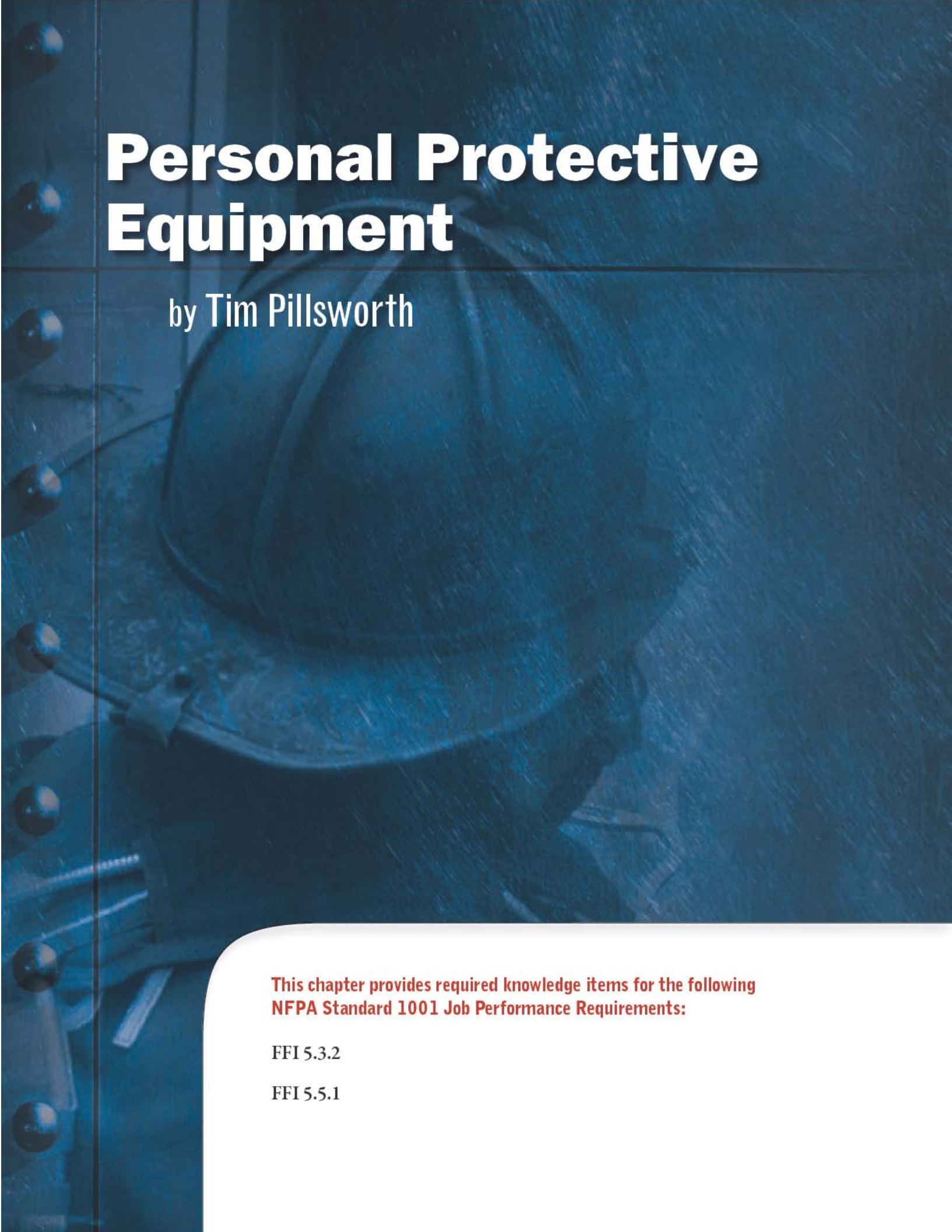

Personal Protective Equipment

by Tim Pillsworth

This chapter provides required knowledge items for the following NFPA Standard 1001 Job Performance Requirements:

FFI 5.3.2

FFI 5.5.1

This chapter contains Skill Drills. When you see this icon, refer to your Skill Drill book for step-by-step instructions.

SKILL DRILL

OBJECTIVES

Upon completion of this chapter, you should be able to the following:

- Describe the different types of personal protective equipment (PPE) worn by firefighters
- Describe the relationship of SCBA and PPE
- Describe the purpose and operation of a personal alert safety system (PASS) used by firefighters
- Describe the six components of structural firefighting gear
- Identify the materials of which PPE is constructed
- Describe the proper method of donning PPE
- Describe the proper method of doffing PPE
- Identify the proper methods for maintaining PPE
- Identify to procedures for inspecting and cleaning PPE

INTRODUCTION

Your **personal protective equipment (PPE)** is your first line of defense when operating at alarms, but it should not be considered the last line of defense. What does this mean? Your PPE is designed to protect you from the day-to-day risks: the mechanical, thermal, and biological risks you may see at any alarm. Your PPE has limitations. The best protection that you have is to understand the fire environment and not put yourself or your partner in a position in which your lives depend solely on your PPE.

Whether a structure, vehicle, or brush fire; motor vehicle accident (MVA); medical call; or any one of the calls for help you receive each and every day, when worn correctly, your PPE offers you the best protection against harm from the forces and elements that surround you. Smoke, fire, heat, blood, sharp objects, and hazardous materials can cause injury or death if you do not respect and shield yourself from them.

Once you complete the reading, receive instruction, and train in the correct use of PPE, you will be able to protect yourself; and by protecting yourself, you protect your partners (brother and sister firefighters) and the general public. Your PPE training

does not end with this chapter. You must continue to practice donning and doffing your PPE on a regular basis.

Although all PPE ensembles have some similar features and can be cross-used at times, they should only be used for their designed purpose. Structural turnout gear is the garment system or ensemble most commonly used. We will discuss this gear last because of its importance, and because it is the PPE we are all issued and use at most alarms. But the other forms of PPE must be covered to understand their use, function, and limitations.

