

Note Taking Guide

Protective Envelope and Foam

Maryland Fire and Rescue Institute
University of Maryland
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The Maryland Fire and Rescue Institute of the University of Maryland is the State's comprehensive training and education system for all emergency services.

The Institute plans, researches, develops, and delivers quality programs to enhance the ability of emergency service providers to protect life, the environment, and property.

Lesson 1-2: Personal Protective Equipment

Student Performance Objective

Given information from discussion, handouts, and reading materials, describe fire service respiratory protection.

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Introduction

- Two safety components used by fire fighters need special consideration:
 - Personal protective equipment (PPE)

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Introduction

- PPE protects the body against a limited amount of heat.

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Personal Protective Equipment

- PPE is essential to a fire fighter's safety
 - Must provide full body coverage and protection from a variety of hazards
 - Must be cleaned, maintained, and inspected regularly.



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Structural Firefighting Ensemble

- The structural firefighting ensemble
 - Enables fire fighters to work in areas with high temperatures and toxic gases
 - Is designed to be worn with self-contained breathing apparatus (SCBA)



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Structural Firefighting Ensemble

TABLE 3-1

Protection Furnished by Personal Protective Equipment

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

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The Helmet

- The helmet
 - Must meet the NFPA 1971 Standard
 - Provides impact protection against falling objects
 - Is often color-coded according to rank and function
 - Must have a label permanently attached



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The Protective Hood

- The protective hood
 - Covers exposed skin
 - Is constructed of flame-resistant materials
 - Is worn over the facepiece but under the helmet



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The Turnout Coat

- The turnout coat
 - Has three layers:
 - Protective outer shell
 - Moisture barrier
 - Thermal barrier
 - Has a flap that provides a secure double seal
 - Comes in two styles—long and short



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Bunker Pants

- Bunker pants
 - Are constructed to match the turnout coat.
 - Have a three-layer protective system
 - Should be large enough to don quickly and move in easily



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Boots

- Boots
 - Are constructed of rubber or leather
 - Must meet NFPA 1971 requirements
 - Have an outer layer that repels water and is flame- and cut-resistant.
 - Have an inner liner that adds thermal protection.



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Gloves

- Gloves
 - Protect from heat, liquid, vapors, cuts, and penetration
 - Must have wristlets to protect skin at the wrist
 - Are usually constructed of heat-resistant leather



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The Personal Alert Safety System

- The personal alert safety system
 - Is an electronic device that sounds a loud signal if a fire fighter:
 - Is motionless for a set period
 - Activates it
 - Can be separate or integrated into the SCBA unit



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Additional PPE

- Approved goggles
- Intercom system
- Flexible ear plugs
- Hand light
- Radio
- Reflective vest
- Drag rescue device



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Limitations of the Structural Firefighting Ensemble

- Tasks require energy and strength
- Body heat and perspiration is retained
- Mobility and range of motion is limited
- Normal sensory abilities are decreased



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Work Uniforms

- Clothing containing nylon or polyester may melt.
- Synthetic fibers are resistant to high temperature.

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Donning and Doffing PPE

- Donning PPE must be done in a specific order to obtain maximum protection.
- To doff PPE, reverse the procedure used in getting dressed.

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Care of PPE

- Check the condition of PPE regularly.
- Repair worn or damaged PPE at once.
- Clean PPE when necessary.
 - Badly soiled by exposure
 - Exposed to chemicals or hazardous materials
- Follow the manufacturer's instructions.

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Specialized Protective Clothing

- Vehicle extrication
 - PPE is generally lighter and more flexible than structural firefighting PPE.
 - Latex gloves should be worn when providing patient treatment.
 - Eye protection also should be worn.

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Specialized Protective Clothing

- Wildland fires
 - PPE must meet NFPA 1977
 - The gear must be
 - Made of fire-resistant materials
 - Designed for comfort and maneuverability
 - Helmet, eye protection, gloves, and boots are designed for comfort and sure footing

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Putting It All Together

- Place the protective hood over your head.
- Put on your bunker pants and boots.
- Put on your turnout coat and secure.

Putting It All Together

- Pull the protective hood up.
- Place your helmet on.
- Turn up your coat collar.

