Module 7:

Personal Protective Equipment
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Module Description

This module covers the protective gear used by hazardous materials Technicians. Other factors related to the use of PPE, such as chemical compatibility, the physiological and psychological stresses of wearing encapsulated clothing, and maintenance are also addressed.

Prerequisites

- Students should have completed a hazardous materials operations level training program.
- Students should have completed Module 3: Health and Safety and Module 5: Practical Chemistry.
- Students must be able to use all the available chemical resources in the jurisdiction. At a minimum these should include the NAERG, NIOSH Pocket Guide and CHRIS manual.
- Students should understand the major hazards of the nine hazard classes.
- Students must be medically cleared to wear the jurisdiction’s SCBA and to wear encapsulating Chemical Protective Clothing.
# Objectives

Upon completion of this module, participants will be able to:

<table>
<thead>
<tr>
<th>Objectives</th>
<th>NFPA Standards</th>
<th>OSHA Standards</th>
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<tbody>
<tr>
<td>Describe the respiratory protection available in their jurisdiction</td>
<td>472 4-4.2</td>
<td>29 CFR 1910.120</td>
</tr>
<tr>
<td>Don, use, and doff the respiratory protection available in their jurisdic-</td>
<td>1500 3-4</td>
<td>(q) (6) (iii) (D)</td>
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<td>tion.</td>
<td>472 4-4.2</td>
<td>29 CFR 1910.120</td>
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<tr>
<td>Describe at least two advantages and two limitations of the following</td>
<td>471 4-5-3.1</td>
<td>(q) (6) (iii) (D)</td>
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<tr>
<td>types of respiratory protection:</td>
<td>472 4-4.2</td>
<td>29 CFR 1910.120</td>
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<tr>
<td>- Positive Pressure SCBA</td>
<td>472 4-3.3.2.1</td>
<td>(q) (6) (iii) (D)</td>
</tr>
<tr>
<td>- Positive Pressure Supplied Air Respirators</td>
<td>472 4-3.3.2</td>
<td>(q) (6) (iii) (D)</td>
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<tr>
<td>- Air Purifying Respirators</td>
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<tr>
<td>- Closed Circuit SCBA</td>
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<tr>
<td>Describe the selection process for respiratory protection</td>
<td>472 4-3.3.2</td>
<td>29 CFR 1910.120</td>
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<tr>
<td>Describe the applicable situations and standards affecting the selection,</td>
<td>472 4-3.3</td>
<td>(q) (6) (iii) (D)</td>
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<td>use, and maintenance of respiratory protection</td>
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<tr>
<td>Identify and describe the following levels of protection:</td>
<td>471 5.5</td>
<td>29 CFR 1910.120</td>
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<tr>
<td>- Level A/Vapor Protective Clothing</td>
<td>472 4-3.3</td>
<td>(q) (6) (iii) (D)</td>
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<tr>
<td>- Level B/Liquid Splash Protective Clothing</td>
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<tr>
<td>- Level C/Support Function Garments</td>
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<td>- Level D</td>
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<td>Identify and describe the conditions that require the use of the various</td>
<td>471 5.6</td>
<td>29 CFR 1910.120</td>
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<td>levels of protection</td>
<td>472 4-3.3.1</td>
<td>(q) (6) (iii) (D)</td>
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<tr>
<td>Describe the following terms in relation to chemical protective clothing:</td>
<td>472 4-3.3.1</td>
<td>29 CFR 1910.120</td>
</tr>
<tr>
<td>Degradation, Penetration, Permeation</td>
<td>472 4-3.3.2</td>
<td>(q) (6) (iii) (D)</td>
</tr>
<tr>
<td>Describe at least one testing technique for each of the terms above</td>
<td>472 4-3.3.2</td>
<td>29 CFR 1910.120</td>
</tr>
<tr>
<td>Define the following terms and describe their relation to chemical</td>
<td>472 4-3.3.3.1</td>
<td>(q) (6) (iii) (D)</td>
</tr>
<tr>
<td>protective clothing selection: Permeation Rate, Actual Breakthrough</td>
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<td>Time, Normalized Breakthrough Time</td>
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<td>Identify the advantages and limitations of the following cooling</td>
<td>472 4-3.3.3.4</td>
<td>29 CFR 1910.120</td>
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<tr>
<td>techniques used with chemical protective clothing:</td>
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<td>(q) (6) (iii) (D)</td>
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<tr>
<td>- Air Cooled</td>
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<td>- Ice Cooled</td>
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<tr>
<td>- Water Cooled</td>
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<td>Identify the physical and psychological stresses that can affect</td>
<td>472 4-3.3.3.7</td>
<td>29 CFR 1910.120</td>
</tr>
<tr>
<td>chemical protective clothing users and methods to control these stresses</td>
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<td>(q) (6) (iii) (D)</td>
</tr>
<tr>
<td>Identify the information necessary to make a chemical protective</td>
<td>472 4-3.3.3.5</td>
<td>29 CFR 1910.120</td>
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<tr>
<td>clothing selection</td>
<td></td>
<td>(q) (6) (iii) (D)</td>
</tr>
<tr>
<td>Given a simulated incident with the following information—work</td>
<td>472 4-3</td>
<td>29 CFR 1910.120</td>
</tr>
<tr>
<td>activities, chemical(s) involved, amount/concentration of chemicals</td>
<td>472 4-3.3.3.6</td>
<td>(q) (6) (iii) (D)</td>
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<tr>
<td>and the appropriate CPC charts—determine the appropriate level and</td>
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<td>materials of protection to safely handle the incident</td>
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<td>Describe the procedures for establishing chemical protective clothing</td>
<td></td>
<td>29 CFR 1910.120</td>
</tr>
<tr>
<td>donning and doffing areas</td>
<td>472 4-4.2</td>
<td>(q) (6) (iii) (D)</td>
</tr>
<tr>
<td>Don, use, and doff all chemical protective clothing available to the</td>
<td>472 4-4.2</td>
<td>29 CFR 1910.120</td>
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<tr>
<td>jurisdiction</td>
<td></td>
<td>(q) (6) (iii) (D)</td>
</tr>
<tr>
<td>Assist in the donning and doffing of chemical protective clothing on</td>
<td>472 4-4.2</td>
<td>29 CFR 1910.120</td>
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<tr>
<td>other personnel</td>
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<td>(q) (6) (iii) (D)</td>
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<tr>
<td>Describe the maintenance, testing, storage, and inspection procedures</td>
<td>471 5</td>
<td>29 CFR 1910.120</td>
</tr>
<tr>
<td>used by the jurisdiction for chemical protective clothing and equipment</td>
<td>472 4-4.2.5</td>
<td>(q) (6) (iii) (D)</td>
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<td>472 4-4.2.6</td>
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</tbody>
</table>
Instructor Preparation
Module 7
Prerequisite Quiz

1. Vapor-protective clothing for hazardous chemical emergency response is described in:
   A. NFPA 1991
   B. NFPA 1992
   C. NFPA 1993
   D. NFPA 1994

2. Chemical protective clothing is specifically designed to:
   A. Repel most liquid chemicals
   B. Prevent or limit inhalation hazards
   C. Prevent or limit skin exposure
   D. Provide chemical and flash protection

3. The process by which a chemical moves through a material by molecular means is called:
   A. Degradation
   B. Penetration
   C. Permeation
   D. Adsorption

4. Which type of respirator should be worn in emergency response?
   A. Demand respirators
   B. Positive pressure self-contained breathing apparatus
   C. Negative pressure self-contained breathing apparatus
   D. Either positive pressure or negative pressure self-contained breathing apparatus

5. Which of the following organizations assigns protection factors to respirators?
   A. National Institutes of Occupational Safety and Health
   B. Environmental Protection Agency
   C. National Fire Protection Administration
   D. Mine Safety and Health Administration

6. The longest approved air line for supplied air respirators is:
   A. 100 feet
   B. 250 feet
   C. 300 feet
   D. 500 feet

7. Support function garments should never be used for:
   A. Decontamination
   B. Waste cleanup
   C. Training
   D. Emergency response
8. Liquid splash-protective clothing for hazardous chemical emergency response is described in:
   A. NFPA 1991
   B. NFPA 1992
   C. NFPA 1993
   D. NFPA 1994

9. Breakthrough time refers to the time it takes for a chemical to:
   A. Penetrate protective clothing
   B. Permeate protective clothing
   C. Affect the integrity of protective clothing
   D. Create any type of opening in protective clothing

10. Which type of resistance data is most valuable when using vapor-protective clothing?
    A. Degradation
    B. Penetration
    C. Permeation
    D. Adsorption
Introduction

Questions

1. What NFPA standard covers Level B chemical protective clothing?

2. Are Level A and B suits tested for resistance to permeation?

Operational level personnel are trained to reduce or eliminate the dangers and damage of a hazardous material in a defensive manner; that is, to deal with the incident without “intentional intimate contact” with the materials.

In many incidents these defensive actions are sufficient to stabilize an incident and downgrade the status from an emergency to a remediation. However, if the defensive actions are not enough to control the incident, more offensive actions may be needed. These actions may put responders in the position to become “intimately” involved with the hazardous materials. That is, they are likely to have significant contact with the materials. Responders who are expected to have this contact must be trained to the Technician level.

Simply avoiding a hazardous material is an excellent way to reduce the harmful effects; however, technician level responders cannot always practice this method. They need another level of protection—a barrier—between their bodies and the materials. This barrier is chemical protective clothing and related equipment.

Knowing what barriers to use and when, is essential to protection of the involved personnel and the successful outcome of the incident.
Respiratory Protection

The easiest, most insidious and most dangerous way you can be exposed to the effects of hazardous materials is via the respiratory system. Inhalation provides a direct route into a responder’s body and into a delicate and crucial system.

The fire service has long recognized that inhalation exposure poses a major risk to fire fighters. Over the past 25 years, self contained breathing apparatus (SCBA), has become the standard for respiratory protection in the fire service.

Protection against airborne contaminants must be second nature to fire service responders.

Types of Respiratory Protection

Positive Pressure Self Contained Breathing Apparatus (PP SCBA)

Also known as an airpack, PP SCBA is the respiratory protection most commonly used in the fire service. The positive pressure full facepiece provides the highest level of respiratory protection to the user. If the mask fails to seal
properly, positive pressure inside the mask unit forces air to be expelled, preventing contaminants from entering. However, the positive pressure effect is not 100% failsafe, and contaminants do occasionally enter the mask.

Over the past years a number of improvements and modifications have been made to positive pressure SCBA:

- Cylinders of air are now available in 30 minute, 45 minute and 60 minute durations.
- Weight (with 30 minute cylinders), has been reduced to about 20 pounds.
- Backplates, harnesses, facepieces and controls are more ergonomic (user friendly).
- Flow rates are more consistent with user demands.

**Advantages to Positive Pressure SCBA**

- Most responders are proficient in its use
- Readily available
- Provides highest level of protection against airborne contaminants and oxygen deficiency

**Limitations to Positive Pressure SCBA**

- Bulky, heavy
- Limited air supply limits work duration (this may actually be an advantage)
- May impair movement in confined spaces
- Unknown resistance to chemicals

**Closed Circuit Self Contained Breathing Apparatus (Rebreathers)**

Closed Circuit Respirators, sometimes known as “rebreathers” operate on the principle of rebreathing the air inside the breathing circuit of the SCBA. By rebreathing the air, the duration of the SCBA can be significantly extended. This differs from the common “open circuit” SCBA in the fire service, which expels exhaled air through the exhalation valve in the facepiece.

A closed circuit respirator works as follows. When a cylinder valve is opened, 100% oxygen flows from the cylinder) through a pressure reducer to fill the breathing circuit. As the wearer inhales, the oxygen is drawn through
the inhalation hose and valve and hose. The exhaled air, containing carbon dioxide, flows through a chemical “scrubber”. The scrubber converts the carbon dioxide into water. This chemical reaction also generates heat in the process. The “scrubber” breathing air flows to the breathing bag and past a cooler. A constant dosage outlet continually adds oxygen to breathing air to replenish the oxygen which is consumed by the wearer. New oxygen is usually supplied via a cylinder of pure, compressed O₂, although experiments with liquid oxygen (LOX) have also been done.

The cooler and the constant dosage help to cool the warm breathing air from the scrubber. For peak demands of breathing air from strenuous work, a valve opens and fills the breathing circuit with additional oxygen. Any excess breathing air in the circuit is expelled through a relief valve.

As can be seen, this method of operation is quite different from that of most fire service SCBA. “Rebreather” technology has progressed a long way from its beginnings (in the 1930s-40s), using state of the art manufacturing, metering and computer chip technology. To comply with NIOSH and OSHA laws, these units are now positive pressure, just like “normal” SCBA. Some fire departments have started to use closed circuit SCBAs in specialized operations, such as tunnel rescue and fires, where travel to the actual emergency site may well exceed even 60 minute duration cylinders.

Use of these systems in chemical protective clothing (CPC) is largely unknown. Extended duration of working time in CPC is generally avoided because of the physical and psychological stresses of working in CPC. Also, the fact that these systems do not expel air and therefore would not “inflate” a “Level A” suit would seem a disadvantage (The positive pressure inside the suit acts as a safety factor.)

Any department considering the use of closed circuit units in conjunction with CPC should contact and discuss the procedures with the manufacturers of both the CPC and closed circuit respirators.
Advantages of Closed Circuit SCBA
- Increased work duration

Limitations of Closed Circuit SCBA
- New technology to the fire service
- Different, if not more difficult, to maintain
- Unknown factors in use with CPC

Positive Pressure Supplied Air Respirator (PP SAR)

Activity

Supplied air respirators combine the full facepiece style of regular SCBA but without the constraints of a backplate, harness and cylinder. A hoseline delivers an air supply to the user’s facepiece and maintains it at a positive pressure.

The user receives the benefits of a full facepiece PP SCBA without having to carry the air supply. It also can provide an almost limitless supply of air. Air line systems can be connected to large cylinders or cylinder switching systems, where the supply can be switched from one cylinder to another when the first cylinder becomes low.
Advantages of Positive Pressure SAR

- Longer work periods than SCBA
- Less bulky and less heavy than SCBA
- Protects against airborne contaminants to the same level as positive pressure SCBA

Limitations of Positive Pressure SAR

- Hoseline impairs mobility
- OSHA / NIOSH limits hose to 300 feet from the point of air supply
  - Check local, state, and manufacturer’s recommendations
- As length of hose is increased, minimum approved air flow may not be delivered to facepiece
- Air line is vulnerable to damage, mechanical contamination, and degradation; decon may be difficult
- Worker must retrace steps to leave work area
- Requires supervision / monitoring of air supply line (manpower)
- Not approved for use in IDLH atmospheres unless equipped with an emergency egress unit such as an escape-only SCBA with a minimum five minute duration

This last point is extremely important because almost all chemical emergency response requires entry into an IDLH atmosphere or an atmosphere that must be assumed to be IDLH.

Air Purifying Respirator (APR)

Air purifying respirators, sometimes known as cartridge respirators do not supply fresh air like the PP SCBA and PP SAR. Instead they filter the air the user draws through the nosepiece. They can be full-face or half-face configurations. They are not commonly considered a tool for emergency responders, who respond to uncontrolled (and in many cases, unknown) releases of hazardous materials. They are usually used by clean-up contractors or other industry workers who work in controlled, well characterized areas.
Advantages of APR

• Enhanced mobility (no weight or air lines)
• Lighter weight than SCBA
• Increased work duration
• Less physical stress on user

Limitations of APR

• Cannot be used in IDLH or oxygen deficient (< 19.5%) atmospheres
• Only protects against specific chemicals up to specific concentrations (proper cartridge must be selected)
• Limited duration of protection; may be hard to gauge safe operating time in field conditions
• Use requires constant monitoring of contaminants and oxygen levels
• Can only be used for gas and vapor contaminants with adequate warning properties (TL-O below TLV-TWA), or for specific gases or vapors provided that the service life is known and a safety factor is applied or if the unit has an End of Service Life Indicator (ESLI)
• Facepieces must be fitted to each individual user to ensure proper seal (no positive pressure)

Most fire departments will never use APRs. However, you may respond to incidents where you will find employees using them, or work with contractors who provide them for their employees. Knowing the limitations and proper uses of these devices is important to overall scene safety.

Respirator Selection

For most fire service personnel the selection of respiratory protection is not a matter of what type to use, but whether respiratory protection is needed at all. This is because the fire service has been using the highest level of respiratory protection for many years as part of their normal response. Some departments may have the ability to use PP SAR, but the limitations of air line systems must be recognized and addressed. Also, chemical protective clothing must be specially modified to accept the use of SAR.
The use of APRs in emergency response is difficult because of the severe limitations on atmospheric conditions/monitoring and identification necessary for safe use.

Between PP SCBA or PP SAR, one is not necessarily “better” than the other. Each has its benefits and limitations and each jurisdiction will need to decide the type of system it prefers.

If PP SCBA is to be used, longer duration cylinders (45 or 60-minute) are recommended. This will allow personnel adequate entry, work, and decontamination time.

Use standard risk analysis and OSHA regulations to determine whether respiratory protection is needed. OSHA requirement 1910.120 (q) (3) (iv) states that:

Employees engaged in emergency response and exposed to hazardous substances presenting an inhalation hazard or potential inhalation hazard shall wear positive pressure SCBA … Until such time as the person in charge of the ICS determines through the use of air monitoring that a decreased level of respiratory protection will not result in hazardous exposure to employees.

In other words, SCBA is assumed necessary unless it can be definitively proven that no airborne hazards exist.

Other Considerations

OSHA has, in 1910.134 (1998 edition), spelled out very specific requirements for selection, use, testing, cleaning and maintenance of respiratory equipment. The law requires that employers develop a complete written respiratory protection program and communicate the program to their employees. It also requires that each employee wear a respirator (SCBA are considered respirators), be medically certified to wear it, and have an annual fit test for the facepiece.

The law is specific in its requirements and provides clear methods of complying. Any department using SCBA should be following this standard, for fires as well as hazardous materials operations.
The latest version of 1910.134 requires fire fighters entering structural fires to wear PP SCBA and to enter in teams of two, with a minimum of two equally equipped fire fighters standing by. This is the so-called “Two In - Two Out” rule. See Appendix E for more information on this rule.
Chemical Protective Clothing

Since the inception of 1910.120 and NFPA 471 and 472, there have been many changes in the field of chemical protective clothing. There are now standards for chemical protective clothing and testing methods to ensure the standards are met and comparisons between clothing can be made.

Materials and manufacturing methods have significantly improved in the past 15 years. There is a much greater choice available now than in the beginning stages of hazardous materials response. Construction of chemical protective clothing has changed from solid materials (e.g. butyl rubber, neoprene and viton) to layered materials. These barrier films can provide resistance to many more chemicals and the layered construction is lighter and more flexible. New materials and methods have also facilitated the construction of reasonably priced disposable garments.

EPA originally established levels for CPC—the now familiar Level A, Level B, Level C and Level D. These levels were related to the style of clothing recommended to protect against various hazards. However, at that time there were no standards or rules regarding the construction and testing of garments made for these levels. There was also no standard for chemical resistance, or chemical resistance information provided with the garment. Users and manufacturers were left to their own devices to determine what was necessary and how to test and report the results.

The NFPA semi-incorporated the EPA levels in NFPA 471. These levels made recommendations for an entire ensemble and in conjunction released NFPA 1991, 1992 and 1993. These three standards describe minimum requirements for chemical resistance, air tightness, flame resistance, abrasion resistance, leak resistance, flexibility, and general wear. It also stated how tests for these various requirements were to be conducted and how the results would be reported. These standards, although minimum requirements, finally provided information that CPC users could use to fairly compare garments. It also gave responders the
knowledge that the CPC they were wearing, if it met the appropriate standard, would provide at least the minimum protection of that standard.

Today the EPA and NFPA guidelines coexist, which sometimes causes confusion among responders. The NFPA Levels A, B, C, and D, while closely mirroring the EPA levels, call for the use of NFPA compliant garments. The EPA levels do not.

Using NFPA-certified garments (known as “compliant” garments), or using non-compliant garments is a decision made by each jurisdiction. Many jurisdictions opt to use a combination of both, allowing greater flexibility in response and purchase. However, the IAFF strongly recommends the use of NFPA compliant garments for all activities involving entry into areas where chemical protective clothing is required.

Levels of Protection

Level A Protection

Chemical protective clothing, like street clothing, has two elements—style and material. Style choices and material choices are separate and distinct. Materials and style each have their own advantages and limitations. The selection should be based on your own department. Level A protection affords the responder the highest level of both respiratory and skin protection. It has sometimes been called a “moon suit” because of its encapsulating style. It has also been called a “body bag with windows” because of the conditions and products it may be used in.

The NFPA standard for Level A protective garments is NFPA 1991, Standard for Vapor-Protective Suits for Hazardous Chemical Emergencies. Suits meeting this standard are called for in NFPA 471—Recommended Practice for Responding to Hazardous Materials Incidents. Level A must have flash protection to comply with NFPA 1991. Compliant garments will have a label on the inside of the suit stating that it is compliant. The label may also list the chemicals the garment protects against. As with other types of PPE, remember that there is no one garment style or material that can protect against all types of chemicals.
<table>
<thead>
<tr>
<th>Features of Level A Chemical Protective Clothing</th>
<th>(Non-Compliant)</th>
<th>NFPA Compliant</th>
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<tbody>
<tr>
<td><strong>Requires SCBA or SAR</strong></td>
<td>Requires SCBA or SAR (Provides for protection of respirator—usually accomplished by placing inside garment)</td>
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<tr>
<td><strong>Fully encapsulating suit (FES)</strong></td>
<td>Totally encapsulating suit (FES)</td>
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<tr>
<td><strong>Airtight</strong></td>
<td>Airtight (and tested to be airtight)</td>
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<tr>
<td><strong>Integral boots and gloves</strong></td>
<td>Integral boots and gloves</td>
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<tr>
<td><strong>Head protection (optional)</strong></td>
<td>Head protection (optional)</td>
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<tr>
<td><strong>Inner/outer gloves that are chemically resistant</strong></td>
<td>Chemically resistant inner/outer gloves (must meet same resistance as materials tested for 60 minutes against ASTM F 1001 21 chemical list)</td>
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<td>All materials/parts of suit must pass 21 chemical tests (visor, closures, seams)</td>
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<td>Tested for flexing/bending resistance</td>
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<td>Tested for resistance to cold</td>
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<td></td>
<td>Tested for non-flammability (ASTM)</td>
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<td>Tested for flash protection (ASTM-then gastight integrity retested)</td>
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<td></td>
<td>Tested for static charge generation and retention</td>
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<td></td>
<td>Tested for abrasion, cut puncture resistance (then re-tested for chemical resistance)</td>
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<td>Two-way radios worn inside</td>
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Indications for Using Level A Protection

- Highest level of respiratory protection needed (based on physical and chemical properties of material)
- Highest level of skin protection is required
- Highest level of eye protection is required
- Constant high concentration exposure (work activities such as plugging/patching)
- Skin absorbable chemicals
- Suspected or confirmed carcinogens
- EPA recommends Level A for entry into confined (closed) areas of unknowns

Level A Advantages

- Can virtually eliminate possibility of any contact with environmental hazards (it’s basically its own environment)
- Best protection known at this time
- Limited thermal protection if NFPA compliant

Level A Limitations

- Bulky
- Physically stressful—does not allow for cooling
- Psychologically stressful (confinement and danger of product—“body bag with windows”)
- Reduced mobility, dexterity—increases time necessary to perform job
- More difficult to don and doff (requires manpower)
- Communications may be difficult
- Cost (suits can range from $1,000 to $4,000)

Questions

1. Recall the last incident you responded to, in which the hazardous materials response team was required. What was the hazard? How was it controlled? Was it handled by the HMRT successfully? Could the situation have been mitigated without the help of the HMRT?