There are several types of PPE, including the following:

1. Station wear
2. Wildland or brush
3. Proximity
4. Medical
5. Technical rescue
6. Hazardous materials
7. Ice rescue
8. Self-contained breathing apparatus (SCBA)
9. Personal alert safety system (PASS)
10. Structural

Each system/ensemble of PPE is covered under a National Fire Protection Association (NFPA) standard. As your career progresses, you should become familiar with the requirements in the regulations so you can better understand why and how the systems are designed, tested, and maintained. This knowledge will be important if one day you must specify PPE for your department. The garments, devices, and other items described show one or a limited number of manufacturers or PPE. For PPE requirements issued in your department, complete additional training with your training officer to ensure you know and understand the correct use and function of the equipment.

TYPES OF PPE ENSEMBLES

FFI 5.3.2 The following are the standard PPE ensembles worn for most department activities and incident responses.

Station wear

Station wear PPE is covered under NFPA 1975: *Standard on Station/Work Uniforms for Emergency Services*. This clothing is worn while on duty in the fire station, awaiting a response (fig. 9–1). Station wear serves as a "work" uniform and is designed to be worn under other protective clothing such as structural firefighting gear (wearing station wear alone is not appropriate for structural firefighting, as they are not considered primary protective clothing).

Fig. 9–1. Station wear

This gear, at a minimum, meets specific ignition and flame spread testing criteria to avoid injury during firefighting activities. In the past, some fire departments issued non-fire-resistant station wear made of synthetic materials. Such practices sometimes led to burn injuries of firefighters. With certified station wear, such problems have been greatly minimized.

Station wear may also be "dual certified" to meet the requirements of a variety of other specific PPE standards such as NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents*; NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*; NFPA 1994, *Standard on Protective Ensem-*

bles for First Responders to CBRN Incidents; and NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations*.

Wildland or brush PPE

Wildland or brush PPE fall under NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*. Wildland or brush gear is designed to protect the firefighters from flash fire and abrasion during wildland fires while allowing the greatest amount of mobility and heat recovery possible (fig. 9–2). Fighting a wildland fire may expose you to extended hours of operation including walking and hiking on uneven terrain, high heat and low humidity, and even the possibility of snake or other small animal bites. The wildland PPE offers limited thermal protection, which structural gear offers, but is much lighter, less restrictive to movement, and will release body heat more readily. PPE garments are constructed of material similar to that of structural gear. Materials such as Nomex® and treated cotton are used in pants and coats, shirts, or overalls (jumpsuits) with common closures, which are worn much like jeans and long-sleeved winter shirts. Often reflective stripping is added for nighttime safety and visibility. Head protection can be offered by a standard structural helmet with eye protection and earflaps or rated as a wildland fire helmet, which are similar in appearance and to construction hard hats. With the wildland fire helmets, hoods for neck and ear protection and goggles are required for full head protection. Protection for the foot, ankle, and lower leg, wildland boots are similar to hiking and construction work boots. They use regular laces or **speed laces** (laces located in the surface of the boot and tightened/secured by a **cinch** system rather than a knot). Leather boots have hardened toes and shank for protection from rocks, punctures, and tools used during wildland operations. Using steel for toe and shank protection reduces the amount of heat buildup from walking on embers. Typically, this style of PPE is only purchased and issued to departments dealing with many large and or prolonged wildland fires. Most departments with limited wildland fires will use their issued structural gear for this purpose. The level of protection offered by the structural gear will be far above the wildland gear, but it will be much heavier and can cause higher levels of heat stress for the firefighter.

Although wildland PPE offers a lighter easy breathing garment, in the event of a fire entrapment situation such as a **blow-up** (a sudden increase in fire intensity), the gear will *not* protect you from the extreme heat. With each set of wildland gear, a **personal fire shelter** should be issued. This is a self-deployable shelter is constructed of an aluminized material to reflect the extreme heat during a fire roll over. This shelter is used as a last line of defense for survival.

Fig. 9–2. Wildland PPE. (Courtesy of Andoni Kastros)

Proximity PPE

Proximity PPE is covered under NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. The proximity gear's outer shell has an aluminized surface. The outer **shell** reflects rather than adsorbs the vast radiant heat created from aircraft and petroleum based fires (fig. 9–3). With an aircraft fire, a single plane can hold 20,000 gal (75,708 L) or more of aircraft fuel. Although this form of gear offers high levels of protection from radiant heat, the outer shell is extremely expensive and cannot withstand the daily punishment from normal municipal firefighting. The thermal and moisture layers (described in detail in the structural firefighting section later in this chapter) within the proximity gear can be constructed from the same materials found in structural gear. Both the helmets and boots for the proximity gear must meet the same standards as the coat and pants. The boots will typically

have an aluminized coating applied, which is similar to the material found on the coat and pants. This coating reflects the high radiant heat. The head protection comes in two forms: a standard structural helmet with elastic covers made from the same material as the outer shell as well as a full-head hood system. To protect the face and the SCBA mask, full-face shields must be incorporated. The shields have a gold tone coating to reflect the radiant heat while still offering visibility. Without the shield, the high radiant heat levels burn the firefighter's face and damage the SCBA masks.

Medical PPE

Medical PPE is covered under NFPA 1999, *Standard on Protective Clothing for Emergency Medical Operations*. The use of medical gear has been increasing over the past few years in many departments that provide medical responses in their jurisdictions. The use of dedicated medical PPE preserves body substance isolation and will greatly reduce the possibility of cross contamination (fig. 9–4). The PPE is much lighter and less cumbersome than structural gear and, in many ways, appearance; and style looks much like wildland fire gear or technical rescue gear. The reduced weight and bulk make for less fatigue while operating at medical calls and MVAs. Where the medical gear differs is its protection from bloodborne pathogens (BBPs). BBPs are microscopic organisms that, if introduced to the body, can cause illness or even death in the most extreme cases. The medical gear has a moisture barrier, which will prevent any liquids such as blood or vomit from penetrating the PPE and reaching your body. It is important to protect your hands with single-use medical gloves that meet NFPA standards. However, because these medical gloves can be damaged under normal working conditions, it is best to carry an extra pair in your gear at all times. Be aware that some firefighters have latex glove allergies; some disposable gloves are made of this material. If you have such an allergy, ensure that you are issued non-latex gloves.

