

# Fire Fighter Safety





## NFPA 1001 Standard

### Fire Fighter I

**5.1.1 General Knowledge Requirements.** The organization of the fire department; the role of the Fire Fighter I in the organization; the mission of fire service; the fire department's standard operating procedures (SOPs) and rules and regulations as they apply to the Fire Fighter I; the role of other agencies as they relate to the fire department; aspects of the fire department's member assistance program; the importance of physical fitness and a healthy lifestyle to the performance of the duties of a fire fighter; the critical aspects of NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, as they apply to the Fire Fighter I; knot types and usage; the difference between life safety and utility rope; reasons for placing rope out of service; the types of knots to use for given tools, ropes, or situations; hoisting methods for tools and equipment; and using rope to support response activities. [p 26–28]

**5.1.2 General Skill Requirements.** The ability to don personal protective clothing within 1 minute; doff personal protective clothing and prepare for reuse; hoist tools and equipment using ropes and the correct knot; and locate information in departmental documents and standard or code materials. [p 42–45, 61–64]

**5.3 Fireground Operations.** This duty shall involve performing activities necessary to ensure life safety, fire control, and property conservation, according to the JPRs in 5.3.1 through 5.3.19. [p 25–72]

**5.3.1 Use self-contained breathing apparatus (SCBA) during emergency operations,** given SCBA and other personal protective equipment, so that the SCBA is correctly donned and activated within 1 minute, the SCBA is correctly worn, controlled breathing techniques are used, emergency procedures are enacted if the SCBA fails, all low-air warnings are recognized, respiratory protection is not intentionally compromised, and hazardous areas are exited prior to air depletion. [p 47–72]

**5.3.1.A Requisite Knowledge.** Conditions that require respiratory protection, uses, and limitations of SCBA, components of SCBA, donning procedures, breathing techniques, indications for and emergency procedures used with SCBA, and physical requirements of the SCBA wearer. [p 47–72]

**5.3.1.B Requisite Skills.** The ability to control breathing, replace SCBA air cylinders, use SCBA to exit through restricted passages, initiate and complete emergency procedures in the event of SCBA failure or air depletion, and complete donning procedures. [p 47–72]

**5.5.1 Clean and check** ladders, ventilation equipment, SCBA, ropes, salvage equipment, and hand tools, given cleaning tools, cleaning supplies, and an assignment, so that equipment is clean and maintained according to the manufacturer's or departmental guidelines, maintenance is recorded, and equipment is placed in a ready state or reported otherwise. [p 64–72]

## Fire Fighter II

**6.1.1 General Knowledge Requirements.** Responsibilities of the Fire Fighter II in assuming and transferring command within an incident management system, **performing assigned duties in conformance with applicable NFPA and other safety regulations and authority having jurisdiction procedures**, and the role of a Fire Fighter II within the organization. [p 25–26]

### Additional NFPA Standards

- NFPA 1404** *Standard for Fire Service Respiratory Protection Training*
- NFPA 1500** *Standard on Fire Department Occupational Safety and Health Program*
- NFPA 1582** *Standard on Comprehensive Operational Medical Program for Fire Departments*
- NFPA 1971** *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*
- NFPA 1975** *Standard on Station/Work Uniforms for Fire and Emergency Services*
- NFPA 1977** *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*
- NFPA 1981** *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*
- NFPA 1982** *Standard on Personal Alert Safety Systems (PASS)*

### Knowledge Objectives

After studying this chapter, you will be able to:

- List safety precautions you need to take during training, during emergency responses, at emergency incidents, at the fire station, and outside your workplace.
- Describe the protection provided by personal protective equipment (PPE).
- Explain the importance of standards for PPE.
- Describe the limitations of PPE.
- Describe how to properly maintain PPE.

- Describe the hazards of smoke and other toxic environments.
- Explain why respiratory protection is needed in the fire service.
- Describe the differences between open-circuit breathing apparatus and closed-circuit breathing apparatus.
- Describe the limitations associated with SCBA.
- List and describe the major components of SCBA.
- Explain the skip-breathing technique.
- Explain the safety precautions you should remember when using SCBA.
- Describe the importance of daily, monthly, and annual SCBA inspections.
- Explain the procedures for refilling SCBA cylinders.
- List the steps for donning a complete PPE ensemble.

### Skills Objectives

After studying this chapter, you will be able to perform the following skills:

- Don approved personal protective clothing.
- Doff approved personal protective clothing.
- Don an SCBA from a seat-mounted bracket.
- Don an SCBA from a side-mounted compartment.
- Don an SCBA from a storage case using the over-the-head method.
- Don an SCBA from a storage case using the coat method.
- Don a face piece.
- Doff an SCBA.
- Perform daily SCBA inspections.
- Perform monthly SCBA inspections.
- Replace an SCBA cylinder.
- Fill an SCBA cylinder from a cascade system.
- Clean and sanitize an SCBA.

# You Are the Fire Fighter

**Y**ou have just been assigned to Station 3 as your first assignment out of recruit school. After a full day of orientation, you are happy that 2200 hours is bunk time. You have just settled into bed when the alarm tones sound for an automobile fire. The dispatcher states you have a fully involved van on the interstate highway. You head out to Engine 403 and start putting on your gear.

1. How does your personal protective equipment protect you on this type of a fire call?
2. Which pieces of personal protective equipment do you need to wear for an automobile fire?

## Fire Fighter Safety

Firefighting, by its very nature, is dangerous. Each individual fire fighter must learn safe methods of confronting the risks presented during training exercises, on the fire ground, and at other emergency scenes.

Every fire department must do everything it can to reduce the hazards and dangers of the job and help prevent fire fighter injuries and deaths. Each fire department must have a strong commitment to fire fighter safety and health, with specific personnel being designated to oversee these programs. Safety must be fully integrated into every activity, procedure, and job description.

Appropriate safety measures must be applied routinely and consistently. During serious incidents, safety officers are responsible for evaluating the hazards of various situations and recommending appropriate safety measures to the incident commander (IC). Each accident or injury must be thoroughly investigated to learn why it happened and how it can be avoided in the future.

Advances in technology and equipment require fire departments to review and revise their safety policies and procedures regularly. Information reviews and research by designated safety personnel can identify new hazards as well as appropriate risk-management measures. In addition, reports of accidents and fatalities from other fire departments can help identify common problems and lead to the development of effective preventive actions.

### Causes of Fire Fighter Deaths and Injuries

Each year, approximately 100 fire fighters are killed in the line of duty in the United States. These deaths occur not only at emergency incident scenes, but also in the station, during training, and while responding to or returning from emergency situations.

Approximately the same number of fire fighter deaths occur on the fire ground or emergency scene as during training or while performing other nonemergency duties. The remainder (approximately 25 percent) occur while fire fighters are responding to or returning from alarms **Figure 2-1 ▶**. The leading cause of fire fighter death is heart attack, both on and off the fire ground.

Vehicle collisions are a major cause of fire fighter fatalities. For every 1000 emergency responses, there is one vehicle collision involving an emergency vehicle **Figure 2-2 ▶**. One study found that 39 percent of the fire fighters who died in those incidents were not using seat belts. Fire fighters should never overlook basic safety procedures, such as always fastening seat belts, especially during emergency responses.

The National Fire Protection Association (NFPA) estimates that 80,100 fire fighters were injured in the line of duty in 2005. Almost half of these injuries occurred while fighting fires. The most common injuries were strains, sprains, and soft-tissue injuries. Burn injuries and smoke and gas inhalation accounted for only a small percentage of total injuries **Table 2-1 ▶**.

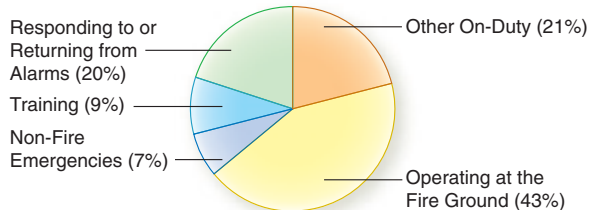
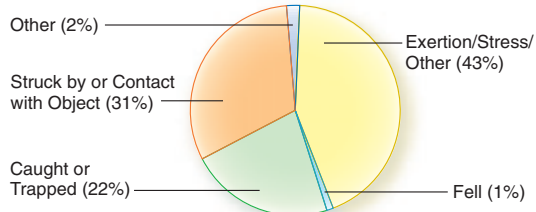
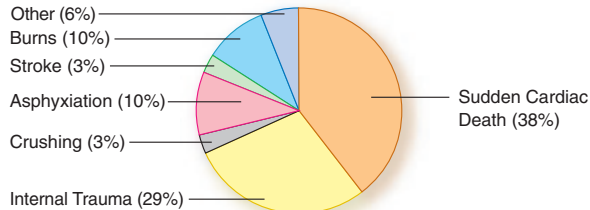
### Injury Prevention

Injury prevention is a responsibility shared by each member of the firefighting team. Fire fighters must always consider three groups when ensuring safety at the scene:

- Their personal safety
- The safety of other team members
- The safety of everyone present at an emergency scene

To reduce the risks of accidents, injuries, occupational illnesses, and fatalities, a successful safety program must have four major components:

- Standards and procedures
- Personnel
- Training
- Equipment

**Fire Fighter Deaths by Type of Duty—2006****Fire Fighter Deaths by Cause of Injury—2006****Fire Fighter Deaths by Nature of Injury—2006****Figure 2-1** Fire fighter deaths in the United States.**Figure 2-2** Motor vehicle collisions are a leading cause of death for fire fighters.**Table 2-1 Fire Fighter Injuries**

| Types of Injury      | % of total |
|----------------------|------------|
| Strains and sprains  | 44%        |
| Soft tissue injuries | 18%        |

ment regulations on workplace safety. NFPA standards often are incorporated by reference in government regulations.

Every fire department should have a set of standard operating procedures (SOPs) or standard operating guidelines (SOGs), which outline how to perform various functions and operations. SOPs and SOGs cover a range of topics—from uniform and grooming standards to emergency scene operations. These procedures should incorporate safe practices and policies. Each fire fighter is responsible for understanding and following these procedures.

The fire department chain of command also enforces safety goals and procedures. In particular, the command structure keeps everyone working toward common goals in a safe manner. An incident command system (ICS) is a nationally recognized plan to establish command and control of emergency incidents. ICS is flexible enough to meet the needs of any emergency situation, so it should be implemented at every emergency scene—from a routine auto accident to a major disaster involving responders from numerous agencies.

Many fire departments have created a health and safety committee that is responsible for establishing policies on fire fighter safety. Members of the committee should include representatives from every area, component, and level within the department, from fire fighters to chief officers. The safety officer and the fire department physician also should be members of the committee.

## Personnel

A safety program is only as effective as the individuals who implement it. For this reason, personnel selection and training in the science of safe and effective fire suppression account for significant portions of fire department operations and budgets.

Teamwork is an essential element of safe emergency operations. On the fire ground and during any hazardous activity, fire fighters must work together to get the job done. Both the lives of citizens and the lives of the department depend on compliance with basic safety concepts and principles of operation.

An overall plan also is essential to coordinate the activities of every team, crew, or unit involved in the operation. The ICS coordinates and tracks the location and function of every individual or work group involved in an operation.

**Freelancing** is acting independently of a superior's orders or the fire department's SOPs. Freelancing has no place on the fire ground; it is a danger to both the fire fighter who acts independently and every other fire fighter. A fire fighter who freelances can easily get into trouble by being in the wrong place at the wrong time or by doing the wrong thing. For example, a fire fighter who enters a burning structure without informing a superior may be trapped by rapidly changing conditions. By the time the fire fighter is missed, it may be too late to perform

## Standards and Procedures

Because safety is such a high priority, several organizations set standards intended to ensure a safe working environment for the fire service. NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, provides a template for implementing a comprehensive health and safety program. Other NFPA standards focus on specific subjects directly related to health and safety. The federal **Occupational Safety and Health Administration (OSHA)**, along with a variety of state and provincial health and safety agencies, develops and enforces govern-

a rescue. Searching for a missing fire fighter exposes others to unnecessary risk.

Safety officers are members of the fire department whose primary responsibility is safety. At the emergency scene, the designated safety officer reports directly to the IC and has the authority to stop any part of an action that is judged to be unsafe. Safety officers observe operations and conditions, evaluate risks, and work with the IC to identify hazards and ensure the safety of all personnel. They also determine when fire fighters can work without SCBA after a fire is extinguished.

Safety officers can enhance safety in the workplace, at emergency incidents, and at training exercises. Even so, each member of the department shares the responsibility for promoting safety, both as an individual and as a member of the team.

## ■ Training

Adequate training is essential for fire fighter safety. The initial fire fighter training covers the potential hazards of each skill and outlines the steps necessary to avoid injury. Fire fighters must avoid sloppy practices or shortcuts that might potentially contribute to injuries and learn how to identify hazards and unsafe conditions.

The knowledge and skills developed during training classes are essential to maintain safety at actual emergency scenes. But the initial training course is only the beginning—fire fighters must continually seek out additional courses and work to keep their skills current to ensure both their personal safety and the safety of their team.

## ■ Equipment

A fire fighter's equipment ranges from power and hand tools to personal protective equipment (PPE) and electronic instruments. Fire fighters must know how to use equipment in the correct manner and operate it safely. Equipment also must be properly maintained. Poorly maintained equipment can create additional hazards to the user or fail to operate when needed.

Manufacturers usually supply operating instructions and safety procedures for their equipment. These instructions cover proper use of the equipment, its limitations, and warnings about potential hazards. Fire fighters must read and heed these warnings and instructions. In addition, new equipment must meet applicable standards to ensure that it can perform under difficult and dangerous conditions on the fire ground.

## ■ Reducing Fire Fighter Injuries and Deaths

Reducing fire fighter injuries and deaths requires the dedicated efforts of every fire fighter, of every fire department, and of the entire fire community working together. In 1992, Congress created the National Fallen Firefighters Foundation to lead a nationwide effort to remember the U.S. fallen firefighters. In the years since then, this foundation has expanded its programs to sponsor the annual National Fallen Firefighters Memorial Weekend, offer support programs for survivors, award scholarships to fire service survivors, and work to prevent line-of-duty injuries and deaths.

Most fire fighter injuries and deaths are the result of preventable situations. Recognizing this fact, the National Fallen

Firefighters Foundation has developed programs with the goal of reducing line-of-duty deaths by 25 percent in 5 years. For example, the National Fire Fighter Near-Miss Reporting System provides a method for reporting situations that could have resulted in injuries or deaths. This system, which is accessible over the World Wide Web, provides a means for all fire fighters to learn from situations that occur only rarely. Representative near-miss reports are included in most chapters of this text so that you can benefit from the experiences of others without getting in harm's way.

In an effort to do more to prevent line-of-duty deaths and injuries, the National Fallen Firefighters Foundation developed a firefighter safety initiative called Everyone Goes Home. The goal of this program is to raise the awareness of life safety issues, improve safety practices, and allow everyone to return home at the end of their shift. In particular, the Everyone Goes Home program has developed “The 16 Firefighter Life Safety Initiatives,” which describe steps that need to be taken to change the current culture of the fire service to help make it a safer place for all **Table 2-2**.

**Table 2-2 16 Firefighter Life Safety Initiatives**

1. Define and advocate the need for a cultural change within the fire service relating to safety and incorporating leadership, management, supervision, accountability, and personal responsibility.
2. Enhance the personal and organizational accountability for health and safety throughout the fire service.
3. Focus greater attention on the integration of risk management with incident management at all levels, including strategic, tactical, and planning responsibilities.
4. Empower all fire fighters to stop unsafe practices.
5. Develop and implement national standards for training, qualifications, and certification (including regular recertification) that are equally applicable to all fire fighters based on the duties they are expected to perform.
6. Develop and implement national medical and physical fitness standards that are equally applicable to all fire fighters based on the duties they are expected to perform.
7. Create a national research agenda and a data collection system that are related to the initiatives.
8. Take advantage of available technology whenever it can produce higher levels of health and safety.
9. Thoroughly investigate all fire fighter fatalities, injuries, and near-misses.
10. Implement grant programs to support the implementation of safe practices and/or mandate safe practices as an eligibility requirement.
11. Develop and champion national standards for emergency response policies and procedures.
12. Develop and champion national protocols for response to violent incidents.
13. Ensure that fire fighters and their families have access to counseling and psychological support.
14. Provide more resources for public education, and champion this kind of education as a critical fire and life safety program.
15. Advocate for the enforcement of codes and installation of home sprinklers.
16. Make safety a primary consideration in the design of apparatus and equipment.

## Safety and Health

Safety and well-being are directly related to personal health and physical fitness. Although fire departments regularly monitor and evaluate the health of fire fighters, each department member is responsible for his or her own personal conditioning and nutrition. Fire fighters should eat a healthy diet, maintain a healthy weight, and exercise regularly.

All fire fighters—whether paid or volunteer—should spend at least an hour each day in physical fitness training. Fire fighters should be examined by either a personal or departmental physician before beginning any new workout routine. An exercise routine that includes weight training, cardiovascular workouts, and stretching with a concentration on job-related exercises is ideal. For example, many fire fighters will use a stair-climbing machine and focus on the muscle groups used for firefighting. This type of exercise builds strength and endurance on the fire ground, but other muscle groups should not be neglected. Physical fitness must be a career-long activity; it is not something to be left at the fire academy when you graduate. Firefighting is a stressful activity that demands you maintain a good fitness level throughout your career.

Hydration is an important part of every workout. A good guideline is to consume 8 to 10 ounces of water for every 5 to 10 minutes of physical exertion. Do not wait until you feel thirsty to start rehydrating. Fire fighters should drink up to a gallon of water each day to keep properly hydrated. Proper hydration enables muscles to work longer and reduces the risk of injuries at the emergency scene.

Diet is another important aspect of physical fitness. A healthy menu includes fruits, vegetables, low-fat foods, whole grains, and lean protein. Pay attention to portion sizes—unfortunately, most people eat larger portions than their bodies need. Substitute healthy choices (such as fruit) for high-calorie desserts.

Heart disease is the leading cause of death both in the United States and among fire fighters. A healthy lifestyle that includes a balanced diet, weight training, and cardiovascular exercises can help reduce many risk factors for heart disease and enable fire fighters to meet the physical demands of the job **Figure 2-3 ▶**.

Many fire departments have adopted policies that prohibit the use of tobacco products by fire fighters, whether on duty or off duty. Smoking is a major risk factor in cardiovascular disease, reduces the efficiency of the body's respiratory system, and increases the risk of lung cancer. Fire fighters should avoid tobacco products entirely for both health and insurance reasons.

Alcohol is another substance that fire fighters should avoid. Alcohol is a mood-altering substance that can be abused. Excessive alcohol use can damage the body and affect performance. Fire fighters who have consumed alcohol must not be permitted to engage in emergency operations.