2. Have you ever donned Level A PPE? What were the primary problems you experienced?

3. What are some types of incidents that may require Level A PPE?
<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemical Class</th>
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<tbody>
<tr>
<td>Acetone</td>
<td>Ketones</td>
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<tr>
<td>Acetonitrile</td>
<td>Nitriles</td>
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<tr>
<td>Ammonia Gas</td>
<td>Inorganic gases/vapors</td>
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<tr>
<td>1, 3 Butadiene</td>
<td>Hydrocarbons</td>
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<tr>
<td>Carbon disulfide</td>
<td>Sulfur compounds</td>
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<tr>
<td>Chlorine gas</td>
<td>Elements</td>
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<tr>
<td>Dichloromethane</td>
<td>Halogen gases</td>
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<tr>
<td>Diethylamine</td>
<td>Amines</td>
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<td>Ethyl acetate</td>
<td>Carboxylic esters</td>
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<td>Ethylene oxide gas</td>
<td>Heterocyclic compounds</td>
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<td>n-Hexane</td>
<td>Hydrocarbons</td>
</tr>
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<td>Hydrogen chloride gas</td>
<td>Inorganic gases/vapors</td>
</tr>
<tr>
<td>Methanol</td>
<td>Hydroxylic compounds</td>
</tr>
<tr>
<td>Methyl chloride gas</td>
<td>Halogen compounds</td>
</tr>
<tr>
<td>Nitrobenzene</td>
<td>Nitro compounds</td>
</tr>
<tr>
<td>40% Sodium hydroxide</td>
<td>Inorganic bases</td>
</tr>
<tr>
<td>95% Sulfuric acid</td>
<td>Inorganic acids</td>
</tr>
<tr>
<td>Tetrachloroethylene</td>
<td>Halogen compounds</td>
</tr>
<tr>
<td>Tetrahydrofuran</td>
<td>Ethers</td>
</tr>
<tr>
<td>Toluene</td>
<td>Hydrocarbons</td>
</tr>
</tbody>
</table>

Table 7.1

ASTM F1001 Chemicals Used in Testing Level A Clothing
Level B Protection

Level B protection affords the user with the highest level of respiratory protection and protection against contact with product from spills and splashes. This level of protection should never be used when there is a possibility of contact with a dangerous vapor/gas.

The NFPA standard for Level B protective garments is NFPA 1992, Standard for Splash-Protective Suits for Hazardous Chemical Emergencies. Suits meeting this standard are called for in NFPA 471—Recommended Practice for Responding to Hazardous Materials Incidents.

Tests done on NFPA 1992 suits are for penetration, not permeation. Many manufacturers supply permeation data for their 1992 compliant garments because they use the same materials as in their 1991 garments. The standard was written to define construction for splash resistance and is concerned with liquid leaks through seams, closures and attachments. This is a critical issue to understand. The standard also eliminated tests against chemicals that were gases, or considered to be a hazard by skin contact or absorption, or carcinogenic.

Compliant Level B garments require that SCBA be covered. Most manufacturers accomplish this by placing the SCBA inside the upper half of the suit. Many of these garments can be as confining, if not more confining, than compliant Level A suits.

Indications for Using Level B Protection

- “The highest level of respiratory protection is necessary, but a lesser level of skin protection is needed.” (1910.120, Appendix B)
- Probable exposure to low concentrations—incidental splash
- Chemical is mainly a respiratory hazard

Level B Advantages

- High level of respiratory protection
- Increased mobility/dexterity (theoretically)
- May be cooler
- Compliant garments have good penetration characteristics
- Cost—ranges from $45 (non-compliant) to $1,500
Level B Limitations

- Not gas/vapor tight—not designed to protect from vapors/gases
- Not designed or tested (NFPA 1992) to be used at scenes involving carcinogens or skin absorbable chemicals
- Non compliant Level B may still leak in liquids
- Non compliant Level B offers no thermal protection

Questions

1. Recall the last incident you responded to, in which Level B PPE was worn. Was this level the highest level of protection worn at the incident? What was the hazard?

2. Have you ever donned Level B PPE? What were the primary problems you experienced?

3. What are some types of incidents that may require Level B PPE?

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Chemical Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>Ketones</td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>Nitriles</td>
</tr>
<tr>
<td>Ammonia Gas</td>
<td>Inorganic gases/vapor</td>
</tr>
<tr>
<td>n-Hexane</td>
<td>Hydrocarbons</td>
</tr>
<tr>
<td>40% Sodium hydroxide</td>
<td>Inorganic bases</td>
</tr>
<tr>
<td>95% Sulfuric acid</td>
<td>Inorganic acids</td>
</tr>
<tr>
<td>Tetrahydrofuran</td>
<td>Ethers</td>
</tr>
</tbody>
</table>

Table 7.2

ASTM F1001 Chemicals Used in Testing Level B Clothing
(Liquid, Non-Skin, Non-Carcinogenic)
**Level C Protection**

Level C protection shows the real differences between NFPA compliant and EPA levels. The EPA Level C is basically the EPA Level B splash protection requirement but instead of SCBA or SAR, Air Purifying Respirators are used. The EPA made no statement regarding the garments used but reduced the level of respiratory protection.

The NFPA also allows for the use of APR but defines the type of garments with which it may be used. The premise for both the EPA and NFPA Level C is that the hazards are well characterized; that is, they are known and measured. Contact between the product’s vapors or liquid/solid and exposed skin would not constitute a health hazard to the exposed individual.

The NFPA standard for Level C protective garments is *NFPA 1993, Standard on Support Function Protective Clothing for Hazardous Chemical Operations*. Suits meeting this standard are called for in NFPA 471—Recommended Practice for Responding to Hazardous Materials Incidents.

**Indications for Use of Level C Protection**

- Reduced level of respiratory protection needed
- Well characterized and measured products
- Splashes or incidental contact with product will not cause harm to skin or be absorbed
- NFPA 1993 garments made for support zone activities, such as decontamination (in some cases), and remedial site mitigation.

**Level C Advantages**

- EPA—reduced respiratory stress (both physical and working time), because of APR use
- NFPA—tested against penetration and liquid integrity
- NFPA—light weight, less physical stress
- NFPA—more comfortable
- NFPA—basically designed to be disposable (no reuse testing)
Level C Limitations

- Can only be used in very controlled situations
- Greatly reduced flammability rating—no flash protection
- Reduced strength from typical Level B

Questions

1. What is the primary limitation of Level C protection in the fire service?

2. What type of incidents require Level C protection?

Level D Protection

Level D protection, in both EPA and NFPA guidelines, addresses normal workplace protections. Level D protection is much more commonly used in routine industrial operations than in the fire service. Remember that depending on the workplace and work activities, you may need different protective clothing/equipment. There is no NFPA standard for garment construction for Level D. However, follow the applicable standards for any items you wear such as eye protection, footwear, and gloves.

Features of Level D Protection (NFPA Compliant and Non-Compliant)

- Eye protection
- Coveralls
- Boots/shoes that are chemically resistant and steel-toed and shanked
- Hard hat
- Gloves (when appropriate)

Indications for Use of Level D Protection

- Atmosphere contains no known hazard
- Work activities preclude splashes, immersion, or the potential for unexpected inhalation or contact with hazardous materials
- THERE IS NO EMERGENCY!
Level D Advantages

- Allows for more efficient work activities in non-emergency situations

Level D Limitations

- Not for use in an emergency situation; typically worn only when moving product within a facility
Stresses of Wearing Chemical Protective Clothing

Heat Related Stress

The body will attempt to maintain an appropriate temperature (97°-100°F). Covering the body with impermeable material such as chemical protective clothing, and performing strenuous work will interfere with the body’s ability to regulate temperature.

Personnel who wear chemical protective clothing should maintain a high level of fitness and hydration and pass a pre-entry medical screen before being permitted to don chemical protective clothing.

Types of Heat Related Stress

Symptoms of Heat Cramps
- Painful, intermittent cramps or spasms in the back, legs, arms, stomach
- Heavy sweating
- Variable pulse
- Variable respiration
- Treatment
  - Stop work activities, rehydrate, examination by EMS

Symptoms of Heat Exhaustion
- Profuse sweating
- Rapid, shallow respiration (panting)
- General fatigue, nausea, vomiting, slow weak pulse, cool, pale, clammy, pounding heart
- Thirst
- Headache, dizziness
- Poor judgment, irritability
- Treatment:
  - Best treatment is prevention—drink plenty of water
• Rest whenever possible in shade or cool area
• Wear only what is necessary
• Monitor yourself and others
• Evaluation by EMS

Symptoms of Heat Stroke
Heat stroke is a true medical emergency and a life-threatening condition. It is a result of unrecognized and untreated heat exhaustion.

• Red, hot, dry skin—no sweating
• Strong, rapid pulse
• Significant change in level of consciousness and possible coma
• Core body temperatures of >104.5°F
• Treatment:
  • Remove from area, remove impermeable clothing
  • EMS evaluation and treatment immediately

Preventing Heat Related Stress

A pre-donning physical evaluation and proper hydration are the best methods to ensure that heat related stresses do not compromise an emergency operation. Realistic work times, close supervision, and monitoring will help maintain the health status of entry personnel.

You can find recommended inclusion criteria for entry personnel in NFPA 471. These criteria, which are summarized below, will help prevent personnel whose systems are already stressed from enduring the extreme stresses of chemical protective clothing. Remember, however, that every department has its own standards, which may differ from NFPA.

NFPA 471 recommends that responders who are donning protective clothing have:

• Blood pressure ≤150/90
• A pulse ≤70% of maximum heart rate (220 minus age)
• A respiratory rate ≤ 24/minute
• An oral temperature between 97°F and 99.5°F, or
• A core temperature between 98°F and 100.5°F
• A normal EKG (no new dysrhythmias)
• No open sores, large rashes or significant sunburn
- A good mental status (no slurred speech, weakness)
- No nausea, vomiting, fever, upper respiratory infection, heat illness, diarrhea or heavy alcohol intake in past 72 hours
- No alcohol in past six hours
- No new prescription drugs in past two weeks and no “over-the-counter” cold/flu remedies in past 72 hours (unless medically cleared through local medical control)
- No pregnancy

Cooling devices can be used to help reduce heat build-up in impermeable clothing. Air cooling systems use ambient temperature or cooled air supplied by a hoseline into the impermeable suit. Ice cooled systems use vests around the torso filled with ice to help remove heat from the user. Water cooled systems are similar to ice systems, but use water filled vests to assist in heat transfer.

Remember that these systems will add weight. The additional weight and associated decrease in mobility may cause increased stress and heat production. Recent information shows that these types of systems may not cool or reduce core temperatures, but may instead give the user a cooling sensation on the surface. This feeling may give the user a false sense of well-being. In the initial phases of hazardous material response, cooling systems were very popular, but many teams have discontinued their use because of the increased weight, unknown efficiency, increased cost and increased maintenance. The work activity duration may also be limited by the capacity of the cooling system.

**Cold Related Stress**

Heat stress is a very serious concern to responders, but thermal stresses can be caused by cold as well. In many areas of North America, the fall and winter seasons can bring extremely low temperatures. Unfortunately, hazardous materials incidents occur in all types of weather. Cold weather also causes additional problems for responders, including more slip hazards and access problems.

Chemical protective clothing is usually not a good insulator. Although it does prevent your body from using normal
cooling techniques, it also allows heat transfer to take place. In a cold ambient environment, you and your chemical protective clothing will be warmer than the surrounding atmosphere. You will lose heat as it radiates from your suit to the environment.

**Types of Cold Related Stress**

Cold related injuries usually are progressive. They start at the peripheries (fingers, toes, hands, feet, ears) and spread inward, lowering core temperature.

**Symptoms of Frostnip (Incipient Frostbite)**
- Sudden whitening of skin
- Some discomfort
- Easily treated, damage not permanent

**Symptoms of Superficial Frostbite**
- Waxy or white skin surface
- Underlying tissue is still resilient
- Treatable, usually not permanent damage

**Symptoms of Deep Frostbite**
- Cold pale skin
- Underlying tissue is solid
- Treatment is difficult and results in permanent damage

**Symptoms of Hypothermia**
- Systemic problem—lowered body temperature
- Progresses from shivering to apathy, listlessness and sleepiness, to slowed pulse, and coma-like respiration, to freezing of extremities, and finally to death

**Preventing Cold Related Stress**

Preparing for cold weather operations is paramount. Wearing appropriate undergarments for cold weather will help you reduce effects of the cold. A warm environment (buses, command vehicles, portable structures, nearby structures, etc.), for briefing, donning, decontamination and doffing, will also help minimize cold injuries.

Plan work activities to reduce the time you spend in hazardous environments. The key to dealing with cold weather is
to do only what is necessary, in the shortest time possible. Give primary consideration to personnel removing chemical protective clothing because they will still be wet from perspiration, and exposure to cold ambient air will cause a sudden decrease in body temperature.

Remember that the cold will affect support personnel just as it affects entry personnel. All personnel, regardless of duties, should be kept warm and safe when not performing their assigned duties. Personnel who are cold and uncomfortable are more likely to make mistakes and/or rush their assigned tasks.

**Psychological Stress**

Chemical protective clothing causes claustrophobia in some responders. Even if personnel have no problems with structural fire fighting clothing and SCBA, the additional confinement of encapsulating or impermeable garments, along with the loss of dexterity and movement, may be overwhelming.

Entry team members in chemical protective clothing also know they will be entering an area where a dangerous chemical exposure may occur. This knowledge may be discomforting to some personnel.

Psychological stresses can be prevented through adequate training, practice and experience. The more confidence you have in your equipment, procedures and skills, the more confidence you will have entering a hazard zone. However, some personnel, especially those with claustrophobia, will not be able to tolerate chemical protective clothing and may not be suited to these activities.
Chemical Resistance/ Compatibility

Level of protection (A, B, C, D) relates to a garment’s style. Chemical resistance or compatibility is dependent on the material used in the construction of the garment. This is commonly referred to as chemical compatibility and is used to determine how much resistance a material has to attack by specified chemicals. Always remember that no single material offers protection against all chemicals, and to some extent, all materials will allow chemicals to pass through, given enough time.

Factors That Affect Chemical Compatibility

There are three principal manners by which chemical protective clothing material can be compromised: penetration, degradation and permeation.

Penetration

Penetration is the movement of a chemical through existing openings in a material or garment. Simply put, it is a leak.

Penetration
- Chemical passes through physical openings in garment
- Garment construction is main factor in penetration
- Zippers, seams, stitching, pass-through openings, relief valves, glove and boot connections are all areas where penetration may occur
- Loose weave materials may allow greater penetration
- Abrasion or creasing may lead to pinholes or cracks in materials

NFPA standard now determines methods for testing penetration of seams and closures and entire garments.
Testing for Penetration
- Visually inspect suspected penetration areas (seams, zippers, other closures)
- NFPA uses a spray booth, with water spray from all directions for 60 minutes

Preventing Penetration
- Use compliant garments
- Use garments properly, with closures appropriately applied
- Visually inspect pre-use and post-use
- Store chemical protective clothing in compliance with manufacturer’s recommendation

NFPA compliant garments have been tested for penetration both on the fabric level and ensemble level. They must not show any leakage for 60 minutes of continuous spray of water. However, the garment must be properly donned and all closure devices used. Non-compliant garments must be viewed on a case by case basis. Inspection of closure location and types should be conducted carefully.

Activity
Chemical Penetration Resistance Results:
Chemical Resistance of Materials, Seams and Closure.
NOTE: In some cases vapor permeation results (ASTM F 739) were accepted in lieu of the liquid penetration test (ASTM F 903) for primary garment materials and glove. These appear as "No Breakthrough* in the tables below. Penetrations results are shown as "Pass".

### Penetration Resistance of Suit Materials and Closure.
PASS CRITERIA: No penetration or permeation breakthrough in one hour.

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Challenge 5000 (primary garment)</th>
<th>Solvent Dipped Neoprene (glove)</th>
<th>10 Mil FEP (visor)</th>
<th>Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>No bt</td>
<td>No bt</td>
<td>No bt</td>
<td>N/A</td>
</tr>
<tr>
<td>Diethyl Amine</td>
<td>No bt</td>
<td>No bt</td>
<td>No bt</td>
<td>N/A</td>
</tr>
<tr>
<td>Ethyl Acetate</td>
<td>No bt</td>
<td>No bt</td>
<td>No bt</td>
<td>N/A</td>
</tr>
<tr>
<td>Hexane</td>
<td>No bt</td>
<td>No bt</td>
<td>No bt</td>
<td>N/A</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>No bt</td>
<td>No bt</td>
<td>No bt</td>
<td>N/A</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>No bt</td>
<td>No bt</td>
<td>No bt</td>
<td>N/A</td>
</tr>
<tr>
<td>Tetrahydrofuran</td>
<td>No bt</td>
<td>No bt</td>
<td>No bt</td>
<td>N/A</td>
</tr>
<tr>
<td>Toluene</td>
<td>No bt</td>
<td>No bt</td>
<td>No bt</td>
<td>N/A</td>
</tr>
</tbody>
</table>

### Penetration Resistance of Abraded and Flexed Materials.
PASS CRITERIA: No penetration or permeation breakthrough in one hour.

**Preconditioning:** NFPA 1992 Sections 5-4 (Abrasion) and 5-5 (Flex)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Challenge 5000 (primary garment)</th>
<th>Solvent Dipped Neoprene (glove)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>Pass</td>
<td>No bt</td>
</tr>
<tr>
<td>Diethyl Amine</td>
<td>Pass</td>
<td>No bt</td>
</tr>
<tr>
<td>Ethyl Acetate</td>
<td>Pass</td>
<td>No bt</td>
</tr>
<tr>
<td>Hexane</td>
<td>Pass</td>
<td>No bt</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>Pass</td>
<td>No bt</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>Pass</td>
<td>No bt</td>
</tr>
<tr>
<td>Tetrahydrofuran</td>
<td>Pass</td>
<td>No bt</td>
</tr>
<tr>
<td>Toluene</td>
<td>Pass</td>
<td>No bt</td>
</tr>
</tbody>
</table>

### Challenge 5000 Seam (primary garment)

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Challenge 5000 Seam</th>
<th>Challenge 5000 Visor Seam</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>No bt</td>
<td>Pass</td>
</tr>
<tr>
<td>Diethyl Amine</td>
<td>No bt</td>
<td>Pass</td>
</tr>
<tr>
<td>Ethyl Acetate</td>
<td>No bt</td>
<td>Pass</td>
</tr>
<tr>
<td>Hexane</td>
<td>No bt</td>
<td>Pass</td>
</tr>
<tr>
<td>Sodium Hydroxide</td>
<td>No bt</td>
<td>Pass</td>
</tr>
<tr>
<td>Sulfuric Acid</td>
<td>No bt</td>
<td>Pass</td>
</tr>
<tr>
<td>Tetrahydrofuran</td>
<td>No bt</td>
<td>Pass</td>
</tr>
<tr>
<td>Toluene</td>
<td>No bt</td>
<td>Pass</td>
</tr>
</tbody>
</table>

* Abrasion and flex pre-conditioning performed in combination.
** Seam could not be flexed due to rigidity of visor material.

Reproduced from Chemical Fabrics Corporation data.

Table 7.3
Degradation

Degradation refers to an actual observable or measurable change in a material caused by contact with another agent.

Degradation

- Material is actually changed or “degraded” by the chemical
- Visible signs—charring, softening, shrinking, cracking, dissolving
- Material is changed chemically
- Sunlight or other ambient conditions may degrade materials

Testing for Degradation

- Tests are done using a clean swatch of material at room temperature according to ASTM standards
- Note visual changes
- Note any change in mass
- Note results in a subjective, qualitative manner (e.g., Excellent, Good, Fair, Poor)

Preventing Degradation

- Do not use materials that are known to degrade when exposed to the chemical in question
- Degradation will allow penetration and possibly permeation
- Store clothing out of sunlight

Activity

Permeation

Permeation is perhaps the most insidious manner in which chemical protective clothing can be compromised. It refers to the movement of a chemical through a material on the molecular level. In most cases, there are no visible signs that the process is occurring. Permeation is similar to skin absorption.

Permeation

- Chemical passes through material at molecular level
- Chemical contacts outside of material as absorption occurs
• Higher concentration outside material than inside
• Chemical is “pushed” through material towards lower concentration by molecular pressure
• Chemical reaches inside of material—desorption occurs
• In general, the higher the temperature, the faster the permeation
• High concentrations of chemicals permeate faster than lower concentrations
• Mixtures of chemicals can permeate faster or slower than the constituent chemicals
• Molecular sizes of chemical and barrier materials are directly related to permeation

The smaller the molecular openings of the material, the less likely a large molecule of chemical will permeate easily. Also, the thicker a material is, the longer it will take for permeation to complete the process. Worn material will increase permeation rate because the material is thinner.

Testing for Permeation
Standardized methods for testing for chemical permeation are referred to in NFPA 1991.
• A sample of material is placed in a special holder (test cell)
• The challenge chemical (at 100% concentration), is applied on one side; detection equipment is placed on the other
• The rate of flow is calculated based on the detection results
• The rate is expressed as the amount of challenge chemical that flows through a given area in a given time. Example: micrograms/cm²/minute
• Results are dependent on sensitivity of detection devices

In order to standardize results, the NFPA requires that the time when the permeation rate reaches \(0.1 \mu g/cm^2/\text{minute}\) be reported (that is one ten-millionth of a gram per square centimeter per minute).
• This time is known as Normalized Breakthrough Time
• Actual Breakthrough Time (BTT) is the time when the detector first detects the chemical
• Some manufacturers report both results
• All tests are done at the same temperature (80.6°F)
• Tests are done for only one chemical at a time

Preventing Permeation
• Permeation can be prevented with the proper use of chemical compatibility charts
• When permeation values are marginal, overprotection (double gloves, overboots), can significantly increase BTT by adding thickness
• Always check the chemical compatibility of all protective clothing items to be used during entry

The use of permeation charts for selection of chemical protective clothing is a skill that requires practice and familiarity with both compatibility charts and garments available. It also requires the ability to predict actual or likely exposure levels and concentrations. At emergency incidents it is wise to have more than one trained and experienced person confirm the values and decisions on chemical protective clothing selection.

Activity

Remember that when a chemical permeates a material, the permeation may not be visible. Permeation can occur even after the chemical is removed in decontamination. For this reason, it is important to keep accurate records of exposures including chemical, time exposed, and concentration. Obtain chemical compatibility charts for all items of chemical protective clothing, including gloves and boots. Generally, the longer the breakthrough time (normalized or actual), the more suitable a garment may be for the chemical. However, some materials may have a long breakthrough time, but a high permeation rate.

Breakthrough time is a key component in determining chemical compatibility. When determining the appropriateness of a material using breakthrough times, remember to factor in the anticipated levels of exposure:
• Will the entry team have contact with 100% product?
• How much area of the garment will actually be exposed? Where?
• What are the toxicological values for the contaminant?
Tychem® Protective Fabrics
Safety you can wear

Tyvek® laminated with Saranex® 23-P

Chemical Splash Protection
Tyvek laminated with Saranex 23-P film provides protection against a broader range of chemicals than Tyvek QC. Economical and lightweight, Tyvek/Saranex 23-P is ideal for chemical mixing, loading and application as well as clean-up and general industrial use.