To protect your face from airborne fluids, a shield or goggles that meet the fluid-borne pathogen resistance standards must be donned. When it comes to foot protection, many departments that issue **day boots** use boots that meet the standards for slip-resistant soles, hardened toes and shank, and body fluid–borne pathogen resistance. The boots will appear and feel much like normal work boots.

Fig. 9–3. Proximity PPE

Fig. 9–4. Medical PPE. (Courtesy of Jeanette Kendall/State Line Fire and Safety)

Fig. 9–5. Technical rescue PPE

Technical rescue PPE

Technical Rescue PPE is covered under NFPA 1951, *Standard on Protective Ensembles for Technical Rescue Incidents*. The ensemble incorporates lightweight flexible PPE to offer protection during special rescue operations (fig. 9–5). Whether it is a high angle, trench, or collapse rescue situation, the PPE is designed to offer protection to the head and body. The PPE can come in the form of a coat and pant or a jumpsuit. They both must offer abrasion, liquid, and flame resistance. Once again the boots are similar to medical boots with toe, foot, and general penetration protection. To protect your head, special *technical rescue* helmets are employed. They typically have no rear brim like a structural firefighting helmet; each has chinstraps, sweat bands, and an internal suspension system. In addition to the PPE, rescue harness, rope, and rope accessories can be included.

Hazardous material PPE

Hazardous material PPE is covered under NFPA 1991 and 1992, *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies* and *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*, respectively. The most technical form of PPE is the equipment used at hazardous material (hazmat) incidents. With the exception of the SCBA, this equipment is vastly different from any other from of PPE. The protection during a hazmat incident can vary from Level A (the highest level of protection) to Level D (the lowest level of protection). The Level A suit is designed to protect you from liquid or vapors and requires full SCBA (fig. 9–6a). Level B will only protect you from liquids but once again requires full SCBA to be donned (fig. 9–6b). Level C has the same level of skin protection as Level B but does not require the use of a SCBA (fig. 9–6c). The lowest protection, Level D, would be covered by your issued structural PPE (fig. 9–6d). The level of required protection is governed by what materials are present, the form they are in (vapor, liquid, particle), their concentration, or if the material is even known. To use this type of PPE, numerous advanced training courses are required and will not be covered in this chapter. This equipment is discussed in further detail in chapter 25: Implementing the Planned Response to a Hazardous Materials Incident.

Fig. 9–6a. Level A hazardous material PPE—This is the highest level of protection, with integrated gloves and boots. They come in different materials for protection against different chemicals. SCBA is donned under the suit for respiratory protection. (Courtesy of Jerry J. Knapp)

Fig. 9–6b. Level B ensemble

Fig. 9–6c. Level C ensemble

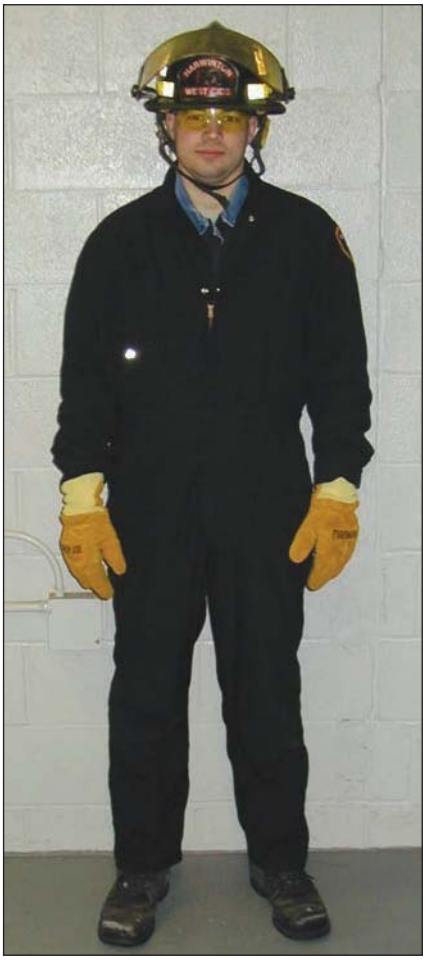

Fig. 9–6d. Level D clothing

Ice rescue PPE

Design of **ice rescue PPE** is not governed by a specific standard (but ice rescue and PPE is covered by NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*). Many think that ice rescue is only on ice, but it is considered a cold-water event in any water less than 70°F (21°C). Therefore, the rescuer must be protected from hypothermia. Water has the ability to remove heat from the human body 32 times faster than air. The heat transfer can be so rapid; a person can be hypothermic in only a few minutes. The ice rescue ensemble will seal your body from the water and the only area exposed is your face. The ice rescue ensemble consists of the suit, helmet, and harness (typically integrated with the suit itself). The suit is one piece, much like coveralls with attached boots, gloves, and hood (fig. 9–7). The integrated gloves and boots are formfitting and do not require the need for additional internal apparel for use. Once donned and closed, the hood creates a tight seal around the face to keep water from entering the suit. Additional ice shoes, which are like sandals with spikes, make maneuvering on ice quicker and safer. A helmet much like the technical rescue helmet is required for protection in case of a fall; remember, ice is slippery. The chest harness is for both your safety and for recovery. It will act as you lifeline but will assist in retrieving the victim from the ground crew.

SCBA as part of PPE

SCBA use and care are covered under NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*. To protect your respiratory system, the use of a SCBA is required. SCBA will be covered in great detail in chapter 10 in its use, care, and procedures. This chapter will cover and show how it interfaces with your PPE garments to complete your full PPE envelope. Without both the SCBA and your PPE garments working together properly, your body will not be completely protected.