Drug use has absolutely no place in the fire service. Many fire departments have drug-testing programs to ensure that fire fighters do not use or abuse drugs. The illegal use of drugs endangers your life, the lives of your team members, and the public you serve.

Of course, everyone is subject to an occasional illness or injury. Fire fighters should not try to work when ill or injured. Operating safely as a member of a team requires both fitness

and concentration. Do not compromise the safety of the team or your personal health by trying to work while you are ill or injured.

### Employee Assistance Programs

**Employee assistance programs (EAPs)** provide confidential help with a wide range of problems that might affect performance. Many fire departments have established EAPs so that fire fighters can get counseling, support, or other assistance in dealing with a physical, financial, emotional, or substance abuse problem. An officer may refer a fire fighter to an EAP if the problem begins to affect job performance. Fire fighters who take advantage of an EAP can do so with complete confidentiality and without fear of retribution.

### Safety During Training

During training, fire fighters learn the actual skills that are later used under emergency conditions. Typically, the patterns that develop during training will continue during actual emergency incidents. Thus developing the proper working habits during training courses helps ensure safety later.

Many of the skills covered during training can be dangerous if they are not performed correctly. According to the NFPA, an average of nine fire fighters are fatally injured during training exercises every year. Proper protective gear and teamwork are as important during training as they are on the fire ground.

Instructors and veteran fire fighters are more than willing to share their experiences and advice. They can explain and demonstrate every skill and point out the safety hazards involved because



**Figure 2-3** Regular exercise will help you to stay healthy and perform your job effectively.

they have performed these skills hundreds of times and know what to do. But here, too, safety is a shared responsibility. Do not attempt anything you feel is beyond your ability or knowledge. If you see something that you believe is an unsafe practice, bring it to the attention of your instructors or a designated safety officer.

As mentioned earlier, freelancing is a dangerous practice, so do not freelance on the training ground. Wait for specific instructions or orders before beginning any task. Do not assume that something is safe and act independently. Follow instructions and learn to work according to the proper procedures.

Teamwork is also important during training exercises. Assignments are given to firefighting teams during most live fire exercises. Teams must stay together. If any member of the team becomes fatigued, is in pain or discomfort, or needs to leave the training area for any reason, notify the instructor or safety officer. Emergency Medical Services (EMS) personnel will be nearby to perform an examination and refer the individual for further treatment if necessary. A fire fighter who is injured during training should not return until medically cleared for duty.

### ■ Safety During the Emergency Response

When a company is dispatched to an emergency, fire fighters need to get to the apparatus and don appropriate PPE quickly before mounting the vehicle and proceeding to the incident. Walk quickly to the apparatus; do not run. Take care not to slip and become injured before you reach the apparatus.

Personal protective gear should be properly positioned so you can don it quickly before getting into the apparatus **Figure 2-4 ▶**. In addition, make sure that seat belts are properly fastened before the apparatus begins to move. All personnel responding on fire apparatus must be seated with seat belts fastened, and seat belts should remain fastened until the apparatus comes to a complete stop. Fire fighters can don SCBA while seated in some vehicles. Learn how to do this without compromising safety.

Drivers of fire apparatus have a great responsibility. They must get the apparatus and the crew members to the emergency scene without having or causing a traffic accident en route. They must know the streets in their first-due area and any target hazards. They must be able to operate the vehicle skillfully and keep it under control at all times. In addition, they must anticipate all responses from other drivers who might not see or hear an approaching emergency vehicle or know what to do when confronted by one. Prompt response is a goal, but safe response is a much higher priority. Before you are qualified to drive any piece of fire department apparatus, you must undergo special training that covers the principles of emergency driving, applicable motor vehicle regulations, and characteristics of the equipment you will be driving. You also need to practice driving with a qualified instructor. You need to demonstrate competency in both required knowledge and skills. These driving skills are not required for the Fire Fighter I and Fire Fighter II courses and are beyond the scope of this textbook.

### ■ Safe Driving of Private Vehicles During Emergency Responses

In some departments where fire fighters are not on duty at the fire station, it may be necessary for members to respond to the station or to the emergency scene in their private vehicles. Driving a



**Figure 2-4** Protective clothing should be properly positioned so you can quickly don it.

private vehicle during an emergency response requires a special degree of safety. Such emergency driving requires added considerations and represents a much different type of driving from the routine driving you normally do. Motor vehicle crashes are the second most common cause of fire fighter deaths. Although some of these crashes involve fire department apparatus, all too many involve fire fighters driving their private vehicles to an emergency. The ensuing collisions sometimes result in injury or death to the fire fighter and civilians. Even when no one is injured, crashes cause fire fighters to be delayed in getting to the emergency.

Many collisions occur when the motor vehicle operator loses control of the vehicle. These crashes may be caused by driving too fast for the prevailing conditions, braking inappropriately, changing directions too abruptly, or tracking around a curve too fast. In addition, many collisions involving emergency vehicles occur on open roads, where excessive speed is often cited as a primary cause. Intersections are common sites of collisions involving emergency vehicles; most of these collisions occur when the emergency vehicle operator fails to stop at an intersection and ensure that other traffic has stopped before proceeding through the intersection.

A motor vehicle collision actually consists of a series of separate collision events. The first collision occurs when the vehicle collides with a second vehicle or with a stationary object;

the second collision occurs when the occupants of the vehicle collide with the interior of the vehicle. Vehicle occupants who are not wearing seat belts are much more likely to suffer serious injuries or death than occupants who have their seat belts properly fastened. Remember that air bags are most effective when seat belts are properly fastened; they are not effective without properly applied seat belts. Seat belts also greatly reduce the possibility that vehicle occupants will be ejected from the vehicle. If you remember nothing from this section except the importance of always fastening your seat belt, you will have learned a most important lesson.

### Laws and Regulations Governing Emergency Vehicle Operation

Four general principles govern emergency vehicle operation:

- Emergency vehicle operators are subject to all traffic regulations unless a specific exemption is made. A specific exemption is a statement that appears in a statute, such as “The driver of an authorized vehicle may exceed the maximum speed limits so long as he or she does not endanger life or property.”
- Exceptions are legal only when operating in emergency mode.
- Even with an exemption, the operator can be found criminally or civilly liable if involved in a crash.
- An exemption does not relieve the driver of an authorized emergency vehicle from the duty to drive with reasonable care for all persons using the highway.

Laws governing emergency vehicle operation vary from one state to another. You must follow the laws and regulations of your state regarding emergency vehicle operations. Some states permit private vehicles to operate as emergency vehicles in responding to a fire station or to the scene of an emergency; other states outline a limited use of emergency equipment and dictate certain restrictions. You must understand and follow the specific laws and regulations of your state.

### Standard Operating Procedures for Emergency Vehicle Operation

The use of personal vehicles to respond to fire and EMS calls constitutes a fire department function. For you to use your personal vehicle in a situation requiring an emergency response, this use must be permitted by state laws and regulations, and this operation must also be permitted by your local fire department. If your local fire department does not permit the use of personal vehicles for emergency responses, then you are not permitted to engage in this behavior regardless of what is permitted by your state's laws. Your fire department should have SOPs that spell out whether private vehicles can be used for emergency response. These procedures typically address what kind of training you must complete before you are permitted to use your personal vehicle for emergency response. This training will usually include a course in defensive driving and functioning as an emergency vehicle operator.

### Safe Driving Begins with You

It has often been stated that the biggest cause of vehicle crashes is “a loose nut behind the wheel.” In other words, one of the major factors in crashes is the attitude and ability of the vehicle

operator. A competent emergency vehicle operator needs to have a confident, but not cocky, attitude. The operator should have good judgment, mental fitness, maturity, physical fitness, and driving habits. It is important to have a clean driving record. A person who has been cited for multiple moving violations in his or her personal vehicle will usually be a poor risk as the driver of an emergency vehicle. It is important to know your state and local laws relating to motor vehicle operations. In addition, an emergency vehicle operator needs to understand reaction time, braking distance, and stopping distance of the vehicle he or she will be driving.

Emergency driving requires good reactions and alertness. It is important for the operator to be in good physical condition and to have good eyesight. Driving while impaired is asking for trouble. Impairment can result from many different sources—for example, using some prescribed medicines, using some over-the-counter medicines, and being overly fatigued. And certainly anyone who has been drinking alcoholic beverages should never think of driving.

In many cases, one of the best predictors of future performance is past behavior. Your driving record is an important consideration in your career in a fire department. A person who has past moving violations for speeding, reckless operation, aggressive driving, chargeable crashes, or driving under the influence of alcohol or drugs may be excluded from driving any emergency vehicles. Your driving record, both on-duty and off-duty, is important to your career as a fire fighter.

### Safe Driving Practices

Safe driving practices will prevent most vehicle collisions. If you are using your personal vehicle to respond to an emergency, it is important to take the characteristics of your vehicle into account while driving. For example, four-wheel-drive pickup trucks and large sport utility vehicles have a higher center of gravity than sleek sports cars, and sudden changes in direction are more likely to result in rollover crashes when a vehicle has a high center of gravity. For this reason, it is critical to learn the characteristics and limitations of your vehicle.

Anticipate the road and road conditions. If you regularly travel the same roads to report to your fire station, learn the characteristics of that strip of roadway and be able to anticipate when you need to slow down or stop. Always drive at a safe speed for that road. Traveling on a limited access highway is much different from traveling through a school zone. Observe the traffic conditions, and slow down when more traffic congestion is present. Expect that motorists around you may do anything at any time. Upon the approach of an emergency vehicle, for example, some motorists will slow down, some will stop, some will speed up, some will pull to the right, and others will turn left in front of you. Expect the unexpected.

Make allowances for weather conditions. On a clear day, it may seem that you can see forever—but you really can't. When there is rain, snow, fog, dust, or darkness, the distance over which you can see is greatly reduced. Reduce your speed to compensate for limited visibility. At night, your vision is limited by the distance your headlights reach, so reduce your speed accordingly. Recognize that you cannot see objects outside the projection of the headlight beams. Understand that the goal of an emergency

response is not to drive as fast as you can, but rather to arrive on the scene as quickly as you can while maintaining safety.

Adjust your speed of response to accommodate any storm conditions. Rainstorms reduce visibility and produce slippery road surfaces. When water collects on a roadway, your vehicle can hydroplane on the thin film of water that separates your tires and the road surface—and you have no control over your vehicle when hydroplaning occurs. During stormy weather, slow down and be prepared for slippery road surfaces. Be aware of high winds from tornados, hurricanes, or other windstorms that can topple trees onto the roadway. During heavy rainstorms, watch for water flowing over the road. You cannot see how deep the water is, and you cannot tell whether the flood water has washed out part of the roadway. Slow down when driving following an earthquake because you will not know where the roadway or overpasses have been damaged or destroyed.

When operating an emergency vehicle, you are not exempt from the laws of physics. The laws of physics tell us that when the speed of a vehicle is doubled, the force exerted by that vehicle increases by a factor of 4. Thus, when the speed of a vehicle increases from 20 miles per hour to 40 miles per hour, the force exerted by that vehicle is increased by a factor of 4. Higher speeds require more braking power and a longer distance to bring the vehicle to a stop.

To drive safely, you need to understand where the greatest risks are located. As mentioned earlier, studies have shown that many crashes involving emergency vehicles occur at intersections. Most fire departments require all emergency vehicles to come to a full stop when the emergency vehicle operator encounters a stop sign or a red traffic light. If you enter an intersection without stopping, you may not be able to see approaching traffic, and many motorists do not drive defensively. They assume that if there is no stop sign or red light, they can proceed through the intersection without looking for oncoming vehicles. Expect the unexpected!

In addition, many emergency vehicle crashes occur on open stretches of straight roads during daylight hours. The primary cause of these crashes is excessive speed. Most of us have limited experience with high-speed driving, so it is important to keep within the limits of your driving skills and within the limits of the vehicle you are operating. Many departments limit the speed during emergency responses to 5 miles per hour over the posted speed limit. Multiple studies have shown that little time is saved by driving at high rates of speed.

During an emergency response, be alert for the presence of other emergency vehicles. These vehicles may carry other fire fighters responding from their homes, or fire, EMS, or law enforcement personnel responding to the same incident. It is difficult to hear the sounds of other apparatus when you are on an emergency response.

Drive with a cushion of safety around you—that is, in such a manner that even if a motorist does the unexpected, you still have enough time and distance to avoid a collision. Remember that the sound of a siren carries only a limited distance. Sometimes in an urban environment motorists may not be able to determine the location of an approaching emergency vehicle owing to surrounding buildings, which distort the sound of the siren. Similarly, emergency lights have limitations and cannot be depended on to clear a path of travel for you.

**Table 2-3 Guidelines for Safe Emergency Vehicle Response**

1. Drive defensively.
2. Drive no more than 5 miles per hour over the speed limit.
3. Always maintain a safe distance. Use the “4-second rule”: Stay at least 4 seconds behind another vehicle in the same lane.
4. Maintain an open space or cushion in the lane next to you as an escape route in case the vehicle in front of you stops suddenly.
5. Always assume that other drivers will not hear the siren or see your emergency lights.
6. Select the shortest and least congested route to the scene at the time of dispatch.
7. Avoid routes with heavy traffic congestion when possible.
8. Go with the flow of traffic.
9. Avoid one-way streets, because they may become clogged. Do not go against the flow of traffic on a one-way street, however, unless absolutely necessary.
10. Watch carefully for bystanders as you approach the scene. They may not move out of your way.

### The Importance of Vehicle Maintenance

Do not underestimate the importance of proper vehicle maintenance for both fire department vehicles and your private vehicle. It is important to perform regular maintenance of the engine, transmission, and other equipment to ensure dependable starting and running. Keep the brakes and tires in proper condition to ensure dependable stopping. In addition, note that tire tread depth for emergency vehicles should exceed the minimum required for nonemergency vehicles. The suspension system and steering system need to be properly maintained to ensure safe handling of the vehicle. Likewise, the windshield wipers and windshield washers must be properly maintained to ensure clear vision. Regularly check all headlights, taillights, and turn signals for proper operation. Private vehicles that are used for emergency response should be maintained at a higher level than vehicles that are not subject to the stresses of emergency operation.

**Table 2-3** summarizes the guidelines when driving to respond to an emergency call.

### Safety at Emergency Incidents

At the emergency scene, fire fighters should never charge blindly into action. The officer in command will “size up” the situation, carefully evaluating the conditions to determine whether the burning building is safe to enter. Wait for instructions and follow directions for the specific tasks to be performed. Do not freelance or act independently of command.

### Teamwork

On the fire ground, a firefighting team should always consist of at least two fire fighters who work together and are in constant communication with each other. Some departments call this scheme the **buddy system** **Figure 2-5**. In some cases, fire fighters work directly with the company officer, and all crew members function as a team. In other situations, two individual fire fighters may form a team that is assigned to carry out a specific task. In either case, the company officer must always know where teams are and what they are doing.



**Figure 2-5** A firefighting team should consist of at least two members who work together.

Partners or assigned team members should enter together, work together, and leave together. If one member of a team must leave the fire building for any reason, the entire team must leave together, regardless of whether it is a two-person team or an entire crew working as a team.

Before entering a burning building to perform interior search and rescue or fire suppression operations, fire fighters must be properly equipped with approved PPE. Partners should check each other's PPE to ensure it is on and working correctly before they enter a hazardous area.

When working in a hazardous area, team members should maintain visual, vocal, or physical contact with one another at all times. At least one member of each team should have a portable **two-way radio** to maintain contact with the IC or a designated individual in the chain of command who remains outside the hazardous area. This radio can be used to relay pertinent information and to summon help if the team becomes disoriented, trapped, or injured. In such a situation, the IC can contact the team with new instructions or an evacuation order.

Fire fighters operating in a hazardous area require backup personnel. The backup team must be able to communicate with the entry team, either by sight or by radio, and should be ready to provide assistance. During the initial stages of an incident, at least two fire fighters must remain outside the hazardous area, properly equipped to respond immediately if the entry team needs to be rescued.

If the incident progresses and additional crews are assigned to work in the hazardous area, a designated **rapid intervention company/crew** (also known as a rapid intervention team) should be established and positioned outside the hazardous area. This team's sole responsibility is to be prepared to provide emergency assistance to crews working inside the hazardous area.

### Accountability

Every fire department must have a **personnel accountability system** to track personnel and assignments on the emergency scene. This system should record the individuals assigned to each company, crew, or entry team; the assignments for each team; and the team's current activities. Several kinds of accountability systems are acceptable, ranging from paper assignments



**Figure 2-6** A passport lists each fire fighter assigned to a crew.

or display boards to laptop computers and electronic tracking devices.

Some departments use a "passport" system. In this scheme, each company officer carries a small magnetic board called a passport. Each crew member on duty with that company has a magnetic name tag on the board **Figure 2-6**. At the incident scene, the company's passport is given to a designated individual who uses it to track the assignment and location of every company at the incident.

Other fire departments employ an "accountability tag" system. With this approach, each fire fighter carries a name tag and turns it in or places it in a designated location on the apparatus when the individual is on the scene. The tags are then collected and used to track crews who are working together as a unit. This system works well when crews are organized based on the available personnel.

Both passport and accountability-tag systems provide an up-to-date accounting of everyone who is working at the incident and how they are organized. At set intervals, an accountability check is performed to account for everyone. Usually, a company officer reports on the status of each crew. The company officer should always know exactly where each crew is and what it is doing. If a crew splits into two or more teams, the company officer should be in contact with at least one member of each team.

An accountability check is also performed when the operational strategy changes or when a situation occurs that could endanger fire fighters. If an accountability check is needed, the list of personnel and assignments should be readily available at the command post.

Fire fighters must learn what kind of accountability system their department uses, how to work within it, and how it works within the ICS. They are responsible for complying with this system and staying in contact with a company officer or assigned supervisor at all times. Most importantly, fire fighters must always remember that teams must stay together.

The accountability system is valuable to identify fire fighters who are lost or trapped in a fire or other emergency situation. Fire

**Table 2-4 Self-Survival for Lost or Trapped Fire Fighters**

Don't get lost or trapped! If you are lost or trapped, take these steps:

- Call for help immediately.
- Activate the radio emergency button.
- Declare a "mayday" on your portable radio.
- Call on a second radio channel if necessary.
- Activate your personal alert safety system (PASS) device.
- Stay with your crew.
- Follow the hose line or life line out of the building.
- Search for an exit.
- Retreat to a safe refuge.
- Stay calm and conserve air.
- Assume a horizontal position.
- Shine your flashlight at the ceiling and tap with a metal tool to attract attention.

fighters, in turn, must work hard to avoid getting lost or trapped in a fire. Chapter 17, Fire Fighter Survival, covers many of these self-survival skills and the steps for calling for help ("mayday"). For now, **Table 2-4** presents these steps in summary form.