Putting It All Together

- Put gloves on.
- Check your clothing.
- Work safely.

Summary

- Personal protective equipment is essential to a fire fighter.
- Structural firefighting PPE allows fire fighters to work in burning buildings, elevated temperatures, and toxic gases.
- PPE consists of a bunker coat and pants, helmet, protective hood, boots, SCBA, PASS, and additional equipment.

Summary

- Structural PPE adds weight.
- Fire fighters should be able to don PPE in less than 1 minute.
- PPE should be checked regularly.
- PPE should be kept clean.
- Gloves and coveralls or jumpsuits are used during vehicle extraction.

Lesson 5-1: Personal Protective Equipment and Self-Contained Breathing Apparatus

Student Performance Objective

Given information from discussion, handouts, and reading materials, describe fire service respiratory protection.

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Introduction

- Two safety components used by fire fighters need special consideration:
 - Personal protective equipment (PPE)
 - Self-Contained breathing apparatus (SCBA)

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Introduction

- PPE protects the body against a limited amount of heat.
- SCBA allows fire fighters to enter smoky and toxic areas and provides respiratory protection for limited time.

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Respiratory Protection

- The interior atmosphere of a burning building is considered immediately dangerous to life and health (IDLH).
- Fire fighters must be proficient in using SCBA before engaging in interior fire-suppression activities.

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Respiratory Hazards of Fires: Smoke

- Smoke includes three major components:
 - Smoke particles
 - Smoke vapors
 - Toxic gases
 - Carbon monoxide
 - Hydrogen cyanide
 - Phosgene

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Respiratory Hazards of Fires: Oxygen Deficiency

- Oxygen deficiency
 - Occurs in two ways:
 - Fire consumes available oxygen.
 - Fire produces gases that displace oxygen.
 - Can lead to disorientation, inability to control muscles, and irrational thinking

Respiratory Hazards of Fires: Oxygen Deficiency

TABLE 3-2

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

Respiratory Hazards of Fires: Increased Temperature

- Inhaling the superheated gases produced by a fire can cause severe burns of the respiratory tract.

Other Toxic Environments

- Fire fighters may encounter toxic gases or oxygen-deficient atmospheres in other emergency situations
 - At hazardous materials releases
 - In confined-space or below-grade structures where toxic gases are present

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Conditions that Require Respiratory Protection

- SCBA must be used:
 - In enclosed areas where there is smoke
 - During overhaul until the air has been tested
 - Whenever toxic gases or an oxygen-deficient atmosphere is possible
- Golden rule: Always assume that the atmosphere is hazardous!

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Types of Breathing Apparatus

- Open-circuit SCBA
 - Is used for structural firefighting
 - Has a tank of compressed air that provides the air supply
 - Has a one-way valve through which exhaled air is released into the atmosphere



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Types of Breathing Apparatus

- Closed-circuit SCBA
 - Closed-circuit SCBA is used for extended operations
 - Air passes through a mechanism that removes carbon dioxide and adds oxygen within a closed system.



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Types of Breathing Apparatus

- A supplied-air respirator
 - Uses a hose line connected to a breathing-air compressor or to compressed air cylinders
 - Is sometimes used for specialized operations



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SCBA Standards and Regulations

- NIOSH
 - Sets the design, testing, and certification requirements for SCBA
- OSHA and state agencies
 - Are responsible for establishing and enforcing regulations for respiratory protection

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SCBA Standards and Regulations

- NFPA standards related to SCBA:
 - NFPA 1500: Basic requirements
 - NFPA 1404: Requirements for SCBA training
 - NFPA 1981: Requirements for design, performance, testing, and certification of open-circuit SCBA

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Limitations of SCBA

- Use is limited by the amount of air in the cylinder
- Fire fighters must consider:
 - Time and effort required to reach destination
 - Amount of air available once destination is reached
 - Amount of time needed to complete the task
 - Amount of time needed to reach a safe area

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Limitations of SCBA

- Added weight and bulk decrease flexibility and mobility
- The facepiece can limit visibility
- Ability to communicate may be affected
- Hearing may be limited



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Physical Limitations of the User

- Moving with the extra weight of SCBA and PPE requires additional energy, which increases air consumption and body temperature.