Fig. 9–7. Ice rescue PPE

PERSONAL ALERT SAFETY SYSTEM DEVICES

PASS is covered under NFPA 1982, *Standard on Personal Alert Safety Systems (PASS)*. The PASS is a device that can be either removable (clipped on a strap) or integrated as a component of an SCBA. When in alarm the PASS will notify firefighters working in and around the scene that a firefighter is down, trapped, or in some life-or-death emergency. The PASS will activate in two different modes. The first is the manual alarm activated by you. You can activate the PASS by turning a switch or pushing a button on the device. The second is by the use of the motion detector within the device. If you are motionless for 30 seconds, the PASS will alarm. In the automatic mode, the PASS will pre-alarm to warn that the full alarm is imminent if there is not motion or a button or switch is not adjusted. Once in full alarm, the only way to deactivate the alarm is to manually turn off the alarm by either a button or switch on the PASS itself. For many years the PASS was a separate unit typically attached to the waist strap of the SCBA and turned on by the firefighter for operation (fig. 9–8).

Fig. 9–8. Stand-alone PASS—The stand-alone PASS is still in compliance but must have the key or clip for activation. Many people forgot to turn on the older switch-style PASS units before entering the IDLH area. (Courtesy of A. Zytowski)

More recently, most SCBA manufacturers have designed integrated PASS alarms into their SCBAs (fig. 9–9). The PASS will operate in the same manner, but the device will be turned on automatically when the SCBA is turned on. This solved the problem of firefighters not turning on their PASS before entering an **immediately dangerous to life and health (IDLH)** area. To have the PASS taken seriously as a safety device, it must be used correctly, which requires a lower number of false activations. With its correct operation, there will be less chance of a false alarm. To ensure that no PASS is left on, practice turning it off after you doff your SCBA or return to the apparatus. Remembering this reduces the "will someone turn that off" alarm, leaving only the true emergencies.

The aforementioned ensemble of PPE and the structural gear, which will be discussed at length in the following text, will not offer any protection to your respiratory system. The products of combustion found in the smoke from all fires will cause damage to your lungs, mouth, nose, and the remainder of the respiratory track. To protect yourself, learn and understand the use and care of the SCBA. This will be covered in depth in chapter 10. But as part of the complete PPE envelope, it will be covered as it interfaces with your helmet, hood, and coat. Without all the parts of the PPE worn correctly, you will not be protected.

Fig. 9–9. SCBA PASS—Today most newly purchased SCBAs have integrated PASS alarms to insure they are activated when the unit is turned on.

STRUCTURAL FIREFIGHTING PPE

Structural PPE is covered under NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*. Structural PPE is also known as **turnout** or **bunker gear**, the names given to the ensemble that we all use and know the most. All the pieces of your turnout gear working together (helmet, coat/jacket, pants, gloves, boots, hood, SCBA along with miscellaneous personal tools) create an ensemble to protect you from the dangers of all operations on the fireground. To know your total structural ensemble, you will need to understand each of its parts.

Working from the bottom to the top, the boots (most likely readied in your pant legs) will be the first donned (fig. 9–10). To meet the NFPA 1971 standard, the use of the hip boots (also known as **¾ rubber boots**) are not allowed. However, they can serve an import role. In the event of water emergencies from the flooded basement to minor street flooding, they can be used to keep you dry and protected. The hip boots must not be worn for any rescue or fire operation, they offer little thermal protection and do not cover the waist area.

The boots used today are typically called **bunker boots**. They can be pull-on leather or rubber boots, which are typically 14–16 in. (36–41 cm) high; or they may be laced/speed laced boots, which are typically 10 in. (25 cm) high. Boots are typically placed within the pants *before use* for efficient donning. Each have their own pros and cons; and depending on your department PPE specifications, you could be issued one of multiple styles. All offer toe protection by steel toe, foot bottom protection by a shank, aggressive tread, and ankle support.

Fig. 9–10. Structural firefighting boots—Boots have changed over the years. The tall rubber boots are no longer appropriate for structural firefighting, but are very good for water emergencies. Rubber and leather pull-on bunker boots are the most popular, while the leather zip-up short boots are used in some areas.

Many leather bunker boots offer additional shin guards and greater ankle support. Also, moisture barriers are now found in many boots for better water resistance and BBP protection. Even with the additional lining, with prolonged exposure to water, the boot will be penetrated. The leather and more recently designed boots of leather and high-tech materials are much lighter, offer a tighter fit, offer better foot and ankle support than traditional rubber boots, and typically are 50% or more in cost. Traditional rubber bunker boots offer the greatest protection from water, are the least expensive to purchase, and are easily donned; but they offer the lowest level of foot and ankle support.

The low-cut laced structural boots, sometimes referred to as *day boots*, offer the highest level of foot ankle support; and they look and feel much like a construction work boot. They are typically lower than the pull-on boots (10 in. vs. 14–16 in.), therefore any deep water will more readily overtop the boot.

Working up from the boots, pants are next in line. With the construction of the pants and coats being the same, the general design will be discussed together. The combination of the coat and pant creates a system designed to work together; they are constructed from three separate layers of materials, which protect you from heat, water, and abrasion (figs. 9–11 and 9–12). Mixing and matching different styles of gear, even from the same manufacturer, will place you at risk of injury and void any testing and certification the manufacturer has on the

gear. The coat and pant is one system or ensemble and cannot be mixed and matched.

Fig. 9–11. The three layers of structural PPE—Thermal liner with the moisture barrier and outer shell of a structural coat

Fig. 9–12. The required NFPA label with the garment's information

The outer shell is the most durable layer and will protect you from flame and abrasion. It can be constructed of Nomex®, PBI®, or Advance Ultra®, just to name a few materials, and can be produced or dyed to a variety of colors. Each material will offer different levels of protection and cost. Many outer shell materials used today are highly heat resistant and have the ability to self-extinguish once the ignition source is removed. With the more advanced material, the ability to dye the shell is becoming limited and the only color available is its natural state. But when dyed, damage can be noticed by the removal or discoloration of the dye. Although this might not be a sign of damage, it does show a heat event happened to the coat.