### Incident Scene Hazards

Fire fighters must be aware of their surroundings when performing their assigned tasks at an emergency scene. At an incident, make a safe exit from the apparatus and look at the building or situation for safety hazards such as traffic, downed utility wires, and adverse environmental conditions. An incident on a street or highway must first be secured with proper traffic- and scene-control devices. Flares, traffic cones, or barrier tape are all measures that can help keep the public at a safe distance from the scene. Emergency vehicles can be placed to block traffic and protect the incident scene. Always operate within established boundaries and protected work areas.

Changing fire conditions will also affect safety. During the overhaul phase and while picking up equipment, watch out for falling debris, smoldering areas of fire, and sharp objects. If a safety officer is not on the scene, another qualified person should be assigned to monitor the atmosphere for the presence of **carbon monoxide (CO)**. CO is an odorless, colorless, tasteless gas that can cause asphyxiation, resulting in unconsciousness or death. Because the chance for injury increases when you are tired, do not let down your guard even though the main part of the fire is over.

### Using Tools and Equipment Safely

Fire fighters must learn how to use tools and equipment properly and safely before attempting to use them at an actual emergency incident. Follow the proper procedures and safety precautions both in training and at an incident scene. In addition, don protective gear such as PPE, safety glasses, and hearing protection when they are required.

Proper maintenance includes sharpening, lubricating, and cleaning each tool. Equipment should always be in excellent condition and ready for use. All fire fighters should be able to do basic repairs such as changing a saw blade or a hand-light battery. Practice these tasks at the fire station until you can perform them quickly and safely on the emergency scene.

### Electrical Safety

Electricity is an emergency scene hazard that must always be respected. Many fires are caused by electricity, such as those ignited by faulty wiring or involving electric-powered equipment. In some cases, energized power lines may be present on the fire ground. Fire fighters must always check for overhead power lines when raising ladders. During any fire, the electric power supply to the building should be turned off as part of the fire-ground task called "controlling the utilities."

Fire departments are often called to electrical emergencies, such as downed power lines, fires or arcing in transformers and switchgear, and stuck elevators. Always disconnect the power to any electrical equipment involved in an emergency incident.

Park apparatus outside the area and away from power lines when responding to a call for an electrical emergency. A downed power line should be considered energized until the power company confirms that it is dead. Secure the area around the power line and keep the public at a safe distance. Never drive fire apparatus over a downed line or attempt to move it using tools. If a sparking power line causes a brush fire, attempt to contain the fire but do not use water near the line.

### Lifting and Moving

Lifting and moving objects is part of a fire fighter's daily duties. Do not try to move something that is too heavy alone—ask for help. Never bend at the waist to lift an object; instead, bend at the knees and use your legs to lift the weight. If you must move objects over a long distance, use equipment such as handcarts, hand trucks, and wheelbarrows.

In addition to moving inanimate objects, fire fighters must often move sick or injured victims. Discuss and evaluate the options before moving a victim, and then proceed very carefully. If necessary, request help. Never be afraid to call for additional resources, such as an additional engine or truck company, to assist in lifting and moving a heavy victim.

### Working in Adverse Weather Conditions

In adverse weather conditions, fire fighters must dress appropriately. A turnout coat and helmet can keep you warm and dry in rain, snow, or ice. Firefighting gloves and knit caps will also help retain body heat and keep you warm. If conditions are icy, make smaller movements, watch your step, and keep your balance. During the hot summer months, many departments allow their members to wear cotton T-shirts and short pants. Check your department's SOPs for guidance on acceptable uniforms.

### Rehabilitation

**Rehabilitation** is a systematic process that provides periods of rest and recovery for emergency workers during an incident. It is usually conducted in a designated area away from the hazards of the emergency scene. The rehabilitation area, or "rehab," is usually staffed by EMS personnel.

A fire fighter who is sent to rehab should be accompanied by the other members of the crew. The company officer should inform the IC of their change in location. While in rehab, fire fighters should take advantage of the opportunity to rest, rehydrate, have their vital signs checked by EMS personnel, and receive treatment for minor injuries **Figure 2-7**. Rehab gives fire fighters the chance to cool off in hot weather and to warm up in cold weather.



**Figure 2-7** In the rehabilitation area, fire fighters can rest and rehydrate.

Rehabilitation time can be used to replace SCBA cylinders, obtain new batteries for portable radios, and make repairs or adjustments to tools or equipment. Firefighting teams can discuss recently completed assignments and plan their next work cycle. When a crew is released from rehab, its members should be rested, refreshed, and ready for another work cycle. If the crew is too exhausted or unable to return to work, they should be replaced and released from the incident.

Never be afraid or embarrassed to admit you need a break when on the emergency scene. Heat exhaustion is a common condition at firefighting incidents and is characterized by profuse sweating, dizziness, confusion, headache, nausea, and cramping. If a fire fighter shows signs or symptoms of heat exhaustion, the company officer should be notified immediately. The officer will then request approval for rehabilitation so the problem can be treated.

Heat exhaustion is usually not life-threatening and, if identified early, can be remedied by rehydration, cooling, and rest. Left untreated, however, heat exhaustion can progress quickly to heat stroke, which is a life-threatening emergency. A lack of sweating, low blood pressure, shallow breathing, and seizures are some of the signs of heat stroke. If you or a member of your team experiences these symptoms during training or on the fire ground, place a “mayday” or “fire fighter in trouble” call. You must report to your superior and seek immediate medical attention.

A fire fighter who experiences chest pain or discomfort should stop and seek medical attention immediately. As noted earlier, heart attack is the leading cause of death among fire fighters.

### Violence at the Scene

Fire fighters are often dispatched to situations involving domestic disputes, injuries from an assault, or other violent scenes. In such an incident, the staging area and the apparatus should be located at some distance from the scene until the police arrive, investigate, and declare the area safe. Only then should fire fighters proceed to enter the emergency scene. A fire fighter’s personal safety should always be paramount. If there is any threat to personal safety, slowly back away from the emergency scene

to a safe distance and request the police to secure the scene. Do not become a victim.

If you are confronted with a potentially violent situation, do not respond violently. Remain calm, speak quietly, and attempt to gain the person’s trust. You might consider taking additional classes to increase your understanding and develop appropriate skills for these situations.

### Critical Incident Stress Debriefing

Some calls are particularly difficult and emotionally traumatic. After experiencing such an incident, fire fighters who were involved may be required to attend a **critical incident stress debriefing (CISD)**. Usually, a stress debriefing is held as soon as possible after a traumatic call. It provides a forum for firefighting and EMS personnel to discuss the anxieties, stress, and emotions triggered by a difficult call. Follow-up sessions can be arranged for individuals who continue to experience stressful or emotional responses after a challenging incident.

Most fire departments have qualified, designated CISD staff available 24 hours a day. The initial CISD is usually a group session for all fire fighters and rescuers; it can also be done on a one-on-one basis or in smaller groups. Everyone handles stress differently, and new fire fighters need time to develop the personal resources to deal with difficult situations. If any call proves emotionally disturbing to you, ask your superior officer for a referral to a qualified CISD counselor.

### Safety at the Fire Station

The fire station is just as much a workplace as the fire ground. Indeed, fire fighters will spend much of the time during a 12- or 24-hour shift at the fire station. While there, be careful when working with power tools, ladders, electrical appliances, pressurized cylinders, and hot surfaces. Injuries that occur at the firehouse can be just as devastating as those that occur at an emergency incident scene.

### Safety Outside Your Workplace

Continue to follow safe practices when you are off duty. An accident or injury, regardless of where it happens, can end your career as a fire fighter. For example, if you are using a ladder

#### Fire Fighter Safety Tips

Remember these guidelines to stay safe—both on and off the job.

- You are personally responsible for safety. Keep yourself safe. Keep your teammates safe. Keep citizens—your customers—safe.
- Work as a team. The safety of the entire firefighting unit depends on the efforts of each member. Become a dependable member of the team.
- Follow orders. Freelancing can endanger other fire fighters as well as yourself.
- Think! Before you act, think about what you are doing. Many people are depending on you.

while off duty, follow the same safety practices that you would use on duty. Keep your seat belt fastened in your personal vehicle, just as you are required to do when you are on duty

**Figure 2-8** ▼

## Personal Protective Equipment

Personal protective equipment is an essential component of a fire fighter's safety system. It enables a person to survive under conditions that might otherwise result in death or serious injury. Different PPE ensembles are designed for specific hazardous conditions, such as structural firefighting, wildland firefighting, airport rescue and firefighting, hazardous materials operations, and emergency medical operations.

The various PPE ensembles provide specific protections, so an understanding of their designs, applications, and limitations

### Fire Fighter Safety Tips

A structural firefighting ensemble is designed only for structural firefighting. It is not designed for other functions such as hazardous materials, water rescue, or wildland firefighting. Instead, each of these specialized functions requires a specific set of PPE. If your department performs specialized operations, you need the appropriate PPE for that activity.



**Figure 2-8** Always use your seat belt.

is critical. For example, a structural firefighting ensemble will protect the wearer from the heat, smoke, and toxic gases present in building fires, but it cannot provide long-term protection from extreme weather conditions and it limits range of motion

**Figure 2-9** ▼

The more you know about the protection your PPE can provide, the better you will be able to judge conditions that exceed its limitations.

A fire fighter's PPE must provide full body coverage and protection from a variety of hazards. To be effective, the entire ensemble must be worn whenever potential exposure to those hazards exists. In addition, PPE must be cleaned, maintained, and inspected regularly to ensure that it will continue to provide the intended degree of protection when it is needed. Worn or damaged articles must be repaired or replaced.

## Structural Firefighting Ensemble

Structural firefighting PPE enables fire fighters to enter burning buildings and work in areas with high temperatures and concentrations of toxic gases. Without PPE, fire fighters would be unable to conduct search and rescue operations or perform fire suppression activities. A structural firefighting ensemble is designed to cover every inch of the body. It provides protection from the fire, keeps water away from the body, and helps reduce trauma from cuts or falls. This type of PPE is designed to be



**Figure 2-9** A protective ensemble for structural firefighting provides protection from multiple hazards.

worn with **self-contained breathing apparatus (SCBA)**, which provides respiratory protection.

The structural firefighting ensemble consists of a protective coat, trousers or coveralls, a helmet, a hood, boots, and gloves. The helmet must have a face shield, goggles, or both. The clothing is worn with SCBA and a PASS device. All of these elements must be worn together to provide the necessary level of protection **Figure 2-10 ▾**.

### Protection Provided

A structural firefighting ensemble is designed for full body coverage and provides several different types of protection **Table 2-5 ▸**. The coat and trousers have tough outer shells that can withstand high temperatures, repel water, and provide protection from abrasions and sharp objects. The knees may be reinforced

with pads for greater protection when crawling. Fluorescent/reflective trim adds visibility in dark or smoky environments. Insulating layers of fire-resistant materials protect the skin from high temperatures. A moisture barrier between the layers keeps liquids and vapors, such as hot water or steam, from reaching the skin.

The helmet protects the head from trauma; it includes ear coverings to protect the ears as well. The face shield helps protect the eyes. A fire-retardant hood covers any exposed skin between the coat collar and the helmet. Gloves protect the hands from heat, cuts, and abrasions. Boots protect the feet and ankles from the fire, keep them dry, prevent puncture injuries, and protect the toes from crushing injuries.

An SCBA provides respiratory protection by giving the fire fighter an independent air supply. In this way, the respiratory system remains isolated from toxic products and hot gases present in the atmosphere.

### Helmet

**Fire helmets** are manufactured in several designs and shapes using a variety of materials. Nevertheless, each design must meet the requirements specified in NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*.



**Figure 2-10** The complete structural firefighting ensemble consists of a helmet, coat, trousers, protective hood, gloves, boots, SCBA, and PASS device.

**Table 2-5 Protection Furnished by Personal Protective Equipment**

- Provides thermal protection
- Repels water
- Provides impact protection
- Protects against cuts and abrasions
- Furnishes padding against injury
- Increases your visibility
- Provides respiratory protection

## Standards for Personal Protective Equipment

The PPE for fire fighters must be manufactured according to exacting standards. Each item must have a permanent label verifying that the particular item meets the requirements of the standard **Figure 2-11 ▸**. Usage limitations as well as cleaning and maintenance instructions should also be provided.

The requirements for firefighting PPE are outlined in three standards:

- NFPA 1971, *Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting*
- NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*

The requirements for SCBA and PASS devices are outlined in two standards:

- NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*
- NFPA 1982, *Standard on Personal Alert Safety Systems (PASS)*



**Figure 2-11** The label provides important information about each item of PPE.



**Figure 2-12** A helmet is constructed with multiple layers and components.

The hard outer shell of the helmet is lined with energy-absorbing material and has a suspension system to provide impact protection against falling objects **Figure 2-12 ▲**. The helmet shell also repels water, protects against steam, and creates a thermal barrier against heat and cold. The shape of the helmet helps to deflect water away from the head and neck.

Face and eye protection can be provided by a face shield, goggles, or both. These components must be attached to the helmet and are used when SCBA is not needed or when the SCBA face piece is not in place. A chin strap is also required and must be worn to keep the helmet in the proper position. In addition, this strap helps to keep the helmet on the fire fighter's head during an impact.

Fire helmets have an inner liner for added thermal protection. This liner also provides protection for the ears and neck. When entering a burning building, the fire fighter should pull down the ear tabs to ensure maximum protection.

Helmets are manufactured with adjustable inner suspension systems that hold the head away from the shell and cushion it against impacts. This suspension system must be adjusted to fit the individual, who should try on the helmet with the SCBA face piece and hood in place. Because helmet shells come in a variety of sizes, fire fighters must be sure to wear the correct-size shell.

In many departments, helmet shells are color-coded according to the fire fighter's rank and function. They often carry company numbers, rank insignia, or other markings. Some fire departments use a shield mounted on the front of the helmet to identify the fire fighter's rank and company. Bright, reflective materials are applied to make the fire fighter more visible in all types of lighting conditions.

NFPA 1971 requires that helmets approved for structural firefighting have a label permanently attached to the inside of the shell. This label lists the manufacturer, model, date of manufacture, weight, size, and recommended cleaning procedures.

### Protective Hood

Although the helmet's ear tabs cover the ears and neck, this area is still at risk for burns when the head is turned or the neck is flexed. **Protective hoods** provide additional thermal protection



**Figure 2-13** A protective hood.

for these areas. Such a hood, which is constructed of a flame-resistant material such as **Nomex®**, **PBI®**, or carbon fiber, covers the whole head and neck, except for that part of the face protected by the SCBA face piece **Figure 2-13 ▲**. The lower part of the hood, which is called the bib, drapes down inside the turnout coat.

Protective hoods are worn over the face piece but under the helmet. After securing the face piece straps, carefully fit the hood around the face piece so that no areas of bare skin are left exposed. The hood must fit snugly around the clear area of the face piece so that vision is not compromised and hot gases cannot leak between the face piece and the hood.

### Turnout Coat

The coats used for structural firefighting are generally called **bunker coats** or **turnout coats** **Figure 2-14 ►**. Only coats that meet NFPA 1971 requirements should be used for structural firefighting.

### Fire Marks

Before hoods were introduced, the skin on the neck and ears of fire fighters was often left exposed. Fire fighters "measured" the temperature in a burning building by how hot their ears felt. Of course, this often resulted in burns to the ears. Even today, fire fighters must be careful to avoid situations where the temperature exceeds the protection provided by PPE.



**Figure 2-14** A bunker or turnout coat.

Turnout coats consist of three layers. The outer layer or shell is constructed of a sturdy, flame-resistant, water-repellant material such as Nomex, **Kevlar®**, or PBI®. Fluorescent reflective material applied to the light-colored outer shell makes the fire fighter more visible in smoky conditions and at night. The light-colored fabric also makes it easier to identify contaminants such as hydrocarbons, blood, and body fluids on the coat.

The second layer of the coat is the moisture barrier, which is usually a flexible membrane attached to a thermal barrier material (the third layer). The moisture barrier helps prevent the transfer of water, steam, and other fluids to the skin. It is critical because water applied to a fire generates large amounts of superheated steam, which can engulf fire fighters and burn unprotected skin.

The third layer of the turnout coat comprises a thermal barrier, which is made of a multilayered or quilted material that insulates the body from external temperatures. It enables fire fighters to operate in the high temperatures generated by a fire and keeps the body warm during cold weather.

The front of the turnout coat has an overlapping flap to provide a secure seal. The inner closure is secured first, and then the outer flap is secured, creating a double seal. Several different combinations of D-rings, snaps, zippers, and Velcro can be used to secure the inner and outer closures.

The collar of the turnout coat works with the hood to protect the neck. The collar has snaps or a Velcro closure system in front to keep it in a raised position. The coat's sleeves feature wristlets that prevent liquids or hot embers from getting between the sleeves and the skin. They also prevent the sleeves from riding up on the wrists, so there is no exposed skin between the gloves and the sleeves, which could result in wrist burns.

Turnout coats come in two lengths—long and short. Both will protect the body as long as the matching style of pants or coveralls is worn simultaneously. The coat must be long enough that you can raise your arms over your head without exposing your midsection. The sleeve length should not hinder arm movement, and the coat should be large enough that it does not interfere with breathing or other movements.

Pockets in the coat can be used for carrying small tools or extra gloves. Additional pockets or loops can be installed to hold radios, microphones, flashlights, or other accessories.



**Figure 2-15** Bunker pants.

### Fire Marks

Bunker coats were originally made of rubber and designed primarily to repel water. Today's coats provide protection from flames, heat, abrasions, and cuts as well as water.

### Bunker Pants

The protective trousers included as part of the structural fire-fighting ensemble are also called **bunker pants** or **turnout pants** **Figure 2-15 ▲**. They can be constructed in a waist-length design or a bib-overall configuration. Like turnout coats, bunker pants must satisfy the conditions specified in NFPA 1971.

Also like turnout coats, bunker pants are constructed with three layers. The outer shell resists abrasions and repels water. The second layer is a moisture barrier that protects the skin from liquids and steam burns. The third, inner layer is a quilted, thermal barrier that protects the body from elevated temperatures. Bunker pants are reinforced around the ankles and knees with leather or extra padding.

Bunker pants are manufactured with a double fastener system at the waist, similar to the front flap of a turnout coat. Florescent or reflective stripes around the ankles provide added



**Figure 2-16** Rubber firefighting boots.



**Figure 2-18** Firefighting gloves.



**Figure 2-17** Leather firefighting boots.

visibility. Suspenders hold the pants up. Pants should be large enough that you can don them quickly. They should be big enough to allow you to crawl and bend your knees easily, but they should not be bigger than necessary.

### Boots

Structural firefighting boots can be constructed of rubber or leather; they are available in a variety of lengths. Rubber firefighting boots come in a step-in style without laces **Figure 2-16 ▲**. Leather firefighting boots are available in a knee-length, pull-on style or in a shorter version with laces **Figure 2-17 ▲**. Many fire fighters install a zipper on the laced boots to aid in quick donning and doffing.