Color Selection
Tyvek/Saranex 23-P is available in the following colors:
White
Gray

Permeation Data for ASTM Recommended List of Chemicals for Evaluating Protective Clothing Materials (ASTM F1001)

<table>
<thead>
<tr>
<th>CHEMICAL NAME</th>
<th>PHYSICAL PHASE</th>
<th>NORMALIZED BREAKTHROUGH TIME (minutes)</th>
<th>PERMEATION RATE (μg/cm²:mm)</th>
<th>INDEX OF CODES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>L</td>
<td>24</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Acetonitrile</td>
<td>L</td>
<td>13</td>
<td>2.8</td>
<td></td>
</tr>
<tr>
<td>Ammonia (anhydrous)</td>
<td>G</td>
<td>37</td>
<td>0.15</td>
<td></td>
</tr>
<tr>
<td>1,3-Butadiene</td>
<td>G</td>
<td>&gt;480</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Carbon disulfide</td>
<td>L</td>
<td>8</td>
<td>&gt;50</td>
<td></td>
</tr>
<tr>
<td>Chlorine gas</td>
<td>G</td>
<td>&gt;480</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Dichloromethane</td>
<td>L</td>
<td>7</td>
<td>&gt;50</td>
<td></td>
</tr>
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<td>Diethylamine</td>
<td>L</td>
<td>12</td>
<td>&gt;50</td>
<td></td>
</tr>
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<td>0.4</td>
<td></td>
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<td>36</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>Ethylene oxide</td>
<td>G</td>
<td>7</td>
<td>9.4</td>
<td></td>
</tr>
<tr>
<td>n-Heptane</td>
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</tr>
<tr>
<td>Hydrogen chloride</td>
<td>G</td>
<td>&gt;480</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Methylvinyl ketone</td>
<td>L</td>
<td>&gt;480</td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>Methyl chloride</td>
<td>G</td>
<td>&gt;480</td>
<td>NO</td>
<td></td>
</tr>
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<td>Nitrobenzene</td>
<td>L</td>
<td>102</td>
<td>2.3</td>
<td></td>
</tr>
<tr>
<td>Sodium hydroxide, 50%</td>
<td>L</td>
<td>&gt;480</td>
<td>NO</td>
<td></td>
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<td>Sulfuric acid (conc.)</td>
<td>L</td>
<td>&gt;480</td>
<td>NO</td>
<td></td>
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<tr>
<td>Tetrachloroethylene</td>
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<td>8</td>
<td>3.7</td>
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</tr>
<tr>
<td>Tetrafluorobenzene</td>
<td>L</td>
<td>immediate</td>
<td>&gt;50</td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td>L</td>
<td>immediate</td>
<td>30</td>
<td></td>
</tr>
</tbody>
</table>

See source site for additional information.

Tyvek is a registered trademark of DuPont.
Saranex 23-P is a registered trademark of The Dow Chemical Company.
Tychem and Tyvex are trademarks of DuPont.

Table 7.4
Storage Conditions and Shelf Life of Saranex® 23-P

Dow Chemical recommends that SARANEX 23-P and garments fabricated from TYVEK®/SARANEX 23-P laminates should be stored away from high heat sources and direct sunlight. The best storage conditions are indoors at temperatures between 30°F and 90°F.

Following these guidelines, the shelf life or chemical barrier properties of SARANEX 23-P will not change for at least 48 months from the initial date of suit manufacture.

NOTE: Shelf life data is based on chemical permeation test results conducted on two and four year old suits fabricated from TYVEK/SARANEX 23-P laminates.

Analysis of these two and four year old materials has shown no statistical loss in barrier properties. Permeation tests were conducted in accordance with ASTM F-729 using the ASTM F-1091 test battery.

Additional information regarding this data can be obtained by contacting Dow Chemical Company at 1-800-441-4360.

Dow does not provide or offer any warranty regarding the performance of SARANEX coextruded barrier film in protective clothing and garment applications. The use of SARANEX coextruded barrier film in protective clothing applications is done without specific recommendations from Dow as to its suitability for specific end-use applications. Furthermore, because it does not warrant the performance of SARANEX coextruded barrier film, Dow cannot accept responsibility or liability in connection with the use of this product.

For more information

For specific permeation rates and breakthrough times for other chemicals, call the DuPont Tyvek® Data Service at 1-800-55-TYVEK or (1-800-558-9329).

DuPont manufactures a complete line of Tychem™ chemical protective fabrics as well as Tyvek® fabric for dry particulate protection. For more information call 1-800-44-TYVEK or (1-800-448-9325).

Tyvek is a registered trademark of DuPont. Saranex 23-P is a registered trademark of the Dow Chemical Company. Tychem and Tyvek are trademarks of DuPont.

This information is based upon technical data that DuPont believes to be reliable. It is subject to revision as additional knowledge and experience are gained.

DuPont makes no guarantee of results and assumes no obligation or liability in connection with this information.

It is the user’s responsibility to determine the level of toxicity and the proper personal protective equipment needed. The information set forth herein reflects laboratory performance of fabrics, not complete garments, under controlled conditions. It is intended for informational use by persons having technical skill for evaluation under their specific end-use conditions, at their own discretion and risk.

Anyone intending to use this information should first verify that the garment selected is suitable for the intended use. In many cases, seams and closures have shorter breakthrough times and higher permeation rates than the fabric. Please contact the garment manufacturer for specific data. If fabric becomes torn, abraded, or punctured, and user should discontinue use of garment to avoid potential exposure to chemical. Since conditions of use are outside our control, we make no warranties, express or implied including, without limitation, any warranty of merchantability or fitness for a particular use and assume no liability in connection with any use of this information. This information is not intended as a license to operate under a recommendation to infringe any patent or technical information of DuPont or others covering any material or its use.

WARNINGS:

1) TYVEK laminated with SARANEX 23-P is not flame resistant and should not be used around heat, flame, sparks, or in potentially flammable or explosive environments.

2) Garments made of TYVEK laminated with SARANEX 23-P should have slip resistant or anti-slip materials on the outer surface of boots, shoe covers, or other garments surfaces in conditions where slipping could occur.

Tychem® Protective Fabrics

P.O. Box 80705
Wilmington, DE 19880-0705
1-800-44-TYVEK
Resistance to Other Contaminants

Responders may be exposed to other hazards besides the expected chemical hazard. Blood and body fluid contamination as well as airborne contamination is also possible. These hazards are sometimes ignored in the commotion of a hazardous materials response. While some of the chemical protective clothing described in this unit would appear to provide adequate protection against these hazards, remember that the garments are not tested against these hazards as part of any chemical protective clothing standard. Manufacturers may test against these hazards if they choose, or a user may request tests from their manufacturer.

OSHA 1910.1030 (Blood Borne Pathogen) and NFPA 1999 require workers to be protected against liquid borne biological contaminants. ASTM (American Society for Testing and Materials) designs and distributes testing methods for various purposes. ASTM has developed two test methods for resistance to synthetic blood and synthetic viral agents—ASTM F1670 and 1671.

Possible terrorist incidents are of increasing concern to the emergency response community. Explosive devices, skin-absorbable substances, persistent toxic agents, and fatal persistent biological agents such as anthrax are the weapons of terrorists. These types of hazards, coupled with the relatively new concept of placing “secondary devices” to target emergency responders are new to most of us. Unfortunately, chemical protective clothing and equipment and the applicable standards and laws normally used by fire service emergency responders were not designed or tested with these hazards in mind.

If your jurisdiction is a likely target of terrorist activity, you should contact the appropriate authorities (U.S. Military, FEMA, CDC) regarding possible protective measures. Manufacturers of equipment and clothing may also be contacted in an attempt to get specific chemical resistance data.
Physical Resistance

CPC is also tested for physical resistance to tears, abrasions, folding, and other types of non-chemical degradation. The following table lists some of the different types of physical resistance tests used by one manufacturer.

Physical Resistance Tests

| Garment Material Seam: | Heat sealed lap seam, heat seal taped over both the inside and outside seam with 3 mil fluoropolymer film. |

<table>
<thead>
<tr>
<th>Style</th>
<th>Supporting Substrate</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>5000</td>
<td>2.7 oz/yd² Spunlaced Nomex</td>
<td>Orange/White</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>CH5000</th>
<th>Test Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (oz/yd²)</td>
<td>10.2</td>
<td>ASTM-D-751-79</td>
</tr>
<tr>
<td>Thickness (in.)</td>
<td>0.019</td>
<td>ASTM-D-751-79</td>
</tr>
<tr>
<td>Tensile Strength (lbs. in.)</td>
<td>43 (W)</td>
<td>FTMS 191.5102.2</td>
</tr>
<tr>
<td>Tongue Tear (lbs.)</td>
<td>11.6 (W)</td>
<td>FTMS 191.5134</td>
</tr>
<tr>
<td>Flame Resist-Vert</td>
<td>0</td>
<td>FTMS 191.5903</td>
</tr>
<tr>
<td>After Flame (sec)</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>After Glow (sec)</td>
<td>1.45</td>
<td></td>
</tr>
</tbody>
</table>

* 10 rolls on hard crease with 10 lb. steel roller, reverse fold with 10 additional rolls. FTMS 191.5102.2 tensile strength retested after folding.

Reproduced from Chemical Fabric Corporation data.

Table 7.5
CPC Accessories and Equipment

Whether using NFPA ensembles or non-compliant garments, additional protective clothing may be necessary. There are hazards other than chemical hazards that you should consider, such as physical, thermal and environmental.

Garments Worn Under CPC

Most jurisdictions standardize the garments worn under chemical protective clothing. Coveralls are suggested by the NFPA but are not mandatory. Garments should be comfortable and have the ability to transfer perspiration from the wearer’s body. Some users suffer skin irritation when bare skin contacts the inside of garments, so long sleeves and pants are usually used. In colder areas, thermal underwear or multiple layers of undergarments should be worn.

Head Protection

Wear a hard hat or bump cap if you are wearing CPC. Hard hats should be approved by OSHA or ANSI. Additionally, they should fit firmly to reduce the chance of falling off into an encapsulating suit and hindering your movement.

Lighting

Portable lights (flashlights) may be necessary for some hazardous materials incidents. Incidents at night or in structures where power has been interrupted present hazards other than chemical such as trip, slip, and fall hazards. Lights should meet the applicable standards for use in dangerous atmospheres. You should realize that “intrinsically safe” lighting equipment may still cause ignition problems if it has not been properly maintained or has been damaged.

Undergloves

Wear a thin, surgical-type glove as a first glove. Chemically resistant gloves of this type (nitrile) are available.
Two sets of chemically resistant gloves can be worn over a third pair of non-chemically resistant gloves (e.g. cotton or nitrile). These gloves increase comfort by absorbing moisture from the skin. Glove removal is also easier.

**Gloves**

Spare gloves or glove assemblies for garments should always be maintained in stock. Additionally, many jurisdictions purchase various types and materials of gloves to provide extra chemical protection and to protect the ensemble’s gloves. “Overgloving” with disposable gloves simplifies decontamination. It can also help protect the ensemble’s glove assembly. For example, an ensemble’s outer glove may have a very good chemical resistance, but may rip easily. To protect ensemble gloves in rough situations a team might don a heavier, structured glove like a butyl glove. The function of a butyl glove is primarily to protect the ensemble glove, not necessarily to provide chemical resistance. Also, gloves that take most abrasion and contact with product will simplify decontamination. By doffing these gloves before entering the first station, entry team members remove a large amount of contamination.

Remember that an NFPA compliant garment with attached glove assembly should not be altered. The new version of the Standard addresses the “scuff” resistance of the ensemble, including the gloves. Many manufacturers have added a “Kevlar®” glove as the outer glove to provide abrasion resistance. These gloves have little chemical resistance and are disposable.

**Activity**

**Boots**

Spare boots or boot assemblies for garments should always be maintained in stock. Many jurisdictions also purchase limited-use boots to provide extra chemical protection or provide protection to the ensemble boots from normal wear. “Overbooting” may also simplify decontamination.
Flash Protection

Additional flash protection may be required for some atmospheres. This protection is worn over chemical protective clothing but has no chemical protective value. *It is always preferable to change the atmosphere* rather than enter an atmosphere that is or may become flammable.

Cold (Cryogenic) Protection

Chemical protective clothing offers no protection against the effects of cryogenic liquids (< minus130°F) or liquefied compressed gases. The extreme cold these products produce will very likely make materials (and the people inside them) brittle, causing them to fail.

There are protective garments, particularly gloves, used by the cryogenic industry for use with these products. If this is a likely hazard in your jurisdiction, contact a local cryogenic manufacturer or gas handler for additional information.

Purchasing Protective Clothing

The type of protective clothing that is appropriate for your hazardous materials team depends on a number of factors:

- The training expertise of team members
- The frequency of hazardous materials incidents in your area
- The type of hazardous materials incidents in your area (for example, if your jurisdiction is primarily rural, urban, industrial, residential, etc.)
- Departmental budgets for purchase and maintenance
- Departmental SOPs that govern hazardous materials activities

No one type of ensemble is suitable for every department; each jurisdiction must carefully consider how the clothing will be used. Guidelines and a sample worksheet are provided in Appendix C.
Selecting and Wearing Chemical Protective Clothing

Selecting CPC

As with most emergency response, a hazard assessment will guide you toward your response objectives, and the equipment necessary to execute those objectives.

To begin a hazard assessment, answer the following questions:

- What is the chemical?
- What is the quantity?
- How can it harm us?
- What should we do about it?
- What is necessary to protect us?
- Do we have that equipment?

Factors to Consider

Level of Protection

If you decide to enter the hazard zone, you must first decide what level of protection is necessary. Indications for use of various levels of protection were discussed earlier in this module.

If the product is a vapor or skin contact hazard because of its toxicity and chemical properties, or if responders will enter a closed area where there may be an unknown hazard, select Level A protection. If meter readings or other clues indicate the possibility of an unchangeable flammable atmosphere, you may also need some type of flash protection.

Use Level B protection when the criteria for level A are not met and only a chemical splash hazard (not immersion) may exist.
Required Actions

Your work activities directly affect the level of protection you need. Reconnaissance missions stress product avoidance, while plugging and patching activities usually require significant contact with products.

Product Properties

The physical and chemical properties of a product determine its health effects on responders. For example, products with low vapor pressures normally do not generate large amounts of vapor into the atmosphere.

CPC Properties

Even if the proper level of chemical protective clothing is available, you should know whether the garment has sufficient chemical resistance for the likely contact and exposure. That is, will the garment protect you for the duration of your mission and through decontamination? You can answer these questions using the chemical compatibility charts and product properties.

During an incident, you may find that a chemical does not appear on the chart, or is not one of the NFPA chemicals tested. This poses a difficult situation. The NFPA chemicals and many other tested chemicals are reported by chemical families. Chemicals in the same families usually share common properties and usually will affect materials in a similar manner, so if the family of the contaminant is known, you may be able to find a similar chemical on the chart. There are exceptions to this, and personnel experienced in chemical protective clothing and chemistry should assist in these decisions. This is not the best method for determining resistance data, but it does offer you flexibility. Even if the proper level of CPC is available, you must be certain it has sufficient chemical resistance to withstand the degree of potential contact and length of exposure. The garment must protect you through the duration of the mission and decontamination. Use chemical compatibility charts and product properties to address these issues.

Activity
To select the appropriate chemical protective clothing you must be able to analyze the situation at hand and combine that analysis with your knowledge of equipment and procedures in your jurisdiction.

Competency comes with practice and experience; however, selecting CPC is such a critical decision, you should always confirm your decision with another experienced person.

**Wearing Chemical Protective Clothing**

Using CPC is not just a matter of “putting on the suit”. Once on, you are expected to carry out job objectives. The objective may be as simple as a recon walk or as complicated as carrying heavy equipment through a maze of dark corridors in an unfamiliar structure to patch a leaking container.

**Issues to Consider When Wearing CPC**

**Buddy System**

All entry teams consist of at least two equally protected responders. Your first priorities are your own safety and the safety of your buddy. Review OSHA’s “Two in/Two out” regulation in Appendix E.

**Communications**

NFPA requires radio communications for all levels of protection. Radios should be safe for the environment they will be used in. If possible, they should have a “hands-free” or voice-operated system. They should also be on a dedicated frequency so that normal non-incident related communications do not interfere.

A set of hand communications should be used as a backup to radio communications. Hand signals should be simple, easy to remember, and distinguishable from a distance. Develop signals (and the required actions) for loss of air
supply (exit Hot Zone-emergency decon), loss of suit integrity (exit Hot Zone-emergency decon), buddy down (send in back-up team), loss of radio communications (jurisdictional decision—can work still be carried out safely?).

Develop an emergency evacuation signal. This signal indicates to entry personnel that they are to immediately exit the area for decontamination. This signal, usually audible, would be in addition to radio communications. Many teams use portable air-horns for this notification.

**Working with Tools**

Using necessary hazardous material mitigation equipment is difficult at best and even more difficult in chemical protective clothing. Responders should practice using needed tools with various levels of chemical protective clothing.

- **Air Monitoring**
  Practice with all air monitoring devices. Changing settings may be difficult in multiple chemical protective gloves. Check your ability to read instrument values through multiple facepieces. If you use colorimetric tubes, practice the manual skills necessary to insert, pump, and remove those tubes.

- **Plugging & Patching Equipment**
  This equipment may include wrenches, screwdrivers, hammers and similar tools. Visibility and dexterity will be limited in CPC, so practice using these tools in order to be effective and safe.

- **Equipment Movement**
  In many instances, you will be required to carry items into the Hot Zone to complete your assigned tasks. Entry personnel almost always have some form of monitoring equipment and may also bring in patch equipment, overpack equipment, absorbents or sampling equipment. Develop easy, efficient methods of transporting this equipment. Disposable five-gallon pails are sometimes useful for carrying small items. Handtrucks may be used to move larger or heavier equipment.
• **In-sight work**
  Whenever possible, zones and entrance points should be chosen so that entry personnel in the Hot Zone can be observed at all times.

**Activity**

Hazardous materials incidents are procedure-driven events. As a Technician, you will enter hazard areas and work under dangerous circumstances with potential injury-causing products. Your working times and air times should be closely monitored. Review action plans before entry. Whenever possible, obtain layouts of the area. When leaving the scene for whatever reason (low air supply, duration up, dangerous condition, etc.) leave as ordered and proceed immediately to decontamination. Support personnel must be ready to do their jobs of decontamination, clothing removal, and medical surveillance.

**Donning/Doffing CPC**

Donning and doffing chemical protective clothing can be a time consuming and confusing operation. Develop, practice, and follow specific procedures during the process.

Instructions for donning chemical protective clothing (e.g., put left leg in pants first) should come from the manufacturer. NFPA-compliant garments are required to have a set of donning instructions. If a garment does not have a donning procedure, call the manufacturer to obtain one or have one approved.

**Generic Donning Procedures**

Remove all personal items (wallets, rings, chains, watches, etc.) and don the approved clothing for use under chemical protective clothing.

If team members require corrected vision, most manufacturers of respiratory equipment can provide an “inside the mask” lens frame. This frame is mounted (temporarily or
permanently) inside the facepiece and a member can have the appropriate lenses made for it. Wearing contact lenses, which in some OSHA interpretations had been considered a “de minimus” violation (no fine imposed), is now gaining favor. Soft or gas permeable lenses appear to now be allowed by OSHA (Feb. ‘98 interpretation), although their use will be documented. OSHA has also requested users’ experiences with contacts, both good and bad. In any case, devices worn to correct vision cannot interfere with the seal of the facepiece.

Entry and backup personnel should be medically evaluated for inclusion criteria. Hydration should begin and continue through the donning process.

A Donning/Doffing Group or Sector should be established in the Incident Management System, with sufficient manpower allocated. Manpower for this sector will require a supervisor and personnel to don four team members in chemical protective clothing. Whenever possible, two persons should be assigned to dress one member in chemical protective clothing. At a minimum there should be a one to one ratio.

Donning and doffing areas should be pre-selected. These areas should be near each other, if not adjacent. The area should be:

- Located as close as possible to entry point, but still isolated from distraction
- Sheltered from the elements (wind, rain, sun). Existing, non-involved structures may provide suitable shelter and isolation. Commercial portable structures are also available, as are consumer type shelters (tents, canopies).
- Large enough to accommodate personnel donning and those assisting (8-12 personnel)
- Clearly delineated. This may be accomplished by the use of road cones and banner tape. Another popular method is to use an appropriately sized synthetic tarp. This clearly marks the area and provides a clean work platform.
CPC items should be deployed in an organized manner.

Check all items for operation. Move zippers, visually inspect clothing, test SCBA or SAR, and deploy and check communications devices.

Entry and backup personnel should be allowed to hydrate through the donning process and have stable seating without backs (which would interfere with SCBA). Some jurisdictions modify chairs; others use short stepladders for each person donning CPC. Entry and backup personnel should receive a briefing regarding their mission, work activities, possible hazards and emergency signals. Briefing should take place before team members suit up; it should not take place during the donning process. Briefing personnel during the donning process is distracting; briefing after the donning process will just keep personnel in CPC longer.

Entry and backup personnel should repeat their instructions to the briefing personnel to ensure understanding.

Entry and backup personnel should dress at the same rate. That is, they should all be brought to the same level of dress at the same time (e.g., legs in suits, arms in suits, etc. at the same time). This is best accomplished with adequate manpower and supervision. The supervisor of the donning group/sector should closely watch the level of dress on each member and re-assign manpower as needed to ensure that personnel are fully dressed at the same time. If you are donning CPC, allow yourself to be dressed and expend a minimum amount of energy in the process. Relax as much as you can to minimize your stress level. Entry and backup personnel should be brought to a “stand-by” level. Personnel should be dressed as completely as possible without going on air. All overgarments should be in place.

When it is time to enter the hazard area, the donning supervisor should give the order. The entry team should be put on air, the donning process completed, and the entry team led to the access point. Before entry, the entry team should be checked by another experienced person, such as a Safety Officer. The backup team should remain at the stand-by level until needed. Backup is usually left off air. If backup is sealed and on air, their stress level will increase as will
core temperature. If they are needed for rescue, they should be rested, unstressed and with full air capacity. A good donning team can have them ready for entry in less than one minute. However, there may be situations when backup personnel are on air and partway into zone to reduce travel time to the entry team.

**Generic Doffing Procedures**

Many jurisdictions use the donning group/sector to perform the doffing operations.

Since members being doffed of chemical protective clothing have usually been contaminated and decontaminated, doffing group/sector personnel may need CPC for the operation. This level of protection should be determined by the Safety Officer and/or Doffing Group/Sector Supervisor. Usually, only chemical protective gloves are required, but some contaminants may require eye and/or body/respiratory protection.

If you are assisting in doffing operations, be aware that the entry team members are likely tired, very warm, and anxious to remove their chemical protective clothing. Their vision may be obscured by fogged facepieces. Watch these individuals for signs of heat stress.

Entry personnel should be doffed according to procedure or manufacturers’ instructions. It is important to expose them to ambient air so they will cool quickly.

As soon as possible, entry team members should be seated and remain seated.

- Assisting personnel should touch only the *outside* of the chemical protective garments.
- Entry team personnel should touch only the *inside* of the garments.
- All efforts should be made to eliminate cross-contamination from outside to inside of the garment.
- Once removed, garments should be zipped (when appropriate) or stored so that inside and outside surfaces do not touch, then placed in a containment bag for further evaluation and decontamination.
The last item removed should be the SCBA or other respiratory protection. It should be removed by the wearer. SCBA should be placed in a clean area for any special cleaning and then the normal post-use checks and maintenance. After doffing, entry personnel should be hydrated, medically evaluated, and debriefed regarding their mission.

