Note Taking Guide

Firefighter I

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.
Student Performance Objective

Given information from discussion, handouts, and reading materials, analyze the role of the fire service and the role of the firefighter in the fire service.

Introduction

- Training to become a fire fighter is not easy.
- Fire fighters are challenged both physically and mentally.
- Fire fighter training will expand your understanding of fire suppression.
Fire Fighter Guidelines

• Be safe.
• Follow orders.
• Work as a team.
• Think!
• Follow the Golden Rule.

Fire Fighter Qualifications

• Age requirements
  – Most departments require that candidates be between 18 and 21 years old.

• Education requirements
  – Most departments require a minimum of a high school diploma or equivalent.

Fire Fighter Qualifications

• Medical requirements
  – Medical evaluations are often required before training can begin.
  – Medical requirements for fire fighters are specified in NFPA 1582, Standard on Comprehensive Operational Medical Program for Fire Departments.
Fire Fighter Qualifications

- Physical fitness requirements
  - Physical fitness requirements ensure that firefighters have the strength and stamina needed.
- Emergency medical requirements
  - Departments may require a fire fighter to be certified as an Emergency Medical Responder, Emergency Medical Technician (EMT)-Basic, or Paramedic.

Roles and Responsibilities for Fire Fighter I

- Properly don and doff PPE.
- Hoist hand tools using appropriate ropes and knots.
- Understand and correctly apply appropriate communication protocols.
- Use self-contained breathing apparatus (SCBA).

Roles and Responsibilities for Fire Fighter I

- Respond on apparatus to an emergency.
- Establish and operate safely in emergency work areas.
- Force entry into a structure.
- Exit a hazardous area safely as a team.
- Set up ground ladders safely and correctly.
Roles and Responsibilities for Fire Fighter I

- Attack a passenger vehicle fire, an exterior Class A fire, and an interior structure fire.
- Conduct search and rescue in a structure.
- Perform ventilation of an involved structure.
- Overhaul a fire scene.

Roles and Responsibilities for Fire Fighter I

- Conserve property with salvage tools.
- Connect an engine to a water supply.
- Extinguish Class A, Class B, Class C, and Class D fires.
- Illuminate an emergency scene.
- Turn off utilities.

Roles and Responsibilities for Fire Fighter I

- Combat a ground cover fire.
- Perform fire safety surveys.
- Clean and maintain equipment.
General Roles Within the Department

• Fire apparatus driver/operator
• Company officer
• Safety officer
• Training officer
• Incident commander
• Fire marshal/inspector/investigator

General Roles Within the Department

• Fire and life safety education specialist
• 911 dispatcher/telecommunicator
• Apparatus mechanic
• Fire policeman
• Information management technician
• Public information officer
• Fire protection engineer

Specialized Response Roles

• Aircraft/crash rescue fire fighter
• Hazardous materials technician
• Technical rescue technician
• SCUBA dive rescue technician
• Emergency Medical Services (EMS) personnel
  – EMT, Advanced EMT, and Paramedic
Working with Other Organizations

- Fire departments need to interact with other organizations in the community.

Working with Other Organizations

- The Incident Command System (ICS)
  - A unified command must be established as part of the ICS
  - Unified command controls multiple agencies at an incident

Fire Department Governance

- Regulations
  - Are detailed rules that implement a law passed by a governmental body

- Policies
  - Outline what is expected in stated conditions
  - May be developed by other government agencies to provide guidelines for actions of fire department personnel
Fire Department Governance

• SOPs
  – Standard Operating Procedures provide specific information on actions that should be taken to accomplish a task.
  – Suggested operating guidelines (SOGs) are not as strict as SOPs.

Company Types

• Engine
• Truck
Company Types

- Rescue
- Wildland/brush
- Hazardous materials
- Emergency Medical Services (EMS)

Other Views of Fire Service Organization

- Staffing
  - The department must have sufficient trained personnel available
- Function
  - Bureau or office
  - Apparatus type
- Geography

Chain of Command

- Chain of Command is a structure for managing the department and the fireground operations.
- Ranks may vary by department, but the concept is the same.
Chain of Command

Source of Authority

- Source of authority
  - Local governments
  - Sometimes state and federal governments
- The fire chief is accountable to the governing body

Basic Principles of Organization

- Discipline
  - Guiding and directing fire fighters
- Division of labor
  - Makes an individual responsible for completing the assigned task
  - Prevents duplicate job assignments
Basic Principles of Organization

• Unity of command establishes a direct route of responsibility from the chief to the firefighter

Basic Principles of Organization

• Span of control
  – The number of people one person can supervise effectively

History of the Fire Service

• Romans created the first fire department, the *Familia Publica*.
  – The first paid department in the United States was in Boston (established in 1679).
  – Ben Franklin started the first volunteer department in the United States in Philadelphia in 1735.
The Great Chicago Fire

- The Great Chicago Fire
  - Began October 8, 1871
  - Burned for 3 days
  - Caused damages of:
    - $200 million
    - 300 dead
    - 90,000 homeless

The Peshtigo Fire

- A flash forest fire in Wisconsin occurred at the same time as the Great Chicago Fire
  - Caused a “tornado of fire” 1,000 ft high and 5 miles wide
  - Burned 2,400 square miles (m²) of forest land
  - Left 2,200 dead
  - Destroyed several small communities

Building Codes

- The history of building codes
  - Egyptians used codes to prevent collapse.
  - Colonial communities had few codes.
  - Present codes address construction materials and “built-in” protection.
**Building Codes**

- Codes are written by national organizations.
  - National Fire Protection Association (NFPA)
- Volunteer committees research and develop proposals.
- The consensus document is presented to the public.