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Psychological Limitations of the User

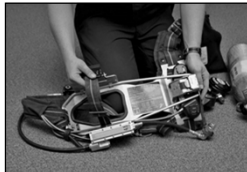
- Breathing through an SCBA can be very stressful.
 - The surrounding environment is foreign as well.
 - Fire fighters must adjust to these stressful conditions.

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Components of SCBA

- Backpack
 - A frame for mounting the other working parts of the SCBA
- Harness
 - Straps and fasteners to attach the SCBA to the fire fighter



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Components of SCBA

- The air cylinder
 - Holds breathing air for an SCBA
 - Is equipped with a hand-operated shut-off valve
 - Has a pressure gauge which shows the amount of pressure currently in the cylinder

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Components of SCBA

- The regulator assembly
 - Controls the flow of air
 - May have a dual-path pressure reducer
 - Requires, to activate:
 - Opening cylinder valve
 - Donning SCBA
 - Attaching regulator to face piece



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Components of SCBA

- The regulator assembly (cont'd)
 - Contains a pressure gauge
 - Requires a second heads-up display.
- The NFPA requires SCBA to include an end-of-service-time-indicator (EOSTI) or low-air alarm.

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Components of SCBA

- The regulator assembly (cont'd)
 - May include a PASS device.
 - Is equipped with a rapid intervention crew/company universal air connection (RIC UAC)



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Components of SCBA

- The face piece assembly
 - Delivers breathing air
 - Consists of:
 - Face mask
 - Exhalation valve
 - Regulator
 - Should cover the entire face
 - Must be annually fit-tested



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Pathway of Air Through an SCBA

- Air passes through the cylinder shut-off valve into the high-pressure hose that takes it to the regulator.
- The regulator sends air into the face piece and to the user.

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Pathway of Air Through an SCBA

- When the user exhales, used air is returned to the face piece.
- Exhaled air is exhausted from the face piece through the exhalation valve.

Skip-Breathing Technique

- Take a short breath, hold, take a second short breath.
 - Do not exhale in between breaths.
- Relax with a long exhale.
- Each breath should take 5 seconds.

Mounting Breathing Apparatus

- The SCBA should be located so that fire fighters can don it quickly.
 - Seat-mounted brackets
 - Compartment-mounted brackets
 - Exterior-mounted SCBA

Donning SCBA

- Before beginning, fire fighters must:
 - Check that air cylinder has 90% pressure.
 - Be sure donning/doffing switch is activated.
 - Open the cylinder and listen for alarm.
 - Check the pressure gauges.
 - Check that harness straps are fully extended.
 - Check that valves are in the correct position.

Donning SCBA From an Apparatus Seat Mount

- Don all protective clothing.
- Place arms through the shoulder straps.
- On arriving at the scene, activate bracket release, and exit apparatus.
- Attach waist strap; tighten and adjust shoulder and waist straps.

Donning SCBA From a Compartment Mount

- Slide arms through the shoulder harness straps.
- Release SCBA from mounting bracket.
- Adjust shoulder straps.
- Attach ends of the waist strap and tighten.

Donning SCBA From the Ground, Floor, or Storage Case

- Coat
 - Grasp one shoulder strap close to the back plate and the other farther from the plate.
 - Swing the SCBA over your left shoulder.

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Donning the Face Piece

- The face piece must be the correct size, and it must be adjusted to fit the face.
 - There must be no facial hair in the seal area.
 - Eyeglasses that pass through the seal area cannot be worn.

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Safety Precautions for SCBA

- Before entering environment, activate PASS device.
- Properly log into accountability system.
- Work in teams of two.
- Have at least two fire fighters outside.

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SCBA Use During Emergency Situations

- Keep calm, stop, and think.
- Control your breathing.
- If SCBA problems are experienced, exit the IDLH area.
- If you are in danger, follow self-survival steps and call a mayday.

Doffing SCBA

- Follow procedures recommended by the manufacturer and your department's SOPs.
- Reverse the steps for donning the SCBA.