The middle layer is the moisture barrier that protects you from water, common liquids (gasoline, battery acid, hydraulic fluid, and chlorine solution of 65%), and BBP; it can be constructed from Crosstech®, Gore®, and Stedair® to name a few materials. The moisture barrier will also prevent any common liquid from entering the thermal layer of the garment and reaching your body while allowing perspiration and body heat to be released. The moisture barrier is the thinnest layer of the garment and is only seen when the inner liner is removed from the outer shell. This layer can be damaged from heat and small punctures with little to no noticeable damage to the stronger outer shell.

The innermost layer is the thermal liner and will protect you from convected and conductive heat and control the moisture (sweat) that you generate. Common materials are Caldura®, Aralite®, and Synergy®. The liner is woven layers of thin materials quilted together, which trap air in between each layer to create the desired thermal protection. Air is a poor conductor of heat and the small air pockets will not allow the heat to transfer toward your body. This is one of the reasons why such a thin layer of material can protect you from such high heat. The innermost surface will typically have a smooth finish for comfort and easy donning. The thermal and moisture layers are attached to the outer shell by a combination of snaps, Velcro®, and zippers.

Structural PPE is required to meet two minimum performance criteria. The first is the **thermal protective performance (TPP)** test, which is essentially a test to measure the time it takes for convective and radiant heat to penetrate through the three layers of a the complete PPE system—the outer shell, moisture barrier, and thermal liner—and injure the wearer. A PPE must receive a minimum TPP numerical rating of 35, which is equivalent to receiving a second-degree burn after 17½ seconds under flashover conditions. Flashover, of course, is considered the worst *fire* condition that a firefighter may encounter.

The TPP is a test by which all three layers of the garment are tested at once by applying heat from a burner and a radiant heat source on one side of the test sample, and a sensor to measure the heat transfer on the other. The test results in a time and temperature graph. Therefore, if your gear has additional insulation, the TPP could increase to 40, which would only increase your time to burn by 2.5 seconds. With an increase in TPP caused by additional insulation, the garment will become heavier and will most likely reduce your body's ability to release heat generated from activity. This test does not mean you cannot get burned while your gear is donned. This is a test for use for comparison and minimum values; it is not actual fire conditions.

The second test is the **total heat loss (THL)** test, which measures the ability of the PPE to allow heat to pass away from the body through the three layers (described earlier) that make up the garment. The minimum required heat loss is 205 W/m^2 (watts, a measurement of heat energy, are described in chapter 5, Fire Behavior). The three layers working together will create air gaps between the layers and have synergistic effect on the values of the tests. This means that the value of the group is higher than the sum of the individual components.

The importance of the removal of heat created from your body (reflected in the THL value) during any alarm is critical. The buildup of body heat within your gear will reduce your efficiency and the total time you are able to perform tasks. If your PPE will not dissipate body heat, the possibility of heat stress and heat stroke increases. The extreme heat stroke can cause permanent brain damage and even death.

In the vulnerable areas of your body and the garment (cuffs, knees, elbows, and shoulders), additional layers of material can be added to increase the thermal and abrasion protection as well as offer padding for comfort. The materials can vary from the outer shell and thermal liner materials as well as high abrasion-resistant materials. Over time leather has been proven to be one of the strongest material for abrasion resistance; but it is heavy, becomes stiff with age, and is prone to absorbing water and fluids, causing problems with decontamination. Many of the new high-abrasion materials such as Arshield® and Dragonhide® offer high levels of abrasion protection, will not stiffen over time, and resist absorbing water and other fluids, thereby reducing the difficulty of decontamination.

For nighttime operations, general visibility and identification NFPA 1971 requires a combination of **retroreflective** (a characteristic in which the light received by the reflective surface is reflected *directly* back at the actual source of light, such as a car's headlight) and fluorescent surfaces on the coat and pant system. The reflective material must be placed in such a way that it is visible from 360°. The minimum requires bands around the coat and pant cuffs, on the front face of the coat at the waist and chest, and on the back at the waist and mid-back or two vertical strips at the sides of the back. This is the only the minimum. Many departments add additional bands to the arms and legs as well as letters and numbers for department and personal identification, which add to the level of protection. The color, material, and layout offer different levels of performances, but the end result is your safety.

With the general knowledge of the makeup of the layers of the coat and pants, now the properties of each can be described. The pants will offer protection from the ankle to the hips and lower back if so equipped. For comfort and protection from heat, additional padding is typically added to the knees. At the fly and waist, there will be a positive fastener system to secure the pants to your waist. With many of the newly designed pants, a belt, clip, or zipper will allow the pants to stay in place without the use of the suspenders. This is important for comfort by taking the weight of the pants off your shoulders, but the suspenders should be worn to ensure that the pants stay at the correct location for the knee pads and ensure they stay on in the event that you need to be rescued. If you go down, your bothers will use every method to pull you out, even pull you by your pants. The suspenders will keep them on.

The coat will protect your torso, chest, back, shoulders, and arms much the same way the pants protect your legs. A fastening system of zippers, Velcro®, snaps, hook and eye, or combinations form a positive seal once donned (figs. 9–13 and 9–14). The collar's neck flap works with the hood and ear flaps to protect the neck and the back of the head. At the end of each arm there are two general types of cuffs, **standard** and **wrist guard**. The difference in the cuffs allows different styles of gloves to be worn. The longer cuff with either a thumbhole and palm protection or thumb loop allow the use of **gauntlet gloves** (an **interface component** that extends from the *end of the glove itself* and provides limited protection to the area where the coat and glove meet). The standard cuff requires **wristlet** style (*interface component*, which is typically a specially designed piece of fabric that extends from the *end of a coat sleeve* that provides limited protection to the area where the glove and coat meet). One new requirement for all structural coats is the **drag rescue device (DRD)**. This was adopted by the NFPA 1971 standard in 2005 to offer a safe and efficient rescue method for a downed firefighter. The DRD is a webbing loop that wraps the back and shoulders when deployed (fig. 9–15). To deploy, lift a flap located on the top back of the coat or within the back of the collar and pull the webbing outward; and you will have 2 ft (61 cm) of a loop to pull your partner to safety. This DRD is designed to allow leverage and distance to pull a firefighter along floor or ground (fig. 9–16). It is not designed to be attached to a rope and used as a lifting or lowering harness or attached to some form of mechanical pulling device (winch). This can cause grave injury.