**Training and Education**

- Today's fire fighters operate high-tech, costly equipment.
- Fire fighters need to continually sharpen their skills and increase their knowledge.

**Fire Equipment**

- Colonial fire fighters had buckets, ladders, and fire hooks.
- Hand-powered pumpers were developed in 1720.
- Steam-powered pumpers were developed in 1829.
Fire Equipment

- Present-day equipment
  - A single apparatus is used for several purposes
- Fire hydrants
  - Were developed in 1817
- The first public call boxes
  - Were developed in 1860

Communications

- Fire wardens and night watchmen sounded the alarm in neighborhoods during the colonial period
- Telegraph alarm systems were developed in the late 1800s
- Present day response time is aided by
  - Hardwired and cellular telephones
  - Computer-aided dispatch facilities

Communications

- Fire-ground communications
  - Early days: Chief’s trumpet, now a symbol of authority
  - Present: Two-way radios
Paying for Fire Service

• In early times, insurance companies paid fire departments for service.
• Career departments are generally funded through local tax funds.

The Fire Service in the United States Today

• There are about 1.1 million fire fighters.
• 75% of career fire fighters serve communities of 25,000 or larger.
• Half of the volunteers serve rural areas with populations of 2,500 or less.
• There are approximately 30,000 fire departments.

Summary

• Be safe, follow orders, work as a team, think, and follow the Golden Rule.
• Training and performance qualifications for fire fighters are specified in NFPA 1001.
• The Fire Fighter I works under direct supervision; the Fire Fighter II works under general supervision.
Summary

• You may assume several roles in the fire department.
• Most large fire departments have teams of specialized fire fighters.
• When multiple agencies work together at an incident, a unified command must be established.

Summary

• Governance is the process by which an organization exercises authority.
• A fire department includes many different types of companies.
• The chain of command is fire fighter, lieutenant, captain, battalion chief, assistant or division chief, and chief of the department.

Summary

• The management principles of the fire service are discipline, division of labor, unity of command, and span of control.
• Building codes govern construction materials.
• It is helpful to study the past and present fire service.
Given information from discussion, handouts, and reading materials, students will analyze fire department communications.

**Introduction**

- A functional communications system links:
  - The public and the fire department
  - Firefighters on the scene and the rest of the organization
  - The fire department with other agencies and facilities
Introduction

• Fire fighters must be familiar with the communications systems, equipment, and procedures used in their departments.
• Basic administration requires an efficient communications network.

The Communications Center

• The communications center is the hub of the fire department response system.
  – Is the central processing point for emergency incident information
  – Connects and controls the department’s communications systems

The Communications Center

• The size and complexity of centers vary, depending on department needs.
• Types
  – Stand-alone
  – Regional
  – Co-located
  – Integrated
Telecommunicators

- Telecommunicators are personnel trained to work in a public safety communications environment.
- Telecommunicators are required to:
  - Perform multiple tasks effectively and make decisions quickly
  - Communicate effectively
  - Operate all systems and equipment
  - Understand and follow operational procedures

Communications Facility Requirements

- Facilities must be designed to ensure a very high degree of operational reliability
  - Well-protected against threats
  - Equipped with emergency generators
  - Secured to prevent unauthorized entry
- A back-up center should be established at another location

Communications Center Equipment

- Dedicated 911 telephones
- Public telephones
- Direct-line telephones to other agencies
- Equipment to receive alarms from public and/or private fire alarm systems
- Computers and/or hard copy files and maps to locate addresses and select units to dispatch
Communications Center Equipment

- Equipment for alerting and dispatching units to emergency calls
- Two-way radio system(s)
- Recording devices to record telephone calls and radio traffic
- Back-up electrical generators
- Records and record management systems

Computer-Aided Dispatch (CAD)

- Automates functions required for receiving calls and dispatching and monitoring resources
- Shortens the time required to take and dispatch calls

Computer-Aided Dispatch (CAD)

- Some systems can track the location of vehicles using global positioning system (GPS) technology.
- Some systems transmit information directly to station or apparatus computers.
Voice Recorders and Activity Logs

- Everything that happens in a communications center is recorded using either:
  - A voice recording system: An audio record of what is said over telephone lines and radios
  - An activity logging system: A written or computerized record of what happened

Voice Recorders and Activity Logs

- Timestamps record the date and time of the event.
- Voice recorders and activity logs are legal records of the official delivery of a government service by the fire department.
- Records may be required for legal proceedings, sometimes years after the incident occurred.

Voice Recorders and Activity Logs

- Reasons for maintaining voice recorder and activity log records:
  - Defending the department’s actions
  - Demonstrating that the organization performed ethically, responsibly, and professionally
  - Reviewing and analyzing information about department operations
Call Response and Dispatch

- Critical functions performed by most CAD systems:
  - Verifying an address
  - Determining which units should respond to an alarm
- Dispatching must follow the standard protocols adopted by the fire department.

Call Response and Dispatch

- The generally accepted “answer-to-dispatch” performance objective is one minute or less.
- Most requests are made by telephone.