Putting It All Together

- Place the protective hood over your head.
- Put on your bunker pants and boots.
- Put on your turnout coat and secure.
- Open the air-cylinder valve on the SCBA, and check the air pressure.
- Put on your SCBA.

Putting It All Together

- Tighten both shoulder straps.
- Attach the waist belt and tighten it.
- Fit the face piece to your face.
- Pull the protective hood up.
- Place your helmet on.
- Turn up your coat collar.

Putting It All Together

- Put gloves on.
- Check your clothing.
- Be sure your PASS device is turned on.
- Attach your regulator or turn it on.
- Work safely.

SCBA Inspection and Maintenance

- SCBA must be properly serviced each time it is used.
 - The air cylinder must be changed or refilled.
 - The facepiece and regulator must be sanitized.
 - The unit must be cleaned, inspected, and checked for proper operation.

SCBA Inspection and Maintenance

- If inspection reveals any problems that cannot be remedied, remove SCBA from service for repair.
- Only properly trained and certified personnel are authorized to repair SCBA.

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Inspection of SCBA

- SCBA should be inspected to identify parts that are damaged or need repair.
- Operational testing checks the functioning parts of SCBA.
 - Should be done after each use and at the beginning of each shift or on a set schedule.

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Inspection of SCBA

- Annual inspection
 - Must be performed on each SCBA.
 - Must be performed by:
 - A certified manufacturer's representative or
 - A person who has been trained and certified

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Servicing SCBA Cylinders

- Cylinders must be visually inspected during daily and monthly inspections.
- Federal law requires periodic hydrostatic testing and limits the number of years a cylinder can be used.

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Replacing SCBA Cylinders

- A single fire fighter must doff an SCBA to replace the air cylinder.
- Two fire fighters working together can change cylinders without removing the SCBA.
- A fire fighter should be able to change cylinders in the dark and while wearing gloves.

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Refilling SCBA Cylinders

- Compressors and cascade systems are used to refill SCBA cylinders.
- Proper training is required to fill SCBA cylinders.



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Cleaning and Sanitizing SCBA

- Follow manufacturers' instructions.
- Rinse the unit with clean water.
- Clean the harness assembly and cylinder with mild soap and water.
- Clean the face pieces and regulators with mild soap and water or a disinfectant solution.

Summary

- Personal protective equipment is essential to a fire fighter.
- Structural firefighting PPE allows fire fighters to work in burning buildings, elevated temperatures, and toxic gases.
- PPE consists of a bunker coat and pants, helmet, protective hood, boots, SCBA, PASS, and additional equipment.

Summary

- The two main types of SCBA are open-circuit and closed-circuit devices.
- SCBA limits the amount of air in the cylinder.
- Breathing through an SCBA is different than breathing normally and can be stressful.

Summary

- SCBA consists of a backpack and harness, air cylinder assembly, regulator assembly, and face piece assembly.
- Air passage through SCBA follows a specific pathway.

Summary

- Skip-breathing conserves air.
- SCBA must be checked regularly.
- SCBA cylinders are refilled via compressors and cascade systems.
- Follow the 18 steps to correctly don PPE.

Lesson 3-1: Hose and Appliances

Student Performance Objective

Given information from discussion, handouts, and reading materials students will describe how water is obtained for fighting fires, describe the procedures to operate a fire hydrant, and describe how to establish a water supply when other resources are not readily available.

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Functions of Fire Hoses

- Supply hose
 - Is used to deliver water
 - Is designed to carry large volumes of water at lower pressures
- Attack hose
 - Is used to discharge water from an attack engine
 - Operates at higher pressures than supply lines

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Sizes of Hose

- Range in size
 - Small-diameter hose (SDH): 1" to 2"
 - Medium-diameter hose (MDH): 2½" to 3½"
 - Large-diameter hose (LDH): 3½" or more



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Hose Couplings

- Hose couplings
 - Are used to connect individual lengths of hose
 - Are used to connect hose line to hydrants, valves, nozzles, fittings, and appliances

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Threaded Couplings

- Threaded couplings are used on most hose up to 3"
- A set consists of male and female
- Standardized hose threads are used by most fire departments



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Threaded Couplings

- If there is any leakage, a spanner wrench can tighten the couplings until the leakage is stopped.
- The couplings are constructed with either rocker lugs or rocker pins.