The donning and doffing of chemical protective clothing is a cooperative effort of the entire response team. It requires pre-planning, adherence to procedures, and continued practice.

Activity

Other Items Used With Protective Clothing

Some departments use other items or materials in conjunction with chemical protective clothing—often inappropriately.

Perhaps the most popular of these items is duct tape. This tape has been used to seal seams, cover zippers, tape extra material for better fit and seal facepieces to garment hoods.

There has been little data regarding the protective value of duct tape against chemical attack. The most recent data shows that duct tape has no protective value whatever, and in some circumstances can add risk by reacting with chemicals or damaging suit materials.

In general, avoid using duct tape on chemical protective clothing material. There may be occasions when duct tape may be useful, such as taping a glove to itself to tighten it around a wrist. However, in these cases, the items are usually disposable and the tape is only applied to itself.

Remember that compliant garments meet penetration and/or gastight integrity standards without the use of additional items. Using duct tape on these garments is unnecessary and may actually damage expensive re-usable garments. Furthermore, it may void any warranties from the manufacturer.
If some type of banding material is needed, only use material that is approved for the chemical hazard. Bands may be made from chemical resistant glove material.
Maintaining Chemical Protective Clothing

NFPA requires maintenance, testing, and record-keeping for chemical protective clothing and equipment. Manufacturers also require that extensive records be kept for garments purchased from them.

It is also just good sense to know what your clothing has been exposed to, when it was exposed, how it was cleaned, when it was tested, etc. Fire-service responders are familiar with testing of fire equipment. Hoses, pumps, ladders, SCBA, PASS devices, and other equipment are all operationally tested to ensure that they will perform properly when needed. The same is true of chemical protective clothing and equipment.

Records

Keep identification records of all chemical protective clothing. At a minimum, these records should contain information on date of purchase, manufacturer, vendor, serial number or other identification markings, color, and material. A distribution record (where the CPC is located or who it is assigned to), should also be maintained. Even the manner and method of its destruction or disposal should be noted.

Information on incidents where CPC was used are also required. Items such as duration of exposure, concentration of the chemical, method of decontamination, and final disposition should be included. This is especially important for re-usable garments so that garments exposed to certain chemicals are not exposed to reactive chemicals at a later incident. For example, a suit worn repeatedly into hydrocarbon or alcohol scenes should not be worn at an oxidizer incident. This information can also be helpful if problems develop with the garment. The history of exposure and use can provide clues to damage or degradation and assist the jurisdiction in future purchases. The jurisdiction may also wish to add its own incident identification information (NFIRS, CFIRS, etc.).
Most manufacturers of compliant chemical protective clothing provide record sheets for their clients. NFPA recommends a Technical Information Package for each garment. While these are good, jurisdictions may wish to add information to them or incorporate them into a larger database.

Also maintain a record of repairs or related activities such as inspections and tests. Again, in the case of limited use garments, record the reason for and method of disposal.

The form on the following page is one example of the documents that should be maintained for chemical protective clothing.

There is no requirement that all this data be kept in the same file. Jurisdictions may elect to keep different types of information in different locations. For example, the history of exposure records or a copy of them may be helpful to store with each garment. This way, a complete record of each suit’s exposures is available to on-scene personnel making chemical protective clothing selections. In any case, a complete file on each garment should be maintained in a safe location.

Records for large quantities of accessory type clothing, such as gloves or overboots are not required. However, there should be documentation that includes manufacturer, vendor, material, color, thickness and other identification information for each item. The method, reason, and number disposed should also be documented.

NFPA-compliant garments are certified by the manufacturer to meet the appropriate requirements upon delivery. If these garments are to be disposed of, keep acceptance records and disposal records. If the garments are to be re-used, then they will need to be tested.
SUIT JOURNAL

Suit Serial No. __3049-004__ Entry No. ____________

A. 1.1 Date of Use:
   1.2 Users’ Name:
   1.3 Type of Use: Training ____________ Response ____________

IF RESPONSE, FILL IN SECTION B:

B. 2.1 Name of Chemical at Response Site:
   2.2 Length of use:
   2.3 Concentration of Chemical:
   2.4 Date of Decontamination:
   2.5 Method of Decontamination:

   2.6 Name of Person(s) Performing Decon:

C. 3.1 Date of Inspection:
   3.2 Name of Inspector:
   3.3 Inspection Findings (use drawings on page 10 to note damages):

D. 4.1 Date the suit is taken out of service:
   4.2 Reason for Action:

   4.3 Types of Repairs Required:

E. 5.1 Date of all Repairs:
   5.2 Name of Person(s) Making Repairs:
   5.3 Description of Repairs:

F. 6.1 Date the Suit is Returned for Repair:
   6.2 Reason for Return:

ATTACH COPIES OF ALL SUIT JOURNALS AND CERTIFICATION DOCUMENTS TO THE SUIT REPAIR FORM WHEN RETURNING A SUIT FOR REPAIR.

Certification Document - Suit Journal

I Certify to the validity of the information contained in Entry No. ____________.

Name: _______________________________________

Title: _______________________________________
Testing

Chemical permeation, degradation and penetration tests cannot be performed by the users of chemical protective clothing. The testing apparatus is large, expensive and usually destructive in nature. However, users can perform some simple tests on their compliant garments.

Testing Compliant Level A Garments

Level A garments can be tested for gastight integrity with a relatively affordable, simple-to-use testing device. Gastight integrity on compliant level A suits is tested by pressurizing the suit with air and checking the pressure after specified periods of time. If the suit maintains appropriate pressure, it has passed the test. Testing data and methods are available from the manufacturer or NFPA 1991. This test only checks for the gastight integrity of the garment. The garment may have suffered other types of damage that did not leak air, such as abrasion, nicks or cracks. However, this type of damage may affect the permeation of a chemical.

Testing Compliant Level B Garments

Visual inspection is an important part of any maintenance and testing program. It is the only easy-to-perform user test for compliant level B garments. A visual inspection can be used to detect damage in level A suits as well. Visual inspection of chemical protective clothing is a close, systematic look at the entire garment.

Inspect garments for abrasion, scuffing, cracks or holes. Many manufacturers now color-code the layers of their garments. A quick visual check of the outside or inside of the suit can reveal if a layer has been worn through. You can also use a strong light source on one side of the garment to detect pinholes or small tears.

During a visual inspection check all areas, both inside and out. Flex the garment to reveal any stress cracks. Carefully inspect the faceshield and its interface with the main body and evaluate it for clarity. Other problem areas, such as
seams and closure devices, should be thoroughly inspected and operated where applicable.

Record the results of these tests and inspections in the appropriate garment record. Garments that fail or are suspect should be sent for a professional evaluation and repair (usually to the manufacturer or their representative).

**Testing Non-Compliant Garments**

Manufacturers of non-compliant garments may suggest testing techniques or inspection criteria. The jurisdiction should request this information during the purchasing procedure. At a minimum, perform a thorough visual inspection as described above.

**Testing Garment Accessories**

Again, visual inspection is paramount. Remove any items showing excessive wear from service. Many jurisdictions replace glove assemblies routinely after a use because it is easier and safer than trying to test the gloves. You should also visually inspect chemical resistant support boots.

**Maintenance / Storage**

Maintain and store garments according to the manufacturers’ recommendations. CPC should be kept safe and away from possible contamination when in storage. Exposure to sunlight over a period of time will begin to degrade many materials.

Many jurisdictions, after the CPC has been cleared for use, store the garment in a container security-sealed with lead seals, wire wraps, or even locks. Security sealing has a number of advantages. First, it provides a known container for the garment. The container provides protection from puncture and everyday dirt, dust, and light. Second, when you first deploy the garments, check the seal. If the seal is not broken, then you can be confident that the garment inside meets the testing and inspection qualifications of the jurisdiction and/or manufacturer. If the seal is broken, use CPC from another container.
Personal protective equipment is a key element of physically handling a hazardous materials incident. It allows responders to intervene in the release and spread of hazardous materials in order to protect the public and environment.

However, it is not just a matter of practicing and becoming competent in the manipulative skills of wearing and working in chemical protective clothing. You need a combination of those skills and critical analysis skills to determine the risk versus benefit of intervention.

Each skill is dependent on the other and all are of critical importance.
Application Exercise
Application Exercise

You will need
- Level A/Fully-encapsulated vapor protective ensembles (enough for each group)
- Level B/Liquid splash-protective ensembles (enough for each group)
- Hand tools
- Detection equipment (if students have received training)
- Water sources
- Departmental SOPs and inclusion criteria, if available

Preparation

This exercise is intended to give students hands-on experience donning, doffing, and wearing different levels of chemical protective clothing. Keep the student/instructor ratio about five to one. If necessary, enlist the assistance of another instructor while conducting this exercise. Set up three work stations, as described below, and divide the class into three groups. Instruct the groups to rotate through each work station until each student has performed every task at all three stations. Complete the Exercise Assessment Sheet on the following page as you observe the groups. Remain available to the students as they work through this exercise. Answer basic questions but encourage them to refer to the manufacturer’s instructions as much as possible.

Reconvene the class and review the exercise and your assessment sheet. Answer any remaining questions about CPC.

Work Stations:

- **Work Station 1:** Students inspect and test CPC. Guide the students through a visual inspection of all CPC available. Have the students conduct a pressure test of Level A garments following the specific manufacturer’s instructions. Each student must perform an inspection and a test.

- **Work Station 2:** Students don and doff Level A garments. Instruct students to work one-to-one. Every student donning an ensemble should have an assistant. Have the teams don the CPC according to manufacturer’s instructions, then have the students switch roles. Students donning the CPC should walk to an area where they are required to perform a simple activity, such as working with hand tools or operating detection equipment, reading a label, or writing their name on the chalkboard. If time permits, allow the students to walk outside for a short period of time to experience heat transfer into (or out of) the protective clothing.

- **Work Station 3:** Students don and doff Level B garments. Instruct students to work one-to-one. Every student donning an ensemble should have an assistant. Have the teams don the
CPC according to manufacturer’s instructions, then have the students switch roles. Students donning the CPC should walk to an area where they are required to perform a simple activity, such as working with hand tools or operating detection equipment, reading a label, or writing their name on the chalkboard.

NOTE: Students at all stations should be encouraged to drink water continuously to maintain hydration. Use the inclusion criteria of the department, if available. Observe students for any signs of stress.

The length of this exercise is dependent on the number of students, number of CPC ensembles available, the type of garments, and the number of instructors. If there are four Level A ensembles and four Level B ensembles, one testing work station and three instructors, this activity can be accomplished in less than four hours.
## Exercise Assessment Sheet

Observe the students as they perform this activity and note any general problems below. Address these problems when you reconvene the class.

<table>
<thead>
<tr>
<th>Work Station # 1</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did most students appear to conduct a thorough visual inspection of the garment?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Were all components of the ensemble inspected?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Did students perform the leak test correctly?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Were procedures followed in the correct sequence?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Were all manufacturers’ instructions followed?</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

General problems/issues at Work Station 1:

<table>
<thead>
<tr>
<th>Work Station # 2</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did most students appear to don the Level A ensemble correctly?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Was the ensemble donned/doffed in the correct sequence?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Were any components not donned/doffed correctly or missed?</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Were all manufacturers’ instructions followed?</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

General problems/issues at Work Station 2:
<table>
<thead>
<tr>
<th>Work Station # 3</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did most students appear to don the Level B ensemble correctly?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Was the ensemble donned/doffed in the correct sequence?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Were any components not donned/doffed correctly or missed?</td>
<td>□</td>
<td>□</td>
</tr>
<tr>
<td>Were all manufacturers’ instructions followed?</td>
<td>□</td>
<td>□</td>
</tr>
</tbody>
</table>

General problems/issues at Work Station 3:
Action Statement
**Action Statement**

You have just completed the seventh module of the Hazardous Materials Technician course. The topics included:

- Types of respiratory protection
- Uses of respirators in emergency response
- NFPA and EPA recommendations for chemical protective clothing
- A review of the levels of chemical protective clothing, including advantages and limitations
- A review of the stresses of wearing chemical protective clothing
- Chemical resistance and compatibility in PPE
- Accessories and equipment for chemical protective clothing
- Selection and use of chemical protective clothing
- Donning and doffing
- Maintaining chemical protective clothing

Knowing how you respond to emergencies in your first due areas, would you change your actions or habits based on the information covered in this module? Listed below are some suggested actions. Some you may already do, and others may not fit your work environment. If there are actions you have not done in the past, do you think you will begin doing them as a result of this training?

As a result of this training I will:

1. Use my SCBA at all fire and potential hazardous materials incidents
2. Practice donning/doffing and working in the CPC available in my department
3. Read and carefully follow manufacturer’s instructions for maintaining the CPC in my department
4. Work with superiors to ensure that the most appropriate type of CPC is purchased
5. (Create my own action statement)
Appendix A

Activities
**SAR Demonstration Activity 1**  
*(Optional)*

If the department you are working with uses a *pass-through* SAR system, show the component to students and explain how it works. Explain that air is stored in typical SCBA cylinders (normally large duration, 60 minute-cylinders are used). Air passes through a valve system to the first regulator (normally reducing the pressure to about 100 psi). It also passes through an alarm system that will alert the attendant when air is running low.

The air then continues to another regulator, and a regulator or “splitter” that divides the air into more than one discharge (typically four, remember Two In / Two Out). Air hose lines are then connected to the regulator and to mask assemblies.

It is important to note that SAR users must also wear a self contained “escape pack” of air when entering IDLH atmospheres.

When the low air alarm sounds, the attendant switches the valve to a full cylinder, shuts down the empty cylinder and replaces it with a full cylinder. This process can be repeated indefinitely.

Demonstrate the air supply, hose line, pass-through valve, facepiece, and escape SCBA. If time permits, have a participant connect and don the SAR. Instruct the student to walk around the room, between desks, and into the hall or outside to demonstrate maneuverability.

**Questions**

1. In what situations would an SAR be preferable to an SCBA? In what situations would SCBA be preferable?

2. Recall the last hazardous materials incident you responded to. Which would have been more appropriate—SCBA or SARs? Discuss your reasoning.
Penetration Demonstration Activity 2

Obtain various protective garments used by the department. Select some garments that are penetrable by liquids and others that are not (e.g., non-compliant garments). Clothing may include:

- Structural fire fighting protective clothing
- Level A fully encapsulated chemical protective clothing
- Level B liquid splash protective clothing
- Disposable protective clothing
- EMS protective clothing
- Vinyl or butyl rubber gloves
- Leather gloves
- Boots/work shoes with closure

Pass the various articles of clothing around the class and allow the students to examine the closures and seams. Ask the students which articles would be penetrable by gases, which would be penetrable by liquids, and which would be impenetrable.

Demonstrate how liquids can penetrate seams and closures. Place the item over a desk blotter. Pour a small amount of water onto each seam or closure and observe how the water moves through the material and wets the blotter (or fails to penetrate). Emphasize that penetration refers to chemicals (gases, liquids, or solids) moving through physical openings in a garment.
Degradation Demonstration Activity 3

Obtain the following materials:
- Vinyl gloves
- Hydraulic fluid
- Various items made of thin, hard plastic
- Acetone
- Other latex and nitrile items
- Glass dishes

Place the vinyl glove in a glass dish and pour a small amount of hydraulic fluid on the glove. Explain that within an hour, the glove will dissolve where it was in contact with the hydraulic fluid. (Remember to show the glove to the students later.)

Place the items made of thin, hard plastic in another glass dish and add acetone. After a few minutes, the acetone will change the consistency of the plastic, making it soft and malleable.

You can also conduct this demonstration with acetone and any products made from latex or a nitrile/latex combination. The acetone will degrade these items within an hour.

Be sure to shut off all potential ignition sources and use full safety precautions (gloves and eye protection) when doing this demonstration.
Permeation Demonstration Activity 4

Obtain a variety of absorbent materials used at home and within the fire department. These materials may include:
- Sponges of various densities
- Cotton padding
- Stack of newspapers
- Commercial absorbents for hazardous materials
- Leather work gloves

Pass the various items around the class and allow the students to examine them. Ask the students which articles are most absorbent, and which has the faster breakthrough time.

Demonstrate how all the items will allow liquids to permeate, but at different breakthrough times. Pour a small amount of water onto each item (colored water may be easier to see) and observe how quickly the water moves through the material. Emphasize that unlike penetration, permeation refers to the passage of chemicals through molecules, not through physical openings.
Glove Activity 5

Place five or six different types of gloves (e.g. latex or vinyl, leather, fabric, cryogenic, CPC, fire fighting) in a box. Write the names of various chemicals (e.g. acetone, gasoline, sodium hydroxide, nitric acid, water) on separate pieces of paper and place them in a different box. Ideally, use chemicals from the manufacturers’ compatibility charts.

Have random participants pull a glove from the glove box and the name of a chemical from the other box. Ask the students to answer the questions below.

Questions

• Is this glove compatible with this chemical?

• If not, how will the chemical affect the glove?

• If this glove is not compatible with the chemical you selected, which glove *is* compatible?
Selecting CPC Activity 6

Several brief scenarios are described below. Read each one aloud to the students and have them identify the appropriate level of personal protective clothing that would be necessary for safe entry: Level A, Level B, or Structural Fire Fighting Clothing (SFFC). Ask them the reasons for their responses. For the purposes of this exercise, assume that:

- Level A is equivalent to fully-encapsulated vapor protective clothing
- Level B is equivalent to liquid splash protective garments

Remind the students that EPA levels C and D are not appropriate for emergency response.

An explanation of the answers appears on the following page.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Level A</th>
<th>Level B</th>
<th>SFFC</th>
<th>Entry is Not Safe</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. An ammonia cloud forms after a tank truck accident. Haz mat team members must enter the area to plug the leak. There are high concentrations of ammonia in the immediate vicinity.</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>2. A reconnaissance team comes into an abandoned hazardous waste site containing hundreds of open drums and two large waste lagoons. There is no vegetation and a dead dog lies near the boundary. No other information is available.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Fire fighters respond to a large sodium fire in a metals processing establishment. The roof collapses as fire fighters arrive. The sky is cloudy, and a thunderstorm is imminent.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. A 55-gallon drum of nitric acid is damaged when it falls off a loading dock at a chemical facility. The acid is leaking slowly and running toward a storm sewer.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. A gasoline tanker has overturned on a busy interstate and a small amount of gasoline has spilled into a ditch. The leak appears to have stopped because the remaining liquid is below the breach.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. A truck carrying several drums of pyrophoric aluminum powder is involved in an accident on a city street. Several drums are damaged and some powder has spilled.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. A train carrying low level radioactive waste uranium is one of several cars that derail during an accident at a rail yard. There is no fire, but several people are injured and must be rescued.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. A tractor trailer carrying a load of phosphoric acid swerves and the load shifts, spilling several gallons of the acid. The driver is still in the cab, injured.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Fire fighters respond to a small fire at a garden center. The fire has extinguished itself when they arrive, but several containers of organophosphate pesticides have been damaged. Two employees have been injured and are in the area of the fire, unconscious.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CPC Work Activity 7

Divide the class into small groups, so that you have one set of the following for each group:

- Level A or Level B suit
- One pair of undergloves
- One combustible gas indicator or other detection equipment

Instruct one student in each group to don the undergloves and the upper body part of the CPC (head and arms).

Give the student a CGI or other detection equipment and instruct them to work the controls and read the gauges. Because the point of this exercise is to allow students to get a feel for the limited dexterity, it is not important that they know how to operate the detection equipment.

Next, have the student manipulate a screwdriver to work a small screw into a piece of wood.

Allow each student the opportunity to perform these same activities. When the groups have finished, discuss their perceptions concerning the limitations of working in CPC.

Questions

1. Did the protective clothing limit your work activity? If so, how?

2. What accommodations or changes, if any, could you make to improve flexibility and maneuverability?
Donning and Doffing Demonstration Activity 8

Ask for a participant to don the fully-encapsulated vapor-protective chemical clothing and ensemble gear available at your training facility. Follow the manufacturer’s instructors, if you do not have instructions. Use the checklist in Appendix B as a guide.

As you help the student don the ensemble, explain the proper procedures for putting on each item. Be sure to explain why certain procedures are necessary.

After the student is fully suited (including air), help him or her remove the CPC. Again, follow the manufacturer’s instructions on the doffing procedures in Appendix B. Emphasize the importance of not allowing the outside surface of the suit to contact the wearer, the assistant, or the inside surface of the suit.

Questions

1. Did you notice any problems with the steps in the checklist? If so, describe them.

2. Why are donning and doffing procedures performed in a specific sequence?

3. If you are familiar with vapor-protective ensembles from other manufacturers, how is yours different?
Appendix B

Donning/Doffing Checklists
Check Sheet for Donning CPC

**Preparation**
- Confirm site for donning (confer with Entry and Branch officers)
  - ____ Adequate space
  - ____ No distractions
  - ____ Sheltered
  - ____ Adequate Manpower (1 to 1 minimum)
- Locate, remove, deploy CPC and equipment
  - ____ Tarp, seats
  - ____ SCBA
  - ____ Correct CPC
- Deploy Donning Area
  - ____ Deploy tarp/chairs
  - ____ Prepare CPC (roll up splash guards, obtain overgloves, etc.)
  - ____ Test SCBA
  - ____ Check CPC closures

**Donning to Standby**
- Receive entry/backup personnel from EMS
  - ____ Personal items removed
  - ____ Team seated
  - ____ Hydration continuing
- Entry/backup briefed on work activities
  - ____ Emergency signals reviewed
  - ____ Briefing understood/repeated
- Ensure that mitigation equipment is ready for team
- Assist entry personnel in donning SCBA harness
- Assist entry personnel in donning inner disposable gloves
- With entry personnel sitting, put legs of CPC on
- Place boots on feet - remember to roll up excess bootie of CPC
- With entry member standing, pull suit up far enough to clear SCBA and allow member to sit on suit
- With entry member sitting, place arms and hands in sleeves/glove assembly
  - If two-piece suit - omit
- Don any additional protective clothing appropriately (extra gloves, etc.)
- Notify Hazardous Materials Branch officer that the team is at stand-by position

**Completion of Donning**
- Assist in facepiece placement on entry personnel and remember to tighten adequately
- Notify and record time that personnel are on air
- Check that SCBA is functioning properly
- With entry personnel standing, close suit
- Notify Branch officer that the team is ready and send to appropriate entrance
Check Sheet for Doffing CPC

Preparation
• Confirm site for doffing (confer with Entry and Branch officers)
  ____ Adequate space       ____ Isolated       ____ Sheltered
• Locate, remove doffing equipment
  ____ Tarp, seats       ____ SCBA       ____ Correct CPC
• Deploy Doffing Area
  ____ Deploy tarp/chairs       ____ Disposal containers       ____ EMS area
  ____ Confer with decon officer about remaining hazards       ____ Choose adequate CPC
• Doffing personnel in proper protective clothing

Doffing
• Receive entry personnel from decontamination—Watch for signs of heat stress
• Expose entry personnel to ambient air
  ____ Unzip suit       ____ Remove top portion
    Doffing touches OUTSIDE ONLY
• Remove/lower enough of suit to allow entry personnel to sit
• Remove any remaining over-coverings and boots
  ____ Gloves       ____ Boots       ____ Disposed of properly
• With entry personnel sitting, remove arms from CPC
• With entry personnel sitting, remove legs from CPC
• Zip or fold garment (avoid outside touching inside)
• Place garment in appropriate container
• Assist entry personnel with removal of SCBA harness
  ____ Touch only harness
• Hold SCBA for entry personnel
• Tell entry personnel to remove inner gloves
• Allow entry personnel to remove SCBA facepiece

Completion of Doffing
• Notify and record time that personnel are off air
• Ensure that EMS evaluate entry personnel
  ____ Begin re-hydration
• Notify Branch officer for debriefing
Appendix C

Purchasing Chemical Protective Clothing
**Purchasing Chemical Protective Clothing**

NOTE: This section may be considered optional if students already have chemical protective clothing. However, the subjects covered may serve as a refresher and generate discussion.