Communications Center Operations

- Basic functions performed:
  - Receiving calls and dispatching units
  - Supporting and coordinating unit operations
  - Keeping track of status of each unit
  - Monitoring level of coverage, managing deployment
  - Notifying designated agencies of particular events
  - Maintaining records of activities
  - Maintaining information required for dispatch
Receiving and Dispatching Emergency Calls

- Receiving and dispatching process:
  - Call receipt
  - Location validation
  - Classification and prioritization
  - Unit selection
  - Dispatch

Call Receipt

- Most communities use 911 to report emergencies.
- The telecommunicator conducts telephone interrogation.
  - Determines location of emergency
  - Determines nature of situation

TDD/TTY/Text Telephones

- Communications centers must be able to process calls made by hearing-impaired callers.
  - TDD (telecommunications device for the deaf)
  - TTY (teletype)
  - Text telephones
Municipal Fire Alarm Systems

- Most communities have fire alarm boxes or emergency telephones in public places.
- The fire alarm box transmits coded signals to the communications center.

Private and Automatic Fire Alarm Systems

- The connection used to transmit alarms from private systems to the communications center will vary.

Walk-ins

- People may come to the fire station.
- Contact and advise the communications center of the situation.
Location Validation

- Enhanced 911 systems have features that help the telecommunicator obtain information.
  - Automatic Number Identification (ANI)
  - Automatic Location Identification (ALI)

Location Validation

- The caller's location may not always be the location of the emergency incident.
  - Always confirm the information is correct.
  - GPS technology is helping to resolve some of these issues.

Call Classification and Prioritization

- Calls must be assigned a response category based on the nature of the reported problem
- The nature of the call dictates which units or combinations of units should be dispatched.
Unit Selection

• The telecommunicator must determine which units to dispatch
• Run cards list units in order of response.
• Some vehicles have locator systems.
• Most CAD systems are programmed to select units automatically.

Dispatch

• The telecommunicator must alert the selected units to respond and transmit information to them
  – Verbal messages
  – CAD system alerts
  – Pagers, outdoor sirens, horns, or whistles
    • Some allow text messages, including incident information

Operational Support and Coordination

• Someone in the communications center must remain in contact with the responding units throughout the entire incident.
• Communications may include
  – Progress and incident status reports
  – Requests for additional units
  – Notifications
  – Requests for information or outside resources
Status Tracking and Deployment Management

• Communications center personnel must know the location and status of every unit at all times.
  – CAD systems allow status changes to be entered through digital status units or computer terminals.
• Communications center personnel must continually monitor the availability of units in each area and redeploy units when coverage is insufficient.

Touring the Communications Center

• New fire fighters should tour the communications center.

Radio Systems

• Radios link the communications center and individual units.
• Radios link units at an incident scene.
• Radios are also used to transmit dispatch information to fire stations, to page volunteers, and to link mobile computer terminals.
Radio Equipment

- Portable radio: Hand-held radio small enough for a firefighter to carry at all times
- Mobile radio: More powerful radio permanently mounted in vehicles

Radio Equipment

- Base station radios are permanently mounted in a building.
- Mobile data terminals transmit data by radio.

Radio Operation

- A radio channel uses one or two frequencies.
  - A simplex channel uses only one frequency.
  - A duplex channel uses two frequencies.
  - Duplex channels are used with repeater systems.
Radio Operation

- U.S. Fire Service frequencies:
  - VHF low band: 33 to 46 MHz
  - VHF high band: 150 to 174 MHz
  - UHF band: 450 to 460 MHz
  - Trunked: 800-MHz band
- A radio can be programmed to operate on several frequencies in a particular band but cannot be used across different bands.

Radio Operation

- Communications over long distances require the use of a repeater.
- Some fire departments switch from a duplex channel to a simplex channel for on-scene communications; this configuration is sometimes called a “talk-around channel.”
Radio Operation

- New radio technologies use a trunking system.
  - A group of shared frequencies is controlled by a computer
  - Messages are transmitted over whatever frequencies are available
  - Eavesdropping is more difficult
  - Different radios can be connected
  - Many agencies are linked on the same system

Using a Radio

- Firefighters must know how to operate any radio, and how to work with the radio system(s) used by the fire department.
- Familiarize yourself with department SOPs.

Using a Radio

- NFPA standards recommend using plain English.
- Arrival and progress reports should be given on a regular basis.
  - Allows IC to assess progress of the incident
Taking Calls

• Know how to answer telephones and use the station intercom.
• Keep personal calls to a minimum.
• Use a standard greeting.

Taking Calls

• Be prompt, polite, professional, and concise.
• Remember that an emergency call can come in on any telephone line.

Summary

• Every fire department depends on a communications center.
• Telecommunicators obtain information from citizens and relay it to dispatch.
• Vital pieces of equipment are located in the communications center.
• CAD enables telecommunicators to work effectively.
Summary

• Everything that is said over the telephone or radio is recorded.
• The communications center performs many basic functions.
• There are five major steps in processing an emergency incident.
• Calls may be received in many different ways.

Summary

• Enhanced 911 systems display additional information.
• Fire department communications depend on two-way radio systems.
• Three types of radios may be used.
• Radios work by broadcasting electronic signals on certain frequencies.
• Radio channels use either one or two frequencies.

Summary

• Each radio channel uses two separate frequencies in a repeater system.
• In a trunking system, a group of shared frequencies are controlled by computer.
• A brief radio report should be given by the first-arriving unit.
• A firefighter who answers the telephone is a representative of the fire department.
Student Performance Objective

Given information from discussion, handouts, and reading materials, describe fire behavior and fire control theory.

Introduction

• Fire has been around since the beginning of time.
• Destruction of lives and property by uncontrolled fires has occurred just as long.
The Chemistry of Fire

- Understanding the conditions needed for a fire to ignite and grow will increase your effectiveness.
- Being well trained in fire behavior will allow the firefighter to control a fire with less water.

