Self Contained Breathing Apparatus

Part 1
Objectives

• Identify the development of the SCBA
• Identify the hazardous environments requiring the use of respiratory protection
• Identify the physical requirements of the SCBA user
• Identify the uses and limitations of the SCBA
• Identify the components, functions and safety features of SCBA
Development of the SCBA

- Firemen would dip their long beards in water and use it as a filter
- In 1823 John and Charles Deane patented a smoke helmet that was fed with fresh air
- In 1863 A. Lacour invented a SCBA of sorts, consisting of an airtight bag made of canvas and rubber
- In the 1890s and early 1900s the Vajen-Bader Co. produced a “Smoke Protector” which sealed off the wearer’s head and supplied air from a compressed-air cylinder
Hazardous environments requiring the use of SCBA

- Oxygen deficiency
- Elevated temperatures / super heated air
- Smoke
- Toxic gases
Hazardous environments requiring the use of SCBA

- **Oxygen deficiency**
  - Combustion process consumes oxygen
  - Production of toxic gases displaces oxygen
  - Oxygen is diluted by other gases
  - Physiological effects of reduced oxygen (hypoxia)
    + 21% oxygen in air
    + 19.5% is considered oxygen deficient
    + 17% will cause muscular impairment and an increase in respiratory rate
    + 12% will cause dizziness, headache and rapid fatigue
    + 9% will cause unconsciousness
    + 6% or less will cause death in minutes
Hazardous environments requiring the use of SCBA

- Elevated temperatures / super heated air
  - Heated air can damage respiratory tract
  - Excessive heat (120°-130° F)
    - Blood pressure drop
    - Circulatory failure
  - Inhalation of heated gases
    - Pulmonary edema
    - Death from asphyxiation
  - Respiratory tissue injury is not immediately reversible with the introduction of fresh, cool air
Hazardous environments requiring the use of SCBA

• Smoke
  – Product of incomplete combustion
  – Suspended particles provide a means for the condensation of some of the gaseous products of combustion
  – Some particles are only irritating while others are lethal
  – The size of the particle will determine how deeply it penetrates into the lungs
Hazardous environments requiring the use of SCBA

- Toxic gases
  - Every fire will present differing products of combustion
  - Combinations of gases may have a synergistic effect
  - May cause disease of the lung tissue
  - Impair the oxygen carrying capacity of red blood cells
  - Commonly found fire gases
    - Carbon monoxide
    - Hydrogen chloride
    - Hydrogen cyanide
    - Carbon dioxide
    - Nitrogen oxides
    - Phosgene
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Hazardous environments requiring the use of SCBA

- Carbon monoxide
  - More fire deaths than any other product of combustion
  - Colorless
  - Odorless
  - Present at every fire
  - Results from incomplete combustion
  - Combines with hemoglobin about 200 times faster than oxygen causing oxygen to be excluded
  - Concentrations above five hundredths of one percent (0.05%) or 500 PPM can be dangerous
Hazardous environments requiring the use of SCBA

• Carbon monoxide
  – Symptoms include
    • Headache
    • Dizziness
    • Nausea
    • Vomiting
    • Cherry-red skin coloration
  – Administering pure oxygen is most important for first aid
  – Brain injuries may appear up to three weeks after severe exposure
Hazardous environments requiring the use of SCBA

- Hydrogen chloride
  - Colorless
  - Pungent odor
  - Causes swelling of upper respiratory tract
    - Labored breathing
    - Suffocation can result
  - Due to the increased use of plastics, polyvinyl chloride (PVC)
  - Overhaul stage is especially dangerous
    - Latent heat can still decompose plastics
    - Electrical cables may continue to decompose after the fire is extinguished
Hazardous environments requiring the use of SCBA

- Hydrogen cyanide
  - Colorless
  - Almond odor
  - Interferes with respiration at the cellular and tissue level
  - Classified as a chemical asphyxiate
  - Concentrations above 50 PPM are almost immediately fatal
  - Materials that emit hydrogen cyanide
    - Wool
    - Nylon
    - Polyurethane foam
    - Rubber
    - Paper
Hazardous environments requiring the use of SCBA