Both boot styles must meet the requirements specified in NFPA 1971. The outer layer of these boots repels water and must be both flame- and cut-resistant. Boots must also have a heavy sole with a slip-resistant design, a puncture-resistant sole, and a reinforced toe to prevent injury from falling objects. An inner liner constructed of a material such as Nomex or Kevlar® adds thermal protection.

Boots must be the correct size for the foot. The foot should be secure within the boot to prevent ankle injuries and enable

### Fire Fighter Safety Tips

Fire boots must be worn with approved bunker pants. Boots worn without bunker pants leave the legs unprotected and exposed to injury.

secure footing on ladders or uneven surfaces. Improperly sized boots will cause blisters and other problems.

### Gloves

Gloves are an important part of the firefighting ensemble, because most fire suppression tasks require the use of the hands **Figure 2-18 ▲**. Gloves must provide adequate protection, yet permit the manual dexterity needed to accomplish tasks. NFPA 1971 specifies that gloves must be resistant to heat, liquid absorption, vapors, cuts, and penetration. Gloves must have a wristlet to prevent skin exposure during normal firefighting activities.

Firefighting gloves are usually constructed of heat-resistant leather. The wristlets are usually made of knitted Nomex or Kevlar®. The liner adds thermal protection and serves as a moisture barrier.

Many fire fighters carry a second set of gloves in their bunker gear or on the fire apparatus so they can change gloves if one pair becomes wet or is damaged. Do not wring or twist wet gloves, as this motion can tear or damage the inner liners.

Although gloves furnish needed protection, they inevitably reduce manual dexterity. For this reason, fire fighters need to

### Fire Fighter Safety Tips

The inner thermal liner of most turnout coats can be removed while the outer shell is being cleaned, but the turnout coat should never be used without the thermal liner. Severe injury could occur if the coat is used without the liner.



**Figure 2-19** A PASS device can save a fire fighter's life.

### Fire Fighter Safety Tips

Plain leather work gloves or plastic-coated gloves should never be used for structural firefighting. Gloves used for structural firefighting must be labeled as such and meet the specifications given by NFPA 1971.



**Figure 2-20** Some fire apparatus are equipped with an intercom system.

### Fire Fighter Tips

Fire fighters have personal preferences about the tools and equipment they carry in their pockets. Observe what seasoned members of your department carry in their pockets. Their choices will help you decide whether you need to carry similar equipment.

practice manual skills while wearing gloves to become accustomed to them and to learn to adjust their movements accordingly.

### Respiratory Protection

The SCBA is an essential component of the PPE used for structural firefighting. Without adequate respiratory protection, fire fighters would be unable to mount an attack. The design, parts, operation, use, and maintenance of this complex piece of equipment are covered later in this chapter.

### Personal Alert Safety System

A **personal alert safety system (PASS)** is an electronic device that sounds a loud audible signal when a fire fighter becomes trapped or injured. This device will sound automatically if a fire fighter is motionless for a set time period. It can also be manually activated to notify other fire fighters that the user needs assistance.

A PASS device can be either separate from or integrated into the SCBA unit **Figure 2-19 ▲**. The integrated PASS devices turn on automatically when the SCBA is activated. The separate PASS devices are often worn on the SCBA harness and must be turned on manually. All fire fighters must check that their PASS devices are on and working properly before they enter a burning building or hazardous area.

The PASS device combines an electronic motion sensor with an alarm system. If the user remains motionless for 30 seconds, it will produce a low warning tone before sounding a full alarm. The user can reset the device by moving during this warning period. Newer PASS devices also include a radio transmitter that sends a signal to the command post when the alarm sounds.

### Additional Personal Protective Equipment

Some eye protection is provided by the face shield mounted on fire helmets. When additional eye protection is needed, such as when they are using power saws or hydraulic rescue tools, fire

fighters can use approved goggles. Goggles can be carried easily in the pockets of the turnout coat.

Fire fighters are often exposed to loud noises such as sirens and engines. Because hearing loss is cumulative, it is important to limit exposure to loud sounds. An intercom system on the apparatus can provide hearing protection **Figure 2-20 ▲**. A small microphone is incorporated into large earmuffs located at each riding and operating position. Fire fighters don the earmuffs, which reduce engine and siren noise; at the same time, the microphone enables crew members to talk to each other in a normal tone of voice and to hear the apparatus radio. Flexible ear plugs are useful in other situations involving loud sounds. Fire fighters should use the hearing protection supplied by their departments to prevent hearing loss.

A fire fighter should always carry a **hand light**, given that most interior firefighting is done in near-dark, zero-visibility conditions. A good working hand light can illuminate your surroundings, mark your location, and help you find your way under difficult conditions.

Two-way radios link the members of a firefighting team. At least one member of each team working inside a burning building or in any hazardous area should always have a radio. Some fire departments provide a radio for every on-duty fire fighter. Follow your department's SOP on radio use. A radio should be considered part of PPE and carried with you whenever it is appropriate.

### Limitations of the Structural Firefighting Ensemble

The structural firefighting ensemble protects a fire fighter from the hostile environment of a fire. To provide complete protection, each component must be properly donned and worn continually.

# Voices of Experience



The word “SAFETY” is consistently reinforced in every fire department throughout our nation. From the east coast to the west, whether professional or volunteer, it’s the tie that binds us together. As a fire service instructor and company officer with over twenty-six years of experience, I have encountered numerous situations where safety was only verbalized. Accomplishing an objective doesn’t necessarily account for safe operations. It is important that aspiring fire fighters understand this concept.

There are three general components to safety that can be instituted at any incident, which must be known in order to accomplish specific tasks in a safe manner.

1. Take your physical fitness seriously. The number one cause of death in the fire service is stress. Being fit will assist you in performing the tasks of your job safely. Your life and the safety of those around you depend on your physical fitness.
2. Learn, know, and understand your job. Your actions throughout your career will depend upon you acquiring and maintaining a working knowledge of the job. Your safety and the safety of your crew depend upon your skill set.
3. Most importantly, always maintain situational awareness. In stressful situations, it is common to acquire tunnel vision. Be aware of your situation and the actions of those around you. This could save your life.

Every fire fighter is responsible for his or her own safety first. Utilizing the three components of “SAFETY” has enhanced not only my own safety, but the safety of my crews and my students. Understanding how to operate safely is the key to your success and longevity as a fire fighter. Remember these components to “SAFETY” during your journey.

Dave Winkler  
El Camino Fire Academy  
Inglewood, California

“Understanding how to operate safely is the key to your success and longevity as a fire fighter.”



**Figure 2-21** It takes practice to don the full PPE.

Unfortunately, even today's advanced PPE has drawbacks and limitations. Understanding those limitations will help you avoid situations that could result in serious injury or death.

First, this ensemble is not easy to don. It includes several components, all of which must be put on in the proper order and correctly secured. You must be able to don your equipment quickly and correctly, either at the fire station before you respond to an emergency, or after you arrive at the scene. Properly donning and doffing PPE takes practice **Figure 2-21**.

PPE is also heavy, accounting for nearly 50 pounds of extra weight. This increased weight means that everything you do—even walking—requires more energy and strength. Tasks such as advancing an attack line up a stairway or using an axe to ventilate a roof can be difficult, even for a fire fighter in excellent physical condition.

Because PPE retains body heat and perspiration, wearing this equipment makes it difficult for the body to cool itself. Perspiration is retained inside the protective clothing rather than being released through evaporation to cool you. As a consequence, fire fighters in full protective gear can rapidly develop elevated body temperatures, even when the ambient temperature is cool. The problem of overheating is more acute when surrounding temperatures are high, which is one reason why fire fighters must undergo regular rehabilitation and fluid replacement.

Another drawback to PPE is that it limits mobility. Full turnout gear not only limits the range of motion, but also makes movements awkward and difficult. This constraint increases energy expenditure and adds stress.

Wearing PPE also decreases normal sensory abilities. The sense of touch is reduced by wearing heavy gloves, for example. Turnout coats and pants protect skin but reduce its ability to determine the temperature of hot air. Sight is restricted when you wear SCBA. The plastic face piece reduces peripheral vision, and the helmet, hood, and coat make turning the head difficult. Both the earflaps and the protective hood over the ears limit hearing. Speaking becomes muffled and distorted by the SCBA face piece, unless it is equipped with a special voice amplification system.

For these reasons, fire fighters must become accustomed to wearing and using PPE. Practicing skills while wearing PPE will help you become comfortable with its operation and limitations.

### Fire Fighter Safety Tips

*Do not* don protective clothing inside the apparatus while en route to an emergency incident. Instead, stay in your assigned seat, properly secured by a seat belt or safety harness, while the vehicle is in motion. Don protective clothing in the firehouse before mounting the apparatus, or put it on at the scene after you arrive.

### Fire Fighter Tips

NFPA 1001 requires fire fighters to don personal protective clothing in 1 minute. Practice donning your protective clothing ensemble until you can do it quickly and smoothly. Remember that each piece of the ensemble must be in place for maximum protection.

### Work Uniforms

A fire fighter's work uniform is also part of the personal protective package. Certain synthetic fabrics can melt at relatively low temperatures and cause severe burns, even when worn under a complete personal protective ensemble. NFPA 1975, *Standard on Station/Work Uniforms for Fire and Emergency Services*, defines criteria for selecting appropriate fabrics for work uniforms.

Clothing containing nylon or polyester, even if these materials are blended with natural fibers, should not be worn in a firefighting environment. Clothing made of natural fibers, such as cotton or wool, is generally safer to wear. Nylon and polyester will melt, but cotton and wool may char or even burn without melting. Special synthetic fibers such as Nomex and PBI®, which are used in turnout clothing, have excellent resistance to high temperatures. Volunteer fire fighters, who often wear PPE over their normal clothing, should consider these fabric properties when selecting their wardrobe.

### Donning Personal Protective Clothing

Donning (i.e., putting on) protective clothing must be done in a specific order to obtain maximum protection; it must also be done quickly. Fire fighters should be able to **don** personal protective clothing in 1 minute or less. Meeting this standard requires considerable practice, but remember that your goals should be (1) to don PPE properly, and (2) to do it consistently in 60 seconds or less.

Following a set pattern of donning PPE can help reduce the time it takes to dress. This exercise does not include donning SCBA, however. First become proficient in donning personal protective clothing, and then add the SCBA. Follow the steps in **Skill Drill 2-1** to don personal protective clothing:

1. Place equipment in a logical order for donning. (**Step 1**)
2. Place the legs of your bunker pants over your boots, and fold the pants down around them.
3. Place your protective hood over the top of your boots to remind you to put on your protective hood.

4. Lay out your coat, helmet, and gloves.
5. Place your protective hood over your head and down around your neck. (Step 2)
6. Step into your boots and pull up your bunker pants. Place the suspenders over your shoulders, and secure the front of the pants using the closure system. (Step 3)
7. Put on your turnout coat, and secure the inner and outer closures. (Step 4)
8. Place your helmet on your head with ear tabs extended, and adjust the chin strap securely. Turn up your coat collar and secure it in front. (Step 5)
9. Put on your gloves. (Step 6)
10. Check all clothing to be sure it is properly secured and in the correct position. Have your partner check your clothing. (Step 7)

## ■ Doffing Personal Protective Clothing

To **do**ff (i.e., remove) your personal protective clothing, reverse the procedure used in getting dressed. Follow the steps in

**Skill Drill 2-2 ▶** to doff personal protective clothing:

1. Remove your gloves. (Step 1)
2. Open the collar of your turnout coat. (Step 2)
3. Release the helmet chin strap and remove your helmet. (Step 3)
4. Remove your turnout coat. (Step 4)
5. Remove your protective hood. (Step 5)
6. Remove your bunker pants and boots. (Step 6)

If necessary, PPE should be cleaned after it is used, and then placed in a convenient location until the next response. Such equipment may be kept close to the apparatus, on the apparatus, or in an equipment locker. Wherever it is stored, personal protective clothing must be properly maintained, organized, and ready for the next emergency response.

## ■ Care of Personal Protective Clothing

Approved personal protective clothing is built to exacting standards but requires proper care if it is to continue to afford maximum protection. Avoid unnecessary wear on turnout clothing. A complete set of approved turnout clothing (excluding SCBA) costs more than \$1000. Keep this expensive equipment in good shape for its intended use—structural firefighting.

Check the condition of your PPE on a regular basis. Clean it when necessary; repair worn or damaged PPE at once. PPE that is worn or damaged beyond repair must be replaced immediately because it will not be able to protect you.

Avoid unnecessary cuts or abrasions on the outer material. This material already meets NFPA standards—do not look for new opportunities to test its effectiveness. If the fabric is

damaged, it must be properly repaired to retain its protective qualities. Follow the manufacturer's instructions for repairing or replacing PPE.

You must also keep personal protective clothing clean so that it will maintain its protective properties. Dirt will build up in the clothing fibers from routine use and exposure to fire environments. Smoke particles will also become embedded in the outer shell material. The interior layers will frequently be soaked with perspiration. Regular cleaning should remove most of these contaminants.

Other contaminants are formed from the by-products of burnt plastics and synthetic products. These residues, which are flammable, can become trapped between the fibers or build up on the outside of PPE, damaging the materials and reducing their protective qualities. A fire fighter who is wearing contaminated PPE is, in essence, bringing additional fuel into the fire on the clothing.

PPE that has been badly soiled by exposure to smoke, other products of combustion, melted tar, petroleum products, or other contaminants needs to be cleaned as soon as possible. Items that have been exposed to chemicals or hazardous materials may have to be impounded for decontamination or disposal.

Cleaning instructions are listed on the tag attached to the clothing. Always follow the manufacturer's cleaning instructions. Failure to do so may reduce the effectiveness of the garment and create an unsafe situation for the wearer.

Some fire departments have special washing machines that are approved for cleaning turnout clothing. Other departments contract with an outside firm to clean and repair protective clothing. In either case, the manufacturer's instructions for cleaning and maintaining the garment must be followed.

Other PPE may also require regular cleaning and maintenance. For example, the outer shell of your helmet should be cleaned with a mild soap as recommended by the manufacturer. The inner parts of helmets should be removed and cleaned according to the manufacturer's instructions. The chin strap and suspension system must be properly adjusted and all parts of the helmet kept in good repair.

Protective hoods and gloves get dirty quickly and should be cleaned according to the manufacturer's instructions. Most hoods can be washed with appropriate soaps or detergents. Repair or discard gloves or hoods that have holes in them; do not use them. Even a small cut or opening in these items can result in a burn injury.

Boots should be maintained according to the manufacturer's instructions. Rubber boots need to be kept in a place that does not result in damage to the boot. Leather boots must be properly maintained to keep them supple and in good repair. Any type of boot needs to be repaired or replaced if the outer shell is damaged. Do not store these items or any other PPE in direct sunlight.

### Fire Fighter Safety Tips

In hot weather, remove as much of your PPE as possible when you arrive at rehab. This step will help you to cool down quickly. Some fire departments even place fans and misting equipment in the rehab area to provide additional cooling.

### Fire Fighter Safety Tips

Make sure your PPE is dry before using it on the fire ground. If wet protective clothing is exposed to the high temperatures of a structural fire, the water trapped in the liner materials will turn into steam and be trapped inside the moisture barrier. The result may be painful steam burns.

Skill Drill **2-1**

## Donning Personal Protective Clothing



- 1** Place your equipment in a logical order for donning.



- 2** Place your protective hood over your head and down around your neck.



- 3** Put on your boots and pull up your bunker pants. Place the suspenders over your shoulders and secure the front of the pants.



- 4** Put on your turnout coat and close the front of the coat.



- 5** Place your helmet on your head and adjust the chin strap securely. Turn up your coat collar and secure it in front.



- 6** Put on your gloves.



- 7** Have your partner check your clothing.

Skill Drill **2-2**

## Doffing Personal Protective Clothing

**1** Remove your gloves.**2** Open the collar of your turnout coat.**3** Release the helmet chin strap and remove your helmet.**4** Remove your turnout coat.**5** Remove your protective hood.**6** Remove your bunker pants and boots.**Fire Fighter Safety Tips**

Turnout clothing must be properly cleaned and maintained to provide maximum protection. Dirty turnout clothing is a sign of carelessness, not of experience.

### ■ Specialized Protective Clothing

#### Vehicle Extrication

Owing to the risk of fire at the scene of a vehicle extrication incident, most members of the emergency team will wear full turnout gear. The officer in charge may also designate one or more members to don SCBA and stand by with a charged hose line. A structural firefighting ensemble also protects against many of the hazards present at a vehicle extrication incident, such as broken glass and sharp metal objects.

Some protective clothing, such as special gloves and coveralls or jumpsuits, has been specifically designed for vehicle extrication. These items are generally lighter in weight and more flexible than structural firefighting PPE, although they may be constructed of the same basic materials.

Fire fighters performing vehicle extrication must always be aware of the possibility of contact with blood or other body fluids. Latex gloves should be worn when providing patient treatment. Eye protection should be worn, given the possibilities of breaking glass, contact with body fluids, metal debris, and accidents with tools. Proper cleaning of extrication gear is especially important because many of the fluids encountered during vehicle extrication are oil based—for example, gasoline, diesel fuel, transmission fluid, and brake fluid. Because of the flammability of these fluids, they pose a hazard for firefighters who enter a burning building while wearing oil-contaminated turnout gear.



## Near Miss REPORT

**Report Number:** 05-0000535

**Report Date:** 09/19/2005 23:04

**Synopsis:** Inadequate protective clothing contributes to fire fighter injury.

**Event Description:** At a structure fire in a metal frame and metal siding workshop, I was on a 2.5-inch line with a fire fighter from another department. At that time, we were conducting an exterior attack on the fire from the front of the building, in front of a metal roll-up door. The door had fallen down and was lying in the way of us advancing the hose line into the shop to extinguish hot spots. The door was also positioned in such a way that it was difficult for me to get the stream where I wanted it inside the shop. I shut down the nozzle and moved the metal door, which was all the way on the ground now and not connected to the building. We had no problem directing our fire stream after that, and we had a clear access point into the shop.

About 10 minutes later, I was picking up an object to move it out of the way (something smaller than the door) with my right hand, which had just a regular leather work glove on it the whole time, when I noticed blood streaming down my wrist and in my glove. I reported to the ambulance and got it flushed, cleaned, and wrapped; I then went back to work.

If the cut had been any deeper, it would have nicked one of my veins and I could have been in bad shape. I never felt the metal door cut into me. I was wearing full PPE the whole time, with the exception of my leather work gloves. I'll have a pretty good scar to remind me. If I had been wearing my fire gloves, which have extended cuffs on them, and had asked for a hand moving the door, I probably would not have been injured. However, at the time, there were not many fire fighters on scene to help me, and coordination between the four or five departments that were there seemed somewhat nonexistent to me. Four other fire fighters were taken out for rehab, two had IVs started on scene, and two or three were transported to the hospital. The contents of the shop were pretty much a total loss.