What Is Fire?

- Fire is a rapid chemical process that produces heat and usually light.
- Fire is neither solid nor liquid.
- Solids, liquids, and gases can all burn and create flaming combustion.

Matter

- Matter is made up of atoms and molecules
- Matter exists in three states
  - Solid
  - Liquid
  - Gas
Fuel

- Fuel is a form of energy
- Energy released in the form of heat and light has been stored before it is burned

Types of Energy

- Chemical energy
  - Chemical energy is energy created by a chemical reaction.
  - Exothermic reactions produce heat.
  - Endothermic reactions absorb heat.

Types of Energy

- Mechanical energy
  - Converted to heat when two materials rub against each other.
- Electrical energy
  - Produces heat while flowing through a wire or another conductive material
Types of Energy

• Light energy
  – Is caused by electromagnetic waves packaged in discrete bundles called photons
• Nuclear energy
  – Is created by nuclear fission or fusion

Conservation of Energy

• Energy cannot be created or destroyed by ordinary means.
• Energy can be converted from one form to another.

Conditions Needed for Fire

• There are three basic factors required for combustion:
  – Fuel
  – Oxygen
  – Heat
• Chemical chain reactions keep the fire burning.
Chemistry of Combustion

• Almost all fuels are hydrocarbons
  – Hydrocarbons consist of both hydrogen and carbon atoms
  – When the fuel combines with oxygen, it produces water and carbon dioxide.
  – Incomplete combustion produces large quantities of deadly gases

Chemistry of Combustion

• Oxidation: combining oxygen with another substance to create a new compound
• Combustion: combining a substance with oxygen to produce heat and light
• Pyrolysis: decomposition of a material brought about by heat in the absence of oxygen

Products of Combustion

• Smoke
  – Smoke is a toxic by-product
  – Smoke is composed of:
    • Particles
    • Vapors
    • Gases
  – Inhalation of smoke can cause severe injuries.
Fire Spread

• Direct contact
  – Direct contact can quickly spread a fire.
  – Many wildland fires start through direct contact.

Fire Spread

• Conduction
  – Heat is transferred from one molecule to another (direct contact)
  – Good conductors absorb heat and transfer it throughout the object.

Fire Spread

• Convection
  – Is a circulatory movement in areas of differing temperatures
  – Creates convection currents
Fire Spread

• Radiation
  – Is the transfer of heat in the form of an invisible wave
  – Travels in all directions
  – Is not seen or felt until it strikes an object

Methods of Extinguishment

• Cool the burning material
• Exclude oxygen
• Remove fuel
• Break the chemical reaction

Classes of Fire

• Class A
  – Class A fires involve ordinary solid combustibles
  – To extinguish, cool the fuel with water
Classes of Fire

• Class B
  – Class B fires involve flammable or combustible liquids
  – To extinguish, shut off the fuel supply or use foam to exclude oxygen from the fuel

Classes of Fire

• Class C
  – Class C fires involve energized electrical equipment
  – Attacking with an extinguishing agent that conducts electricity can result in injury or death.

Classes of Fire

• Class D
  – Class D fires involve combustible metals
  – The application of water will result in violent explosions
  – Class D fires must be attacked with special agents
Classes of Fire

• Class K
  – Class K fires involve combustible cooking oils and fats
  – Special extinguishers are available to handle this type of fire.

Solid Fuels

• Most fires encountered involve solid fuels.
• Solid fuels do not actually burn in the solid state
  – Must be heated or pyrolyzed
  – May change directly from a solid to a gas
• Wood does not have a fixed ignition temperature

Solid-Fuel Fire Development

• Progress through four distinct phases:
  – Ignition
  – Growth
  – Fully developed
  – Decay
**Ignition Phase**

- Heat ignites paper.
- Heat from the paper sets up a convection current, and the flame produces radiated energy.

**Growth Phase**

- Kindling starts to burn, increasing convection of hot gases upward.
- Energy radiates in all directions.
- There is major growth in an upward direction.

**Fully Developed Phase**

- The fully developed phase produces the maximum rate of burning.
- Fire will burn as long as fuel and oxygen remain.
Decay Phase

- Fuel is nearly exhausted.
- Rate of burning slows.
- Flames become smoldering embers.

Key Principles of Solid-Fuel Fire Development

- Hot gases and flame tend to rise.
- Convection is the primary factor in spreading the fire upward.
- Downward spread occurs primarily from radiation and falling chunks of flaming material.
- If there is no remaining fuel, the fire will go out.

Key Principles of Solid-Fuel Fire Development

- Variations in the direction of fire spread occur if air currents deflect the flame.
- The total material burned reflects the intensity of the heat and the duration of the exposure to the heat.
- An adequate supply of oxygen must be available to fuel a free-burning fire.
Room Contents

- Synthetic products will usually pyrolyze to volatile products.
- Newer paints generally burn readily.
- Carpets ignite readily.
- Furniture has improved resistance to heat from glowing sources, but it has almost no resistance to ignition from flaming sources.

Room-and-Contents Fire: Ignition Phase

- Flame begins small and localized.
- Convection of hot gases is the primary means of fire growth.
- Fire could probably be extinguished with a portable fire extinguisher.

Room-and-Contents Fire: Growth Phase

- Additional fuel is drawn into the fire.
- Flames spread upward and outward.
- Radiation starts to play a greater role.
- Growth is limited by the fuel and oxygen available.
**Room-and-Contents Fire: Fully Developed Phase**

- Flammable materials are pyrolyzed.
- Volatile gases are being released.
- **Flashover**
  - Combustible materials ignite at once.
  - Temperatures reach 1000°F.