- Carbon dioxide
  - Colorless
  - Odorless
  - Non-flammable
  - Concentrations greater than 10-12% cause death within a few minutes from paralysis of the brain’s respiratory center
  - Use caution when working around a carbon dioxide total flooding system
Hazardous environments requiring the use of SCBA

- Nitrogen oxides
  - Two dangerous types
    - Nitrogen dioxide
      - Reddish brown in color
      - Commonly called silo gas
      - Released from pyroxylin plastics
    - Nitric oxide
      - Rapidly oxidized in air to form nitrogen dioxide
  - Causes pulmonary edema
  - Reacts with water and oxygen to form nitric and nitrous acids
  - Causes arterial dilation, variation in blood pressure, dizziness and headaches
  - Irritating effects can be tolerated while a lethal dose is being inhaled
Hazardous environments requiring the use of SCBA

- Phosgene
  - Colorless
  - Tasteless
  - Disagreeable odor
  - Produced when freon comes into contact with flame
  - When in contact with water, it decomposes into hydrochloric acid
  - Concentrations above 25 PPM are hazardous
Requirements of the SCBA User

• Sound physical condition
  – Maximize amount of work that can be performed
  – Maximize available air supply

• Agility
  – Unit will restrict wearer’s movements
  – Will affect balance

• Facial features
  – Need a good facepiece seal
  – Facial hair may not permit a proper facepiece seal
Requirements of the SCBA User

• Medical
  – Good motor coordination needed
  – Must have good physical strength and size
  – Good cardiovascular system
  – Healthy respiratory system

• Mental
  – Adequate training in use of equipment
  – Self-confidence
  – Emotional stability
Uses and Limitations of SCBA

- Limited visibility
- Decreased ability to communicate
- Increased weight
- Decreased mobility
- Limited air supply
Uses and Limitations of SCBA

• Conservation of air
  – Always practice controlled breathing
  – When supply is low, you may practice skip breathing
    • Emergency breathing technique
    • Inform partner of low air and exit toxic atmosphere
    • Inhale, hold your breath as long as it would take to exhale, then inhale once again before exhaling
    • Exhale slowly to keep carbon dioxide in the lungs in the proper balance
Components, Functions and Safety Features of SCBA

• Open circuit SCBA
  – Air cylinder assembly
    • Main weight of the breathing apparatus
    • Many different cylinder pressures and capacities

• Low pressure 2216 PSI
  – Contains 45 cubic feet of air
  – Rated as a 30 minute supply
  – Expected use of time 12 to 18 minutes

• Low pressure 3000 PSI
  – Contains 66 cubic feet of air
  – Rated as a 45 minute supply

• High pressure 4500 PSI
  – Contains 45 cubic feet of air
  – Rated as a 30 minute supply

• High pressure 4500 PSI
  – Contains 87 to 90 cubic feet of air
  – Rated as a 60 minute supply
Components, Functions and Safety Features of SCBA

• Open circuit SCBA
  – Backpack and harness assembly
    • Designed to hold the air cylinder
    • Harness straps provide a secure fit
    • Waist strap is designed to distribute weight of cylinder
  – Regulator
    • Reduces the pressure to slightly above atmospheric pressure and controls the flow to meet needs of wearer
    • By-pass or purge valve is used as an emergency valve should regulator fail
    • Pressure gauge located in close proximity to face piece
      – Should read within 100 PSI of cylinder gauge
    • Audible low pressure / quarter service alarm
Components, Functions and Safety
Features of SCBA

- **Open circuit SCBA**
  - Face piece assembly
    - Lens
    - Exhalation valve / one way valve
    - Possibly a low pressure hose
    - Adjustable straps or webbing
    - Speaking diaphragm
Components, Functions and Safety Features of SCBA

• Closed-circuit breathing apparatus
  – Not commonly used in the fire service
  – Sometimes used for hazmat or confined spaces
  – Air supply of 30 minutes to 4 hours
  – Contains a cylinder of oxygen, filter system and regulator valves
  – Filters and cleans exhaled breath and adds pure oxygen
Q & A