**Background**

In the past, purchasing chemical protective clothing was a relatively easy process. There were only a few brands, types, and materials of garments and there were no standards. Now there are many new materials, construction techniques, manufacturers, and certifications.

The new methods and construction techniques have led to the development of limited use garments. “Limited use” is the industry’s terminology for disposable. These garments, many of which are NFPA compliant, are single use or made to be used only a few times before they are disposed of. They are usually available at much less cost than reusable garments.

The IAFF strongly recommends the use of NFPA compliant chemical protective clothing for entry into hazardous materials incidents.

Jurisdictions must now make many decisions regarding CPC; limited use or reusable, compliant or non-compliant, and levels to be purchased are just a few of the questions that must be answered. However, always keep in mind that any CPC is considered limited use if it is damaged or cannot be adequately cleaned.

**Limited Use vs. Reusable**

Many limited use garments are available. NFPA compliant CPC will perform to the NFPA standard just like a reusable garment; that is, for at least one use they will meet the standard. The manufacturer will state under what conditions, if any, the garment could be reused.

**Advantages/Limitations of Limited Use Garments**

- May reduce concern regarding decontamination and reuse
- Reduces chance of exposing garment to incompatible chemicals by multiple entries at different scenes
- NFPA compliant garments afford same protection as reuseable garments
- Cost may be significantly less than reuseable
- May be very cost effective for decontamination personnel
- Requires a relatively large supply of garments to ensure continued service of hazardous material mitigation activities
NFPA Compliant vs. Non-compliant

With the introduction of the NFPA standards regarding chemical protective clothing, a minimum performance and construction standard was established. This standard allows for direct comparison between certified garments from different manufacturers. Some jurisdictions may find that a combination of both compliant and non-compliant garments best suits their individual needs.

Advantages/Limitations of Compliant Garments

- Known test results for battery of chemicals as an ensemble (all pieces of protection)
- Meets certain wear/tear resistance values as an ensemble
- Meets certain flammability standards as an ensemble
- Level A and B protects breathing apparatus
- May cost significantly more than non-compliant garments (initial cost and replacement cost)
- May not meet jurisdiction’s needs for chemical compatibility

Advantages/Limitations of Non-Compliant Garments

- Reduces cost
- Generally lighter in weight
- Many non-compliant garments are designed as limited use
- May protect against specific hazards as well as, or better than, compliant garments
- Unknown or undocumented wear/tear resistance data
- Requires the additional research and purchase of additional items (boots, gloves) to complete the ensemble

Other Issues

Sizing

Sizing is an important issue in the field of chemical protective clothing. The NFPA addresses this problem in their standards. In any case, response personnel should ask manufacturers to provide sample garments of various sizes so that the personnel who will use the garments can judge the best size for them. Working in chemical protective clothing that is too large or too small will add significantly to the stress of work activities.

Identification

Identification of garments is also recommended. Not only should garments be marked for record keeping operations (e.g., serial numbers), garments should also have markings recognizable from a distance. This allows safety observers to identify the different personnel working in the Hot Zone. These markings can be ordered from the manufacturer or approved tags or signs can be added as necessary.
Design

The individual construction of clothing should be considered. There are front entry suits, side entry suits or rear entry suits manufactured in both compliant and non-compliant versions.

Area Hazards

The jurisdiction should complete a hazard survey and analysis to determine what hazards are stored or transported through the area. The analysis should include estimations of likely releases and affected populations. This type of data should be available from the Local Emergency Planning Committee and anecdotal information from past experience.

The jurisdiction must then decide what level of service they wish to provide. Providing Level A service will increase cost of service but may be necessary considering the hazards in the jurisdiction.

Personnel

The availability of sufficient personnel should be considered. Hazardous materials mitigation by Technicians is a personnel-intensive operation. A minimum of four personnel is required when CPC is used. This includes at least one person to supervise, personnel for decontamination, personnel for donning and doffing. These must be dedicated personnel and not assigned to carry out other site activities such as site control or research.

Some jurisdictions may choose to have a core of trained Technicians supported by well cross-trained personnel to perform donning, doffing and decontamination. Another option is to become part of a regional team or team based on mutual aid agreements.

Certification

Even with NFPA compliant garments, there are major differences regarding the use of the garments. Many manufacturers, in order to meet the flame resistance, flash protection and abrasion resistance criteria, manufacture a lighter weight chemical protective garment and a separate aluminized fiberglass, Nomex or PBI oversuit. These two items must be used together to meet the NFPA certification. Other manufacturers produce a single garment that meets the specifications. This CPC is usually more expensive and slightly heavier. Jurisdictions should take this into account when specifying and purchasing chemical protective clothing.

Testing

Manufacturers regularly test for chemical resistance against a variety of chemicals other than those specified by the NFPA. Most will test against a specific chemical if the jurisdiction pays for the test. Test results allow the purchaser to compare resistance data from many sources and choose the material and garments best suited to their needs. Manufacturers should provide this data with their garments or upon request.
Summary

The purchase of chemical protective clothing is a major expenditure to most jurisdictions and represents only one of the expenses incurred in training and equipping a hazardous materials Technician team. However, if the wrong CPC is purchased, replacement is extremely expensive.

This program should give the participants the basic knowledge to ask the appropriate questions of vendors and themselves before purchasing chemical protective clothing and related equipment.

Since many jurisdictions cannot afford to purchase CPC of many different materials and styles, responders and the jurisdictional leadership should understand that there may be incidents where their ability to intervene in an offensive manner may be limited.
<table>
<thead>
<tr>
<th>Commercially Available Ensemble Pieces</th>
<th>Cost</th>
<th>Use (Multiple Use or Disposable)</th>
<th>Anticipated Types of Exposure</th>
<th>Comments</th>
<th>Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>M/U DIS</td>
<td>Immersion Splash Airborne</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Suit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gloves</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Boots</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>SCBA/PP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Other Accessories</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Appendix D

29 CFR 1910.134
29 CFR 1910.120 (Appendices A and B)
29 CFR 1910.120 (g)
OSHA Regulations (Standards - 29 CFR)
Respiratory Protection. - 1910.134

- Standard Number: 1910.134
- Standard Title: Respiratory Protection.
- SubPart Number: I
- SubPart Title: Personal Protective Equipment

This section applies to General Industry (part 1910), Shipyards (part 1915), Marine Terminals (part 1917), Longshoring (part 1918), and Construction (part 1926).

1910.134(a)

(a)
Permissible practice.

(a)(1)
In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. This shall be accomplished as far as feasible by accepted engineering control measures (for example, enclosure or confinement of the operation, general and local ventilation, and substitution of less toxic materials). When effective engineering controls are not feasible, or while they are being instituted, appropriate respirators shall be used pursuant to this section.

(a)(2)
Respirators shall be provided by the employer when such equipment is necessary to protect the health of the employee. The employer shall provide the respirators which are applicable and suitable for the purpose intended. The employer shall be responsible for the establishment and maintenance of a respiratory protection program which shall include the requirements outlined in paragraph (c) of this section.

1910.134(b)

(b)
Definitions. The following definitions are important terms used in the respiratory protection standard in this section.

Air-purifying respirator means a respirator with an air-purifying filter, cartridge, or canister that removes specific air contaminants by passing ambient air through the air-purifying element.

Assigned protection factor (APF) [Reserved]

Atmosphere-supplying respirator means a respirator that supplies the respirator user with breathing air from a source independent of the ambient atmosphere, and includes supplied-air respirators (SARs) and self-contained breathing apparatus (SCBA) units.

Canister or cartridge means a container with a filter, sorbent, or catalyst, or combination of these items, which removes specific contaminants from the air passed through the container.

Demand respirator means an atmosphere-supplying respirator that admits breathing air to the facepiece only when a negative pressure is created inside the facepiece by inhalation.
Emergency situation means any occurrence such as, but not limited to, equipment failure, rupture of containers, or failure of control equipment that may or does result in an uncontrolled significant release of an airborne contaminant.

Employee exposure means exposure to a concentration of an airborne contaminant that would occur if the employee were not using respiratory protection.

End-of-service-life indicator (ESLI) means a system that warns the respirator user of the approach of the end of adequate respiratory protection, for example, that the sorbent is approaching saturation or is no longer effective.

Escape-only respirator means a respirator intended to be used only for emergency exit.

Filter or air purifying element means a component used in respirators to remove solid or liquid aerosols from the inspired air.

Filtering facepiece (dust mask) means a negative pressure particulate respirator with a filter as an integral part of the facepiece or with the entire facepiece composed of the filtering medium.

Fit factor means a quantitative estimate of the fit of a particular respirator to a specific individual, and typically estimates the ratio of the concentration of a substance in ambient air to its concentration inside the respirator when worn.

Fit test means the use of a protocol to qualitatively or quantitatively evaluate the fit of a respirator on an individual. (See also Qualitative fit test QLFT and Quantitative fit test QNFT.)

Helmet means a rigid respiratory inlet covering that also provides head protection against impact and penetration.

High efficiency particulate air (HEPA) filter means a filter that is at least 99.97% efficient in removing monodisperse particles of 0.3 micrometers in diameter. The equivalent NIOSH 42 CFR 84 particulate filters are the N100, R100, and P100 filters.

Hood means a respiratory inlet covering that completely covers the head and neck and may also cover portions of the shoulders and torso.

Immediately dangerous to life or health (IDLH) means an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual’s ability to escape from a dangerous atmosphere.

Interior structural firefighting means the physical activity of fire suppression, rescue or both, inside of buildings or enclosed structures which are involved in a fire situation beyond the incipient stage. (See 29 CFR 1910.155)

Loose-fitting facepiece means a respiratory inlet covering that is designed to form a partial seal with the face.

Maximum use concentration (MUC) [Reserved].

Negative pressure respirator (tight fitting) means a respirator in which the air pressure inside the facepiece exceeds the ambient air pressure outside the respirator.

Oxygen deficient atmosphere means an atmosphere with an oxygen content below 19.5% by volume.

Physician or other licensed health care professional (PLHCP) means an individual whose legally permitted scope of practice (i.e., license, registration, or certification) allows him or her to independently provide, or be delegated the responsibility to provide, some or all of the health care services required by paragraph (e) of this section.

Positive pressure respirator means a respirator in which the pressure inside the respiratory inlet covering exceeds the
ambient air pressure outside the respirator.

Powered air-purifying respirator (PAPR) means an air-purifying respirator that uses a blower to force the ambient air through air-purifying elements to the inlet covering.

Pressure demand respirator means a positive pressure atmosphere-supplying respirator that admits breathing air to the facepiece when the positive pressure is reduced inside the facepiece by inhalation.

Qualitative fit test (QLFT) means a pass/fail fit test to assess the adequacy of respirator fit that relies on the individual’s response to the test agent.

Quantitative fit test (QNFT) means an assessment of the adequacy of respirator fit by numerically measuring the amount of leakage into the respirator.

Respiratory inlet covering means that portion of a respirator that forms the protective barrier between the user’s respiratory tract and an air-purifying device or breathing air source, or both. It may be a facepiece, helmet, hood, suit, or a mouthpiece respirator with nose clamp.

Self-contained breathing apparatus (SCBA) means an atmosphere-supplying respirator for which the breathing air source is designed to be carried by the user.

Service life means the period of time that a respirator, filter or sorbent, or other respiratory equipment provides adequate protection to the wearer.

Supplied-air respirator (SAR) or airline respirator means an atmosphere-supplying respirator for which the source of breathing air is not designed to be carried by the user.

This section means this respiratory protection standard.

Tight-fitting facepiece means a respiratory inlet covering that forms a complete seal with the face.

User seal check means an action conducted by the respirator user to determine if the respirator is properly seated to the face.

(c)
Respiratory protection program. This paragraph requires the employer to develop and implement a written respiratory protection program with required worksite-specific procedures and elements for required respirator use. The program must be administered by a suitably trained program administrator. In addition, certain program elements may be required for voluntary use to prevent potential hazards associated with the use of the respirator. The Small Entity Compliance Guide contains criteria for the selection of a program administrator and a sample program that meets the requirements of this paragraph. Copies of the Small Entity Compliance Guide will be available on or about April 8, 1998 from the Occupational Safety and Health Administration’s Office of Publications, Room N 3101, 200 Constitution Avenue, NW, Washington, DC, 20210 (202-219-4667).

(c)(1)
In any workplace where respirators are necessary to protect the health of the employee or whenever respirators are required by the employer, the employer shall establish and implement a written respiratory protection program with worksite-specific procedures. The program shall be updated as necessary to reflect those changes in workplace conditions that affect respirator use. The employer shall include in the program the following provisions of this section, as applicable:

(c)(1)(i)
Procedures for selecting respirators for use in the workplace;
(c)(1)(ii)
Medical evaluations of employees required to use respirators;

(c)(1)(iii)
Fit testing procedures for tight-fitting respirators;

(c)(1)(iv)
Procedures for proper use of respirators in routine and reasonably foreseeable emergency situations;

(c)(1)(v)
Procedures and schedules for cleaning, disinfecting, storing, inspecting, repairing, discarding, and otherwise maintaining respirators;

(c)(1)(vi)
Procedures to ensure adequate air quality, quantity, and flow of breathing air for atmosphere-supplying respirators;

(c)(1)(vii)
Training of employees in the respiratory hazards to which they are potentially exposed during routine and emergency situations;

1910.134(c)(1)(viii)
(c)(1)(viii)
Training of employees in the proper use of respirators, including putting on and removing them, any limitations on their use, and their maintenance; and

(c)(1)(ix)
Procedures for regularly evaluating the effectiveness of the program.

(c)(2)
Where respirator use is not required:

(c)(2)(i)
An employer may provide respirators at the request of employees or permit employees to use their own respirators, if the employer determines that such respirator use will not in itself create a hazard. If the employer determines that any voluntary respirator use is permissible, the employer shall provide the respirator users with the information contained in Appendix D to this section (“Information for Employees Using Respirators When Not Required Under the Standard”); and

(c)(2)(ii)
In addition, the employer must establish and implement those elements of a written respiratory protection program necessary to ensure that any employee using a respirator voluntarily is medically able to use that respirator, and that the respirator is cleaned, stored, and maintained so that its use does not present a health hazard to the user. Exception: Employers are not required to include in a written respiratory protection program those employees whose only use of respirators involves the voluntary use of filtering facepieces (dust masks).

(c)(3)
The employer shall designate a program administrator who is qualified by appropriate training or experience that is commensurate with the complexity of the program to administer or oversee the respiratory protection program and conduct the required evaluations of program effectiveness.

(c)(4)
The employer shall provide respirators, training, and medical evaluations at no cost to the employee.

(d)Selection of respirators. This paragraph requires the employer to evaluate respiratory hazard(s) in the workplace, identify relevant workplace and user factors, and base respirator selection on these factors. The paragraph also
specifies appropriately protective respirators for use in IDLH atmospheres, and limits the selection and use of air-purifying respirators.

(d)(1)
General requirements.

(d)(1)(i)
(i) The employer shall select and provide an appropriate respirator based on the respiratory hazard(s) to which the worker is exposed and workplace and user factors that affect respirator performance and reliability.

(d)(1)(ii)
The employer shall select a NIOSH-certified respirator. The respirator shall be used in compliance with the conditions of its certification.

(d)(1)(iii)
The employer shall identify and evaluate the respiratory hazard(s) in the workplace; this evaluation shall include a reasonable estimate of employee exposures to respiratory hazard(s) and an identification of the contaminant’s chemical state and physical form. Where the employer cannot identify or reasonably estimate the employee exposure, the employer shall consider the atmosphere to be IDLH.

1910.134(d)(1)(iv)
(d)(1)(iv)
The employer shall select respirators from a sufficient number of respirator models and sizes so that the respirator is acceptable to, and correctly fits, the user.

(d)(2)
Respirators for IDLH atmospheres.

(d)(2)(i)
The employer shall provide the following respirators for employee use in IDLH atmospheres:

(d)(2)(i)(A)
A full facepiece pressure demand SCBA certified by NIOSH for a minimum service life of thirty minutes, or

(d)(2)(i)(B)
A combination full facepiece pressure demand supplied-air respirator (SAR) with auxiliary self-contained air supply.

(d)(2)(ii)
Respirators provided only for escape from IDLH atmospheres shall be NIOSH-certified for escape from the atmosphere in which they will be used.

(d)(2)(iii)
All oxygen-deficient atmospheres shall be considered IDLH. Exception: If the employer demonstrates that, under all foreseeable conditions, the oxygen concentration can be maintained within the ranges specified in Table II of this section (i.e., for the altitudes set out in the table), then any atmosphere-supplying respirator may be used.

(d)(3)
Respirators for atmospheres that are not IDLH.

(d)(3)(i)
The employer shall provide a respirator that is adequate to protect the health of the employee and ensure compliance with all other OSHA statutory and regulatory requirements, under routine and reasonably foreseeable emergency situations.
(d)(3)(i)(A) Assigned Protection Factors (APFs) [Reserved]

(d)(3)(i)(B) Maximum Use Concentration (MUC) [Reserved]

(d)(3)(ii) The respirator selected shall be appropriate for the chemical state and physical form of the contaminant.

(d)(3)(iii) For protection against gases and vapors, the employer shall provide:

(d)(3)(iii)(A) An atmosphere-supplying respirator, or

(d)(3)(iii)(B) An air-purifying respirator, provided that:

(d)(3)(iii)(B)(1) The respirator is equipped with an end-of-service-life indicator (ESLI) certified by NIOSH for the contaminant; or

(d)(3)(iii)(B)(2) If there is no ESLI appropriate for conditions in the employer’s workplace, the employer implements a change schedule for canisters and cartridges that is based on objective information or data that will ensure that canisters and cartridges are changed before the end of their service life. The employer shall describe in the respirator program the information and data relied upon and the basis for the canister and cartridge change schedule and the basis for reliance on the data.

(d)(3)(iv) For protection against particulates, the employer shall provide:

(d)(3)(iv)(A) An atmosphere-supplying respirator; or

(d)(3)(iv)(B) An air-purifying respirator equipped with a filter certified by NIOSH under 30 CFR part 11 as a high efficiency particulate air (HEPA) filter, or an air-purifying respirator equipped with a filter certified for particulates by NIOSH under 42 CFR part 84; or

(d)(3)(iv)(C) For contaminants consisting primarily of particles with mass median aerodynamic diameters (MMAD) of at least 2 micrometers, an air-purifying respirator equipped with any filter certified for particulates by NIOSH.

TABLE I. — Assigned Protection Factors [Reserved]

1910.134(e) (e) Medical evaluation. Using a respirator may place a physiological burden on employees that varies with the type of respirator worn, the job and workplace conditions in which the respirator is used, and the medical status of the employee. Accordingly, this paragraph specifies the minimum requirements for medical evaluation that employers must implement to determine the employee’s ability to use a respirator.
(e)(1) General. The employer shall provide a medical evaluation to determine the employee’s ability to use a respirator, before the employee is fit tested or required to use the respirator in the workplace. The employer may discontinue an employee’s medical evaluations when the employee is no longer required to use a respirator.

(e)(2) Medical evaluation procedures.

(e)(2)(i) The employer shall identify a physician or other licensed health care professional (PLHCP) to perform medical evaluations using a medical questionnaire or an initial medical examination that obtains the same information as the medical questionnaire.

(e)(2)(ii) The medical evaluation shall obtain the information requested by the questionnaire in Sections 1 and 2, Part A of Appendix C of this section.

(e)(3) Follow-up medical examination.

(e)(3)(i) The employer shall ensure that a follow-up medical examination is provided for an employee who gives a positive response to any question among questions 1 through 8 in Section 2, Part A of Appendix C or whose initial medical examination demonstrates the need for a follow-up medical examination.

(e)(3)(ii) The follow-up medical examination shall include any medical tests, consultations, or diagnostic procedures that the PLHCP deems necessary to make a final determination.

(e)(4) Administration of the medical questionnaire and examinations.

(e)(4)(i) The medical questionnaire and examinations shall be administered confidentially during the employee’s normal working hours or at a time and place convenient to the employee. The medical questionnaire shall be administered in a manner that ensures that the employee understands its content.

(e)(4)(ii) The employer shall provide the employee with an opportunity to discuss the questionnaire and examination results with the PLHCP.

(e)(5) Supplemental information for the PLHCP.

(e)(5)(i) The following information must be provided to the PLHCP before the PLHCP makes a recommendation concerning an employee’s ability to use a respirator:

(e)(5)(i)(A) The type and weight of the respirator to be used by the employee;

(e)(5)(i)(B) The duration and frequency of respirator use (including use for rescue and escape);
The expected physical work effort;

Additional protective clothing and equipment to be worn; and

Temperature and humidity extremes that may be encountered.

Any supplemental information provided previously to the PLHCP regarding an employee need not be provided for a subsequent medical evaluation if the information and the PLHCP remain the same.

The employer shall provide the PLHCP with a copy of the written respiratory protection program and a copy of this section.

Note to Paragraph (e)(5)(iii): When the employer replaces a PLHCP, the employer must ensure that the new PLHCP obtains this information, either by providing the documents directly to the PLHCP or having the documents transferred from the former PLHCP to the new PLHCP. However, OSHA does not expect employers to have employees medically reevaluated solely because a new PLHCP has been selected.

Medical determination. In determining the employee’s ability to use a respirator, the employer shall:

Obtain a written recommendation regarding the employee’s ability to use the respirator from the PLHCP. The recommendation shall provide only the following information:

Any limitations on respirator use related to the medical condition of the employee, or relating to the workplace conditions in which the respirator will be used, including whether or not the employee is medically able to use the respirator;

The need, if any, for follow-up medical evaluations; and

A statement that the PLHCP has provided the employee with a copy of the PLHCP’s written recommendation.

If the respirator is a negative pressure respirator and the PLHCP finds a medical condition that may place the employee’s health at increased risk if the respirator is used, the employer shall provide a PAPR if the PLHCP’s medical evaluation finds that the employee can use such a respirator; if a subsequent medical evaluation finds that the employee is medically able to use a negative pressure respirator, then the employer is no longer required to provide a PAPR.

Additional medical evaluations. At a minimum, the employer shall provide additional medical evaluations that comply with the requirements of this section if:

An employee reports medical signs or symptoms that are related to ability to use a respirator;
(e)(7)(ii)
A PLHCP, supervisor, or the respirator program administrator informs the employer that an employee needs to be reevaluated;

(e)(7)(iii)
Information from the respiratory protection program, including observations made during fit testing and program evaluation, indicates a need for employee reevaluation; or

(e)(7)(iv)
A change occurs in workplace conditions (e.g., physical work effort, protective clothing, temperature) that may result in a substantial increase in the physiological burden placed on an employee.

(f) Fit testing. This paragraph requires that, before an employee may be required to use any respirator with a negative or positive pressure tight-fitting facepiece, the employee must be fit tested with the same make, model, style, and size of respirator that will be used. This paragraph specifies the kinds of fit tests allowed, the procedures for conducting them, and how the results of the fit tests must be used.

(f)(1)
The employer shall ensure that employees using a tight-fitting facepiece respirator pass an appropriate qualitative fit test (QLFT) or quantitative fit test (QNFT) as stated in this paragraph.