**Room-and-Contents Fire: Decay Phase**

- Burning decreases to the point of smoldering fuel.
- A large volume of toxic gases may continued to be produced.

**Thermal Layering**

- Gases rise and form layers.
- Thermal balance can be upset by:
  - Water applied to a fire creating steam
  - Steam displacing hot gases at top of the room
- Ventilate while attacking the fire.
- Avoid directing water at the ceiling.
Flameover (Rollover)

- Flameover is spontaneous ignition of hot gases layered in a developing room or compartment fire
- Flames can extend throughout the room at the ceiling level.
- Flameover is a sign that temperature is rising

Flashover

- Flashover
  - Is caused by rising temperature during flameover
  - Is the near-simultaneous ignition of combustible material
- Temperatures are not survivable by firefighters.

Backdraft

- Backdraft is caused by introduction of oxygen in an enclosure where superheated gases and contents are hot enough but do not have oxygen to burn
- Backdrafts require a "closed box"
Backdraft

- Signs and symptoms:
  - Confined fire with a large heat build-up
  - Little visible flame from the exterior
  - Smoke puffing from the building
  - Smoke that seems to be pressurized
  - Smoke-stained windows
  - No smoke showing
  - Turbulent smoke
  - Thick yellowish smoke

Fire Behavior in Modern Structures

- Modern construction has altered fire behavior due to:
  - Building construction
  - Widespread use of plastics and petroleum-based products for furniture and accessories

Fire Behavior in Modern Structures

- Fire in a modern structure progresses to the fully developed phase quickly.
  - Fire fighters introduce a fresh supply of oxygen by opening the front door.
  - Fire rapidly grows and spreads.
Wind Effect

• Wind influences fire behavior and may affect which side of the structure to enter.
• Size-up of a structure fire must include a wind evaluation regardless.

Liquid-Fuel Fires

• A liquid must be converted to a gaseous state before it will burn.
• Conditions required for ignition:
  – Fuel-air mixture within flammable limits
  – An ignition source with sufficient energy
  – Sustained contact between ignition source and fuel-air mixture

Liquid-Fuel Fires

• Flammability is determined by the compound with the lowest ignition temperature.
  – Flash point: lowest temperature at which vapor is produced
  – Flame point: lowest temperature at which sufficient vapors are produced
Vapor Density

- Weight of a gas fuel
  - Gas with vapor density less than 1 will rise.
  - Gas with vapor density greater than 1 will settle.
- Knowing vapor density helps predict where the danger of ignition will be.

Flammability Limits

- Below the lower flammability limit
  - Too little fuel = too lean
- Above the upper flammability limit
  - Too much fuel = too rich

BLEVE

- BLEVE occurs when a vessel storing liquid fuel under pressure is heated excessively
  - The vessel can then fail, releasing all of the heated fuel in a massive explosion.
Smoke Reading

• Smoke reading enables the fire fighter to learn where the fire is, how big it is, and where it is moving.
• Fires are dynamic events.
• Smoke is the fuel all around you at a fire.
• The best place to observe patterns of smoke is outside the fire building.

Smoke Reading

• Determining the key attributes of smoke
  – Smoke volume
  – Smoke velocity
  – Smoke density
  – Smoke color

Smoke Reading

• Determine the influences on the key attributes
  – Size of the structure
  – Wind conditions
  – Thermal balance
  – Fire streams
  – Ventilation openings
  – Sprinkler systems
Smoke Reading

- Determine the rate of change
  - Changes in the four key attributes indicate changes in the fire.
- Predict the event
  - Consider the key attributes, what influences them, and their rate of change
  - Communicate key parts to the company officer

Smoke Reading Through a Door

- Indications of a hot fire may mean you are dealing with fire in a decay phase
  - This is a sign of great danger.
  - The addition of oxygen results in violent backdraft.
  - Fires can be dangerous even with little smoke.

- If smoke exits through the top half and clean air enters through the bottom half
- If smoke rises and the opening clears
- If smoke thins but still fills the door
Summary

- Fire is a chemical process.
- Matter exists in three states: solid, liquid, and gas.
- Fuels are a form of energy.
- Three basic conditions are needed for fire: fuel, oxygen, and heat.
- Smoke is the by-product of fire.

Summary

- Fire can spread by direct contact, conduction, convection, and radiation.
- Direct contact is a flame touching a fuel.
- Conduction is the transfer of heat through matter.
- Convection is a circulatory movement in a gas or fluid.

Summary

- Radiation transfers heat via invisible waves.
- The four principle methods of fire extinguishment are cooling the fuel, excluding oxygen, removing the fuel, and interrupting the chemical reaction.
- The four categories of fire are Class A, Class B, Class C, Class D, and Class K.
Summary

- Most fires involve solid fuels.
- Solid-fuel fires develop in four phases: ignition phase, growth phase, fully developed phase, and decay phase.
- Growth of fires depends on room characteristics and contents.

- Special considerations of room-and-contents fires are thermal layering, flameovers, flashovers, thermal layering, and backdrafts.
- Modern structures are more tightly sealed, are constructed of lighter-weight materials, and contain more plastics.

