Self-Contained Breathing Apparatus (SCBA) Types and Uses

Rationale
Wearing SCBA protects the firefighter's respiratory system from superheated atmospheres, toxic gases, and other hazards associated with atmospheres that are Immediately Dangerous to Life and Health (IDLH). Firefighters can suffer from the immediate short-term effects of not wearing SCBA and the long-term effects from repeatedly exposing themselves to IDLH atmospheres. With over 4,000 incidents of smoke inhalation suffered by firefighters each year, it is imperative that firefighters understand the reasons for wearing SCBA while performing their job.

Objectives
The students will be able to:
1. Describe the hazardous environments that require the use of respiratory protection
2. Identify the types of self-contained breathing apparatus
3. Describe the safety features and the function of the open circuit self-contained breathing apparatus
4. Describe the operational check of a SCBA and a (personal alert safety system) PASS device
5. Demonstrate an operational check of SCBA and a PASS device

Engage
Lead students in a discussion about the respiratory hazards present in common fire service responses including potentially fatal short- and long-term effects. Some examples of respiratory hazards that may be discussed are
- Oxygen deficient atmospheres (hypoxia)
- Elevated temperatures that can cause injuries such as pulmonary edema
- Smoke and other toxic atmospheres such as irritants and toxicants that can injure or kill firefighters

Use the Discussion Rubric for assessment.

Key Points
1. Respiratory Hazards
   A. Oxygen Deficient Atmospheres
      1. Occur when the fire consumes the oxygen in a compartment fire
      2. Can occur in
         a) Below-grade confined spaces
         b) Chemical storage tanks
         c) Grain bins and silos
         d) Rooms protected by total flooding extinguishing systems
      3. The Occupational Safety and Health Administration (OSHA) and the National Fire Protective Association (NFPA) define oxygen deficient atmospheres as containing less than 19.5% oxygen

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4. When the oxygen level in an atmosphere reaches
   a) 18% – the body will adjust by increasing its respiratory rate
      (breathing more rapidly)
   b) 17% – impairment of muscular coordination
   c) 12% – dizziness, headache, tiring rapidly
   d) 9% – unconsciousness
   e) 6% – death within a short period of time from heart and
      respiratory failure
5. Departments that are equipped to monitor atmospheres should
   do so
6. Departments should remind firefighters to wear SCBA whenever
   they are unsure of the oxygen level of the atmosphere in which
   they are working

B. Elevated Temperatures (Respiratory Hazard)
1. Can cause severe damage to a firefighter’s respiratory tract by
   causing
   a) Burns
   b) Decreased blood pressure
   c) Circulatory system failure
   d) Example – pulmonary edema is an accumulation of fluids in
      the lungs which causes death through asphyxiation
2. The tissue damage caused by inhaling superheated gases
   cannot be reversed immediately by just breathing fresh cool air
3. Oxygen therapy and other prompt medical treatment are needed

C. Smoke (Respiratory Hazard)
1. Smoke typical in a compartment fire includes a mixture of the
   following
   a) Oxygen
   b) Nitrogen
   c) Carbon monoxide
   d) Carbon dioxide
   e) Soot (carbon particles)
2. Suspended smoke particles
   a) Often contain aldehydes and organic acids that are formed
      from carbon
   b) Some may only be irritating to the respiratory tract, others
      may have deadly affects
3. The size of the suspended particles determines how deep into
   the lungs they travel
4. They may burn the respiratory tract as well

D. Toxic Atmospheres Associated with Fire
1. Gases commonly found in fire
   a) Carbon monoxide
      (1) Causes most fire deaths
      (2) A product of incomplete combustion
      (3) Combines with blood hemoglobin 200 times more
readily than does oxygen

(4) Excludes oxygen from the blood, causing victims to experience hypoxia of the brain and body that is followed by death

b) Carbon dioxide is the end product of complete combustion
c) Hydrogen chloride irritates eyes and the respiratory tract
d) Hydrogen cyanide is a chemical asphyxiate
e) Nitrogen dioxide irritates the nose and the throat
f) Phosgene forms hydrochloric acid in the lungs due to moisture

2. All of the gases listed above can be IDLH, producing immediate, irreversible, debilitating effects on a firefighter’s health
3. This depends upon how many parts per million (ppm) there are of the gas compared to the volume of air ppm