**Lessons Learned:** Wear your PPE so that no skin is exposed. Ask for help when moving heavy objects—don't try to fight the fire by yourself.

Fewer trucks and more personnel on the scene can sometimes lead to less chaos. Likewise, better coordination of tasks and teams leads to more effective operations.

Better training and equipment for volunteer fire fighters would also be helpful. Some fire fighters who were on scene just stood around not knowing what was going on and couldn't do much because they didn't have the knowledge or the equipment to assist safely. Some groups of fire fighters with no PPE were walking around the shop with small portable foam units applying it to the fire through holes in the wall, even as others were washing the foam away with the hose lines from the front of the building and negating what the others were doing.

### Demographics

**Department type:** Combination, mostly volunteer

**Job or rank:** Fire Fighter

**Department shift:** Other

**Age:** 25–33

**Years of fire service experience:** 4–6

**Region:** FEMA Region VI

### Event Information

**Event type:** Fire emergency event: structure fire, vehicle fire, wildland fire, etc.

**Event date:** 09/01/2005

**Event participation:** Involved in the event

**Do you think this will happen again?** Uncertain

**What were the contributing factors?**

Teamwork

Human error

Equipment

Individual action

**What do you believe is the loss potential?**

Life-threatening injury

## Wildland Fires

Gear that is designed specifically for fighting wildland or brush fires must meet the requirements outlined in NFPA 1977, *Standard on Protective Clothing and Equipment for Wildland Fire Fighting*. In this type of firefighting ensemble, the jacket and pants are made of fire-resistant materials, such as Nomex or specially treated cotton, which are designed for comfort and maneuverability while working in the wilderness. Wildland fire fighters wear a helmet of a thermo-resistant plastic, eye protection, and pigskin or leather gloves. Their boots are designed to provide comfort and sure footing while hiking to a remote fire scene and to ensure protection against crush and puncture injuries.

## Respiratory Protection

Respiratory protection equipment is an essential component of the structural firefighting personal protection ensemble. An SCBA is both expensive and complicated; using one confidently requires practice. Fire fighters must be proficient in using SCBA before they engage in interior fire suppression activities.

The interior atmosphere of a burning building is considered to be **IDLH (immediately dangerous to life and health)**. Attempting to work in such an atmosphere without proper respiratory protection can cause serious injury or death. Never enter or operate in a fire atmosphere without first ensuring appropriate respiratory protection.

## Respiratory Hazards of Fires

Fire fighters need respiratory protection because a fire involves a complex series of chemical reactions that can rapidly affect the atmosphere in unpredictable ways. The most readily evident by-product of a fire is smoke. The visible smoke produced by a fire contains many different substances, some of which are dangerous if inhaled. In addition, smoke contains invisible, highly toxic products of combustion. The process of combustion consumes oxygen and can lower the oxygen concentration in the atmosphere below the level necessary to support life. In addition, the atmosphere of a fire may become so hot that one unprotected breath can result in fatal respiratory burns.

These respiratory hazards require fire fighters to use respiratory protection in all fire environments, regardless of whether the environment is known to be contaminated, suspected of being contaminated, or could possibly become contaminated without warning. The use of SCBA allows fire fighters to enter and work in a fire atmosphere with a safe, independent air supply.

### Smoke

Most fires do not have an adequate supply of oxygen to consume all of the available fuel. As a consequence, they result in **incomplete combustion** and produce a variety of by-products, which are then released into the atmosphere. Many of these by-products are extremely toxic. Collectively, the airborne products of combustion are called smoke. Smoke has three major components: particles, vapors, and gases.

**Smoke Particles** **Smoke particles** consist of unburned, partially burned, and completely burned substances. These particles are lifted in the thermal column produced by the fire and are usu-

### Fire Marks

Modern SCBA has made interior firefighting operations safer and more effective. Before SCBA, fire-ground injuries and fatalities caused by smoke inhalation were common. Thousands of fire fighters died from respiratory diseases, cancer, or other medical conditions that were direct consequences of repeated, unprotected exposure to smoke and other products of combustion. These exposures often had a cumulative, sometimes delayed effect. Each time fire fighters inhaled poisonous compounds, their lungs became more damaged, even though the damage did not become evident until years later.

### Fire Fighter Safety Tips

Smoky environments and oxygen-deficient atmospheres are deadly! It is essential to use SCBA at all times when operating in a smoky environment.

ally readily visible. The completely burned particles are primarily ash; the unburned and partially burned smoke particles can include a variety of substances. The concentration of unburned or partially burned particles depends on the amount of oxygen that was available to fuel the fire.

Many smoke particles are so small that they can pass through the natural protective mechanisms of the respiratory system and enter the lungs. Some are toxic to the body and can result in severe injuries or death if they are inhaled. These particles also can prove extremely irritating to the eyes and digestive system.

**Smoke Vapors** Smoke also contains small droplets of liquids. These smoke vapors are similar to fog, which consists of small water droplets suspended in the air. When oil-based compounds burn, they produce small hydrocarbon droplets that become part of the smoke. If inhaled or ingested, these compounds can affect the respiratory and circulatory systems. Some of the toxic droplets in smoke can cause poisoning if they are absorbed through the skin.

When water is applied to a fire, it creates steam and water droplets that in turn become part of the smoke. These water droplets can absorb some of the toxic substances contained in the smoke.

**Toxic Gases** A fire also produces several types of gases. The amount of oxygen available to the fire and the type of fuel being burned determine precisely which gases are produced. A fire fueled by wood, for example, produces a different mixture of gases than one fueled by petroleum-based products. (Remember, many common products—such as plastics—are made from petroleum-based compounds.) The concentrations of these gases can change rapidly as the oxygen supply is consumed or as fresh oxygen is introduced to the combustion process.

Many of the gases commonly produced by residential or commercial fires are highly toxic. Carbon monoxide, hydrogen cyanide, and phosgene are three of many gases often present in smoke.

**Table 2-6 Physiological Effects of Reduced Oxygen Concentration**

| Oxygen Concentration | Effect                                                     |
|----------------------|------------------------------------------------------------|
| 21%                  | Normal breathing air                                       |
| 17%                  | Judgment and coordination impaired; lack of muscle control |
| 12%                  | Headache, dizziness, nausea, fatigue                       |
| 9%                   | Unconsciousness                                            |
| 6%                   | Respiratory arrest, cardiac arrest, death                  |

Carbon monoxide is deadly in small quantities. When inhaled, this gas quickly replaces the oxygen in the bloodstream because it binds with hemoglobin molecules (which normally carry oxygen to the body's cells) in the blood 200 times more readily than oxygen does. Even a small concentration of CO can quickly disable and kill a fire fighter. Carbon monoxide is odorless, colorless, and tasteless, which also makes it dangerous. Because this gas cannot be detected without special instruments, fire fighters must always assume that it is present in the atmosphere around a fire.

**Hydrogen cyanide** is formed when plastic products—such as the polyvinyl chloride pipe used in residential construction—burn. This poisonous gas is quickly absorbed by the blood and interferes with cellular respiration. Just a small amount of hydrogen cyanide can easily render a person unconscious. Recent studies have indicated that cyanide poisoning in fire fighters may be more common than previously known.

**Phosgene** gas is formed from incomplete combustion of many common household products, including vinyl materials. This gas can affect the body in several ways. At low levels, it causes itchy eyes, a sore throat, and a burning cough. At higher levels, phosgene gas can cause pulmonary edema (fluid retention in the lungs) and death. Phosgene gas was used as a weapon in World War I to disable and kill soldiers.

Fires produce other gases that may affect the human body in harmful ways. Among these toxic gases are hydrogen chloride and several compounds containing different combinations of nitrogen and oxygen. Carbon dioxide, which is produced when sufficient oxygen is available to allow for complete combustion, is not toxic, but it can displace oxygen from the atmosphere and cause asphyxiation.

### Oxygen Deficiency

Oxygen is required to sustain human life. Normal outside or room air contains approximately 21 percent oxygen. A decrease in the amount of oxygen in the air, however, may drastically affect an individual's ability to function **Table 2-6**. An atmosphere with an oxygen concentration of 19.5 percent or less is considered oxygen-deficient. If the oxygen level drops below 17 percent, people can experience disorientation, an inability to control their muscles, and irrational thinking, which can make escaping a fire much more difficult.

During compartment fires (fires burning within enclosed areas), **oxygen deficiency** occurs in two ways. First, the fire consumes large quantities of the available oxygen, thereby decreas-

ing the concentration of oxygen in the atmosphere. Second, the fire produces large quantities of other gases, which decrease the oxygen concentration by displacing the oxygen that would otherwise be present inside the compartment.

### Increased Temperature

Heat is also a respiratory hazard. The temperature of the gases generated during a fire varies, depending on the fire conditions and the distance traveled by the hot gases. Inhaling superheated gases produced by a fire can cause severe burns of the respiratory tract. If the gases are hot enough, a single inhalation can cause fatal respiratory burns. More information about fire behavior and products of combustion appears in Chapter 5, Fire Behavior.

### Other Toxic Environments

Not all hazardous atmospheric conditions are caused by fires. Indeed, fire fighters may encounter toxic gases or oxygen-deficient atmospheres in numerous types of emergency situations. Respiratory protection is just as important in these situations as in a fire suppression operation.

For example, toxic gases may be released at hazardous materials incidents from leaking storage containers or industrial equipment, from chemical reactions, or from the normal decay of organic materials. Carbon monoxide can be produced by internal combustion engines or improperly adjusted heating appliances. Exposure to carbon monoxide or some other toxic gas should be suspected whenever fire fighters find one or more unconscious patients with no evident cause.

Toxic gases can quickly fill confined spaces or below-grade structures. Any confined space or below-grade area must be treated as a hazardous atmosphere until it has been tested to ensure that the concentration of oxygen is adequate and that no hazardous or dangerous gases are present.

### Fire Fighter Safety Tips

Consider all below-grade areas or confined spaces to be IDLH—until they have been tested.

### Conditions That Require Respiratory Protection

Most fire deaths are caused by smoke inhalation rather than burns. Clearly, then, adequate respiratory protection is essential to your safety. In fact, the products of combustion from house fires and commercial fires may be so toxic that just a few breaths can result in death—which is why you must always take respiratory protection precautions before entering the fire. When you first arrive at the scene of a fire, you do not have any way to measure the immediate danger to your life and your health posed by that fire. You must use approved breathing apparatus if you are going to enter and operate within this atmosphere.

Whenever you are in an area where there is smoke, you must use SCBA. This includes when you are responding to outside fires such as vehicle and dumpster fires. Use your SCBA

at the fire scene and continue to wear it during overhaul until the air has been tested and proven to be safe by the safety officer. Do not remove your SCBA just because a fire has been knocked down.

SCBA must also be used in any situation where there is a possibility of toxic gases being present or oxygen deficiency, such as in a confined space. Always assume that the atmosphere is hazardous until it has been tested and proven to be safe.

## Types of Breathing Apparatus

The basic respiratory protection hardware used by the fire service is the SCBA. The term “self-contained” in the acronym for this equipment refers to the requirement that the apparatus be the sole source of the fire fighter’s air supply. In other words, SCBA is an independent air supply that will last for a predictable duration.

The two main types of SCBA are open-circuit and closed-circuit devices. **Open-circuit breathing apparatus** is typically used for structural firefighting. A tank of compressed air provides the breathing air supply for the user, and exhaled air is released into the atmosphere through a one-way valve **Figure 2-22**. Approved open-circuit SCBA comes in several different models, designs, and options.

**Closed-circuit breathing apparatus** recycles the user’s exhaled air. The air passes through a mechanism that removes carbon dioxide and adds oxygen within a closed system, where the oxygen is generated from a chemical canister **Figure 2-23**. Many closed-circuit SCBAs include a small oxygen tank as well as chemically generated oxygen. Closed-circuit breathing apparatus

is often used for extended operations, such as mine rescue work, where breathing apparatus must be worn for a long time.

A **supplied-air respirator (SAR)** uses an external source for the breathing air **Figure 2-24**. In this type of device, a hose line is connected to a breathing-air compressor or to compressed air cylinders located outside the hazardous area. The user breathes air through the line and exhales through a one-way valve, just as with an open-circuit SCBA.

Although SARs are commonly used in industrial settings, they are not used by fire fighters for structural firefighting. Hazardous materials teams and confined space rescue teams sometimes use SARs for specialized operations. Some fire service SCBA units can be adapted for use as SARs.



**Figure 2-22** Open-circuit SCBA.



**Figure 2-23** Closed-circuit SCBA.



**Figure 2-24** A supplied-air respirator may be needed for special rescue operations.

### Fire Fighter Safety Tips

Always put on SCBA before entering a confined space or a below-ground structure. Continue to use respiratory protection until the air is tested and deemed safe by the safety officer. Do not attempt confined-space operations without special training.

### Fire Fighter Tips

Do not confuse SCBA and SCUBA. SCBA is used by fire fighters during fire suppression activities. **Self-contained underwater breathing apparatus (SCUBA)** is used by divers while swimming underwater.

## ■ SCBA Standards and Regulations

In the United States, the **National Institute for Occupational Safety and Health (NIOSH)** sets the design, testing, and certification requirements for SCBA. NIOSH is a federal agency that researches, develops, and implements occupational safety and health programs. It also investigates fire fighter fatalities and serious injuries, and makes recommendations on how to prevent accidents from recurring.

OSHA and state agencies are responsible for establishing and enforcing regulations for respiratory protection programs. In some states and in Canadian provinces, individual occupational safety and health agencies establish and enforce these regulations.

The NFPA has developed three standards directly related to SCBA:

- NFPA 1500, *Standard on Fire Department Occupational Safety and Health Program*, includes the basic requirements for SCBA use and program management.
- NFPA 1404, *Standard for Fire Service Respiratory Protection Training*, sets the requirements for an SCBA training program within a fire department.
- NFPA 1981, *Standard on Open-Circuit Self-Contained Breathing Apparatus (SCBA) for Emergency Services*, includes requirements for the design, performance, testing, and certification of open-circuit SCBA for the fire service.

Each fire department must follow applicable standards and regulations to ensure safe working conditions for all personnel.

### Fire Marks

Many of the occupational health and safety regulations for the fire service and other workers use the term **respirator**. A respirator is a device that provides respiratory protection for the user. Several types of respirators are available that are geared toward different applications. SCBA is a particular type of respirator.

## ■ Uses and Limitations of Self-Contained Breathing Apparatus

SCBA is designed to provide pure breathing air to fire fighters who are working in the hostile environment of a fire. It must

meet rigid manufacturing specifications so that it can function in the increased temperature and smoke-filled environments that fire fighters encounter. When properly maintained, it will provide sufficient quantities of air for fire fighters to perform rigorous tasks.

Using SCBA requires that fire fighters develop unique skills, including different breathing techniques. This equipment limits normal sensory awareness; the senses of smell, hearing, and sight are all affected by the apparatus. Proficiency in the use of SCBA and other PPE requires ongoing training and practice.

Like any type of equipment, SCBA also has its limitations. Some of these limitations apply to the equipment; others apply to the user's physical and psychological abilities.

### Limitations of the Equipment

Because an SCBA carries its own air supply in a pressurized cylinder, its use is limited by the amount of air in the cylinder. SCBA for structural firefighting must carry enough air for a minimum of 30 minutes; cylinders rated for 45 minutes and 60 minutes are also available. These duration ratings, however, are based on ideal laboratory conditions. The realistic useful life of an SCBA cylinder for firefighting operations is usually much less than the rated duration, and actual use time will depend on the activities being performed and on the person who is using the apparatus. An SCBA cylinder will generally have a realistic useful life of 50 percent of the rated time. For example, an SCBA cylinder rated for 30 minutes can be expected to last for a maximum of 15 minutes of interior firefighting.

Fire fighters must manage their working time while using SCBA so that they have enough time to exit from the hazardous area before exhausting the air supply. If it takes 5 minutes to reach the work area and 5 minutes to return to fresh air, a 15-minute air supply provides a maximum of only 5 minutes of working time.

The weight of an SCBA varies, based on the manufacturer and the type and size of cylinder. Generally, an SCBA weighs at least 25 pounds. The size of the unit also makes it more difficult for the user to fit into small places **Figure 2-25 ▶**. The added weight and bulk decrease the user's flexibility and mobility, and shift the user's center of gravity.

The design of the SCBA face piece limits the fire fighter's vision—particularly his or her peripheral vision. The face piece may fog up under some conditions, further limiting visibility. SCBA also may affect the user's ability to communicate, depending on the type of face piece and any additional hardware provided, such as voice amplification and radio microphones. The equipment is noisy during inhalation and exhalation, which may limit the user's hearing as well.

### Physical Limitations of the User

Conditioning is important for SCBA users. An out-of-shape fire fighter will consume the air supply from this equipment more quickly and will have to exit the fire building long before a well-conditioned fire fighter. Overweight or poorly conditioned fire fighters are also at greater risk for heart attack due to physical stress.

The protective clothing and SCBA that must be worn when fighting fires weigh more than 50 pounds. Moving with this extra weight requires additional energy, which in turn increases



**Figure 2-25** SCBA expands a user's profile, making it more difficult to pass through tight spaces.

air consumption and body temperature. Taken collectively, this activity places additional stress on a fire fighter's body. A person with ideal body weight will be able to perform more work per cylinder of air than a person who is overweight.

The weight and bulk of the complete PPE ensemble limits a fire fighter's ability to walk, climb ladders, lift objects, and crawl through restricted spaces. Fire fighters must become accustomed to these limitations and learn to alter their movements accordingly. Practice and conditioning are key to becoming proficient in wearing and using PPE while fighting fires.

### Psychological Limitations of the User

In addition to the physical limitations, the user must make mental adjustments when wearing an SCBA. Breathing through an SCBA is different from normal breathing and can be very stressful. Covering your face with a face piece, hearing the air rushing in, hearing valves open and close, and exhaling against a positive pressure are all foreign sensations. The surrounding environment, which is often dark and filled with smoke, is foreign as well.

Fire fighters must adjust so that they can operate effectively under these stressful conditions. Practice in donning PPE, breathing through SCBA, and performing firefighting tasks in darkness helps to build confidence, not only in the equipment, but also in the fire fighter's personal skills. Training generally introduces one skill at a time. Practice each skill as it is introduced and try to become proficient in that skill. As your skills improve, you will be able to tackle tasks characterized by increasing levels of difficulty.



**Figure 2-26** SCBA backpacks come in a variety of models.

## Components of Self-Contained Breathing Apparatus

SCBA consists of four main parts: the backpack and harness, the air cylinder assembly, the regulator assembly, and the face piece assembly. Although the basic features and operations of all models are similar, you need to become familiar with the specific SCBA used by your department.