Summary

- Liquid-fuel fires require fuel, air, an ignition source, and contact between fuel and the ignition.
- Flammable vapors are described in terms of vapor density and flammability limits.
- A boiling liquid/expanding vapor explosion (BLEVE) occurs in a vessel containing both boiling liquid and vapor.
Summary

- Fire prediction and development stage depend on assessment of smoke volume, velocity, density, and color.
- Smoke reading involves the effect of the building, weather, and ventilation.
Student Performance Objective

Given information from discussion, handouts, and reading materials, the student will describe the various tools and methods for combating wildland fires.

Introduction

- Wildland fires:
  - As defined by the NFPA, are unplanned and uncontrolled fires burning in vegetative fuel that sometimes includes structures
  - Can consume grasslands, brush, and trees of all sizes
  - Are referred to by different terms
Introduction

• Ground cover fires burn loose debris on the surface of the ground.
• Many structural fire fighters are called on to extinguish wildland and ground fires at some point.

Introduction

• Large wildland fires are handled by specialized agencies.
  – Each state has an agency designated to coordinate wildland firefighting.
  – There are federal agencies that are responsible for coordinating firefighting activities at large incidents.

Wildland and Ground Fires and the Fire Triangle

• Wildland and ground fires require the same three elements as structural fires.
  – Conditions under which elements come together to produce a fire are different.
Fuel

• Primary fuel is area vegetation.
• Vegetative fuels can be located:
  – Under the ground
  – On the surface
  – Above the ground

Fine Fuels

• Fine fuels
  – Include dried vegetation (e.g., twigs, leaves, needles, grass, moss, and light brush)
  – Are the main type of fuel in ground cover fires
  – Aid the ignition of heavier fuels

Heavy Fuels

• Heavy fuels
  – Include large brush, heavy timber, stumps, branches, dead timber, and slash
  – Do not spread a fire as rapidly as fine fuels
  – Can burn with a high intensity
Subsurface Fuels

- Subsurface fuels are located under the ground
  - Roots, moss, duff, and decomposed stumps
- Fires involving subsurface fuels are hard to locate and extinguish.

Surface Fuels

- Surface fuels
  - Are located close to the surface of the ground (grass, leaves, twigs, needles, small trees, and slash)
  - Are sometimes called ground fuels
  - Are involved in ground cover fires

Aerial Fuels

- Aerial Fuels
  - Are also called canopy fuels
  - Are located more than 6 feet above the ground
  - Usually consist of trees (limbs, leaves, needles on limbs, and moss)
Other Fuel Characteristics

- Size and shape
- Compactness
- Continuity
- Volume
- Moisture level

Other Fuel Characteristics

- Fuel compactness
  - Oxygen and heat cannot get to large surfaces in a short period.
- Fuel continuity
  - Fuels touch each other, allowing fire to spread from one area to the next.

Other Fuel Characteristics

- Fuel volume
  - Is the quantity of fuel available in an area
    - Influences growth and intensity of fire
- Fuel moisture
  - Fuels with high moisture will not ignite and burn as readily as fuels with low moisture
Oxygen

- Oxygen is not an important variable in the ignition or spread of wildland and ground fires.
- Air movement influences the speed with which a fire moves.

Heat

- Sufficient heat must be applied to fuel in the presence of adequate oxygen to produce a fire.
- There are three categories of factors:
  - Natural causes
  - Unintentional causes
  - Intentional causes

Weather

- Relative humidity
  - Relative humidity is the ratio of the amount of water vapor present in the air compared with the maximum amount the air can hold at a given temperature
  - When relative humidity is low, vegetative fuels are more susceptible to ignition.
Weather

• Precipitation
  – Precipitation helps increase the relative humidity.
  – Precipitation is absorbed by plants.
  – When there is adequate precipitation, fire risk is lower.

Wind

• Wind has the ability to move a fire at great speed.
• The effect is similar to fanning a fire to help it burn more rapidly.

Topography

• Topography refers to changes of elevation in the land and the position of natural and manmade features
• On flat land, heat rises into the air.
• On a hillside, convective and radiant heat cause a more rapid fire spread.
Anatomy of a Wildland Fire

• The area of origin
  – Location where fires begin

• The head of the fire
  – The head is the main or running edge of a fire
  – The head of the fire spreads with the greatest speed

Anatomy of a Wildland Fire

• The heel or the rear of the fire
  – Is opposite the head, close to the area of origin

• A finger
  – Is a narrow point of fire caused by a shift in wind or a change in topography
  – Can grow and produce a secondary direction of travel for the fire

Anatomy of a Wildland Fire

• A pocket
  – Is unburned fuel surrounded by fire

• An island
  – Is an unburned area surrounded by fire
Anatomy of a Wildland Fire

• A spot fire
  – Is a new fire that starts outside the main fire
• “Green”
  – Describes areas of unburned fuels
• “Black”
  – Describes areas that have already been burned

Cooling the Fuel

• Water is used to cool the fuel.
  – Backpack pump extinguishers
  – Booster tanks from apparatus
  – Aircraft

Removing the Fuel

• Removing the fuel can be accomplished with:
  – A fire broom
  – Steel fire rakes
  – A McLeod fire tool
  – An Adze and axe
  – Council rakes
Removing the Fuel

• Sometimes saws are used to remove heavy brush and trees from the fire.
• Backfiring can create an area devoid of vegetation.