Fig. 9–13. Coat closure, zipper, and Velcro®

Fig. 9–14. Coat closure, hook & dee, and Velcro®

Fig. 9–15. Stowed structural coat drag rescue device (DRD) under outer shell

Fig. 9–16. Deployed DRD—While short, it is usable for a firefighter rescue in a horizontal direction only.

The structural gloves are required to offer a minimum TPP value of 35, the same requirement as your coat and pants. Typically, the outer layer is made from some form cow or elk leather or kangaroo hide (fig. 9–17). But many gloves made with the newer materials in conjunction with the leather to create a more comfortable and user-friendly glove. Thin layers of thermal protection and a moisture barrier under the outer layer complete your protection (fig. 9–18). One of the largest complaints of fire gloves is the loss of dexterity with the gloves donned. The solution to this compliant is twofold. First, get fitted for the correct size gloves. A properly fitted set of gloves not only offers you the best protection, it allows for the greatest level of dexterity. Second, wear your gloves, all the time, at all alarms and drills. With high level of use, you will gain muscle memory making the tasks of starting saws and operating tools easier.

Fig. 9–17. Structural gloves

Fig. 9–18. Structural coat wristers

A structural hood is worn under your helmet and over the SCBA facepiece netting to protect your ears, neck, and any exposed skin not covered by the helmet, facepiece, or collar. The structural hoods come in various styles and are constructed of Nomex®, PBI®, and Carbon-X®, and when donned correctly with the helmet and facepiece, there will not be any exposed skin visible. The hood covers the most important and most difficult area of your body to protect. When donned correctly the hood is tucked into the coat so it will lay flat along your head, neck, and shoulders. To have it tucked into your coat it should be donned before the coat.

The interface with the SCBA facepiece is completed by sliding the hood over the back of the head, then donning the facepiece, which is covered in depth in chapter 10. Once the facepiece is in place, you can slide your thumbs around at the base of the head, hook the hood, and slide over the netting. Once complete, adjust any areas to ensure complete coverage. If correct, no visible skin will be exposed and the entire head net of the facepiece will be covered (figs. 9–19a, 9–19b, and 9–19c).

Fig. 9–19a. Hood donned and tucked under coat

Fig. 9–19b. Hood donned correctly

Fig. 9–19c. Hood donned incorrectly—Old, stretched hoods leave open gaps that will allow the super-heated atmosphere to reach the sensitive skin of the face and ears.

Last, let's cover what protects the thing you should use the most on the fireground: your head. Helmets come in many different shapes and styles and are constructed from many different materials.

From traditional to modern styles, from leather to plastic, the structural helmet can take different forms and materials. With all their visual differences, each has the same components (eye protection, suspension system, ear flap, chin strap, identification shield, reflective material, and protective shell), which meet or exceed the same NFPA standards (figs. 9–20a, 9–20b, 9–20c, and 9–20d).

All PPE manufacturers must submit samples to undergo extensive testing, as required NFPA 1971, before it can be used by firefighters. Each PPE component is thoroughly analyzed. For example, structural firefighting helmets must undergo several rigorous tests. These tests include an impact resistance test, a corrosion resistance test, an electrical insulation test, a retention system test for chinstraps, a suspension system retention test, a shell retention test, a retroreflectivity and fluorescence test, a radiant heat resistance test, and flame resistance tests.

To have the helmet protect your head, it must be worn correctly, every time. The **ratchet adjustment** (a change-

able headband inside the helmet) will allow you to make changes to the fit, having the helmet donned with or without the SCBA facepiece and hood. Adjust the ratchet for a snug comfortable fit, and use and adjust your chinstrap every time. With both in use and adjusted correctly, your helmet will stay in place offering you the best protection. If your helmet falls off, it can be lost in a smoke-filled room and you will have lost your protection from both heat and impact. *The use of the chin strap is essential at all times; it is critical for your safety if you should fall and strike your head.*

Either a **Bourke shield**™ or face shield can offer secondary eye protection. Both styles will protect your eyes from an object from the straight-ahead direction, but not from spray or an object bouncing under the face shield. If a SCBA facepiece is not donned, to meet the primary level of eye protection, goggles or safety glasses must be used, especially when using tools.

Frontpieces, also known simply as *fronts* or shields, display your fire company identification and rank on the front of your helmet.

DONNING AND DOFFING PPE

Donning your PPE

SKILL DRILL

Now with your newly gathered knowledge of what and how your structural PPE is constructed, you will need to learn how to don it correctly, and in under 1 minute. It might seem impossible to do now, but with practice and some basic tricks, it will be an easy task. But to do this, you first need to have your gear set up for donning (ready for the next alarm).

Place your boots in your pant legs and pull the pants down around the boots, leaving the tops of the boots and bootstraps exposed. Place the suspenders over the tops of the boots so they are visible and remain untangled. Place your hood in an accessible location so it can be donned before your coat; on top of the helmet or on top of the boots or pant pocket works well for many. Have your coat open when it is hanging up and your helmet in close proximity. Your gloves can be in the coat pocket or kept with a glove keeper. Many departments have gear racks, which allow the gear to be stowed in a convenient and orderly manner (fig. 9–21).

Donning is in the following order:

1. Clear the suspenders from the tops of the boots, and set in/pull boots on.
2. Pull up your pants from the waist, pull the suspenders over your shoulders, and fasten the waist closure.
3. Gather your hood and pull it over your head.
4. Don your coat and fasten the closure. Close the coat fastener system and collar.
5. Slide your hood off your head and down to your neck.
6. Don your hand light and radio if so equipped and required.
7. Don your helmet with chinstrap.
8. Don your SCBA.
9. If needed, don your facepiece, pull the hood over the netting, and replace your helmet and chin strap.
10. Gather and don your gloves.