### Backpack and Harness

The **backpack** provides the frame for mounting the other working parts of the SCBA **Figure 2-26** . It is usually constructed of a lightweight metal or composite material.

The **SCBA harness** consists of the straps and fasteners used to attach the SCBA to the fire fighter. Most harnesses have two adjustable shoulder straps and a waist belt. Depending on the specific model of SCBA, the waist belt and shoulder straps will carry different proportions of the weight. The procedures for tightening and adjusting the straps also vary based on the model. The harness must be secure enough to keep the SCBA firmly fastened to the user, but not so tight that it interferes with breathing or movements. The waist strap must be tight enough to keep the SCBA from moving from side to side or getting caught on obstructions.

### Air Cylinder Assembly

A compressed **air cylinder** holds the breathing air for an SCBA. This removable cylinder is attached to the backpack harness and can be changed quickly in the field. An experienced fire fighter should be able to remove and replace the cylinder in complete darkness.

Fire fighters should be familiar with the type of cylinders used in their departments. Cylinders are marked with the materials used in their construction, the working pressure, and the rated duration.

The air pressure in filled SCBA cylinders ranges from 2200 to 4500 **pounds per square inch (psi)**. The greater the air pressure, the more air that can be stored in the cylinder.

Low-pressure cylinders, which are pressurized at 2200 psi, can be constructed of steel or aluminum and are usually rated



**Figure 2-27** SCBA regulator.

for 30 minutes of use. Composite cylinders are generally constructed of an aluminum shell wrapped with carbon, Kevlar, or glass fibers. They are significantly lighter in weight, can be pressurized up to 4500 psi, and are rated for 30, 45, or 60 minutes of use.

As previously noted, the rated duration times are established under laboratory conditions. A working fire fighter can quickly use up the air because of exertion, so the ratings should be viewed with caution. Generally, the working time available for a particular cylinder is half the rated duration.

The neck of an air cylinder is equipped with a hand-operated shut-off valve. The **pressure gauge** is located near the shut-off valve; it shows the amount of pressure currently in the cylinder. Be careful not to damage the threads or let any dirt get into the outlet of the cylinder.

### Regulator Assembly

**SCBA regulators** may be mounted on the waist belt or shoulder strap of the harness or attached directly to the face piece **Figure 2-27** ▶. The regulator controls the flow of air to the user. Inhaling decreases the air pressure in the face piece. This change in pressure opens the regulator, which in turn releases air from the cylinder into the face piece. When inhalation stops, the regulator shuts off the air supply. Exhaling opens a second valve (the exhalation valve) to expel the exhaled air into the atmosphere. SCBA regulators are capable of delivering large volumes of air to support the strenuous activities required in firefighting.

SCBA regulators will maintain a slight positive air pressure in the face piece in relation to the ambient air pressure outside the face piece. This feature helps to prevent the hazardous atmosphere outside the face piece from leaking into the face piece during inhalation. If any leakage occurs in the area where the face piece and the face make the seal, the positive-pressure breathing air inside the face piece will help to prevent the hazardous atmosphere from entering the device. Regardless of the positive pressure, a proper face piece-to-face seal must always be maintained. Breathing with this slight positive pressure may require some practice. New fire fighters often report that it takes more energy to breathe when first using positive-pressure SCBA, but note that this sensation gradually decreases.

Regulators are equipped for two modes of operation—normal mode and emergency bypass mode. In normal mode (which was described previously), the regulator supplies breathing air during inhalation, stops when inhalation stops, and then opens an exhalation valve to exhaust used air into the atmosphere. To activate the normal mode, some SCBA models require that the user turn a yellow-colored valve. Simply attaching the regulator to the face piece and beginning to breathe will activate the normal mode in other models.

The **emergency bypass mode** is used only if the regulator malfunctions. Some manufacturers provide a combination bypass/purge valve on certain SCBA models. The combination valve permits the wearer to “purge” the face piece for defogging purposes and also functions as a bypass valve in the event of regulator failure. The bypass valve is activated when the user turns on the red-colored emergency bypass valve or the combination bypass/purge valve. This action releases a constant flow of breathing air into the face piece. The emergency bypass mode uses more air, but it enables fire fighters to exit a hazardous environment if the regulator stops operating. A fire fighter who must use the emergency bypass mode must leave the hazardous area *immediately*.

Like the cylinder, the regulator has a gauge that indicates the pressure of the breathing air remaining in the cylinder. This gauge enables the user to monitor the amount of air remaining in the cylinder. The regulator pressure gauge can be mounted directly on the regulator or may be located on a separate hose so it can be attached to a shoulder strap for easier viewing. The readings on the regulator and cylinder pressure gauges should be within 100 psi of each other.

NFPA standards require that SCBA include a low-air alarm that activates when one-fourth of the air supply remains. This alarm may take the form of a bell or whistle, a vibration, or a flashing **light-emitting diode (LED)**. Early SCBA devices (those manufactured before the 1997 edition of NFPA 1981 became effective) have a single low-air supply alarm. Newer models have two types of low-air alarms that operate independently of each other and activate different senses. For example, one alarm might ring a bell, whereas the second alarm might vibrate or flash an LED. Fire fighters should never ignore the low-air alarm.

Some SCBA models include integrated PASS devices. Turning on the air supply automatically activates these PASS devices, which ensures that a fire fighter doesn't forget to turn the PASS device on when entering a hazardous area. If your SCBA is equipped with a PASS device, learn how to activate it and how to turn it off **Figure 2-28** ▶.

Although many models of SCBA regulators exist, fire fighters must learn how to operate the particular model that is used in their department. They should be able to operate the regulator in the dark and with gloves on.

### Face Piece Assembly

The **face piece** delivers breathing air to the fire fighter and protects the face from high temperatures and smoke **Figure 2-29** ▶. The face piece consists of a face mask with a clear lens, an exhalation valve, and—on models with a harness-mounted regulator—a flexible low-pressure supply hose. In some models, the regulator is attached directly to the face piece.



**Figure 2-28** A PASS device can be integrated into an SCBA.



**Figure 2-29** SCBA face pieces come in several sizes.

The face piece should cover the entire face. The part that comes in contact with the skin is made of special rubber or silicon, because these materials provide for a tight seal. The clear lens allows for better vision. Exhaled air is expelled from the face piece through the one-way exhalation valve, which has a spring mechanism to maintain positive pressure inside the face piece. Because it is hard to communicate through a face piece, some models include a voice amplification device.

Face pieces may be equipped with nose cups to help prevent fogging of the clear lens. Fogging is a greater problem in colder climates. It occurs because the compressed air you breathe is dry, but the air you exhale is moist. The flow of dry air helps to prevent fogging of the lens.

The face piece is held in place with a weblike series of straps, or a net and straps. Face pieces should be stored with the straps in the longest position to make them easier to don. Pull the end of the straps toward the back of the head (not out to the sides) to tighten them and ensure a snug fit.

A leak in the face piece seal may result from an improperly sized face piece, an improper donning procedure, or facial hair around the edge of the face piece. Leaks are dangerous for two reasons. First, a large leak could overcome the positive pressure in the face piece and allow contaminated air to enter the face

piece. Second, a leak of any size will deplete the breathing air and reduce the amount of time available for fire fighting.

Face pieces are manufactured in several sizes. NFPA 1500 requires that all fire fighters must have their face pieces fit-tested annually to ensure that they are wearing the proper size. Some departments issue individual face pieces to each fire fighter; others provide a selection of sizes on each apparatus. NFPA 1500 also requires that the sealing surface of the face piece must be in direct contact with the user's skin; that is, hair or a beard cannot be in the seal area.

### ■ Pathway of Air through an SCBA

The breathing air is stored under pressure in the cylinder. The air passes through the cylinder shut-off valve into the high-pressure air line (hose) that takes it to the regulator. The regulator reduces the high pressure to low pressure.

The regulator opens when the user inhales, reducing the pressure on the downstream side. In an SCBA unit with a face piece-mounted regulator, the air next goes directly into the face piece. In units with a harness-mounted regulator, the air travels from the regulator through a low-pressure hose into the face piece. From the face piece, the air is inhaled through the user's air passages and into the lungs.

When the user exhales, used air is returned to the face piece. The exhaled air is exhausted from the face piece through the exhalation valve. This cycle repeats with every inhalation. As the pressure in the face piece drops, the exhalation valve closes and the regulator opens.

### Fire Fighter Safety Tips

Be sure that your face piece is properly fitted and is the correct size for your face.

### Fire Fighter Tips

#### Controlled-Breathing Technique

Controlled breathing helps extend the SCBA air supply. It consists of a conscious effort to inhale naturally through the nose and to force exhalation from the mouth. Practicing controlled breathing during training will help you to maximize the efficient use of air while you are working.

### ■ Skip-Breathing Technique

The skip-breathing technique helps conserve air while using an SCBA in a firefighting situation. In this technique, the fire fighter takes a short breath, holds it, takes a second short breath (without exhaling in between breaths), and then relaxes with a long exhale. Each breath should take 5 seconds.

A simple drill can demonstrate the benefits of skip breathing. In this exercise, one fire fighter dons PPE and an SCBA with a full air cylinder, and walks in a circle around a set of traffic cones, around the track at the local school, or, if safety permits, around the parking lot at the fire station. A second fire fighter

times how long it takes for the fire fighter to completely deplete the air in the SCBA. After the first fire fighter is completely rested, the air cylinder is replaced, and the same drill is repeated using the skip-breathing technique. A comparison of the times after completion of both cycles should confirm that skip breathing conserves the air in the cylinder.

## ■ Mounting Breathing Apparatus

SCBA should be located so that fire fighters can don it quickly when they arrive at the scene of a fire. Seat-mounted brackets enable fire fighters to don SCBA en route to an emergency scene, without unfastening their seat belts or otherwise endangering themselves. This approach enables fire fighters to begin work as soon as they arrive.

Several types of apparatus seat-mounting brackets are available. Some hold the SCBA with the friction of a clip. Others are equipped with a mechanical hold-down device that must be released to remove the SCBA. Regardless of which mounting system is employed, it must hold the SCBA securely in the bracket; a collision or sudden stop should not dislodge the SCBA from the brackets, because a loose SCBA can be a dangerous projectile. The fire fighter who dons SCBA from a seat-mounted bracket should not tighten the shoulder straps while seated, so as not to dislodge the SCBA in a sudden-stop situation. The fire fighter should be secured by a seat belt or combination seat belt/shoulder harness.

Compartment-mounted SCBA units also can be donned quickly. These units are used by fire fighters who arrive in vehicles without seat-mounted SCBA or whose seats were not equipped with them. Apparatus drivers and fire fighters who arrive in their private vehicles often use these types of SCBA. The mounting brackets should be positioned high enough to allow for easy donning of the equipment. Some mounting brackets allow the fire fighter to lower the SCBA without removing it from the mounting bracket. Older apparatus may have the brackets mounted on the exterior of the vehicle. An exterior-mounted SCBA should be protected from weather and dirt by a secure cover.

SCBA also may be kept in a storage case. This method is most appropriate for transporting extra SCBA units. It should not be used to transport SCBA that will be used during the initial phase of operations at a fire scene.

The SCBA should be stored on the apparatus in ready-for-use condition, with the main cylinder valve closed. After checking the SCBA, close the cylinder valve and slowly open the purge valve to release pressure in the system. The low-pressure alarm should sound as the pressure bleeds down. After releasing the pressure, close the bypass valve. The SCBA is now ready to be placed in a bracket for immediate use.

## ■ Donning Self-Contained Breathing Apparatus

Donning SCBA is an important skill. Fire fighters must be able to don and activate SCBA in 1 minute; both the fire fighter's personal safety and the effectiveness of the firefighting operation depend on mastery of this skill. Fire fighters must already

be wearing full PPE before they don SCBA. Before beginning the actual donning process, fire fighters must carefully check the SCBA to ensure it is ready for operation:

- Check whether the air cylinder is at least 90 percent of its rated pressure.
- If the SCBA has a donning/doffing switch, confirm that it is activated.
- Open the cylinder valve two or three turns, listen for the low-air alarm to sound, and then open the valve fully.
- Check the pressure gauges on both the regulator and the cylinder. The reading for these gauges should be within 100 psi of each other.
- Check all harness straps to ensure that they are fully extended.
- Check all valves to ensure that they are in the correct position. (An open purge valve will waste air.)

### Donning SCBA from an Apparatus Seat Mount

Donning SCBA while en route to an emergency can save valuable time. However, this maneuver requires that you don all of your protective clothing before mounting the apparatus. Place your arms through the shoulder straps as you sit down, and then fasten your seat belt. Alternatively, you can fasten your seat belt first, and then slide one arm at a time through the shoulder straps of the SCBA harness. You can partially tighten the shoulder straps while you are seated.

When you arrive at the emergency scene, release your seat belt, activate the bracket release, and exit the apparatus. Be sure to take a face piece with you. Face pieces should be kept in a storage bag close to each seat-mounted SCBA or attached to the harness. After exiting from the apparatus, attach the waist strap, and then tighten and adjust the shoulder and waist straps.

Follow the steps in **Skill Drill 2-3 ▶** to don SCBA from a seat-mounted bracket. Before beginning this skill drill, inspect the SCBA to ensure it is ready for service.

1. Don your full PPE ensemble prior to mounting the fire apparatus. Safely mount the apparatus and sit in the seat, placing your arms through SCBA shoulder straps. **(Step 1)**
2. Fasten your seat belt. Partially tighten the shoulder straps; do not fully tighten them at this time. When the apparatus comes to a complete stop at the emergency scene, release your seat belt and release the SCBA from the mounting bracket. Carefully exit the apparatus. **(Step 2)**
3. Attach the waist belt and cinch down. **(Step 3)**
4. Adjust shoulder straps until they are tight. **(Step 4)**
5. Open the main cylinder valve. **(Step 5)**
6. Remove or loosen your helmet and pull back the protective hood. Don the face piece and check for leaks. Pull the protective hood up over your head, put the helmet back in place, and secure the chin strap. **(Step 6)**
7. If necessary, connect the regulator to the face piece. **(Step 7)**
8. Activate the air flow and PASS alarm. **(Step 8)**

### Donning SCBA from a Compartment Mount

To don a compartment-mounted SCBA, slide one arm through the shoulder harness strap, and then slide the other arm through the other shoulder strap. Release the SCBA from the mounting

## Skill Drill 2-3

## Donning SCBA from an Apparatus Seat Mount



- 1 Don your full PPE ensemble prior to mounting the fire apparatus. Safely mount the apparatus and sit in the seat, placing your arms through SCBA shoulder straps.



- 2 Fasten your seat belt. Partially tighten the shoulder straps. When the apparatus stops, release the seat belt and release the SCBA from its brackets. Exit the apparatus.



- 3 Attach the waist belt and cinch down.



- 4 Adjust shoulder straps until they are tight.



- 5 Open the main cylinder valve.



- 6 Remove or loosen your helmet and pull hood back. Don the face piece and check for leaks. Replace the protective hood and helmet, and secure the chin strap.



- 7 If necessary, connect the regulator to the face piece.



- 8 Activate the air flow and PASS alarm.

bracket. Adjust the shoulder straps so that you can carry the SCBA fairly high on your back. Attach the ends of the waist strap and tighten the waist strap.

Follow the steps in **Skill Drill 2-4** (Fire Fighter I, 5.3.1) to don SCBA from a side-mounted compartment or bracket. Before starting, confirm that the SCBA has been inspected and is ready for service. Examine the SCBA to see how it is mounted in the compartment. Check the release mechanism and determine how it operates. If the SCBA is mounted on an exterior bracket, remove the protective cover before beginning the donning sequence.

1. Stand in front of the SCBA bracket and fully open the main cylinder valve.
2. Turn your back toward the SCBA, slide your arms through the shoulder straps, and partially tighten the straps.
3. Release the SCBA from the bracket and step away from the apparatus.
4. Attach the waist belt and tighten it.
5. Adjust the shoulder straps.
6. Remove your helmet and pull the hood back.
7. Don the face piece and check for an adequate seal.
8. Pull the protective hood into position, replace your helmet, and secure the chin strap.
9. If necessary, connect the regulator to the face piece.
10. Activate the air flow and PASS alarm.

### Donning SCBA from the Ground, the Floor, or a Storage Case

Fire fighters must sometimes don an SCBA that is stored in a case or on the ground. Two methods can be used in these situations: the over-the-head method and the coat method.

**Over-the-Head Method** To don an SCBA using the over-the-head method, place the SCBA on the ground or on the floor with the cylinder valve facing away from you. Lay the shoulder straps out to each side of the backpack. Grasp the backplate with both hands, and lift the SCBA over your head. Let the backpack slide down your back; the straps will slide down your arms. Balance the unit on your back. First attach and tighten the waist strap, and then tighten the shoulder straps. Follow the steps in **Skill Drill 2-5** to don SCBA using the over-the-head method. Before starting, confirm that the SCBA has been inspected and is ready for service.

1. If necessary, open the protective case and lay out the SCBA so that the cylinder valve is away from you and the shoulder straps are to the sides. (Step 1)
2. Fully open the main cylinder valve. (Step 2)
3. Bend down and grasp the SCBA backplate with both hands. Using your legs, lift the SCBA over your head. Once the SCBA clears your head, rotate it 180 degrees so that the waist straps are pointed toward the ground. (Step 3)
4. Slowly slide the pack down your back. Make sure that your arms slide into the shoulder straps. Once the SCBA is in place, tighten the shoulder straps and secure the waist strap. (Step 4)
5. Remove your helmet and pull the hood back. Don the face piece and check for an adequate seal. Pull your protective

hood into position, replace your helmet, and secure the chin strap. (Step 5)

6. If necessary, connect the regulator to the face piece. Activate the air flow and PASS alarm. (Step 6)

**Coat Method** To don an SCBA using the coat method, place the SCBA on the ground or on the floor with the cylinder valve facing toward you. Spread out and extend the shoulder straps. Use your left hand to grasp the left shoulder strap close to the backplate; use your right hand to grasp the right shoulder strap farther away from the backplate. Swing the SCBA over your left shoulder. Release your right arm and slide it through the right shoulder harness strap. Tighten both shoulder straps. Attach and tighten the waist belt.

Follow the steps in **Skill Drill 2-6** to don SCBA using the coat method. Before starting, confirm that the SCBA has been inspected and is ready for service.