Removing Oxygen

• Smothering
  – Is most commonly used when overhauling the last remnants of a fire
  – Is not as useful during the more active phases of a fire

• Compressed air foam systems (CAFSs)
  – Combine foam concentrate, water, and compressed air to produce a foam
  – Extinguish with less water
  – Reduce rekindling
Direct Attack

• A direct attack is mounted by containing and extinguishing the fire at its burning edge
• A direct attack is dangerous to fire fighters because they must work in smoke and heat
• An advantage is quick containment of the fire

Direct Attack

• A pincer attack
  – Requires two teams
    • Team one mounts along the left flank near the point of origin
    • Team two mounts along the right flank near the point of origin

Direct Attack

• A flanking attack
  – A flanking attack requires one team
  – Attack is made on either flank
    • Based on the flank with greatest risk
Indirect Attack

- Indirect attack
  - Is used for large fires that are too dangerous to approach through a direct attack
  - Is mounted by building a fire line
  - Is most appropriate when the topography is so rough that a direct attack is dangerous

Priorities of Attack

- The Incident Commander must assess and evaluate the priorities for preserving lives and property before determining how to attack a wildland fire.

Fire Apparatus Used for Wildland Fires

- Structural fire apparatus
  - Do not have pump and roll capabilities
  - Do not possess off-road capabilities
Fire Apparatus Used for Wildland Fires

- Wildland fire apparatus
  - Range from small pick-up trucks and jeeps to large all-wheel drive trucks

Hazards of Wildland Firefighting

- Driving in rough terrain
  - Risk of rollover
- Working in rough terrain
  - Risk of falls
- Burns and smoke inhalation

Hazards of Wildland Firefighting

- Falling trees
- Electrical hazards
  - Wires that drop on vegetation
  - Downed wires
- Dehydration and heat stroke
Personal Protective Equipment

- Jumpsuit, or a coat, shirt, and trousers
- Approved helmet
- Respiratory protection
  - SCBA in heavy smoke and poisonous gases

Fire Shelters

- Fire shelters
  - Are made of reflective foil attached to fiberglass
  - Reflect approximately 95% of a fire's radiant heat for a short period
  - Are used when a firefighter is unable to reach safety in time

The Wildland-Urban Interface

- The wildland-urban interface
  - Is an area where undeveloped land with vegetative fuels is mixed with human-made structures
  - Presents a significant life safety hazard and huge property loss potential
The Wildland-Urban Interface

- Because of the nature of wildland-urban interfaces, it is important that structural fire fighters learn the basic principles of fighting wildland fires.
- Efforts geared at reducing loss need to be directed at prevention.

Wildland Fire Safety

1. Keep informed on fire weather conditions and forecasts.
2. Know what your fire is doing at all times.
3. Base actions on the behavior of the fire.
4. Identify escape routes and safety zones.
5. Post lookouts when there is danger.
6. Be alert, calm, clear, and decisive.
7. Maintain prompt communications.
8. Give clear instructions and ensure they are understood.
9. Maintain control of your forces.
10. Fight fire aggressively, having provided for safety first.
Summary

• Wildland fires are fires burning in vegetative fuel.
• Wildland fires are sometimes called brush fires, forest fires, ground cover fires, ground fires, natural cover fires, and wildfires.
• Wildland is land in an uncultivated natural state.

Summary

• Large fires are handled by specialized agencies.
• The wildland fire triangle consists of three elements.
• Vegetation is the primary fuel for wildland fires.
• The size and shape of a fuel influence how it burns.

Summary

• Air movement influences the speed and direction of the fire.
• Lightening is the source of almost all naturally caused wildland fires.
• Weather conditions and topography have a great effect on wildland fires.
• The location where a wildland fire starts is called the origin.
Summary

• The head of the fire is rapidly moving.
• A finger is an extension of fire.
• A pocket is an unburned area.
• Green areas contain unburned fuels; black areas have already burned.
• Wildland fires can be controlled by cooling, removing, or smothering the fire.

Summary

• Backpack pump extinguishers may be effective against small wildland fires.
• Hand tools may remove fuel from the fire.
• CAFS foam may smother wildland fires.
• Direct and indirect attacks are used.
• Fire fighters should know escape routes.

Summary

• Hazards include apparatus rollovers, falls, burns, smoke inhalation, dehydration, and heat stroke.
• Fire shelters are important pieces of PPE.
• The wildland-urban interface presents a significant risk to both lives and structures.
Lesson 4-1: Building Construction

Student Performance Objective

Given information from discussion, handouts, and reading materials, describe building construction as it applies to the fire service.

Introduction

• Building construction affects how fires grow and spread.
  – Firefighters need to understand how each type of building construction reacts when exposed to the effects of heat.
  • Determines when it is safe to enter a burning building and when it is necessary to evacuate
Occupancy

- The term "occupancy" refers to how a building is used
  - Classifications indicate who is likely to be inside, how many people are inside, and what they are likely to be doing.

Contents

- Contents must be considered when responding to a building.
  - Contents vary widely but are usually related to occupancy.
  - Similar occupancies can pose different levels of risk.

Types of Construction Materials

- The properties of building materials and the details of their construction determine the basic fire characteristics of the building itself.
- Key factors that affect combustibility are
  - Combustibility
  - Thermal conductivity
  - Decrease of strength at elevated temperatures
  - Thermal expansion when heated
Masonry

- Masonry is inherently fire resistive
- Masonry is a poor conductor
- Openings can allow fire to spread.
- With prolonged exposure to fire, masonry can collapse.

Concrete

- Concrete
  - Is naturally fire resistive
  - Is a poor conductor of heat
  - Is strong under compression
  - Is weak under tension
  - Can be damaged through exposure to fire
    - Spalling

Steel

- Steel
  - Is the strongest material in common use
  - Is strong in both compression and tension
  - Will rust if exposed to air and moisture
  - Is not fire resistive
  - Is a good conductor of heat
Steel

- Steel expands and loses strength when heated.
- Any sign of bending, sagging, or stretching indicates immediate risk of failure.