(f)(2)
The employer shall ensure that an employee using a tight-fitting facepiece respirator is fit tested prior to initial use of the respirator, whenever a different respirator facepiece (size, style, model or make) is used, and at least annually thereafter.

(f)(3)
The employer shall conduct an additional fit test whenever the employee reports, or the employer, PLHCP, supervisor, or program administrator makes visual observations of, changes in the employee’s physical condition that could affect respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight.

(f)(4)
If after passing a QLFT or QNFT, the employee subsequently notifies the employer, program administrator, supervisor, or PLHCP that the fit of the respirator is unacceptable, the employee shall be given a reasonable opportunity to select a different respirator facepiece and to be retested.

1910.134(f)(5)
(f)(5)
The fit test shall be administered using an OSHA-accepted QLFT or QNFT protocol. The OSHA-accepted QLFT and QNFT protocols and procedures are contained in Appendix A of this section.

(f)(6)
QLFT may only be used to fit test negative pressure air-purifying respirators that must achieve a fit factor of 100 or less.

(f)(7)
If the fit factor, as determined through an OSHA-accepted QNFT protocol, is equal to or greater than 100 for tight-fitting half facepieces, or equal to or greater than 500 for tight-fitting full facepieces, the QNFT has been passed with that respirator.
Fit testing of tight-fitting atmosphere-supplying respirators and tight-fitting powered air-purifying respirators shall be accomplished by performing quantitative or qualitative fit testing in the negative pressure mode, regardless of the mode of operation (negative or positive pressure) that is used for respiratory protection.

Qualitative fit testing of these respirators shall be accomplished by temporarily converting the respirator user’s actual facepiece into a negative pressure respirator with appropriate filters, or by using an identical negative pressure air-purifying respirator facepiece with the same sealing surfaces as a surrogate for the atmosphere-supplying or powered air-purifying respirator facepiece.

Quantitative fit testing of these respirators shall be accomplished by modifying the facepiece to allow sampling inside the facepiece in the breathing zone of the user, midway between the nose and mouth. This requirement shall be accomplished by installing a permanent sampling probe onto a surrogate facepiece, or by using a sampling adapter designed to temporarily provide a means of sampling air from inside the facepiece.

Any modifications to the respirator facepiece for fit testing shall be completely removed, and the facepiece restored to NIOSH-approved configuration, before that facepiece can be used in the workplace.

Use of respirators. This paragraph requires employers to establish and implement procedures for the proper use of respirators. These requirements include prohibiting conditions that may result in facepiece seal leakage, preventing employees from removing respirators in hazardous environments, taking actions to ensure continued effective respirator operation throughout the work shift, and establishing procedures for the use of respirators in IDLH atmospheres or in interior structural firefighting situations.

The employer shall not permit respirators with tight-fitting facepieces to be worn by employees who have:

Facial hair that comes between the sealing surface of the facepiece and the face or that interferes with valve function; or

Any condition that interferes with the face-to-facepiece seal or valve function.

If an employee wears corrective glasses or goggles or other personal protective equipment, the employer shall ensure that such equipment is worn in a manner that does not interfere with the seal of the facepiece to the face of the user.

For all tight-fitting respirators, the employer shall ensure that employees perform a user seal check each time they put on the respirator using the procedures in Appendix B-1 or procedures recommended by the respirator manufacturer that the employer demonstrates are as effective as those in Appendix B-1 of this section.

Continuing respirator effectiveness.
(g)(2)(i) Appropriate surveillance shall be maintained of work area conditions and degree of employee exposure or stress. When there is a change in work area conditions or degree of employee exposure or stress that may affect respirator effectiveness, the employer shall reevaluate the continued effectiveness of the respirator.

(g)(2)(ii) The employer shall ensure that employees leave the respirator use area:

1910.134(g)(2)(ii)(A) To wash their faces and respirator facepieces as necessary to prevent eye or skin irritation associated with respirator use; or

(g)(2)(ii)(B) If they detect vapor or gas breakthrough, changes in breathing resistance, or leakage of the facepiece; or

(g)(2)(ii)(C) To replace the respirator or the filter, cartridge, or canister elements.

(g)(2)(iii) If the employee detects vapor or gas breakthrough, changes in breathing resistance, or leakage of the facepiece, the employer must replace or repair the respirator before allowing the employee to return to the work area.

(g)(3) Procedures for IDLH atmospheres. For all IDLH atmospheres, the employer shall ensure that:

(g)(3)(i) One employee or, when needed, more than one employee is located outside the IDLH atmosphere;

(g)(3)(ii) Visual, voice, or signal line communication is maintained between the employee(s) in the IDLH atmosphere and the employee(s) located outside the IDLH atmosphere;

(g)(3)(iii) The employee(s) located outside the IDLH atmosphere are trained and equipped to provide effective emergency rescue;

(g)(3)(iv) The employer or designee is notified before the employee(s) located outside the IDLH atmosphere enter the IDLH atmosphere to provide emergency rescue;

(g)(3)(v) The employer or designee authorized to do so by the employer, once notified, provides necessary assistance appropriate to the situation;

(g)(3)(vi) Employee(s) located outside the IDLH atmospheres are equipped with:

(g)(3)(vi)(A) Pressure demand or other positive pressure SCBAs, or a pressure demand or other positive pressure supplied-air respirator with auxiliary SCBA; and either
(g)(3)(vi)(B) Appropriate retrieval equipment for removing the employee(s) who enter(s) these hazardous atmospheres where retrieval equipment would contribute to the rescue of the employee(s) and would not increase the overall risk resulting from entry; or

(g)(3)(vi)(C) Equivalent means for rescue where retrieval equipment is not required under paragraph (g)(3)(vi)(B).

(g)(4) Procedures for interior structural firefighting. In addition to the requirements set forth under paragraph (g)(3), in interior structural fires, the employer shall ensure that:

(g)(4)(i) At least two employees enter the IDLH atmosphere and remain in visual or voice contact with one another at all times;

(g)(4)(ii) At least two employees are located outside the IDLH atmosphere; and

(g)(4)(iii) All employees engaged in interior structural firefighting use SCBAs.

Note 1 to paragraph (g): One of the two individuals located outside the IDLH atmosphere may be assigned to an additional role, such as incident commander in charge of the emergency or safety officer, so long as this individual is able to perform assistance or rescue activities without jeopardizing the safety or health of any firefighter working at the incident.

Note 2 to paragraph (g): Nothing in this section is meant to preclude firefighters from performing emergency rescue activities before an entire team has assembled.

(h) Maintenance and care of respirators. This paragraph requires the employer to provide for the cleaning and disinfecting, storage, inspection, and repair of respirators used by employees.

(h)(1) Cleaning and disinfecting. The employer shall provide each respirator user with a respirator that is clean, sanitary, and in good working order. The employer shall ensure that respirators are cleaned and disinfected using the procedures in Appendix B-2 of this section, or procedures recommended by the respirator manufacturer, provided that such procedures are of equivalent effectiveness. The respirators shall be cleaned and disinfected at the following intervals:

(h)(1)(i) Respirators issued for the exclusive use of an employee shall be cleaned and disinfected as often as necessary to be maintained in a sanitary condition;

(h)(1)(ii) Respirators issued to more than one employee shall be cleaned and disinfected before being worn by different individuals;

(h)(1)(iii) Respirators maintained for emergency use shall be cleaned and disinfected after each use; and

(h)(1)(iv) Respirators used in fit testing and training shall be cleaned and disinfected after each use.
(h)(2)
Storage. The employer shall ensure that respirators are stored as follows:

(h)(2)(i)
All respirators shall be stored to protect them from damage, contamination, dust, sunlight, extreme temperatures, excessive moisture, and damaging chemicals, and they shall be packed or stored to prevent deformation of the facepiece and exhalation valve.

(h)(2)(ii)
In addition to the requirements of paragraph (h)(2)(i) of this section, emergency respirators shall be:

(h)(2)(ii)(A)
Kept accessible to the work area;

(h)(2)(ii)(B)
Stored in compartments or in covers that are clearly marked as containing emergency respirators; and

(h)(2)(ii)(C)
Stored in accordance with any applicable manufacturer instructions.

1910.134(h)(3)
(h)(3)
Inspection.

(h)(3)(i)
The employer shall ensure that respirators are inspected as follows:

(h)(3)(i)(A)
All respirators used in routine situations shall be inspected before each use and during cleaning;

(h)(3)(i)(B)
All respirators maintained for use in emergency situations shall be inspected at least monthly and in accordance with the manufacturer’s recommendations, and shall be checked for proper function before and after each use; and

(h)(3)(i)(C)
Emergency escape-only respirators shall be inspected before being carried into the workplace for use.

(h)(3)(ii)
The employer shall ensure that respirator inspections include the following:

(h)(3)(ii)(A)
A check of respirator function, tightness of connections, and the condition of the various parts including, but not limited to, the facepiece, head straps, valves, connecting tube, and cartridges, canisters or filters; and

(h)(3)(ii)(B)
A check of elastomeric parts for pliability and signs of deterioration.

(h)(3)(iii)
In addition to the requirements of paragraphs (h)(3)(i) and (ii) of this section, self-contained breathing apparatus shall be inspected monthly. Air and oxygen cylinders shall be maintained in a fully charged state and shall be recharged when the pressure falls to 90% of the manufacturer’s recommended pressure level. The employer shall determine that the regulator and warning devices function properly.
(h)(3)(iv)
For respirators maintained for emergency use, the employer shall:

(h)(3)(iv)(A)
Certify the respirator by documenting the date the inspection was performed, the name (or signature) of the person who made the inspection, the findings, required remedial action, and a serial number or other means of identifying the inspected respirator; and

(B) Provide this information on a tag or label that is attached to the storage compartment for the respirator, is kept with the respirator, or is included in inspection reports stored as paper or electronic files. This information shall be maintained until replaced following a subsequent certification.

(h)(4)
Repairs. The employer shall ensure that respirators that fail an inspection or are otherwise found to be defective are removed from service, and are discarded or repaired or adjusted in accordance with the following procedures:

(h)(4)(i)
Repairs or adjustments to respirators are to be made only by persons appropriately trained to perform such operations and shall use only the respirator manufacturer’s NIOSH-approved parts designed for the respirator;

(h)(4)(ii)
Repairs shall be made according to the manufacturer’s recommendations and specifications for the type and extent of repairs to be performed; and

(h)(4)(iii)
Reducing and admission valves, regulators, and alarms shall be adjusted or repaired only by the manufacturer or a technician trained by the manufacturer.

(i)
Breathing air quality and use. This paragraph requires the employer to provide employees using atmosphere-supplying respirators (supplied-air and SCBA) with breathing gases of high purity.

(i)(1)
The employer shall ensure that compressed air, compressed oxygen, liquid air, and liquid oxygen used for respiration accords with the following specifications:

(i)(1)(i)
Compressed and liquid oxygen shall meet the United States Pharmacopoeia requirements for medical or breathing oxygen; and

1910.134(i)(1)(ii)
(i)(1)(ii)
Compressed breathing air shall meet at least the requirements for Grade D breathing air described in ANSI/Compressed Gas Association Commodity Specification for Air, G-7.1-1989, to include:

(i)(1)(ii)(A)
Oxygen content (v/v) of 19.5-23.5%;

(i)(1)(ii)(B)
Hydrocarbon (condensed) content of 5 milligrams per cubic meter of air or less;

(i)(1)(ii)(C)
Carbon monoxide (CO) content of 10 ppm or less;
(i)(1)(ii)(D) Carbon dioxide content of 1,000 ppm or less; and


(i)(2) The employer shall ensure that compressed oxygen is not used in atmosphere-supplying respirators that have previously used compressed air.

(i)(3) The employer shall ensure that oxygen concentrations greater than 23.5% are used only in equipment designed for oxygen service or distribution.

(i)(4) The employer shall ensure that cylinders used to supply breathing air to respirators meet the following requirements:

(i)(4)(i) Cylinders are tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR part 173 and part 178);

(i)(4)(ii) Cylinders of purchased breathing air have a certificate of analysis from the supplier that the breathing air meets the requirements for Grade D breathing air; and

(i)(4)(iii) The moisture content in the cylinder does not exceed a dew point of -50 deg.F (-45.6 deg.C) at 1 atmosphere pressure.

(i)(5) The employer shall ensure that compressors used to supply breathing air to respirators are constructed and situated so as to:

(i)(5)(i) Prevent entry of contaminated air into the air-supply system;

(i)(5)(ii) Minimize moisture content so that the dew point at 1 atmosphere pressure is 10 degrees F (5.56 deg.C) below the ambient temperature;

(i)(5)(iii) Have suitable in-line air-purifying sorbent beds and filters to further ensure breathing air quality. Sorbent beds and filters shall be maintained and replaced or refurbished periodically following the manufacturer’s instructions.

(i)(5)(iv) Have a tag containing the most recent change date and the signature of the person authorized by the employer to perform the change. The tag shall be maintained at the compressor.

(i)(6) For compressors that are not oil-lubricated, the employer shall ensure that carbon monoxide levels in the breathing air do not exceed 10 ppm.
(i)(7) For oil-lubricated compressors, the employer shall use a high-temperature or carbon monoxide alarm, or both, to monitor carbon monoxide levels. If only high-temperature alarms are used, the air supply shall be monitored at intervals sufficient to prevent carbon monoxide in the breathing air from exceeding 10 ppm.

(i)(8) The employer shall ensure that breathing air couplings are incompatible with outlets for nonrespirable worksite air or other gas systems. No asphyxiating substance shall be introduced into breathing air lines.

(i)(9) The employer shall use breathing gas containers marked in accordance with the NIOSH respirator certification standard, 42 CFR part 84.

(j) Identification of filters, cartridges, and canisters. The employer shall ensure that all filters, cartridges and canisters used in the workplace are labeled and color coded with the NIOSH approval label and that the label is not removed and remains legible.

(k) Training and information. This paragraph requires the employer to provide effective training to employees who are required to use respirators. The training must be comprehensive, understandable, and recur annually, and more often if necessary. This paragraph also requires the employer to provide the basic information on respirators in Appendix D of this section to employees who wear respirators when not required by this section or by the employer to do so.

(k)(1) The employer shall ensure that each employee can demonstrate knowledge of at least the following:

1910.134(k)(1)(i) Why the respirator is necessary and how improper fit, usage, or maintenance can compromise the protective effect of the respirator;

(k)(1)(ii) What the limitations and capabilities of the respirator are;

(k)(1)(iii) How to use the respirator effectively in emergency situations, including situations in which the respirator malfunctions;

(k)(1)(iv) How to inspect, put on and remove, use, and check the seals of the respirator;

(k)(1)(v) What the procedures are for maintenance and storage of the respirator;

(k)(1)(vi) How to recognize medical signs and symptoms that may limit or prevent the effective use of respirators; and

(k)(1)(vii) The general requirements of this section.

(k)(2) The training shall be conducted in a manner that is understandable to the employee.
(k)(3)
The employer shall provide the training prior to requiring the employee to use a respirator in the workplace.

(k)(4)
An employer who is able to demonstrate that a new employee has received training within the last 12 months that addresses the elements specified in paragraph (k)(1)(i) through (vii) is not required to repeat such training provided that, as required by paragraph (k)(1), the employee can demonstrate knowledge of those element(s). Previous training not repeated initially by the employer must be provided no later than 12 months from the date of the previous training.

(k)(5)
Retraining shall be administered annually, and when the following situations occur:

(k)(5)(i)
Changes in the workplace or the type of respirator render previous training obsolete;

(k)(5)(ii)
Inadequacies in the employee’s knowledge or use of the respirator indicate that the employee has not retained the requisite understanding or skill; or

(k)(5)(iii)
Any other situation arises in which retraining appears necessary to ensure safe respirator use.

(k)(6)
The basic advisory information on respirators, as presented in Appendix D of this section, shall be provided by the employer in any written or oral format, to employees who wear respirators when such use is not required by this section or by the employer.

(l)
Program evaluation. This section requires the employer to conduct evaluations of the workplace to ensure that the written respiratory protection program is being properly implemented, and to consult employees to ensure that they are using the respirators properly.

(l)(1)
The employer shall conduct evaluations of the workplace as necessary to ensure that the provisions of the current written program are being effectively implemented and that it continues to be effective.

(l)(2)
The employer shall regularly consult employees required to use respirators to assess the employees’ views on program effectiveness and to identify any problems. Any problems that are identified during this assessment shall be corrected. Factors to be assessed include, but are not limited to:

1910.134((l)(2)(i)
(l)(2)(i)
Respirator fit (including the ability to use the respirator without interfering with effective workplace performance);

(l)(2)(ii)
Appropriate respirator selection for the hazards to which the employee is exposed;

(l)(2)(iii)
Proper respirator use under the workplace conditions the employee encounters; and

(l)(2)(iv)
Proper respirator maintenance.
Recordkeeping. This section requires the employer to establish and retain written information regarding medical evaluations, fit testing, and the respirator program. This information will facilitate employee involvement in the respirator program, assist the employer in auditing the adequacy of the program, and provide a record for compliance determinations by OSHA.

1910.134(m)(1)
Medical evaluation. Records of medical evaluations required by this section must be retained and made available in accordance with 29 CFR 1910.1020.

(m)(2)
Fit testing.

(m)(2)(i)
The employer shall establish a record of the qualitative and quantitative fit tests administered to an employee including:

(m)(2)(i)(A)
The name or identification of the employee tested;

(m)(2)(i)(B)
The type of fit test performed;

(m)(2)(i)(C)
Specific make, model, style, and size of respirator tested;

(m)(2)(i)(D)
The date of test; and

(m)(2)(i)(E)
The pass/fail results for QLFTs or the fit factor and strip chart recording or other recording of the test results for QNFTs.

(m)(2)(ii)
Fit test records shall be retained for respirator users until the next fit test is administered.

(m)(3)
A written copy of the current respirator program shall be retained by the employer.

(m)(4)
Written materials required to be retained under this paragraph shall be made available upon request to affected employees and to the Assistant Secretary or designee for examination and copying.

(n)
Dates.

(n)(1)
Effective date. This section is effective April 8, 1998. The obligations imposed by this section commence on the effective date unless otherwise noted in this paragraph. Compliance with obligations that do not commence on the effective date shall occur no later than the applicable start-up date.
(n)(2) Compliance dates. All obligations of this section commence on the effective date except as follows:

1910.134(n)(2)(i) Compliance with provisions of this section for all other provisions shall be completed no later than October 5, 1998.

(n)(2)(ii) The determination that respirator use is required (paragraph (a)) shall be completed no later than September 8, 1998.


(n)(4) Existing Respiratory Protection Programs. If, in the 12 month period preceding April 8, 1998, the employer has conducted annual respirator training, fit testing, respirator program evaluation, or medical evaluations, the employer may use the results of those activities to comply with the corresponding provisions of this section, providing that these activities were conducted in a manner that meets the requirements of this section.

1910.134(o) Appendices.

(o)(1) Compliance with Appendix A, Appendix B-1, Appendix B-2, and Appendix C of this section is mandatory.

(o)(2) Appendix D of this section is non-mandatory and is not intended to create any additional obligations not otherwise imposed or to detract from any existing obligations.

[63 FR 1152, Jan. 8, 1998; 63 FR 20098, April 23, 1998]
APPENDICES TO Sec. 1910.120—HAZARDOUS WASTE OPERATIONS AND EMERGENCY RESPONSE

Note: The following appendices serve as non-mandatory guidelines to assist employees and employers in complying with the appropriate requirements of this section. However paragraph 1910.120(g) makes mandatory in certain circumstances the use of Level A and Level B PPE protection.

Appendix A to Sec. 1910.120—Personal Protective Equipment Test Methods

This appendix sets forth the non-mandatory examples of tests which may be used to evaluate compliance with Sec. 1910.120(g)(4) (ii) and (iii). Other tests and other challenge agents may be used to evaluate compliance.

A. Totally-encapsulating chemical protective suit pressure test

1.0—Scope

1.1 This practice measures the ability of a gas tight totally-encapsulating chemical protective suit material, seams, and closures to maintain a fixed positive pressure. The results of this practice allow the gas tight integrity of a totally-encapsulating chemical protective suit to be evaluated.

1.2 Resistance of the suit materials to permeation, penetration, and degradation by specific hazardous substances is not determined by this test method.

2.0—Definition of terms

2.1 Totally-encapsulating chemical protective suit (TECP suit) means a full body garment which is constructed of protective clothing materials; covers the wearer’s torso, head, arms, legs and respirator; may cover the wearer’s hands and feet with tightly attached gloves and boots; completely encloses the wearer and respirator by itself or in combination with the wearer’s gloves and boots.

2.2 Protective clothing material means any material or combination of materials used in an item of clothing for the purpose of isolating parts of the body from direct contact with a potentially hazardous liquid or gaseous chemicals.

2.3 Gas tight means, for the purpose of this test method, the limited flow of a gas under pressure from the inside of a TECP suit to atmosphere at a prescribed pressure and time interval.

3.0—Summary of test method

3.1 The TECP suit is visually inspected and modified for the test. The test apparatus is attached to the suit to permit inflation to the pre-test suit expansion pressure for removal of suit wrinkles and creases. The pressure is lowered to the test pressure and monitored for three minutes. If the pressure drop is excessive, the TECP suit fails the test and is removed from service. The test is repeated after leak location and repair.

4.0—Required Supplies

4.1 Source of compressed air.

4.2 Test apparatus for suit testing, including a pressure measurement device with a sensitivity of at least \1/4\ inch water gauge.

4.3 Vent valve closure plugs or sealing tape.

4.4 Soapy water solution and soft brush.

4.5 Stop watch or appropriate timing device.

5.0—Safety Precautions

5.1 Care shall be taken to provide the correct pressure safety devices required for the source of compressed air used.

6.0—Test Procedure

6.1 Prior to each test, the tester shall perform a visual inspection of the suit. Check the suit for seam integrity by visually examining the seams and gently pulling on the seams. Ensure that all air supply lines, fittings, visor, zippers, and valves are secure and show no signs of deterioration.

6.1.1 Seal off the vent valves along with any other normal inlet or exhaust points (such as umbilical air line
fittings or face piece opening) with tape or other appropriate means (caps, plugs, fixture, etc.). Care should be exercised in the sealing process not to damage any of the suit components.

6.1.2 Close all closure assemblies.

6.1.3 Prepare the suit for inflation by providing an improvised connection point on the suit for connecting an airline. Attach the pressure test apparatus to the suit to permit suit inflation from a compressed air source equipped with a pressure indicating regulator. The leak tightness of the pressure test apparatus should be tested before and after each test by closing off the end of the tubing attached to the suit and assuring a pressure of three inches water gauge for three minutes can be maintained. If a component is removed for the test, that component shall be replaced and a second test conducted with another component removed to permit a complete test of the ensemble.

6.1.4 The pre-test expansion pressure (A) and the suit test pressure (B) shall be supplied by the suit manufacturer, but in no case shall they be less than: (A)=three inches water gauge; and (B)=two inches water gauge. The ending suit pressure (C) shall be no less than 80 percent of the test pressure (B); i.e., the pressure drop shall not exceed 20 percent of the test pressure (B).

6.1.5 Inflate the suit until the pressure inside is equal to pressure (A), the pre-test expansion suit pressure. Allow at least one minute to fill out the wrinkles in the suit. Release sufficient air to reduce the suit pressure to pressure (B), the suit test pressure. Begin timing. At the end of three minutes, record the suit pressure as pressure (C), the ending suit pressure. The difference between the suit test pressure and the ending suit test pressure (B-C) shall be defined as the suit pressure drop.

6.1.6 If the suit pressure drop is more than 20 percent of the suit test pressure (B) during the three-minute test period, the suit fails the test and shall be removed from service.