E. Toxic Atmospheres Not Associated with Fire
1. Usually associated with industrial processes that use dangerous chemicals
2. Some of these chemicals include
   a) Ammonia
      (1) Irritates the respiratory tract and eyes
   b) Sulfur Dioxide
      (1) Irritates the respiratory tract and eyes
      (2) Reacts with moisture from the lungs to form sulfuric acid
   c) Chlorine
      (1) Used to manufacture plastic, rubber compounds, and synthetic textiles
      (2) Used to treat water
3. Transportation leaks can occur from traffic accidents, train derailments, etc.
   a) Natural gas leaks
   b) Chemical leaks
4. The Department of Transportation (DOT) defines hazardous materials as
   a) “Any substance which may pose unreasonable risk to health and safety of operating or emergency personnel, the public, and/or the environment if it is not properly controlled during handling, storage, manufacture, processing, packaging, use, disposal, or transportation”
   b) May include biologically hazardous materials such as etiologic agents which are living microorganisms that can cause human disease

II. Types of SCBA
   A. Open-Circuit SCBA
      1. Discharges the wearer’s air directly into the atmosphere
2. Four basic components
   a) Backpack harness assembly – rigid frame with straps that hold the air cylinder to the firefighter’s back
   b) Air Cylinder
      (1) Includes the cylinder, cylinder valve, main pressure gauge, and in some units the integrated Personal Alert Safety System (PASS) alarm
      (2) Must be strong enough to contain the pressure – on some units as high as 4,500 psi
      (3) 30-minute cylinders hold 2216 psi
      (4) A cylinder must be at least 90% full (2000 psi) before donning it at an emergency scene
   c) Regulator Assembly
      (1) Includes a high pressure hose, pressure reducing device, low pressure regulator, and bypass valve
      (2) Reduces pressure to slightly above the atmospheric pressure for use by the wearer
      (3) There is also a remote gauge positioned for the wearer to see how much air remains
      (4) The cylinder gauge and the main gauge must read within 100 psi of each other, or be the same if the gauges read in larger increments
   d) Facepiece Assembly
      (1) Includes a facepiece lens and exhalation valve, and on some units a low pressure breathing tube, voice amplifier, head harness, or helmet mounting bracket
      (2) External fogging of the facepiece can be prevented or eliminated by the use of a nose cup, or by applying an anti-fogging chemical to the interior of the facepiece

3. Open-Circuit Airline Equipment
   a) Used when first responders may be forced to remain in a contaminated atmosphere for extended periods of time
   b) Supply hoses are used from a large supply source and run directly to the open-circuit SCBA
      (1) These units are often called Supplied Air Respirators (SARs)
   c) Emergency Breathing Support Systems (EBSS) use a 5-10 minute emergency egress cylinder
   d) Airline systems allow emergency service personnel to operate as far as 300 feet from their supply source

B. Closed-Circuit Breathing Apparatus
   1. Systems in which the wearer’s exhalation is recycled and rebreathed after the carbon dioxide has been removed and replaced with oxygen
   2. Used for long-duration operations
   3. Restore oxygen to the system by the use of
III. Safety Features and Functions of the Open-Circuit SCBA

A. Personal Alert Safety System (PASS) alarm
   1. Sometimes referred to as a Personal Alert Device (PAD)
   2. Used to find lost, disoriented, or incapacitated firefighters
      a) Many newer generation SCBA
         (1) Have the PASS alarm integrated into the air supply system
         (2) Activate when the main air valve is opened
      b) Detachable PASS alarms
         (1) Are worn on the SCBA harness or on the turnout coat
         (2) Must be manually turned on with a switch
   3. Both types of units will automatically sound an alarm if the firefighter wearing the unit remains motionless for approximately 30 seconds
   4. Both types of units can be activated manually by the wearer if he or she is conscious and senses the need for assistance
   5. Rescuers follow the sound of the alarm to find the firefighter that is in need

B. Bypass valve – controls the direct airflow from the cylinder in the event of a regulator malfunction

C. Remote pressure gauge – shows the wearer what air pressure remains in the cylinder
   1. The remote pressure gauge should read within 100 psi of the main gauge if the increments are in psi
   2. If the measurements are shown as percentages or fractions, the gauges should read the same

D. Low pressure alarm – designed to activate when the cylinder pressure drops below ¼ of its rated capacity (between 500 and 600 psi)

E. Facepiece seal – designed to maintain positive air pressure within the facepiece to prevent toxic smoke and gases from being inhaled by the wearer

Activities
Operational Check of SCBA for Emergency Use. Have students demonstrate and describe the “operational check” of a SCBA and a PASS device. Use the Operational Check of SCBA for Emergency Use Checklist for the activity and for assessment.