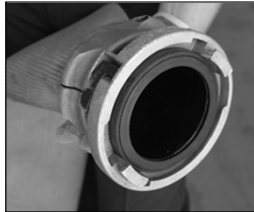


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Storz-Type Couplings

- Storz-type couplings have neither male nor female ends.
- Couplings are mated face-to-face.
- Adapters are used to connect Storz-type couplings to threaded couplings.



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Uncoupling

- Charged hose lines should never be disconnected while the water inside the hose is under pressure.
- Always shut off the water supply and bleed off the pressure before uncoupling.

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Attack Hose

- Attack hose
 - Is used for fire suppression
 - Carries water from the attack pumper to the fire
 - Is commonly
 - 1½" or 1¾" lines
 - 1" booster lines
 - 1" or 1½" forestry lines

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Supply Hose

- Supply hose
 - Is used to deliver water to an attack engine from a pressurized source.
 - Ranges from 2½" to 6" in diameter.
- Large diameters are much more efficient for moving larger volumes of water over longer distances.

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Supply Hose

- Soft suction hose
 - Is a short section of large diameter hose
 - Is used to connect a fire department engine directly to the steamer outlet on a hydrant

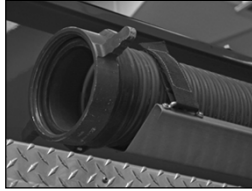


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Supply Hose

- Hard suction hose
 - Hard suction hose is used to draft water from a static source
 - Water is drawn into the pump on a fire department engine or into a portable pump.



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Hose Appliances

- Wyes
 - A wye splits one hose stream into two
 - A gated wye is equipped so that the flow of water to each of the split lines can be controlled independently.



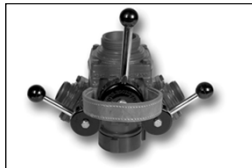
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Hose Appliances

- A water thief
 - Is similar to a gated wye
 - Has an additional 2½" outlet



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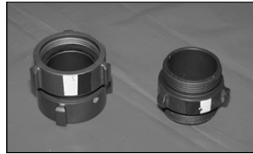
Hose Appliances

- A siamese connection
 - Combines two hose lines into one
 - Is often used on engine outlets, master streams, and fire department connections



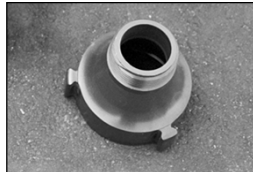
Hose Appliances

- Adapters
 - Are used to connect same size hoses with dissimilar threads
 - Are double-female or double-male



Hose Appliances

- Reducers
 - Are used to attach smaller hoses to larger hoses
 - Are commonly used to reduce a 2½" hose to a 1½" hose



Hose Appliances

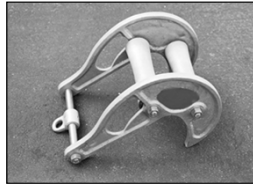
- Hose jacket
 - Is used to stop a leaking section of hose
 - Consists of a split metal cylinder that fits tightly over the hose



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Hose Appliances

- A hose roller
 - Is used to protect a line being hoisted over an edge
 - Prevents chafing and kinking



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Hose Appliances

- A hose clamp
 - Is used to temporarily stop the flow of water in a hose
 - Can be used if a hose ruptures or it has to be connected to a different appliance



Hose Appliances

- Valves
 - Control the flow of water in a hose or pipe
 - Are of different types:

- Ball valve
- Gate valve
- Butterfly Valve



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Courtesy of Aisin-Bosch Company

FIRE 102-PPT-3-1-21

Summary

- Couplings connect fire hose together.
- There are two types of couplings: threaded and Storz-type.
- Supply hose can be soft or hard suction.
- Fire hose should be inspected per NFPA standards.

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Summary

- Common causes of hose damage are mechanical, heat and cold, chemical, and mildew.
- Several types of hose appliances are available.