1. If necessary, open the protective case and lay out the SCBA so that the cylinder valve is facing you and the straps are laid out to the sides. Fully open the main cylinder valve. Place your dominant hand on the opposite shoulder strap. For safety reasons, be sure to grasp the strap as close to the backplate as possible. (Step 1)
2. Lift the SCBA and swing it over your dominant shoulder, being mindful of people or objects around you. (Step 2)
3. Slide your other hand between the SCBA cylinder and the corresponding shoulder strap. (Step 3)
4. Tighten the shoulder straps. (Step 4)
5. Attach the waist belt and adjust its tightness. (Step 5)
6. Remove your helmet and pull your hood back. Don the face piece and check for an adequate seal. (Step 6)
7. Pull the protective hood into position, replace the helmet, and secure the chin strap. If necessary, connect the regulator to the face piece. Activate the air flow and PASS alarm. (Step 7)

These instructions will have to be modified for different SCBA models. In particular, the sequence for adjusting the shoulder straps and the waist belt varies with different models. Modifications must also be made for SCBA models with waist-mounted regulators. Refer to the specific manufacturer's instructions supplied with each unit. Follow the SOPs for your department.

To don SCBA from a seat-mounted position with a safety latch, follow the steps in **Skill Drill 2-7**:

1. With the SCBA straps fully extended, place your dominant arm between the shoulder strap and the SCBA bottle. Repeat the same process with the other arm. (Step 1)
2. Tighten the shoulder straps. (Step 2)
3. Attach the waist belt and adjust its tightness. (Step 3)
4. If the apparatus has a SCBA locking device, detach the device from the SCBA. *Note:* Fire fighters should never take off their seat belts to perform this action. Stay seated and buckled up while the apparatus is in motion. (Step 4)

### Donning the Face Piece

Your face piece keeps contaminated air outside and pure breathable air inside. To perform properly, it must be the correct size and must be adjusted to fit your face. Be sure you have been tested to determine the proper size for you.

## Skill Drill 2-5

## Donning SCBA Using the Over-the-Head Method



- 1** Open the case and lay out the SCBA with the cylinder valve away from you and the shoulder straps out to the sides.



- 2** Fully open the main cylinder valve.



- 3** Bend down and grasp the SCBA backplate with both hands. Using your legs, lift the SCBA over your head. Rotate the SCBA 180 degrees so that the waist straps are pointed at the ground.



- 4** Slide the SCBA down your back while your arms slide into the shoulder straps. Tighten the shoulder straps and secure the waist belt.



- 5** Remove your helmet and pull the hood back. Don your face piece and check for an adequate seal. Pull your protective hood into position, replace your helmet, and secure the chin strap.



- 6** If necessary, connect the regulator to the face piece. Activate the air flow and PASS alarm.

There must be no facial hair in the seal area. Eyeglasses that pass through the seal area cannot be worn with a face piece, because they can cause leakage between the face piece and your skin. Your face piece must match your SCBA—you cannot interchange a face piece from a different SCBA model.

Face pieces for various brands and models of SCBAs may differ slightly. Some have the regulator mounted on the face piece; others have it mounted on the harness straps. Fire fighters must learn about the specific face pieces used by their departments.

Follow the steps in **Skill Drill 2-8 ▶** to don a face piece. Before beginning this procedure, make sure you have donned your protective hood. Remove your helmet and pull the hood down over your neck.

- 1.** Fully extend the straps on the face piece. (Step 1)
- 2.** Rest your chin in the chin pocket at the bottom of the mask. (Step 2)

- 3.** Fit the face piece to your face, bringing the straps or webbing over your head. (Step 3)
- 4.** Tighten the lowest two straps. To tighten them, pull the straps straight back, rather than out and away from your head. (Step 4)
- 5.** Tighten the pair of straps at your temple, if these straps are present.
- 6.** If your model has additional straps, tighten the top strap(s) last. (Step 5)
- 7.** Check for a proper seal. This process depends on the model and type of face piece you use. (Step 6)
- 8.** Pull the protective hood up so that it covers all bare skin. Make sure it does not get under your face piece or obscure your vision.
- 9.** Replace your helmet and secure the chin strap. (Step 7)
- 10.** Install the regulator on your face piece or attach the low-pressure air supply hose to the regulator. (Step 8)

Skill Drill **2-6**

## Donning SCBA Using the Coat Method



- 1** Open the case and lay out the SCBA with the cylinder valve away from you and the shoulder straps out to the sides. Fully open the main cylinder valve. Place your dominant hand on the opposite shoulder strap.



- 2** Lift the SCBA and swing it over your dominant shoulder.



- 3** Slide your other hand between the SCBA cylinder and the corresponding shoulder strap.



- 4** Tighten the shoulder straps.



- 5** Attach the waist belt and adjust its tightness.



- 6** Remove your helmet and pull your hood back. Don the face piece and check for an adequate seal.



- 7** Pull the hood into position, replace the helmet, and secure the chin strap. If necessary, connect the regulator to the face piece. Activate the air flow and PASS alarm.

## Skill Drill 2-7

## Donning SCBA from a Seat-Mounted Position with a Safety Latch



- 1 With the SCBA straps fully extended, place your dominant arm between the shoulder strap and the SCBA bottle. Repeat the same process with the other arm.



- 2 Tighten the shoulder straps.



- 3 Attach the waist belt and adjust its tightness.



- 4 If the apparatus has a SCBA locking device, detach the device from the SCBA. *Note:* Fire fighters should never take off their seat belts to perform this action. Stay seated and buckled up while the apparatus is in motion.

Skill Drill **2-8**

## Donning a Face Piece



- 1** Fully extend the straps on the face piece.



- 2** Place your chin in the chin pocket.



- 3** Fit the face piece to your face, bringing the straps or webbing over your head.



- 4** Tighten the lowest two straps.



- 5** If there are more straps, tighten the top straps last.



- 6** Follow the manufacturer's instructions to check for a proper seal.



- 7** Pull your protective hood up so that it covers all bare skin. Don your helmet and secure the chin strap.



- 8** Install the regulator on your face piece or attach the low-pressure air supply hose to the regulator.

## Fire Fighter Safety Tips

NFPA 1001 requires you to don and activate your SCBA in 1 minute. Practice donning your SCBA until you can do it quickly and smoothly.

## Safety Precautions for Self-Contained Breathing Apparatus

As you practice using your SCBA, remember that this equipment is your protection against serious injury or death in hazardous conditions. Practice safe procedures from the beginning.

Learn to recognize the low-air alarm on your SCBA. As soon as your alarm goes off, you must exit the hazardous environment before your air supply is depleted. Never get into a situ-

### Fire Fighter Tips

#### Restricted Spaces

The size and shape of SCBA may make it difficult for you to fit through tight openings. Several techniques may help you navigate these spaces.

- Change your body position: Rotate your body by 45 degrees and try again.
- Loosen one shoulder strap and change the location of the SCBA on your back.
- If you have no other choice, you may have to remove your SCBA. In this case, do not let go of the backpack and harness for any reason. Keep the unit in front of you as you navigate through the tight space. Reattach the harness as soon as you are through the restricted space. *Note:* This is an absolutely “last resort” procedure!

ation from which you cannot escape when your low-air alarm goes off.

Before you enter a hazardous environment, make sure that your PASS device is activated and that you are properly logged into your accountability system. Always work in teams of two in hostile environments. In addition, always have at least two fire fighters outside at the ready whenever two fire fighters are working in a hostile environment.

### ■ Preparing for Emergency Situations

Because hostile environments are often unpredictable, fire fighters must be prepared to react if an emergency situation occurs while they are using SCBA. In emergencies, follow simple guidelines. Most importantly, keep calm, stop, and think. Panic increases air consumption. Try to control your breathing by maintaining a steady rate of respirations. A calm person has a greater chance of surviving an emergency.

If the problem is with your SCBA, try to exit the hostile environment. Use the emergency bypass valve so you can breathe if your regulator malfunctions.

If you are in danger, follow the steps for self-survival and calling a “mayday.” This topic is discussed in Chapter 17, Fire Fighter Survival.

One way to build confidence and skill in using an SCBA is to practice carrying out a variety of skills and activities while using an SCBA. Skill Drill 13-1 in Chapter 13, Search and Rescue, describes how to perform search and rescue while wearing SCBA. Another helpful exercise is learning how to pass through a restricted space while wearing an SCBA. This activity is illustrated in Skill Drill 17-4 in Chapter 17, Fire Fighter Survival.

A third activity designed to familiarize you with your SCBA is **Skill Drill 2-9 ▶**, which simulates the activities you would perform when ventilating a roof. Once you have mastered donning and doffing your PPE ensemble, you may perform this activity to help you master the use of your SCBA.

1. Don your PPE ensemble, including the SCBA.
2. Work with at least one other team member.
3. Bring an axe and other appropriate hand tools.

4. Don the face piece and activate the air supply. (Step 1)
5. Sound the rafters for safety. (Step 2)
6. Move into position on the roof or simulated roof. Have a second team member support the other team member. (Step 3)
7. Chop on the roof or simulated roof using short, powerful, controlled strokes.
8. Rotate team members.
9. Recognize low-air warnings, report to the officer, and exit the hazard area.
10. Doff the PPE and SCBA.
11. Report to your supervisor. (Step 4)

### Doffing Self-Contained Breathing Apparatus

The procedure for doffing your SCBA depends on which model you use and whether it has a face piece-mounted regulator or a harness-mounted regulator. Follow the procedures recommended by the manufacturer and your department’s SOPs.

In general, when doffing your SCBA, you should reverse the steps you followed to don your SCBA. Follow the steps in **Skill Drill 2-10 ▶** to doff your SCBA:

1. Remove your gloves. Remove the regulator from your face piece or disconnect the low-pressure air supply hose from the regulator. (Step 1)
2. Shut off the air-supply valve.
3. Remove your helmet and pull your protective hood down around your neck. (Step 2)
4. Loosen the straps on your face piece. (Step 3)
5. Remove your face piece. (Step 4)
6. Release your waist belt. (Step 5)
7. Loosen the shoulder straps and remove the SCBA. (Step 6)
8. Shut off the air-cylinder valve. (Step 7)
9. Bleed the air pressure from the regulator by opening the purge valve. (Step 8)
10. If you have an integrated PASS device, turn it off.
11. Place the SCBA in a safe location where it will not get dirty or damaged. (Step 9)

### Putting It All Together: Donning the Entire PPE Ensemble

The complete PPE ensemble consists of both personal protective clothing and respiratory protection (SCBA). Although donning personal protective clothing and donning and operating SCBA can be learned and practiced separately, you must be able to integrate these skills to have a complete PPE ensemble. Each part of the complete ensemble must be in the proper place to provide whole-body protection.

The steps for donning a complete PPE are summarized below:

1. Place the protective hood over your head.
2. Put on your bunker pants and boots. Adjust the suspenders and secure the front flap of the pants.
3. Put on your turnout coat and secure the front.

Skill Drill **2-9**

## Performing Simulated Roof-Ventilation Operations



- 1** Don your PPE ensemble, including the SCBA. Bring an axe and other appropriate hand tools. Don the face piece and activate the air supply.



- 2** Sound the rafters for safety.



- 3** Move into position on the roof and have a team member support you.



- 4** Chop on the roof or simulated roof using short, powerful, controlled strokes. Rotate team members. Recognize low-air warnings, report to the officer, and exit the hazard area. Do off the PPE and SCBA. Report to your supervisor.

- 4.** Open the air-cylinder valve on your SCBA and check the air pressure.
- 5.** Put on your SCBA.
- 6.** Tighten both shoulder straps.
- 7.** Attach the waist belt and tighten it. Tighten the chest straps, if present.
- 8.** Fit the face piece to your face.

- 9.** Tighten the straps, beginning with the lowest straps.
- 10.** Check the face piece for a proper seal. (Follow the manufacturer's instructions.)
- 11.** Pull the protective hood up so that it covers all bare skin but does not obscure your vision.
- 12.** Place your helmet on your head with the ear tabs extended, and secure the chin strap.

Skill Drill **2-10**

## Doffing SCBA



- 1** Remove your gloves. Remove the regulator from the face piece or disconnect the low-pressure hose from the regulator.



- 2** Remove your helmet and pull the protective hood down around your neck.



- 3** Loosen the face piece straps.



- 4** Remove your face piece.



- 5** Release your waist belt.



- 6** Loosen the shoulder straps and remove the SCBA.



- 7** Shut off the air-cylinder valve.



- 8** Bleed the air pressure from the regulator.



- 9** Place the SCBA in a safe location.

13. Turn up your coat collar and secure it in front.
14. Put on your gloves.
15. Check your clothing to be sure it is properly secured.
16. Make sure your PASS device is turned on.
17. Attach your regulator or turn it on to start the flow of breathing air.
18. Work safely!

## ■ SCBA Inspection and Maintenance

SCBA must be properly serviced and prepared for the next use each time it is used, whether in an actual emergency incident or as part of a training exercise. The air cylinder must be changed or refilled, the face piece and regulator must be sanitized according to the manufacturer's instructions, and the unit must be cleaned, inspected, and checked for proper operation. It is the user's responsibility to ensure that the SCBA is in ready condition before it is returned to the fire apparatus.

Each SCBA must be checked on a regular basis to ensure that it is ready for use. Different procedures are followed for the daily, monthly, and annual inspections. The daily inspection procedure should be used when restoring a unit to service after it has been used.

If an SCBA inspection reveals any problems that cannot be remedied by routine maintenance, the SCBA must be removed from service for repair. Only properly trained and certified personnel are authorized to repair SCBA.

### Daily Inspection

Each SCBA unit should be inspected daily or at the beginning of each shift. When fire stations are not staffed, SCBA should be inspected at least once a week. Follow the steps in

**Skill Drill 2-11 ▶** for daily SCBA inspection:

1. Check the backpack and harness straps. Make sure these components are intact and the straps are kept lengthened. (Step 1)
2. Check the air-cylinder pressure. Make sure it is full. Turn on the air-cylinder valve. Check the regulator gauge or remote gauge. Its reading should be within 100 psi of the reading on the cylinder gauge. (Step 2)
3. Check the condition of all hoses while they are pressurized. (Step 3)
4. Activate the integrated PASS device, if there is one. (Step 4)
5. Check the face piece; it should be clean and undamaged. Check the operation of the exhalation valve. (Step 5)
6. Connect the regulator to the face piece and take one or two test breaths. (Step 6)
7. Close the cylinder valve and open the purge valve to bleed the pressure. (Step 7)
8. Check that the low-pressure alarm activates at the proper pressure. Close the emergency bypass valve and restore the SCBA to ready condition. (Step 8)

### Monthly Inspection

SCBA should be completely checked each month for proper operation, leaks, and any deterioration. Follow the steps in

**Skill Drill 2-12 ▶** for monthly SCBA inspection:

1. Remove the SCBA from the apparatus and place it on the floor or on a workbench.
2. Inspect the mounting bracket for damage or wear. Lubricate it if this measure is recommended by manufacturer.

3. Look at the overall condition of the SCBA and note any damage.
4. Remove the air cylinder from the SCBA harness and check the hydrostatic test date. (Step 1)
5. Check the air cylinder for damage or wear. (Step 2)
6. Inspect the SCBA shoulder straps and waist belt for damage, cuts, burns, or wear. (Step 3)
7. Check all buckles and fasteners to ensure they work properly.
8. Examine the backplate for damage, cracks, or rust. (Step 4)
9. Make sure all connection points between the cylinder and the SCBA harness operate properly and are free of damage or corrosion. Lubricate them if this measure is recommended by the manufacturer's literature. (Step 5)
10. Reattach the air cylinder to the SCBA harness. (Step 6)
11. Check all hoses and connection points for wear, cuts, or damage. (Step 7)
12. Open the air-cylinder valve. Compare the readings on the cylinder and regulator gauges to ensure they match. (Step 8)
13. Attach the face piece and check the regulator for proper operation.
14. Activate the PASS alarm. Allow the SCBA to sit idle until the PASS alarm sounds.
15. Shut off the air-cylinder valve and open the purge valve to bleed the pressure. Check the low-pressure alarm as the pressure bleeds down.
16. Return the SCBA to the mounting bracket.
17. Complete all necessary paperwork. (Step 9)

### Annual Inspection

A complete annual inspection and maintenance must be performed on each SCBA. The annual inspection must be performed by a certified manufacturer's representative or a person who has been trained and certified to perform this work. SCBA requires regular inspection and maintenance to ensure that it will perform as intended.

## ■ Servicing SCBA Cylinders

A pressurized SCBA cylinder contains a tremendous amount of potential energy. Not only does the air within the cylinder exert considerable pressure on its walls, but the cylinder itself is used under extreme conditions on the fire ground. If the cylinder ruptures and suddenly releases this energy, it can cause serious injury or death. For this reason, cylinders must be regularly inspected and tested to ensure they are safe. These devices must be visually inspected during daily and monthly inspections. A more detailed inspection is required if a cylinder has been exposed to excessive heat, has come into contact with flame, has been exposed to chemicals, or has been dropped.

The U.S. Department of Transportation requires **hydrostatic testing** for SCBA cylinders on a periodic basis and limits the number of years that a cylinder can be used. Hydrostatic testing identifies defects or damage that might render the cylinder unsafe. Any cylinder that fails a hydrostatic test should be immediately taken out of service and cannot be used.

Cylinders constructed of different materials have different testing requirements. Aluminum, steel, and carbon-fiber cyl-

Skill Drill **2-11**

## Daily SCBA Inspection



- 1** Check the backpack and harness straps.



- 2** Check the air pressure. Turn on the air-cylinder valve and check the gauge pressure.



- 3** Check the condition of all hoses while pressurized.



- 4** Activate the integrated PASS device, if present.



- 5** Check the face piece.



- 6** Connect the regulator to the face piece and take test breaths.



- 7** Close the cylinder valve and open the purge valve to bleed the pressure.



- 8** Check the function and activation of the low-air alarm. Close the bypass valve and restore the unit to ready condition.

inders must be hydrostatically tested every 5 years. Cylinders constructed of composite materials such as Kevlar® or fiberglass fibers must be tested every 3 years. Fire fighters must know which types of cylinders are used by their departments and must check each cylinder for a current hydrostatic test date before filling it.

### ■ Replacing SCBA Cylinders

A used air cylinder can be quickly replaced with a full cylinder in the field to enable you to continue firefighting activities. A

fire fighter who is working alone must doff his or her SCBA to replace the air cylinder; two fire fighters who are working together can change each other's cylinders without removing their SCBA. The steps listed below outline how a single person makes a cylinder change. This procedure may vary slightly depending on the model of SCBA being used. Follow the procedure recommended by the SCBA manufacturer and by department SOPs.

Practice changing air cylinders until you become proficient. A fire fighter should be able to change cylinders in the dark and

Skill Drill **2-12**

## Monthly SCBA Inspection



- 1** Remove the air cylinder from the SCBA harness and check the hydrostatic test date.



- 2** Check the air cylinder for damage or wear.



- 3** Inspect the SCBA shoulder straps and waist belt for damage, cuts, burns, or wear.



- 4** Check all buckles and fasteners to ensure they work properly. Examine the backplate for damage, cracks, or rust.