Assessments
SCBA Types and Uses Quiz and Key
Operational Check of SCBA for Emergency Use Checklist
Discussion Rubric
Research Rubric
Writing Rubric

Materials
SCBA Types and Uses computer-based presentation
Open-Circuit SCBA used by local jurisdiction
PASS alarm

Resources
0135151112, Essentials of Firefighting (5th Edition), International Fire Service Training Association (IFSTA), 2008

Accommodations for Learning Differences
For reinforcement, students will imagine that they are a firefighter preparing to enter a burning structure. They will write down what they must know about SCBA prior to entry. They will describe and outline the operational check they will do prior to coming on duty, and describe and explain the safety features and functions of an open-circuit SCBA. Use the Writing Rubric for assessment.

For enrichment, students will research and describe the different types and uses of SCBA used in the fire service. Use the Research Rubric for assessment.

State Education Standards
Texas Essential Knowledge and Skills for Career and Technical Education
§130.299. Firefighter I (One to Two Credits).
(10) The student analyzes the internal systems that sustain life in the human body and identifies the physical requirements of a self-contained breathing apparatus wearer. The student is expected to:
   (D) describe the hazardous environments that require the use of respiratory protection;
   (E) identify the types of self-contained breathing apparatus; and
   (F) describe the safety features and function of the open circuit self-contained breathing apparatus.
(14) The student demonstrates the proper testing and operation of a personal alert safety system device. The student is expected to:
   (A) explain the proper operation of a safety device; and
   (B) demonstrate the proper testing of a safety device.

College and Career Readiness Standards
IV. Listening

B. Listen effectively in informal and formal situations.
   1. Listen critically and respond appropriately to presentations.
   2. Listen actively and effectively in one-on-one communication situations.
SCBA Types and Uses Quiz

1. _____ Firefighters suffer from over how many thousand incidents of smoke inhalation each year?
   a. 3000
   b. 4000
   c. 5000
   d. 6000

2. _____ The OSHA and NFPA define oxygen deficient atmospheres as atmospheres containing less than what percent of oxygen?
   a. 21%
   b. 20.5%
   c. 19.5%
   d. 18%

3. _____ At which percent oxygen level does your body begin to increase its respiratory rate to compensate for the lower oxygen concentration?
   a. 21%
   b. 20.5%
   c. 19.5%
   d. 18%

4. _____ At which percent oxygen level does death occur within a short period of time due to heart and respiratory failure?
   a. 6%
   b. 9%
   c. 12%
   d. 17%

5. _____ SCBA air cylinders must be able to contain pressures up to how high on some SCBA units?
   a. 2200 psi
   b. 3500 psi
   c. 4500 psi
   d. 6200 psi

6. _____ The main cylinder gauge and the remote gauge must read within how many psi of each other (unless the gauges read in larger increments)?
   a. 10 psi
   b. 25 psi
   c. 50 psi
   d. 100 psi
7. _____ Which of the following is not one of the four basic components of an open circuit self-contained breathing apparatus?
   a. Backpack/harness assembly
   b. Cylinder assembly
   c. Low pressure alarm assembly
   d. Facepiece assembly

8. _____ Emergency Breathing Support Systems use an emergency egress cylinder that provides air for approximately how many minutes?
   a. 3–5
   b. 5–10
   c. 10–15
   d. 15–20

9. _____ Airline systems allow emergency service personnel to operate how many feet away from their air supply source?
   a. 300
   b. 400
   c. 500
   d. 1000

10. ____ Personal Alert Safety Systems will automatically sound an alarm if the firefighter wearing the unit remains motionless for approximately how many seconds?
    a. 30
    b. 45
    c. 60
    d. 90