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FIRE 102-PPT-3-1-23

Lesson 6-2 Fire Attack and Foam

Student Performance Objective

- Given information from handouts, text, and discussion the student will be able to describe the equipment, agents and techniques used to apply foam to extinguish fires.

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Objectives

- Describe how foam suppresses fire.
- Describe the characteristics of Class A foam.
- Describe the characteristics of Class B foam.
- List the major categories of Class A foam concentrate.

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Objectives

- Describe the characteristics of compressed air foam (CAF).
- List the major categories of Class B foam concentrate.
- Describe the characteristics of protein foam.

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Objectives

- Describe the characteristics of fluoroprotein foam.
- Describe the characteristics of aqueous film-forming foam.
- Describe the characteristics of alcohol-resistant foam.

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Objectives

- Describe how foam proportioner equipment works with foam concentrate to produce foam.
- Describe how foam is applied to fires.

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Foam

- Foam
 - Is used to fight several types of fires
 - Is used to prevent ignition of materials
 - Is used to neutralize hazardous materials
 - Is produced by mixing foam concentrate with water and air

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Foam Classifications

- Class A foam
 - Is used to fight fires involving ordinary combustible materials
 - Increases effectiveness of water by reducing the surface tension of water
 - Can be added to water streams and applied with several types of nozzles

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Foam Classifications

- Class B foam
 - Class B foam fights flammable and combustible liquids
 - Class B foam separates fuel from the fire
 - The foam blanket must not be disturbed.
 - Class B foam can be applied to flammable liquid spills to prevent fire

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Class A Foam Concentrates

- Class A foams are usually formulated to be mixed with water in ratios from 0.1% to 1% solution
- "Wet" foam has good penetration properties.
- "Stiff" foam is more effective when applied for protecting buildings.

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Compressed Air Foam Systems

- The CAF method of making Class A foam
 - Compressed air is injected into a stream of water mixed with foam
 - The foam adheres to most surfaces and absorbs more heat than water
 - Hose lines with CAF are lighter

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Class B Foam Concentrates

- Class B foam concentrates are used as either 3% or 6% solution
- Different types of foam concentrate should not be mixed.
- There are four major categories of Class B foam concentrate:
 - Protein foams
 - Fluoroprotein foams
 - Aqueous film forming foam (AFFF)
 - Alcohol-resistant foam

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Foam Equipment

- Foam proportioning equipment
 - A foam eductor draws foam concentrate from a container into a moving stream of water.
 - A foam injector adds the foam concentrate to the water stream under pressure.

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Foam Equipment

- Batch mixing
 - Concentrate is poured directly into booster tank
- Premixing
 - Pre-mixed foam is commonly used in 2½-gal. extinguishers
 - The extinguisher is filled with foam solution and pressurized.

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Foam Application

- Foam can be applied through:
 - Portable extinguishers
 - Handlines
 - Master stream devices
 - Fixed systems

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Foam Application

- Foam can be applied with a range of expansion rates:
 - Low-expansion foam
 - Medium-expansion foam
 - High-expansion foam

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Foam Application Techniques

- Sweep method (or roll-on)
 - Used on flammable product on open ground
- Bankshot method (or bounce-off)
 - Used at fires where there is an object that can be used to deflect the foam stream
- Rain-down method

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Backup Resources

- If the flow of foam has to be interrupted, the fire will destroy the foam that has been applied.
- There are specific formulas to calculate how much foam is required to extinguish fires.

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Foam Apparatus

- Some fire departments operate apparatus specifically designed to produce and apply foam.
 - These apparatus are commonly used at airports.
 - Large vehicles are designed to quickly apply large quantities of foam to flammable-liquids fire.
 - Remote-control monitors can be used to apply foam while the vehicle is in motion.

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Summary

- Foam can fight multiple types of fire.
- Foams are either Class A or Class B.
- Foam extinguishes flammable-liquid fires by separating the fuel from the fire.
- Foam concentrate is mixed with water in different ratios to produce a foam solution.

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Summary

- There are five categories of Class B foam.
- Compressed air foam (CAF) systems are a way to make Class A foam.
- A foam proportioner mixes foam concentrate into the fire stream in the proper percentage.
- Foam solution can be produced by batch mixing or premixing.

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