- 5** Make sure all connection points between the cylinder and the SCBA harness operate properly and are free of damage or corrosion. Lubricate them if this measure is recommended by the manufacturer's literature.



- 6** Reattach the air cylinder to the SCBA harness.



- 7** Check all hoses and connection points for wear, cuts, or damage.



- 8** Open the air-cylinder valve. Compare the readings on the cylinder and regulator gauges to ensure they match.



- 9** Attach the face piece and check the regulator for proper operation and test PASS alarm and low-pressure alarm.

while wearing gloves. Follow the steps in **Skill Drill 2-13 ▶** to replace an SCBA cylinder:

1. Place the SCBA on the floor or a bench. (Step 1)
2. Turn off the cylinder valve. (Step 2)
3. Bleed off the pressure by opening the purge valve. (Step 3)
4. Disconnect the high-pressure supply hose. Keep the ends clean. (Step 4)
5. Release the cylinder from the backpack. (Step 5)
6. Slide a full cylinder into the backpack. Align the outlet to connect the supply hose. Lock the cylinder in place. (Step 6)
7. Check that the “O” ring is present and in good shape. (Step 7)
8. Connect the high-pressure hose to the cylinder. Hand-tighten only. (Step 8)
9. Open the cylinder valve. Check the regulator gauge or remote gauge. Its reading should be within 100 psi of the reading on the cylinder gauge. (Step 9)

## Replacing an SCBA Cylinder on Another Fire Fighter

If you need to quickly reenter the fire scene, a second person can replace your air cylinder while you continue to wear your SCBA harness. Be sure that you are physically able to fight a second round with the fire. It is better to allow yourself a few minutes in rehab than to get back into the fire immediately and require rescue from other crew members. Do not overtax yourself by replacing the cylinder and going back to work without adequate rest when you need it.

Follow the steps in **Skill Drill 2-14 ▶** to replace a SCBA cylinder on another fire fighter:

1. Remove the regulator from the face piece or remove the face piece so that you can breathe ambient air. (Step 1)
2. Turn off the cylinder valve on the used cylinder. (Step 2)
3. Open the purge valve to bleed off pressure from the high-pressure supply line. (Step 3)
4. Disconnect the high-pressure supply hose (Step 4)
5. Release the SCBA cylinder from the backpack assembly and set it aside. (Step 5)
6. Slide full SCBA cylinder into the backpack. (Step 6)
7. Check for the presence and satisfactory condition of the “O” ring. (Step 7)
8. Lock the SCBA cylinder into place. (Step 8)
9. Connect the high-pressure hose to the SCBA cylinder. (Step 9)
10. Open the cylinder valve and state the pressure reading of the SCBA cylinder to the fire fighter.
11. Notify the fire fighter that the SCBA cylinder change is complete. (Step 10)

## Refilling SCBA Cylinders

**Compressors** and **cascade systems** are used to refill SCBA cylinders. A compressor or a cascade system can be permanently located at a maintenance facility or at a firehouse, or it can be mounted on a truck or a trailer for mobile use. Mobile filling units are often brought to the scene of a large fire.



**Figure 2-30** Air compressors are installed at many fire stations to refill SCBA cylinders.

Compressor systems filter atmospheric air, compress it to a high pressure, and transfer it to the SCBA cylinders **Figure 2-30 ▲**. Cascade systems have several large storage cylinders of compressed breathing air connected by a high-pressure manifold system. The empty SCBA cylinder is connected to the cascade system, and compressed air is transferred from the storage tanks to the cylinder. The storage cylinder valves must be opened and closed, one at a time, to fill the SCBA cylinder to the recommended pressure. This is done by opening the lowest-pressure SCBA cylinder first and then filling it from cylinders containing more pressure. The specific steps for filling SCBA cylinders vary with different systems. It is important to follow the manufacturer's directions when refilling SCBA cylinders.

Follow the steps in **Skill Drill 2-15 ▶** to safely fill SCBA cylinders from a cascade system:

1. Complete the fill record form, including the date, hydrostatic test date, and cylinder serial number. (Step 1)
2. Ensure that the cylinder is safe to fill by checking its date of manufacture and the hydrostatic test date. (Step 2)
3. Check the cylinder for visible damage (Step 3)
4. Follow the cascade system filling procedures.
5. Secure the cascade system after use according to system procedures. (Step 4)

Proper training is required to fill SCBA cylinders. Whether your department has an air compressor or a cascade system, only those fire fighters who have been trained on this equipment should use it to refill air cylinders.

## Cleaning and Sanitizing SCBA

Most SCBA manufacturers provide specific instructions for the care and cleaning of their models. The first step in cleaning the SCBA is to rinse the entire unit using a hose with clean water. The harness assembly and cylinder can be cleaned with a mild soap and water solution. If additional cleaning is needed, the unit can be scrubbed with a stiff brush. After scrubbing, the SCBA harness and cylinder should be rinsed with clean water.

After a fire, face pieces and regulators can be cleaned with a mild soap and warm water or a disinfectant cleaning solution.

Skill Drill **2-13**

## Replacing an SCBA Cylinder



- 1** Place the SCBA on the floor or a bench.



- 2** Turn off the cylinder valve.



- 3** Open the purge valve to bleed off the pressure.



- 4** Disconnect the high-pressure supply hose.



- 5** Release the cylinder from the backpack.



- 6** Slide a full cylinder into the backpack. Align the outlet to the supply hose. Lock the cylinder in place.



- 7** Check that the "O" ring is present and in good shape.



- 8** Connect the high-pressure hose to the air cylinder.



- 9** Open the cylinder valve. Check the gauge reading.

Skill Drill **2-14**

## Replacing an SCBA Cylinder on Another Fire Fighter



- 1** Remove the regulator from the face piece or remove the face piece so that you can breathe ambient air.



- 2** Turn off the cylinder valve on the used cylinder.



- 3** Open the purge valve to bleed off pressure from the high-pressure supply line.



- 4** Disconnect the high-pressure supply hose.



- 5** Release the SCBA cylinder from the backpack assembly and set it aside.

**Fire Fighter Safety Tips**

Refilling SCBA cylinders requires special precautions because of the high pressures involved in this procedure. The SCBA cylinder must be in a shielded container while it is being refilled **Figure 2-31 ▶**. Such a container is designed to prevent injury if the cylinder ruptures. The hydrostatic test date must be checked before the cylinder is refilled to ensure that its certification has not expired. Special procedures must be followed to ensure that the air used to fill the SCBA cylinder is not contaminated.



**Figure 2-31** SCBA cylinders are refilled in a protective enclosure.

Skill Drill **2-14**

## Replacing an SCBA Cylinder on Another Fire Fighter (continued)



- 6** Slide the full SCBA cylinder into the backpack.



- 7** Check for the presence and satisfactory condition of the "O" ring.



- 8** Lock the SCBA cylinder into place.



- 9** Connect the high-pressure hose to the SCBA cylinder



- 10** Open cylinder valve and notify the fire fighter that the SCBA cylinder change is complete.

The face piece should be fully submerged in the cleaning solution. If additional cleaning is needed, a soft brush can be used to scrub the face piece. Avoid scratching the lens or damaging the exhalation valve. The regulator can be cleaned with the same solution, but should not be submerged. The face piece and regulator should then be rinsed with clean water.

Allow the SCBA time to dry completely before returning it to service. Also check for any damage before returning this

equipment to service. Follow the steps in **Skill Drill 2-16** to clean and sanitize an SCBA:

- 1.** Inspect the SCBA for any damage that may have occurred before cleaning. (**Step 1**)
- 2.** Remove the face piece from the regulator. On some models, the regulator also can be removed from the harness. (**Step 2**)
- 3.** Detach the SCBA cylinder from the harness. (**Step 3**)

Skill Drill **2-15**

## Refilling SCBA Cylinders from a Cascade System



- 1 Complete the fill record form, including the date, hydrostatic test date, and cylinder serial number.



- 2 Ensure the cylinder is safe to fill by checking its date of manufacture and the hydrostatic test date.



- 3 Check the cylinder for visible damage.



- 4 Follow the cascade system filling procedures. Secure the cascade system after use according to system procedures.

4. Rinse all parts of the SCBA with clean water. Water from a garden hose can be used for this step. (Step 4)
5. Using a stiff brush, along with a soap-and-water solution, scrub the SCBA cylinder and harness. Rinse and set these pieces aside to dry. (Step 5)
6. In a 5-gallon bucket, make a mixture of mild soap and water; alternatively, use the manufacturer's recommended cleaning and disinfecting solution and water. (Step 6)
7. Submerge the SCBA face piece into the soapy water or cleaning solution. For heavier cleaning, allow the face piece to soak. (Step 7)
8. Clean the regulator with the soapy water or cleaning solution, following the manufacturer's instructions.
9. Use a soft brush, if necessary, to scrub contaminants from the face piece and regulator. (Step 8)
10. Completely rinse the face piece and the regulator with clean water. Set them aside and allow them to dry.
11. Reassemble and inspect the entire SCBA before placing it back in service. (Step 9)

Skill Drill **2-16**

## Cleaning SCBA



- 1** Inspect the SCBA for any damage that may have occurred before cleaning.



- 2** Remove the face piece from the regulator. On some models, the regulator also can be removed from the harness.



- 3** Detach the SCBA cylinder from the harness.



- 4** Rinse all parts of the SCBA with clean water. Water from a garden hose can be used for this step.



- 5** Using a stiff brush, along with a soap-and-water solution, scrub the SCBA cylinder and harness. Rinse and set these pieces aside to dry.



- 6** In a 5-gallon bucket, make a mixture of mild soap and water; alternatively, use the manufacturer's recommended cleaning and disinfecting solution and water.



- 7** Submerge the SCBA face piece into the soapy water or cleaning solution. For heavier cleaning, allow the face piece to soak.



- 8** Clean the regulator with the soapy water or cleaning solution, following the manufacturer's instructions.



- 9** Completely rinse the face piece and the regulator with clean water. Set them aside and allow them to dry. Reassemble and inspect the entire SCBA before placing it back in service.

# Wrap-Up

## ■ Chief Concepts

- Safety is a critical part of a fire fighter's job.
- Preventing injuries is always preferable to treating them.
- Injury prevention measures extend to standards and procedures, personnel, training, and the department's equipment.
- It is important to exercise good safety practices during training, during responses, at emergency incidents, at the fire station, and outside the workplace.
- Personal protective equipment must meet NFPA standards to ensure your safety.
- The personal protective ensemble includes a helmet, a protective hood, a turnout coat, bunker pants, boots, gloves, SCBA, and a PASS device.
- All parts of the PPE ensemble must be donned and in place for maximum protection. Fire fighters must be able to don protective clothing in 1 minute or less.
- Fire fighters must care for and maintain PPE properly so that it works as it should.
- Fires produce smoke particles, smoke vapors, toxic gases, oxygen-deficient atmospheres, and high temperatures. These conditions require fire fighters to use respiratory protection.
- The primary respiratory protection equipment used by the fire service is SCBA.
- Fire fighters must understand the major parts of SCBA and be able to don the equipment quickly—in 1 minute or less.
- Regular inspection and proper maintenance of SCBA is vital to the fire fighter's safety.
- Good safety practices must be followed during training, during response, at emergency incidents, at the firehouse, and outside the workplace.
- The PPE ensemble for structural firefighting consists of a helmet, a protective hood, a turnout coat, bunker pants, boots, gloves, SCBA, and a PASS device.
- Respiratory hazards from fires include smoke particles and vapors, toxic gases, an oxygen-deficient environment, and high temperatures.
- Understanding the uses and limitations of SCBA is essential for your safety at fire scenes.

## ■ Hot Terms

**Air cylinder** The component of the SCBA that stores the compressed air supply.

**Air line** The hose through which air flows, either within an SCBA or from an outside source to a supplied air respirator.

**Backpack** The harness of the SCBA, which supports the components worn by a fire fighter.

**Buddy system** A system in which two fire fighters always work as a team for safety purposes.

**Bunker coat** The protective coat worn by a fire fighter for interior structural firefighting; also called a turnout coat.

**Bunker pants** The protective trousers worn by a fire fighter for interior structural firefighting; also called turnout pants.

**Carbon monoxide (CO)** A toxic gas produced through incomplete combustion.

**Cascade system** An apparatus consisting of multiple tanks that is used to store compressed air and fill SCBA cylinders.

**Closed-circuit breathing apparatus** SCBA designed to recycle the user's exhaled air. This system removes carbon dioxide and generates fresh oxygen.

**Compressor** A mechanical device that increases the pressure and decreases the volume of atmospheric air; it is used to refill SCBA cylinders.

**Critical incident stress debriefing (CISD)** A confidential group discussion among those who served at a traumatic incident to address emotional, psychological, and stressful issues related to the event. It usually occurs within 24 to 72 hours of the incident.

**Doff** To take off an item of clothing or equipment.

**Don** To put on an item of clothing or equipment.

**Emergency bypass mode** An operating mode that allows some SCBA to be used even if part of the regulator fails to function properly.

**Employee assistance programs (EAPs)** Programs offered by many departments that allow fire fighters to receive confidential help with problems such as substance abuse, stress, depression, or burnout that can affect their work performance.

**Face piece** A component of SCBA that fits over the face.

**Fire helmet** Protective head covering worn by fire fighters to protect the head from falling objects, blunt trauma, and heat.

**Freelancing** The dangerous practice of acting independently of command instructions.

**Hand light** A small, portable light carried by fire fighters to improve visibility at emergency scenes; it is often powered by rechargeable batteries.

**Hydrogen cyanide** A toxic gas produced by the combustion of materials containing cyanide.

**Hydrostatic testing** Periodic certification testing performed on pressurized vessels, including SCBA cylinders.

# Wrap-Up

**Immediately dangerous to life and health (IDLH)** A situation in which an atmospheric concentration of any toxic, corrosive, or asphyxiant substance poses an immediate threat to life or could cause irreversible or delayed adverse health effects. There are three general classifications of IDLH atmospheres: toxic, flammable, and oxygen-deficient.

**Incomplete combustion** A burning process in which the fuel is not completely consumed, usually due to a limited supply of oxygen.

**Kevlar®** A strong synthetic material used in the construction of protective clothing and equipment.

**Light-emitting diode (LED)** An electronic semiconductor that emits a single-color light when activated.

**National Institute for Occupational Safety and Health (NIOSH)** U.S. federal agency responsible for research and development on occupational safety and health issues.

**Nomex®** A fire-resistant synthetic material used in the construction of personal protective equipment for fire fighting.

**Nose cups** An insert inside the face piece of an SCBA that fits over the user's mouth and nose.

**Occupational Safety and Health Administration (OSHA)** The federal agency that regulates worker safety and, in some cases, responder safety. OSHA is part of the U.S. Department of Labor.

**Open-circuit breathing apparatus** SCBA in which the exhaled air is released into the atmosphere and is not reused.

**Oxygen deficiency** Any atmosphere where the oxygen level is less than 19.5 percent. Low oxygen levels can have serious effects on people, including adverse reactions such as poor judgment and lack of muscle control.

**PBI®** A fire-retardant synthetic material used in the construction of personal protective equipment.

**Personnel accountability system** A method of tracking the identities, assignments, and locations of fire fighters operating at an incident scene.

**Personal alert safety system (PASS)** A device worn by a fire fighter that sounds an alarm if the fire fighter is motionless for a period of time.

**Personal protective equipment (PPE)** Gear worn by fire fighters that includes the helmet, gloves, hood, coat, pants, SCBA, and boots. PPE provides a thermal barrier that protects fire fighters against intense heat.

**Phosgene** A chemical agent that causes severe pulmonary damage; it is a by-product of incomplete combustion.

**Pounds per square inch (psi)** The standard unit for measuring pressure.

**Pressure gauge** A device that measures and displays pressure readings. In an SCBA, the pressure gauges indicate the quantity of breathing air that is available at any time.

**Protective hood** A part of a fire fighter's personal protective equipment that is designed to be worn over the head and under the helmet; it provides thermal protection for the neck and ears.

**Rapid intervention company/crew (RIC)** A minimum of two fully equipped personnel who are on site, in a ready state, for immediate rescue of injured or trapped fire fighters. Also known as a rapid intervention team.

**Rehabilitation** A systematic process to provide periods of rest and recovery for emergency workers during an incident. "Rehab" is usually conducted in a designated area away from the hazardous area.

**Respirator** A protective device used to provide safe breathing air for a user in a hostile or dangerous atmosphere.

**SCBA harness** The part of SCBA that allows fire fighters to wear it as a "backpack."

**SCBA regulator** The part of the SCBA that reduces the high pressure in the cylinder to a usable lower pressure and controls the flow of air to the user.

**Self-contained breathing apparatus (SCBA)** Respirator with independent air supply used by fire fighters to enter toxic or otherwise dangerous atmospheres.

**Self-contained underwater breathing apparatus (SCUBA)** A respirator with an independent air supply that is used by underwater divers.

**Smoke particles** Airborne solid materials consisting of ash and unburned or partially burned fuel released by a fire.

**Supplied-air respirator (SAR)** A respirator that obtains its air through a hose from a remote source, such as a compressor or storage cylinder.

**Turnout coat** Protective coat that is part of a protective clothing ensemble for structural firefighting; also called a bunker coat.

**Turnout pants** Protective trousers that are part of a protective clothing ensemble for structural firefighting; also called bunker pants.

**Two-way radio** A portable communication device used by fire fighters. Every firefighting team should carry at least one radio to communicate distress, progress, changes in fire conditions, and other pertinent information.

## Fire Fighter *in Action*



Just after lunch, you receive a call for the report of a fire in a townhouse. You quickly walk to the engine and begin to don your boots, bunker pants, hood, and turnout coat. You hoist yourself into your seat and buckle your seat belt. This is your first structure fire, so you try to think of all the things you have learned. As you review your role on this call, the following questions come to mind.

1. You and your officer are a team. This means you should
  - A. Check each other's SCBA to make sure it is working properly.
  - B. Enter together, work together, and leave together.
  - C. Maintain visual, vocal, or physical contact with each other.
  - D. All of the above.
2. The SCBA that your department uses is rated at 45 minutes of air supply. This means that you should expect
  - A. At least 30 minutes of use from each air cylinder.
  - B. Approximately 45 minutes of use for the average fire fighter.
  - C. Much less than 45 minutes of use during fire fighting activities.
  - D. A varying amount of minutes of use based on the air temperature.
3. Your PASS device is activated when
  1. You become motionless.
  2. You press an emergency button.
  3. Your air supply is low.
  4. It gets too hot.
    - A. 3 and 4
    - B. 1 and 3
    - C. 1 and 2
    - D. 2 and 4
4. When properly worn, your PPE ensemble will protect you
  - A. During a flashover
  - B. In temperatures up to 4000 °F.
  - C. From limited heat conditions.
  - D. Unless the fire contains oil-based products