11. ____ Low pressure alarms are designed to activate when the cylinder pressure drops below what percent of its weighted capacity?
    a. 30%
    b. 50%
    c. 25%
    d. 20%

12. ____ The low pressure alarm will activate when the air pressure falls to approximately what psi range?
    a. 200–300 psi
    b. 300–400 psi
    c. 400–500 psi
    d. 500–600 psi
13. ____ A SCBA cylinder rated for 30 minutes of use contains how much pressure when it is full?
   a. 2000
   b. 2216
   c. 4500
   d. 4516

14. ____ To what percent must a cylinder be filled prior to donning it for an emergency?
   a. 60%
   b. 70%
   c. 80%
   d. 90%

15. ____ When a 30-minute cylinder is 90% full, what will the pressure gauge read in psi?
   a. 2000
   b. 2216
   c. 4500
   d. 4516
SCBA Types and Uses Quiz Key

1. B
2. C
3. D
4. A
5. C
6. D
7. C
8. B
9. A
10. A
11. C
12. D
13. B
14. D
15. B
Operational Check of SCBA for Emergency Use Checklist

Directions – demonstrate the “operational check” of a Self-Contained Breathing Apparatus (SCBA) and a PASS device. Verbalize the mandatory steps while performing this skill. Begin on my instruction to start. Time will stop when all of the identified steps have been accomplished and you put your hands in the air to signal that you are finished with this skill. Do you understand these instructions?

### Performance Objectives

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<th>Objectives</th>
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<td>Have students describe and demonstrate the following tasks:</td>
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<td>• Identify and verbalize that all of the components of the SCBA are present: <strong>backpack and harness assembly, air cylinder assembly, regulator assembly, and face piece assembly</strong></td>
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<td>• Check all of the components for cleanliness and damage</td>
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<td>• Check the cylinder gauge and verbalize the cylinder pressure (It must be no less than 90% of capacity, or 2000 psi)</td>
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<td>• Open the cylinder valve fully; verbalize and verify the operation of the low pressure alarm</td>
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<td>• Verbalize and verify that the PASS device is activated</td>
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<td>• Verbalize and check the remote gauge to ensure that it reads within 100 psi of the main gauge (gauges not marked in increments of 100 psi should read the same)</td>
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<td>• Operate the purge/bypass valve</td>
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<td>• Purge the facepiece, don or hold the facepiece to your face, and breathe the air</td>
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<td>• Manually activate the PASS device</td>
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<td>• Close the cylinder valve, relieve the pressure, and prepare the SCBA for the next user</td>
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**Total points possible - 10**

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**Instructor’s Signature**

**Date**
# Discussion Rubric

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<td>Participates in group discussion</td>
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<td>Encourages others to join the conversation</td>
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<td>Keeps the discussion progressing to achieve goals</td>
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<td>Shares thoughts actively while offering helpful recommendations to others</td>
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<td>Gives credit to others for their ideas</td>
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<td>Respects the opinions of others</td>
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<td>Involves others by asking questions or requesting input</td>
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<td>Expresses thoughts and ideas clearly and effectively</td>
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**Total Points (32 pts.)**

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<td><strong>Question/goal</strong></td>
<td>Student identified and communicated a question or goal of the research</td>
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<td><strong>Research/Gathering information (if relevant)</strong></td>
<td>Student used a variety of methods and sources to gather information. Student took notes while gathering information</td>
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<td><strong>Conclusion/Summary</strong></td>
<td>Student drew insightful conclusions and observations from the information gathered. Information is organized in a logical manner</td>
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<td><strong>Communication</strong></td>
<td>Student communicated the information gathered and summary or conclusions persuasively. Student demonstrated skill in the use of media used to communicate the results of research</td>
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<td><strong>Reflection</strong></td>
<td>Student reflected on the importance of the research and its potential application</td>
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### Writing Rubric

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<td>The writing has all required parts from introduction to conclusion in smooth transition.</td>
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<td>The writing is interesting, supportive, and complete.</td>
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<td>The writing demonstrates that the writer comprehends the writing process.</td>
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<td>Accurate spelling, grammar, and punctuation</td>
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<td>The content of paragraphs emphasizes appropriate points.</td>
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<td>The writer shows an understanding of sentence structure, paragraphing, and punctuation.</td>
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<td>All sources and references are clearly and accurately documented.</td>
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