Fig. 9–21. Gear properly stored on rack—Your gear can be stored in an open locker, apparatus compartment, or gear room.

Fig. 9–20a. Structural helmets

Fig. 9–20b. Rear of structural helmets

Fig. 9–20c. Structural helmet suspension—note all approved helmets have attached ear protection and chin straps.

Fig. 9–20d. Structural helmet eye protection

Once complete, all your skin will be covered by one or more layers of protection (fig. 9–22). All pieces of the PPE, when sized correctly, will allow for maxim movement without being overly large or binding.

Doffing your PPE

SKILL DRILL

Doffing (removing) your gear is an important task rarely talked about. Under normal circumstances, the most import thing to remember is to remove it in the order it was donned and stow your gear the same way each time. By placing your hood and gloves in the same location, and stowing your gear the same way each and every time, you will be able to don it faster at your next alarm. Stopping to search for your gloves or hood will be slow and inefficient.

Fig. 9–22. Correctly donned structural PPE

While doffing, perform a quick inspection of any component you feel you might have damaged or contaminated. Before stowing your PPE—whether in a locker, bag, or compartment on the apparatus—make sure all components are completely dry. Wet gear will not dry when packed away, which promotes mold growth. Additionally, donning wet gear is more difficult and very uncomfortable. Make sure the coat cuffs are pulled out and the tops of the boots are clear with the handles exposed from the pants for easy donning for the next alarm.

Under most conditions, doffing your PPE will not take much attention and become a routine after every alarm, with one exception: doffing superheated gear. Injuries from superheated gear have been on the rise for the last few years. This is because of the high level of protection from your PPE. If you are operating within a superheated environment for a prolonged time, all your gear will become superheated. The temperature will be high enough to cause burns if you do not doff quickly and correctly.

A signal that your gear is superheated is the **off-gassing** your PPE exhibits; the gear is literally *smoking* when you leave the building (not to be confused with steam coming off your PPE when leaving the fire building and going into a cold environment). This process is your gear releasing heat absorbed from the fire. If this happens you will feel the heat on your body and at best are very uncomfortable or feel pain from the burning heat. This is not the time to apply water or pat down your gear in an attempt to cool off or *put out* your gear. This will cause the air pockets within the gear to be filled with steam or collapse, keeping the superheated gases closer to your body. The discomfort you were feeling will be greatly increased.

If you are in superheated gear, follow the following steps to limit any burns you might receive. This set of procedures was developed by Firefighter Patrick Brown of the Chicago Fire Department:

1. Keep your gloves on and remove your regulator from your facepiece.
2. Loosen the shoulder straps to your SCBA.
3. Open the collar tab and closure from the top down.
4. Once at your waist strap, open the strap and open the top of your pants.
5. Open your coat as wide as possible and roll the coat and SCBA out and off your shoulders and let them slide to the ground.
6. Use your feet step on your coat and help pull your arms out of the coat.
7. Undo your suspenders and let the pants fall down and step out of your boots.

This procedure can be done by yourself or with the assistance of a firefighter on the scene. If there is a member

there to assist you, tell him or her that you have superheated gear and need assistance; talk him or her through the process.

If this does happen, your gear must be removed from service and completely inspected for any damage. There will be a good chance that the gear has been damaged and will require repairs or replacement.

AUXILIARY PPE

Many items may not be required in the NFPA PPE standards, but they do offer you convenience and safety while working on the fireground. Some items may be clips, tabs, glove keepers, and pockets on your coat and pants or the personal tools and equipment you carry in them to make your work safer and easier.

Pockets will allow you to carry tools, radio, and safety equipment at all times while keeping your hands free, reducing entanglement issues, and protecting the tools from heat and loss. Typically, bellow-style pockets that expand for storage are found on each side of the coat and each pant leg. A radio pocket can be added for radio storage, protection, and convenience. Remember that all the tools you might put into your pocket will be there all the time. They are additional weight and possibly snag or become entangled. If possible, place all auxiliary PPE inside a pocket to avoid entanglement hazards. Anything on the outside of your PPE will become an entanglement hazard (e.g., hand light, radio strap, mic cord, rope).

Whenever you don your PPE, have at least one hand light, even in the middle of the day, and a radio. If the hand light or radio has a shoulder strap, wear it under the SCBA straps to reduce the chance of entanglement. Inside every structure fire, the rooms are dark; or at a MVA, additional light might be required to see under the dashboard.

Personal hand tools such as pliers, knife, wire cutters, window punch, shove knife, screw driver (combination flat/Phillips to reduce number), door wedge (two in a pocket, one on helmet), webbing, hose strap, spanner wrench, rope, and extra medical gloves are important to carry (fig. 9–23). All these tools will be helpful whether disconnecting a car battery, resetting a pull station, or cutting your way free from entanglements. Place the life safety tools (knife and wire cutters) in a place that can be easily accessed when full PPE is donned, including SCBA, working in zero visibility. Lives could depend on the life-safety tools, so keep them accessible. Your pant pockets may offer the best location for these tools, because your SCBA straps will interfere with access to them in a coat pocket. The remaining tools can be kept in a comfortable safe location. To keep the tools from damaging your gear, try to wrap them in a tool roller or inside an old glove, or place them in an old section of hose. The sharp points and edges will damage the expensive PPE and your body if you do not protect them.

Fig. 9–23. Personal tools—your personal tools should include some combination of extra medical gloves (in a holder or even a 35 mm film case), wire cutters, screwdriver, pliers, center punch, and a knife. They can be used while performing your duties, or even to rescue yourself in an emergency.