7.0—Retest Procedure

7.1 If the suit fails the test check for leaks by inflating the suit to pressure (A) and brushing or wiping the entire suit (including seams, closures, lens gaskets, glove-to-sleeve joints, etc.) with a mild soap and water solution. Observe the suit for the formation of soap bubbles, which is an indication of a leak. Repair all identified leaks.

7.2 Retest the TECP suit as outlined in Test procedure 6.0.

8.0—Report

8.1 Each TECP suit tested by this practice shall have the following information recorded:

8.1.1 Unique identification number, identifying brand name, date of purchase, material of construction, and unique fit features, e.g., special breathing apparatus.

8.1.2 The actual values for test pressures (A), (B), and (C) shall be recorded along with the specific observation times. If the ending pressure (C) is less than 80 percent of the test pressure (B), the suit shall be identified as failing the test. When possible, the specific leak location shall be identified in the test records. Retest pressure data shall be recorded as an additional test.

8.1.3 The source of the test apparatus used shall be identified and the sensitivity of the pressure gauge shall be recorded.

8.1.4 Records shall be kept for each pressure test even if repairs are being made at the test location.

Caution

Visually inspect all parts of the suit to be sure they are positioned correctly and secured tightly before putting the suit back into service. Special care should be taken to examine each exhaust valve to make sure it is not blocked.

Care should also be exercised to assure that the inside and outside of the suit is completely dry before it is put into storage.

B. Totally-encapsulating chemical protective suit qualitative leak test

1.0—Scope

1.1 This practice semi-qualitatively tests gas tight totally-encapsulating chemical protective suit integrity by detecting inward leakage of ammonia vapor. Since no modifications are made to the suit to carry out this test, the results from this practice provide a realistic test for the integrity of the entire suit.
1.2 Resistance of the suit materials to permeation, penetration, and degradation is not determined by this test method. ASTM test methods are available to test suit materials for these characteristics and the tests are usually conducted by the manufacturers of the suits.

2.0—Definition of terms

2.1 Totally-encapsulated chemical protective suit (TECP suit) means a full body garment which is constructed of protective clothing materials; covers the wearer’s torso, head, arms, legs and respirator; may cover the wearer’s hands and feet with tightly attached gloves and boots; completely encloses the wearer and respirator by itself or in combination with the wearer’s gloves, and boots.

2.2 Protective clothing material means any material or combination of materials used in an item of clothing for the purpose of isolating parts of the body from direct contact with a potentially hazardous liquid or gaseous chemicals.

2.3 Gas tight means, for the purpose of this test method, the limited flow of a gas under pressure from the inside of a TECP suit to atmosphere at a prescribed pressure and time interval.

2.4 Intrusion Coefficient means a number expressing the level of protection provided by a gas tight totally-encapsulating chemical protective suit. The intrusion coefficient is calculated by dividing the test room challenge agent concentration by the concentration of challenge agent found inside the suit. The accuracy of the intrusion coefficient is dependent on the challenge agent monitoring methods. The larger the intrusion coefficient the greater the protection provided by the TECP suit.

3.0—Summary of recommended practice

3.1 The volume of concentrated aqueous ammonia solution (ammonia hydroxide NH₄OH) required to generate the test atmosphere is determined using the directions outlined in 6.1. The suit is donned by a person wearing the appropriate respiratory equipment (either a positive pressure self-contained breathing apparatus or a positive pressure supplied air respirator) and worn inside the enclosed test room. The concentrated aqueous ammonia solution is taken by the suited individual into the test room and poured into an open plastic pan. A two-minute evaporation period is observed before the test room concentration is measured, using a high range ammonia length of stain detector tube. When the ammonia vapor reaches a concentration of between 1000 and 1200 ppm, the suited individual starts a standardized exercise protocol to stress and flex the suit. After this protocol is completed, the test room concentration is measured again. The suited individual exits the test room and his stand-by person measures the ammonia concentration inside the suit using a low range ammonia length of stain detector tube or other more sensitive ammonia detector. A stand-by person is required to observe the test individual during the test procedure; aid the person in donning and doffing the TECP suit; and monitor the suit interior. The intrusion coefficient of the suit can be calculated by dividing the average test area concentration by the interior suit concentration. A colorimetric ammonia indicator strip of bromophenol blue or equivalent is placed on the inside of the suit face piece lens so that the suited individual is able to detect a color change and know if the suit has a significant leak. If a color change is observed the individual shall leave the test room immediately.

4.0—Required supplies

4.1 A supply of concentrated aqueous ammonium hydroxide (58% by weight).

4.2 A supply of bromophenol/blue indicating paper or equivalent, sensitive to 5-10 ppm ammonia or greater over a two-minute period of exposure, [pH 3.0 (yellow) to pH 4.6 (blue)]

4.3 A supply of high range (0.5-10 volume percent) and low range (5-700 ppm) detector tubes for ammonia and the corresponding sampling pump. More sensitive ammonia detectors can be substituted for the low range detector tubes to improve the sensitivity of this practice.

4.4 A shallow plastic pan (PVC) at least 12<sup>1/2</sup> and a half pint plastic container (PVC) with tightly closing lid.

4.5 A graduated cylinder or other volumetric measuring device of at least 50 milliliters in volume with an accuracy of at least plus-minus 1 milliliters.

5.0—Safety precautions

5.1 Concentrated aqueous ammonium hydroxide, NH₄OH, is a corrosive volatile liquid requiring eye, skin, and respiratory protection. The person conducting the test shall review the MSDS for aqueous ammonia.

5.2 Since the established permissible exposure limit for ammonia is 35 ppm as a 15 minute STEL, only persons wearing a positive pressure self-contained breathing apparatus or a positive pressure supplied air respirator shall be in the chamber. Normally only the person wearing the totally-encapsulating suit will be inside the chamber. A stand-by person shall have a positive pressure self-contained breathing apparatus, or a positive pressure supplied air respirator available to enter the test area should the suited individual need assistance.
5.3 A method to monitor the suited individual must be used during this test. Visual contact is the simplest but other methods using communication devices are acceptable.

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5.4 The test room shall be large enough to allow the exercise protocol to be carried out and then to be ventilated to allow for easy exhaust of the ammonia test atmosphere after the test(s) are completed.

5.5 Individuals shall be medically screened for the use of respiratory protection and checked for allergies to ammonia before participating in this test procedure.

6.0—Test procedure

6.1.1 Measure the test area to the nearest foot and calculate its volume in cubic feet. Multiply the test area volume by 0.2 milliliters of concentrated aqueous ammonia solution per cubic foot of test area volume to determine the approximate volume of concentrated aqueous ammonia required to generate 1000 ppm in the test area.

6.1.2 Measure this volume from the supply of concentrated aqueous ammonia and place it into a closed plastic container.

6.1.3 Place the container, several high range ammonia detector tubes, and the pump in the clean test pan and locate it near the test area entry door so that the suited individual has easy access to these supplies.

6.2.1 In a non-contaminated atmosphere, open a pre-sealed ammonia indicator strip and fasten one end of the strip to the inside of the suit face shield lens where it can be seen by the wearer. Moisten the indicator strip with distilled water. Care shall be taken not to contaminate the detector part of the indicator paper by touching it. A small piece of masking tape or equivalent should be used to attach the indicator strip to the interior of the suit face shield.

6.2.2 If problems are encountered with this method of attachment, the indicator strip can be attached to the outside of the respirator face piece lens being used during the test.

6.3 Don the respiratory protective device normally used with the suit, and then don the TECP suit to be tested. Check to be sure all openings which are intended to be sealed (zippers, gloves, etc.) are completely sealed. DO NOT, however, plug off any venting valves.

6.4 Step into the enclosed test room such as a closet, bathroom, or test booth, equipped with an exhaust fan. No air should be exhausted from the chamber during the test because this will dilute the ammonia challenge concentrations.

6.5 Open the container with the pre-measured volume of concentrated aqueous ammonia within the enclosed test room, and pour the liquid into the empty plastic test pan. Wait two minutes to allow for adequate volatilization of the concentrated aqueous ammonia. A small mixing fan can be used near the evaporation pan to increase the evaporation rate of the ammonia solution.

6.6 After two minutes a determination of the ammonia concentration within the chamber should be made using the high range colorimetric detector tube. A concentration of 1000 ppm ammonia or greater shall be generated before the exercises are started.

6.7 To test the integrity of the suit the following four minute exercise protocol should be followed:

6.7.1 Raising the arms above the head with at least 15 raising motions completed in one minute.

6.7.2 Walking in place for one minute with at least 15 raising motions of each leg in a one-minute period.

6.7.3 Touching the toes with at least 10 complete motions of the arms from above the head to touching of the toes in a one-minute period.

6.7.4 Knee bends with at least 10 complete standing and squatting motions in a one-minute period.

6.8 If at any time during the test the colorimetric indicating paper should change colors, the test should be stopped and section 6.10 and 6.12 initiated (See para.4.2).

6.9 After completion of the test exercise, the test area concentration should be measured again using the high range colorimetric detector tube.

6.10 Exit the test area.

6.11 The opening created by the suit zipper or other appropriate suit penetration should be used to determine the ammonia concentration in the suit with the low range length of stain detector tube or other ammonia monitor. The internal TECP suit air should be sampled far enough from the enclosed test area to prevent a false ammonia reading.

6.12 After completion of the measurement of the suit interior ammonia concentration the test is concluded and the suit is doffed and the respirator removed.

6.13 The ventilating fan for the test room should be turned on and allowed to run for enough time to remove the
ammonia gas. The fan shall be vented to the outside of the building.

6.14 Any detectable ammonia in the suit interior (five ppm ammonia (NH₃) or more for the length of stain detector tube) indicates that the suit has failed the test. When other ammonia detectors are used a lower level of detection is possible, and it should be specified as the pass/fail criteria.

6.15 By following this test method, an intrusion coefficient of approximately 200 or more can be measured with the suit in a completely operational condition. If the intrusion coefficient is 200 or more, then the suit is suitable for emergency response and field use.

7.0—Retest procedures

7.1 If the suit fails this test, check for leaks by following the pressure test in test A above.

7.2 Retest the TECP suit as outlined in the test procedure 6.0.

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8.0—Report

8.1 Each gas tight totally-encapsulating chemical protective suit tested by this practice shall have the following information recorded.

8.1.1 Unique identification number, identifying brand name, date of purchase, material of construction, and unique suit features; e.g., special breathing apparatus.

8.1.2 General description of test room used for test.

8.1.3 Brand name and purchase date of ammonia detector strips and color change data.

8.1.4 Brand name, sampling range, and expiration date of the length of stain ammonia detector tubes. The brand name and model of the sampling pump should also be recorded. If another type of ammonia detector is used, it should be identified along with its minimum detection limit for ammonia.

8.1.5 Actual test results shall list the two test area concentrations, their average, the interior suit concentration, and the calculated intrusion coefficient. Retest data shall be recorded as an additional test.

8.2 The evaluation of the data shall be specified as “suit passed” or “suit failed,” and the date of the test. Any detectable ammonia (five ppm or greater for the length of stain detector tube) in the suit interior indicates the suit has failed this test. When other ammonia detectors are used, a lower level of detection is possible and it should be specified as the pass/fail criteria.

Caution

Visually inspect all parts of the suit to be sure they are positioned correctly and secured tightly before putting the suit back into service. Special care should be taken to examine each exhaust valve to make sure it is not blocked.

Care should also be exercised to assure that the inside and outside of the suit is completely dry before it is put into storage.

Appendix B to Sec. 1910.120—

General Description and Discussion of the Levels of Protection and Protective Gear

This appendix sets forth information about personal protective equipment (PPE) protection levels which may be used to assist employers in complying with the PPE requirements of this section. As required by the standard, PPE must be selected which will protect employees from the specific hazards which they are likely to encounter during their work on-site. Selection of the appropriate PPE is a complex process which should take into consideration a variety of factors. Key factors involved in this process are identification of the hazards, or suspected hazards; their routes of potential hazard to employees (inhalation, skin absorption, ingestion, and eye or skin contact); and the performance of the PPE materials (and seams) in providing a barrier to these hazards. The amount of protection provided by PPE is material-hazard specific. That is, protective equipment materials will protect well against some hazardous substances and poorly, or not at all, against others. In many instances, protective equipment materials cannot be found which will provide continuous protection from the particular hazardous substance. In these cases the breakthrough time of the protective material should exceed the work durations.
Other factors in this selection process to be considered are matching the PPE to the employee’s work requirements and task-specific conditions. The durability of PPE materials, such as tear strength and seam strength, should be considered in relation to the employee’s tasks. The effects of PPE in relation to heat stress and task duration are a factor in selecting and using PPE. In some cases layers of PPE may be necessary to provide sufficient protection, or to protect expensive PPE inner garments, suits or equipment. The more that is known about the hazards at the site, the easier the job of PPE selection becomes. As more information about the hazards and conditions at the site becomes available, the site supervisor can make decisions to up-grade or down-grade the level of PPE protection to match the tasks at hand.

The following are guidelines which an employer can use to begin the selection of the appropriate PPE. As noted above, the site information may suggest the use of combinations of PPE selected from the different protection levels (i.e., A, B, C, or D) as being more suitable to the hazards of the work. It should be cautioned that the listing below does not fully address the performance of the specific PPE material in relation to the specific hazards at the job site, and that PPE selection, evaluation and re-selection is an ongoing process until sufficient information about the hazards and PPE performance is obtained.

Part A. Personal protective equipment is divided into four categories based on the degree of protection afforded. (See Part B of this appendix for further explanation of Levels A, B, C, and D hazards.)

I. Level A—To be selected when the greatest level of skin, respiratory, and eye protection is required.

The following constitute Level A equipment; it may be used as appropriate;

1. Positive pressure, full face-piece self-contained breathing apparatus (SCBA), or positive pressure supplied air escape SCBA, approved by the National Institute for Occupational Safety and Health (NIOSH).
2. Totally-encapsulating chemical-protective suit.
3. Coveralls.
4. Long underwear.
5. Gloves, outer, chemical-resistant.
7. Boots, chemical-resistant, steel toe and shank.
9. Disposable protective suit, gloves and boots (depending on suit construction, may be worn over totally-encapsulating suit).

II. Level B—The highest level of respiratory protection is necessary but a lesser level of skin protection is needed.

The following constitute Level B equipment; it may be used as appropriate.

1. Positive pressure, full-facepiece self-contained breathing apparatus (SCBA), or positive pressure supplied air respirator with escape SCBA (NIOSH approved).
2. Hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls.
4. Gloves, outer, chemical-resistant.
5. Gloves, inner, chemical-resistant.
6. Boots, outer, chemical-resistant steel toe and shank.
9. [Reserved]
10. Face shield.

III. Level C—The concentration(s) and type(s) of airborne substance(s) is known and the criteria for using air purifying respirators are met.

The following constitute Level C equipment; it may be used as appropriate.

1. Full-face or half-mask, air purifying respirators (NIOSH approved).
2. Hooded chemical-resistant clothing (overalls; two-piece chemical-splash suit; disposable chemical-resistant overalls).
3. Coveralls.
Optional, as applicable.

4. Gloves, outer, chemical-resistant.
5. Gloves, inner, chemical-resistant.
6. Boots (outer), chemical-resistant steel toe and shank.
10. Face shield.

IV. Level D—A work uniform affording minimal protection, used for nuisance contamination only.
The following constitute Level D equipment; it may be used as appropriate:
1. Coveralls.
2. Gloves.
3. Boots/shoes, chemical-resistant steel toe and shank.
4. Boots, outer, chemical-resistant (disposable).
5. Safety glasses or chemical splash goggles*.
7. Escape mask.
8. Face shield.

Part B. The types of hazards for which levels A, B, C, and D protection are appropriate are described below:
I. Level A—Level A protection should be used when:
1. 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 of atmospheric vapors, gases, or particulates; or the site operations and work functions involve a high potential for splash, immersion, or exposure to unexpected vapors, gases, or particulates of materials that are harmful to skin or capable of being absorbed through the skin;
2. Substances with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible; or
3. Operations are being conducted in confined, poorly ventilated areas, and the absence of conditions requiring Level A have not yet been determined.
II. Level B—Level B protection should be used when:
1. The type and atmospheric concentration of substances have been identified and require a high level of respiratory protection, but less skin protection;
2. The atmosphere contains less than 19.5 percent oxygen; or
3. 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.

Note: This involves atmospheres with IDLH concentrations of specific substances that present severe inhalation hazards and that do not represent a severe skin hazard; or that do not meet the criteria for use of air-purifying respirators.

III. Level C—Level C protection should be used when:
1. The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect or be absorbed through any exposed skin;
2. The types of air contaminants have been identified, concentrations measured, and an air-purifying respirator is available that can remove the contaminants; and

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3. All criteria for the use of air-purifying respirators are met.
IV. Level D—Level D protection should be used when:
   1. The atmosphere contains no known hazard; and
   2. Work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

Note: As stated before, combinations of personal protective equipment other than those described for Levels A, B, C, and D protection may be more appropriate and may be used to provide the proper level of protection.

As an aid in selecting suitable chemical protective clothing, it should be noted that the National Fire Protection Association (NFPA) has developed standards on chemical protective clothing. The standards that have been adopted by include:

These standards apply documentation and performance requirements to the manufacture of chemical protective suits. Chemical protective suits meeting these requirements are labelled as compliant with the appropriate standard. It is recommended that chemical protective suits that meet these standards be used.[Code of Federal Regulations] [Title 29, Volume 5, Parts 1900 to 1910.999][Revised as of July 1, 1998] From the U.S. Government Printing Office via GPO Access [CITE: 29CFR1910.120]
(g) Engineering controls, work practices, and personal protective equipment for employee protection. Engineering controls, work practices, personal protective equipment, or a combination of these shall be implemented in accordance with this paragraph to protect employees from exposure to hazardous substances and safety and health hazards.

(1) Engineering controls, work practices and PPE for substances regulated in subparts G and Z. (i) Engineering controls and work practices shall be instituted to reduce and maintain employee exposure to or below the permissible exposure limits for substances regulated by 29 CFR part 1910, to the extent required by subpart Z, except to the extent that such controls and practices are not feasible.

Note to (g)(1)(i): Engineering controls which may be feasible include the use of pressurized cabs or control booths on equipment, and/or the use of remotely operated material handling equipment. Work practices which may be feasible are removing all non-essential employees from potential exposure during opening of drums, wetting down dusty operations and locating employees upwind of possible hazards.

(ii) Whenever engineering controls and work practices are not feasible or not required, any reasonable combination of engineering controls, work practices and PPE shall be used to reduce and maintain employee exposures to or below the permissible exposure limits or dose limits for substances regulated by 29 CFR part 1910, subpart Z.

(iii) The employer shall not implement a schedule of employee rotation as a means of compliance with permissible exposure limits or dose limits except when there is no other feasible way of complying with the airborne or dermal dose limits for ionizing radiation.

(iv) The provisions of 29 CFR, subpart G, shall be followed.

(2) Engineering controls, work practices, and PPE for substances not regulated in subparts G and Z. An appropriate combination of engineering controls, work practices and personal protective equipment shall be used to reduce and maintain employee exposure to or below published exposure levels for hazardous substances and health hazards not regulated by 29 CFR part 1910, subparts G and Z. The employer may use the published literature and MSDS as a guide in making the employer's determination as to what level of protection the employer believes is appropriate for hazardous substances and health hazards for which there is no permissible exposure limit or published exposure limit.

(3) Personal protective equipment selection. (i) Personal protective equipment (PPE) shall be selected and used which will protect employees from the hazards and potential hazards they are likely to encounter as identified during the site characterization and analysis.

(ii) Personal protective equipment selection shall be based on an evaluation of the performance characteristics of the PPE relative to the requirements and limitations of the site, the task-specific conditions and duration, and the hazards and potential hazards identified at the site.

(iii) Positive pressure self-contained breathing apparatus, or positive pressure air-line respirators equipped with an escape air supply, shall be used when chemical exposure levels present will create a substantial possibility of immediate death, immediate serious illness or injury, or impair the ability to escape.

(iv) Totally-encapsulating chemical protective suits (protection equivalent to Level A protection as recommended in appendix B) shall be used in conditions where skin absorption of a hazardous substance may result in a substantial possibility of immediate death, immediate serious illness or injury, or impair the ability to escape.

(v) The level of protection provided by PPE selection shall be increased when additional information on site conditions indicates that increased protection is necessary to reduce employee exposures below permissible exposure limits and published exposure levels for hazardous substances and health hazards. (See appendix B for guidance on selecting PPE ensembles.)

Note to (g)(3): The level of employee protection provided may be decreased when additional information or site conditions show that decreased protection will not result in hazardous exposures to employees.

(vi) Personal protective equipment shall be selected and used to meet the requirements of 29 CFR part 1910,
subpart I, and additional requirements specified in this section. 

(4) Totally-encapsulating chemical protective suits. (i) Totally-encapsulating suits shall protect employees from the particular hazards which are identified during site characterization and analysis.

(ii) Totally-encapsulating suits shall be capable of maintaining positive air pressure. (See appendix A for a test method which may be used to evaluate this requirement.)

(iii) Totally-encapsulating suits shall be capable of preventing inward test gas leakage of more than 0.5 percent. (See appendix A for a test method which may be used to evaluate this requirement.)

(5) Personal protective equipment (PPE) program. A written personal protective equipment program, which is part of the employer's safety and health program required in paragraph (b) of this section or required in paragraph (p)(1) of this section and which is also a part of the site-specific safety and health plan shall be established. The PPE program shall address the elements listed below. When elements, such as donning and doffing procedures, are provided by the manufacturer of a piece of equipment and are attached to the plan, they need not be rewritten into the plan as long as they adequately address the procedure or element.

(i) PPE selection based upon site hazards,

(ii) PPE use and limitations of the equipment,

(iii) Work mission duration,

(iv) PPE maintenance and storage,

(v) PPE decontamination and disposal,

(vi) PPE training and proper fitting,

(vii) PPE donning and doffing procedures,

(viii) PPE inspection procedures prior to, during, and after use,

(ix) Evaluation of the effectiveness of the PPE program, and

(x) Limitations during temperature extremes, heat stress, and other appropriate medical considerations.
Appendix E

Two In / Two Out
United States Department of Labor  
Occupational Safety and Health Administration  
Fire Fighters’ Two In/Two Out Regulation

The federal Occupational Safety and Health Administration (OSHA) recently issued a revised standard regarding respiratory protection. Among other changes, the regulation now requires that interior structural fire fighting procedures provide for at least two fire fighters inside the structure. Two fire fighters inside the structure must have direct visual or voice contact between each other and direct, voice or radio contact with fire fighters outside the structure. This section has been dubbed the fire fighters’ “two-in/two-out” regulation. The International Association of Fire Fighters and the International Association of Fire Chiefs are providing the following questions and answers to assist you in understanding the section of the regulation related to interior structural fire fighting.

1. **What is the federal OSHA Respiratory Protection Standard?**

In 1971, federal OSHA adopted a respiratory protection standard requiring employers to establish and maintain a respiratory protection program for their respirator-wearing employees. The revised standard strengthens some requirements and eliminates duplicative requirements in other OSHA health standards.

The standard specifically addresses the use of respirators in immediately dangerous to life or health (IDLH) atmospheres, including interior structural fire fighting. OSHA defines structures that are involved in fire beyond the incipient stage as IDLH atmospheres. In these atmospheres, OSHA requires that personnel use self-contained breathing apparatus (SCBA), that a minimum of two fire fighters work as a team inside the structure, and that a minimum of two fire fighters be on standby outside the structure to provide assistance or perform rescue.

