.

EXERCISE 1.19-N How could this incident have been prevented?

ANSWER 1.19-N The worker should have been with a buddy and had the piping and vault atmosphere tested prior to entry. The passersby (assuming the worker did not have a buddy and did not have the air tested) should have called 911 for immediate assistance and NOT entered the vault.

EXERCISE 1.19-O What is the proper DOE/OSHA classification of this incident, and why?

ANSWER 1.19-O Unusual occurrence, because of loss of life and violation of federal (OSHA) safety requirements.

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EXERCISE 1.19-P Briefly define the following terms related to respiratory protection.

- Threshold limit values
- Time-weighted average
- Short-term exposure limit
- Recommended exposure limit
- Immediately dangerous to life and health
- Protection factor
- Derived air concentration

ANSWER 1.19-P (Any reasonable paraphrase of the following.)

- Threshold limit values - refer to airborne concentrations of substances; and it is believed represent conditions under which nearly all workers may be repeatedly exposed, day after day without adverse effect.
- Time-weighted average - the time-weighted average concentration for a normal 8-hour workday or 40-hour workweek, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect.
- Short-term exposure limit - the maximal concentration to which workers can be exposed for a period of up to 15 minutes continuously without suffering from irritation, chronic or irreversible tissue change, or narcosis of sufficient degree to increase the likelihood of accidental injury, impair self-rescue, or materially reduce work efficiency.
- Recommended exposure limit - time-weighted average concentrations for up to a 10-hour workday during a 40-hour workweek.
- Immediately dangerous to life and health - an atmospheric concentration of any toxic, corrosive, or asphyxiant substance that poses an immediate threat to life or would interfere with an individual's ability to escape from a dangerous atmosphere.
- Protection factor - the level of protection that can be provided by a respirator; a number, which is determined experimentally by measuring face-piece seal and exhalation valve leakage, indicates the relative difference in concentrations of substances outside and inside the facepiece that can be maintained by the respirator.
- Derived air concentration - the average atmospheric concentration of the radionuclide that would lead to the allowable limit on intake in a reference person as a consequence of exposure at that concentration for a 2,000-hour workyear.