PPE INSPECTION AND MAINTENANCE

SKILL DRILL

FFI 5.5.1 Care, inspection, and maintenance of firefighting PPE is covered in NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting.*

NFPA 1851 requires all PPE to be fully inspected, cleaned, and repaired (if required) a minimum of *twice* per year to prevent the buildup of containments (fig. 9–24). The contaminates your PPE holds will degrade the materials, will conduct electricity more readily, may cause illness, and may reduce your overall level of protection. By no means must the inspection and cleaning take place *only* twice per year, it can be completed more often if you see or feel there was any damage to your PPE. Remember, if it is damaged, it will not offer you full protection. The idea that having the dirtiest, most worn gear in the station makes you

look seasoned or macho is long past. The contaminants found in the smoke—such as hydrocarbons, grease, and oil from MVAs, BBPs, and possibly even carcinogens such as asbestos—will penetrate the PPE and must be removed from your gear to ensure it is safe to wear.

Fig. 9–24. Damaged gear being inspected

Inspections should be done to some extent after every alarm as well as prior to and after cleaning. As you are doffing your gear, look at it. Does it have a hole, burn, cut, or a seam opening? Is their any reflective striping missing or hanging? Does one area of your body get wet quickly while the remainder stays dry? These are all part of normal wear-and-tear damage that happens to all gear over time. If they are not addressed correctly, they will put you at risk.

A full inspection should be done when the gear is up for its cleaning cycle, or after any event when you feel there was the possibility of damage. Because you must remove everything from your pockets to separate the components, this would be a good time to inspect your personal tools.

Separate the outer shell and the inner liner so each component can be inspected.

The outer shell should not have any holes, cuts, separated seams, or missing reflective striping. All snaps, Velcro®, and fasteners must be in working order.

The outer shell will be able to withstand damage from heat better than the moisture barrier, and the damage to the moisture barrier might not be visible from the outside. The moisture barrier should be uniform in color. All seams should be intact. There should not be any signs of abrasion (typically in joint and pressure point areas such as the knees, shoulders, and elbows). When the moisture barrier has sustained heat damage, the area will become brown to black and can crust or char.

The thermal liner is the innermost layer and is next to your body. The sweat from your body will be absorbed into this layer, possibly causing bacterial growth. Look for signs of staining, worn seams, and quilting becoming unwoven. Some firefighters may spray air fresheners, odor removers, or other materials to remove any body odors; but this should not be done unless the materials being used are approved by your PPE manufacturer. Using non-approved sprays can result in degradation of the materials or lamination.

When any damage is found, the PPE needs to be taken out of service and either repaired by the manufacturer or certified repair facility or replaced. If you find or suspect any damage, report it to the station officer in charge of PPE.

There are two ways to properly clean your gear. You can send it to an approved cleaning facility or clean it at your station. Never bring your gear home to wash it in your own washing machine. By doing this, you will bring all the contaminants (BBP, smoke, grease, and oil) home to your family. If you clean your gear at your station, you must learn two important things. First, learn how to operate your model of washer. It might sound like something you already know, but each unit and its cleaning chemical work differently. Second, know the cleaning requirements for your gear. This information must be gathered from the manufacturers. They will be able to supply you with the correct methods, chemicals, and protocols to follow.

Never wash the outer shell together with the inner liner! The cleaning chemicals are designed differently to remove the containments from that component. Start by washing your inner liner first with the correct cleaning chemical. The reason is that the inner liner will take longer to air dry. While the outer shell is being washed, the inner liner is already drying. Do not reassemble the PPE until everything is dry. Once reassembled, everything will take longer to dry; and wet gear can grow mildew or cause steam burns. For additional information on the care and maintenance of your PPE, review manufacturer's recommendations.

If your department sends your gear to an approved cleaning facility, contact the officer in charge of PPE and follow the department protocols for sending the gear out. It will most likely be out of service for 3 to 7 days. Once it is returned, inspect it much like you would inspect your dry cleaning. Make sure it is your gear and there was no damage from the cleaning process.

NOTES

NFPA 1951 *Standard on Protective Ensemble for USAR Operations*

NFPA 1971 *Standard on Protective Ensemble for Structural Fire Fighting*

NFPA 1976 *Standard on Protective Ensemble for Proximity Fire Fighting*

NFPA 1977 *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*

NFPA 1999 *Standard on Protective Clothing for Emergency Medical Operations*

NFPA 1981 *Standard on Open-Circuit Self-Contained Breathing Apparatus for Fire and Emergency Services*

NFPA 1982 *Standard on Personal Alert Safety Systems (PASS)*

NFPA 1991 *Standard on Vapor-Protective Ensembles for Hazardous Materials Emergencies*

NFPA 1992 *Standard on Liquid Splash-Protective Ensembles and Clothing for Hazardous Materials Emergencies*

Recommended additional reading material

Manufacture specifications and product information for the PPE that you are issued from your department. Include all aspects of the PPE you are issued, helmet, hood, coat, pants, boots, gloves, and eye protection. Read and understand the design and construction on the PPE that will be protecting your body at your next alarm.

QUESTIONS

1. What is the best protection you have on the fire scene?
2. What level of hazmat protection does structural PPE provide?
3. The PASS will activate in what two modes?
4. NFPA _____ covers structural PPE.
5. What are the advantages and disadvantages of leather bunker boots?
6. What are the advantages and disadvantages of rubber bunker boots?
7. What are the three layers of structural PPE and what do they protect the wearer from?
8. What is the minimum performance criterion for thermal protective performance for structural PPE? What is this number equal to on a fire scene?
9. What is the minimum performance criterion for total heat loss for Structural PPE? What does it tell us?
10. How is the drag rescue device (DRD) designed to be used?
11. Does the face shield or flip down on a helmet provide primary eye protection? Why or why not?
12. Structural PPE should be donned within _____ minute(s).
13. NFPA requires all PPE to be formally inspected, cleaned, and repaired, if needed, a minimum of _____ times per year to prevent the buildup of contaminates.
14. What are some contaminates that can get on your PPE?
15. When should a full field inspection of your PPE take place?
16. During an inspection, what are you looking for in the outer shell? The moisture barrier? The thermal liner?