2. **Why is this standard important to fire fighters?**

This standard, with its two-in/two-out provision, may be one of the most important safety advances for fire fighters in this decade. Too many fire fighters have died because of insufficient accountability and poor communications. The standard addresses both and leaves no doubt that two-in/two-out requirements must be followed for fire fighter safety and compliance with the law.

3. **Which fire fighters are covered by the regulations?**

The federal OSHA standard applies to all private sector workers engaged in fire fighting activities through industrial fire brigades, private incorporated fire companies (including the “employees” of incorporated volunteer companies and private fire departments contracting to public jurisdictions) and federal fire fighters. In 23 states and 2 territories, the state, not the federal government, has responsibility for enforcing worker health and safety regulations. These “state plan” states have earned the approval of federal OSHA to implement their own enforcement programs. These states must establish and maintain occupational safety and health programs for all public employees that are as effective as the programs for private sector employees. In addition, state safety and health regulations must be at least as stringent as federal OSHA regulations. Federal OSHA has no direct enforcement authority over state and local governments in states that do not have state OSHA plans.

All professional career fire fighters, whether state, county, or municipal, in any of the states or territories where an OSHA state plan agreement is in effect, have the protection of all federal OSHA health and safety standards, including the new respirator standard and its requirements for fire fighting operations. The following states have OSHA-approved plans and must enforce the two-in/two-out provision for all fire departments.
A number of other states have adopted, by reference, federal OSHA regulations for public employee fire fighters. These states include Florida, Illinois and Oklahoma. In these states, the regulations carry the force of state law.

Additionally, a number of states have adopted NFPA standards, including NFPA 1500, Standard for Fire Department Occupational Safety and Health Program. The 1997 edition of NFPA 1500 now includes requirements corresponding to OSHA’s respiratory protection regulation. Since the NFPA is a private consensus standards organization, its recommendations are preempted by OSHA regulations that are more stringent. In other words, the OSHA regulations are the minimum requirement where they are legally applicable. There is nothing in federal regulations that “deem compliance” with any consensus standards, including NFPA standards, if the consensus standards are less stringent.

It is unfortunate that all U.S. and Canadian fire fighters are not covered by the OSHA respiratory protection standard. However, we must consider the two-in/two-out requirements to be the minimum acceptable standard for safe fire ground operations for all fire fighters when self-contained breathing apparatus is used.

4. When are two-in/two-out procedures required for fire fighters?

OSHA states that “once fire fighters begin the interior attack on an interior structural fire, the atmosphere is assumed to be IDLH and paragraph 29 CFR 1910.134(g)(4) [two-in/two-out] applies.” OSHA defines interior structural fire fighting “as the physical activity of fire suppression, rescue or both inside of buildings or enclosed structures which are involved in a fire situation beyond the incipient stage.” OSHA further defines an incipient stage fire in 29 CFR 1910.155(c)(26) as a “fire which is in the initial or beginning stage and which can be controlled or extinguished by portable fire extinguishers, Class II standpipe or small hose systems without the need for protective clothing or breathing apparatus.” Any structural fire beyond incipient stage is considered to be an IDLH atmosphere by OSHA.

5. What respiratory protection is required for interior structural fire fighting?

OSHA requires that all fire fighters engaged in interior structural fire fighting must wear SCBAs. SCBAs must be NIOSH-certified, positive pressure, with a minimum duration of 30 minutes. [29 CFR 1910.156(f)(1)(ii)] and [29 CFR 1910.134(g)(4)(iii)]

6. Are all fire fighters performing interior structural fire fighting operations required to operate in a buddy system with two or more personnel?

Yes. OSHA clearly requires that all workers engaged in interior structural fire fighting operations beyond the incipient stage use SCBA and work in teams of two or more. [29 CFR 1910.134(g)(4)(i)]

7. Are fire fighters in the interior of the structure required to be in direct contact with one another?

Yes. Fire fighters operating in the interior of the structure must operate in a buddy system and maintain voice or visual contact with one another at all times. This assists in assuring accountability within the team. [29 CFR 1910.134(g)(4)(i)]

8. Can radios or other means of electronic contact be substituted for visual or voice contact, allowing fire fighters in an interior structural fire to separate from their “buddy” or “buddies”?

No. Due to the potential of mechanical failure or reception failure of electronic communication devices, radio contact is not acceptable to replace visual or voice contact between the members of the “buddy system” team. Also, the individual needing rescue may not be physically able to operate an electronic device to alert other members of the interior team that assistance is needed.
Radios can and should be used for communications on the fire ground, including communications between the interior fire fighter team(s) and exterior fire fighters. They cannot, however, be the sole tool for accounting for one's partner in the interior of a structural fire. [29 CFR 1910.134(g)(4)(i)] [29 CFR 1910.134(g)(3)(ii)]
9. Are fire fighters required to be present outside the structural fire prior to a team entering and during the team's work in the hazard area?

Yes. OSHA requires at least one team of two or more properly equipped and trained fire fighters be present outside the structure before any team(s) of fire fighters enter the structural fire. This requirement is intended to assure that the team outside the structure has the training, clothing and equipment to protect themselves and, if necessary, safely and effectively rescue fire fighters inside the structure. For high-rise operations, the team(s) would be staged below the IDLH atmosphere. [29 CFR 1910.134(g)(3)(iii)]

10. Do these regulations mean that, at a minimum, four individuals are required, that is, two individuals working as a team in the interior of the structural fire and two individuals outside the structure for assistance or rescue?

Yes. OSHA requires that a minimum of two individuals, operating as a team in direct voice or visual contact, conduct interior fire fighting operations utilizing SCBA. In addition, a minimum of two individuals who are properly equipped and trained must be positioned outside the IDLH atmosphere, account for the interior team(s) and remain capable of rapid rescue of the interior team. The outside personnel must at all times account for and be available to assist or rescue members of the interior team. [29 CFR 1910.134(g)(4)]

11. Does OSHA permit the two individuals outside the hazard area to be engaged in other activities, such as incident command or fire apparatus operation (for example, pump or aerial operators)?

OSHA requires that one of the two outside person's function is to account for and, if necessary, initiate a fire fighter rescue. Aside from this individual dedicated to tracking interior personnel, the other designated person(s) is permitted to take on other roles, such as incident commander in charge of the emergency incident, safety officer or equipment operator. However, the other designated outside person(s) cannot be assigned tasks that are critical to the safety and health of any other employee working at the incident.

Any task that the outside fire fighter(s) performs while in standby rescue status must not interfere with the responsibility to account for those individuals in the hazard area. Any task, evolution, duty, or function being performed by the standby individual(s) must be such that the work can be abandoned, without placing any employee at additional risk, if rescue or other assistance is needed. [29 CFR 1910.134(g)(4)(Note 1)]

12. If a rescue operation is necessary, must the buddy system be maintained while entering the interior structural fire?

Yes. Any entry into an interior structural fire beyond the incipient stage, regardless of the reason, must be made in teams of two or more individuals. [29 CFR 1910.134(g)(4)(i)]

13. Do the regulations require two individuals outside for each team of individuals operating in the interior of a structural fire?

The regulations do not require a separate “two-out” team for each team operating in the structure. However, if the incident escalates, if accountability cannot be properly maintained from a single exposure, or if rapid rescue becomes infeasible, additional outside crews must be added. For example, if the involved structure is large enough to require entry at different locations or levels, additional "two-out" teams would be required. [29 CFR 1910.134(g)(4)]

14. If four fire fighters are on the scene of an interior structural fire, is it permissible to enter the structure with a team of two?

OSHA's respiratory protection standard is not about counting heads. Rather, it dictates functions of fire fighters prior to an interior attack. The entry team must consist of at least two individuals. Of the two fire fighters outside, one must perform accountability functions and be immediately available for fire fighter rescue. As explained above, the other
may perform other tasks, as long as those tasks do not interfere with the accountability functions and can be abandoned to perform fire fighter rescue. Depending on the operating procedures of the fire department, more than four individuals may be required. [29 CFR 1910.134(g)(4)(i)]

15. Does OSHA recognize any exceptions to this regulation?

OSHA regulations recognize deviations to regulations in an emergency operation where immediate action is necessary to save a life. For fire department employers, initial attack operations must be organized to ensure that adequate personnel are at the emergency scene prior to any interior attack at a structural fire. If initial attack personnel find a known life-hazard situation where immediate action could prevent the loss of life, deviation from the two-in/two-out standard may be permitted, as an exception to the fire department’s organizational plan.

However, such deviations from the regulations must be exceptions and not defacto standard practices. In fact, OSHA may still issue “de minimis” citations for such deviations from the standard, meaning that the citation will not require monetary penalties or corrective action. The exception is for a known life rescue only, not for standard search and rescue activities. When the exception becomes the practice, OSHA citations are authorized. [29 CFR 1910.134(g)(4)(Note 2)]

16. Does OSHA require employer notification prior to any rescue by the outside personnel?

Yes. OSHA requires the fire department or fire department designee (i.e. incident commander) be notified prior to any rescue of fire fighters operating in an IDLH atmosphere. The fire department would have to provide any additional assistance appropriate to the emergency, including the notification of on-scene personnel and incoming units. Additionally, any such actions taken in accordance with the “exception” provision should be thoroughly investigated by the fire department with a written report submitted to the Fire Chief. [29 CFR 1910.134(g)(3)(iv)]

17. How do the regulations affect fire fighters entering a hazardous environment that is not an interior structural fire?

Fire fighters must adhere to the two-in/two-out regulations for other emergency response operations in any IDLH, potential IDLH, or unknown atmosphere. OSHA permits one standby person only in those IDLH environments in fixed workplaces, not fire emergency situations. Such sites, in normal operating conditions, contain only hazards that are known, well characterized, and well controlled. [29 CFR 1910.120(q)(3)(vi)]

18. When is the new regulation effective?

The revised OSHA respiratory protection standard was released by the Department of Labor and published in the Federal Register on January 8, 1998. It is effective on April 8, 1998.

"State Plan" states have six months from the release date to implement and enforce the new regulations.

Until the April 8 effective date, earlier requirements for two-in/two-out are in effect. The formal interpretation and compliance memo issued by James W. Stanley, Deputy Assistant Secretary of Labor, on May 1, 1995 and the compliance memo issued by Assistant Secretary of Labor Joe Dear on July 30, 1996 establish that OSHA interprets the earlier 1971 regulation as requiring two-in/two-out. [29 CFR 1910.134(n)(1)]

19. How does a fire department demonstrate compliance with the regulations?

Fire departments must develop and implement standard operating procedures addressing fire ground operations and the two-in/two-out procedures to demonstrate compliance. Fire department training programs must ensure that fire fighters understand and implement appropriate two-in/two-out procedures. [29 CFR 1910.134(c)]
20. What can be done if the fire department does not comply?

Federal OSHA and approved state plan states must “. . . assure so far as possible every working man and woman in the Nation safe and healthful working conditions.” To ensure such protection, federal OSHA and states with approved state plans are authorized to enforce safety and health standards. These agencies must investigate complaints and conduct inspections to make sure that specific standards are met and that the workplace is generally free from recognized hazards likely to cause death or serious physical harm.

Federal OSHA and state occupational safety and health agencies must investigate written complaints signed by current employees or their representatives regarding hazards that threaten serious physical harm to workers. By law, federal and state OSHA agencies do not reveal the name of the person filing the complaint, if he or she so requests. Complaints regarding imminent danger are investigated even if they are unsigned or anonymous. For all other complaints (from other than a current employee, or unsigned, or anonymous), the agency may send a letter to the employer describing the complaint and requesting a response. It is important that an OSHA (either federal or state) complaint be in writing.

When an OSHA inspector arrives, he or she displays official credentials and asks to see the employer. The inspector explains the nature of the visit, the scope of the inspection and applicable standards. A copy of any employee complaint (edited, if requested, to conceal the employee’s identity) is available to the employer. An employer representative may accompany the inspector during the inspection. An authorized representative of the employees, if any, also has the right to participate in the inspection. The inspector may review records, collect information and view work sites. The inspector may also interview employees in private for additional information. Federal law prohibits discrimination in any form by employers against workers because of anything that workers say or show the inspector during the inspection or for any other OSHA protected safety-related activity.

Investigations of imminent danger situations have top priority. An imminent danger is a hazard that could cause death or serious physical harm immediately, or before the danger can be eliminated through normal enforcement procedures. Because of the hazardous and unpredictable nature of the fire ground, a fire department’s failure to comply with the two-in/two-out requirements creates an imminent danger and the agency receiving a related complaint must provide an immediate response. If inspectors find imminent danger conditions, they will ask for immediate voluntary correction of the hazard by the employer or removal of endangered employees from the area. If an employer fails to do so, federal OSHA can go to federal district court to force the employer to comply. State occupational safety and health agencies rely on state courts for similar authority.

Federal and state OSHA agencies are required by law to issue citations for violations of safety and health standards. The agencies are not permitted to issue warnings. Citations include a description of the violation, the proposed penalty (if any), and the date by which the hazard must be corrected. Citations must be posted in the workplace to inform employees about the violation and the corrective action. [29 CFR 1903.3(a)]

It is important for labor and management to know that this regulation can also be used as evidence of industry standards and feasibility in arbitration and grievance hearings on fire fighter safety, as well as in other civil or criminal legal proceedings involving injury or death where the cause can be attributed to employer failure to implement two-in/two-out procedures. Regardless of OSHA’s enforcement authority, this federal regulation links fire ground operations with fire fighter safety.

21. What can be done if a fire fighter does not comply with fire department operating procedures for two-in/two-out?

Fire departments must amend any existing policies and operational procedures to address the two-in/two-out regulations and develop clear protocols and reporting procedures for deviations from these fire department policies and procedures. Any individual violating this safety regulation should face appropriate departmental action.
22. How can I obtain additional information regarding the OSHA respirator standard and the two-in/two-out provision?

Affiliates of the International Association of Fire Fighters may contact:

International Association of Fire Fighters
Department of Occupational Health and Safety
1750 New York Avenue, NW
Washington, DC  20006
202-737-8484
202-737-8418 (FAX)

Members of the International Association of Fire Chiefs may contact:

International Association of Fire Chiefs
4025 Fair Ridge Drive
Fairfax, VA 22033-2868
703-273-0911
703-273-9363 (FAX)
IAFF
Fire Department Standard Operating Procedure
Rapid Intervention Teams for Fire Fighter Accountability & Rescue
Two-In / Two-Out

Purpose:

The Fire Department responds to emergency incidents that present high risk to fire fighter safety. This policy identifies the requirements, implementation, and operation of a Rapid Intervention Team and is consistent with the Respiratory Protection Requirements (including the two-in / two-out procedures) as required by the U.S. Occupational Safety and Health Administration and NFPA 1500, Standard on Fire Department Occupational Safety and Health Program. The objective of a Rapid Intervention Team (Rapid Intervention Crew) is to have a fully equipped rescue team on site, and in a ready state to immediately act to rescue injured and trapped fire fighters. This procedure shall be implemented at all working interior structural fires or situations where an equipment failure or sudden change in conditions may trap or injure personnel, or any incident that poses significant risk to fire fighter safety exists. These include but are not limited to:

1. Offensive Fire Operations
2. Hazardous Materials Incidents
3. Trench Rescue
4. Confined Space Rescue

Policy:

It shall be the policy of the Fire Department that no fewer than four fully equipped and trained fire fighters be on scene prior to initiating interior operations that involve an unknown, potential, or actual “immediately dangerous to life and health” atmosphere (IDLH). This procedure increases fire fighter safety at emergency incidents by providing rescue capability at the outset of an event before a team enters one of these atmospheres. An IDLH atmosphere related to structure fire is defined as any fire which is beyond the incipient stage and which cannot be controlled by portable fire extinguishers and where fire fighters do not need respiratory protection or protective clothing.

Initial Operations:

1. Fire fighters operating in an IDLH atmosphere must operate in teams of at least two personnel (Buddy System). The members of each team must be in direct voice or visual contact with one another. Radios or other means of electronic contact shall not be substituted for direct voice or visual contact. During preliminary
operations, when two fire fighters, using the buddy system enter an IDLH atmosphere, at least two other fully equipped and trained fire fighters, designated as the Initial Rapid Intervention Team, shall remain outside the IDLH area, monitor the entry team, and be prepared to rescue those fire fighters inside. The policy is not limited to attack functions, but includes all functions requiring respiratory protection at a fire emergency where the fire is beyond the incipient stage, regardless of the operations being performed, including command, interior hoseline lays, fire attack, interior ventilation, and search and rescue.

2. The function of the Initial Rapid Intervention Team is to account for and initiate a fire fighter rescue. On the Initial Rapid Intervention Team (IRIT), one member shall be solely assigned to monitor and track interior personnel. This fire fighter must be free of all other tasks in order to account for, and if necessary, initiate a rescue for, those fire fighters inside and shall be designed as the Primary IRIT member. The other fire fighter is permitted to perform other tasks, but only if those tasks could be immediately abandoned without jeopardizing the safety and health of others at the emergency scene. This individual shall be designated as the Secondary IRIT member. No one may serve as a standby member of IRIT when the other activities in which he or she is engaged inhibit his or her ability to assist in or perform rescue, if necessary, or are of such importance that they cannot be abandoned without placing other fire fighters in danger.

3. Personnel assigned to the first units to arrive on scene shall implement the Initial Rapid Intervention Team. One fire fighter shall be assigned duties as the Primary IRIT and one fire fighter will assume the Secondary IRIT position. Only the individual assigned as the Secondary IRIT position shall be permitted to perform tasks in addition to accountability as outlined above. At no time shall an interior attack be made with less than four fire fighters assembled at the emergency scene.

   a. If interior fire fighting operations are to commence prior to the arrival of the second due (outlying area) company, the Engineer (Driver/Pump Operator) shall be permitted to assume the Secondary IRIT position. If the Engineer is assigned this position, entry by the initial attack team shall not occur until the Engineer has charged the attack lines, secured a continuous water supply, set the pump (including throttle, relief valves and discharge gates) and donned protective clothing and equipment. The Engineer shall not assume the secondary IRIT position if the apparatus placement (e.g. any reverse lay that positions apparatus a distance from fireground) prevents voice and visual contact with the primary IRIT position at the place where the primary IRIT position is monitoring and tracking the interior team.

   b. This attack evolution would utilize a mobile command with the Company Officer making entry with the nozzle person. The hydrant person (hose person, line person) would assume the Primary IRIT position after securing a water supply and the Engineer would assume the Secondary IRIT position.
The Company Officer shall notify Dispatch of this strategy and Dispatch shall direct the second due Engine Company to the position of the first due apparatus.

4. The exception to this requirement for an IRIT is when units arrive on scene and discover that an emergency rescue of civilians is necessary. This may be accomplished before an IRIT or full RIT is assembled. This exception is only permitted in known life-threatening situations where immediate action is necessary to save lives. Any such actions taken in accordance with this exception must be thoroughly investigated by the fire department with a written report submitted to the Fire Chief. This exception is not to be confused with the standard mission of completing a primary search as part of an initial interior fire attack.

5. All members of an entry team must exit the building when an SCBA low air alarm or PASS alarm activates. The purpose is to ensure no one leaves, or remains in the building alone.

Sustained Operations:

1. When an incident escalates beyond the incipient stage (i.e. a second line is taken inside), or when there is significant risk to fire fighters due to the magnitude of the incident, the Incident Commander shall upgrade the IRIT to full Rapid Intervention Team (RIT) that consists of four dedicated, fully equipped and trained fire fighters. The purpose is to be prepared to rescue fire fighters that may become trapped.

2. The Rapid Intervention Team is designated by the Incident Commander and assigned to a location determined by Command. Under some conditions, the RIT may conduct reconnaissance to maintain an awareness of the companies’ locations and scene conditions. However, they must remain immediately available for a rescue if needed.

3. The RIT shall be immediately ready for assignment and must have full personal protective clothing and SCBA in standby and a minimum of two radios. The RIT Officer must closely monitor the tactical radio channels at all times for activities and status of companies. The RIT shall maintain knowledge of all company locations.

4. The Incident Commander may assign more than one RIT depending on the magnitude of the Incident. They should be located at entry points to the structure.

Missing and Trapped Fire Fighters:

1. The Incident Commander shall assume an individual is lost, trapped, or missing until that individual or crew is accounted for. The actions taken by the IC to locate and rescue trapped fire fighters shall be quick and decisive.
2. Whenever a crew or individual is lost or missing, a “Mayday” shall be transmitted over the radio.
   
a. The radio message “MAYDAY” shall be used by fire fighters to report their status as being in trouble and needing rescue. Any report of “MAYDAY” shall receive priority radio traffic followed by an emergency traffic tone. A “MAYDAY” transmission is reserved to ONLY report missing or trapped fire fighters. An “EMERGENCY TRAFFIC” transmission will be used to report all other emergencies.

3. The IC shall then initiate a rapid recall and accountability of all crews on the fire ground to determine who is missing.

4. The IC shall immediately assign a Chief Officer to the Rescue Sector and commit the RIT to locate the missing or trapped crews. The RIT shall gather as much information as possible on the last known location and assignment of the missing fire fighter(s). The operation changes to a high priority rescue.

5. The IC shall assign another company as a RIT.

6. The IC shall notify the Fire Chief and request additional resources as necessary. These may include an EMS unit, a Rescue Squad, a special operations unit (e.g. US&R Team) or structural engineer. A medical treatment and Triage Sector may need to be established.

7. The Fire Chief shall notify Senior Staff and inform them of the situation

8. Fire fighting operations shall not be abandoned and it may be necessary to reinforce those operations. Ventilation and lighting are an important aspect in locating missing or trapped fire fighters.

9. The IC shall assign additional safety officers as necessary.

**Rapid Intervention Team Search Considerations:**

1. A RIT should consider the following items when conducting a search for missing and trapped fire fighters:
   
a. Visible sightings of arms, legs, or equipment
   
b. Knowledge of last known location
   
c. Sound of an SCBA or PASS device operating in low air or alarm mode, shouts for help, breathing or moaning, or tapping sounds. The RIT may have to occasionally stop to listen for these types of noises.
d. Radio requests for help

e. Tracing attack lines

f. Building descriptions by lost fire fighters

g. Flashlight beams

h. Open and unlock all doors

i. Complete a thorough search

2. In the event of a building collapse, the RIT should consider the potential for a secondary collapse.

3. The RIT should consider an air supply for trapped fire fighters as theirs may be depleted.

**Fire Fighter Self Survival Techniques:**

Fire fighters can implement some very simple procedures that may reduce or eliminate the potential of becoming lost, disoriented, or trapped. The following items should be considered.

1. Always stay with your crew. Never freelance and keep your company officer informed of your actions.

2. Stay alert for the actions and behaviors of others. Don’t allow someone in your crew to act independently outside of direction of the Officer.

3. Try to remain calm at all times

4. Change your flashlight batteries on a regular basis so as to ensure your light operates effectively at all times.

5. When entering a structure, stay near an exterior wall.

6. If lost or trapped, transmit a “Mayday” call on your radio.

7. If lost or trapped, manually activate the alarm system on the PASS.

8. Attempt to locate a hallway as they usually lead to an exit.

9. If lost, provide the IC a description of your location, if possible.

10. If the SCBA is completely out of air, use the hood over the nose and mouth to filter materials and stay low.

11. Attempt to locate a hose line and follow it out of the structure. Keep in mind the feel of the couplings, as they will help direct you out.

12. If all else is not working, place the SCBA flat on the floor as this helps transmit the alert sound. Point the beam of your flashlight towards the ceiling.
Appendix F
Slide Script