Other Metals

- Aluminum
  - Is used in siding, window and door frames, and roof panels.
  - Often melts and drips in fires.
- Copper
  - Is primarily used for piping and wiring.
- Zinc
  - Is used as a protective coating for metals.

Glass

- Glass is noncombustible but not fire resistive.
- Ordinary (nontreated) glass will break when exposed to flame.
Gypsum Board

- Gypsum is a very good insulator
- Gypsum has limited combustibility
  - Paper will burn, but gypsum itself will not.
  - It is often used as a firestop
- Prolonged exposure to fire will cause failure.

Wood

- Wood is the most common building material
- Engineered wood products are also called manufactured board, human-made wood, and composite wood.
  - May warp, contain toxic products, burn, and fail quickly.
- The most important characteristic of wood is combustibility.
- Wood structures weaken when they are consumed by fire
- Wood ignites, burns, and decomposes based on:
  - Ignition, moisture, density, preheating, size, and form
- High temperatures decrease wood strength via pyrolysis.
Plastics

- Plastics are rarely used for structural support.
- The combustibility of plastic varies greatly.
- Many plastics release dense, toxic smoke when they burn.
- Thermoplastic materials melt and drip.
- Thermoset materials lose strength but will not melt.

Types of Construction

- Type I: Fire resistive
- Type II: Noncombustible
- Type III: Ordinary
- Type IV: Heavy timber
- Type V: Wood frame

Type I: Fire-Resistive

- All structural components must be noncombustible.
- Fire-resistive construction is used for:
  - Buildings designed for large numbers of people
  - Tall or large area buildings
  - Special occupancies
Type I: Fire-Resistive

- Building materials should not provide fuel for a fire.
- Steel framing must be protected.
- Fires can be very hot and hard to ventilate.
- In extreme conditions Type I buildings can collapse.

Type II: Noncombustible

- All structural components must be noncombustible.
- Fire-resistive requirements are less stringent than Type I.

Type II: Noncombustible

- Structural components contribute little or no fuel.
- Fire severity is determined by contents.
- Noncombustible construction is most commonly found in single-story warehouses or factories.
Type III: Ordinary

- Ordinary construction
  - Is used in a wide range of buildings
  - Is usually limited to no more than four stories
  - Has limited fire resistance requirements
- Masonry exterior walls support floors and roof.

Type III: Ordinary

- There are two separate fire loads:
  - Contents
  - Construction materials
- Fire resistance depends on building age and local building codes.
- Exterior walls, floors, and roof are connected.

Type IV: Heavy Timber

- Exterior masonry walls
- Interior structural elements, floors, and roof of wood
**Type IV: Heavy Timber**

- There are no concealed spaces or voids
- Heavy timber construction is used for buildings as tall as eight stories with open spaces suitable for manufacturing and storage
- New Type IV construction is rare.

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**Type V: Wood Frame**

- Wood frame is the most common type of construction in use
- All major components are wood or other combustible materials.

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**Type V: Wood Frame**

- Wood frame construction is used in buildings of up to four stories
- Wooden I-beams and trusses
  - Are just strong enough to carry the required load
  - Have no built-in safety margin
  - Collapse early and suddenly
- Structural fires cause the veneer to collapse and peel away
  - Fire fighters should be aware of construction.
Type V: Wood Frame

- Balloon-frame construction
  - Exterior walls assembled with continuous wood studs
- Platform-frame construction
  - Exterior wall studs not continuous

Building Components

- Understanding how various components of a building function will improve a fire fighter's safety.

Foundations

- Foundations
  - Transfer the weight of the building and its components to the ground
  - Ensure building is firmly planted
  - If weak or shifting can cause collapse.
Floors and Ceilings

- Fire-resistive floors
  - In a fire-resistive building, the floor-ceiling system is designed to prevent vertical fire spread
  - If space above ceiling is not partitioned or protected, fire can quickly extend horizontally.

Floors and Ceilings

- Wood-supported floors
  - Heavy-timber floors can often contain a fire for an hour or more.
  - Conventional wood flooring burns readily and can fail in as little as 20 minutes.
  - Modern construction uses lightweight wood I-beams and trusses

Roofs

- Roofs are not designed to be as strong as floors
- There are three primary designs:
  - Pitched roofs
  - Curved roofs
  - Flat roofs
Pitched Roofs

- Pitched roofs
  - Are sloped or inclined
  - Can be gable, hip, mansard, gambrel, or lean-to
  - Are usually supported by rafters or trusses
  - Require some sort of roof covering

Curved Roofs

- Curved roofs
  - Are used for large buildings that require large, open interiors
  - Are usually supported by bowstring trusses or arches

Flat Roofs

- Flat roofs have a slight slope for drainage
- Wood support structures use solid wood beams and joists.
Flat Roofs

- Open-web steel trusses (bar joists) are often used for support.
- Most coverings are highly combustible.
- Ventilation may involve cutting through many layers of roofing.

Trusses

- Triangular geometry creates a strong, rigid structure.
- Trusses are usually prefabricated wood or steel
- There are three types:
  - Parallel chord
  - Pitched chord
  - Bowstring

Trusses

- Parallel chord truss
- Pitched chord truss
- Bowstring truss
Trusses

• Under fire, trusses provide little margin of safety
• Failure at one point produces failure for the entire truss.
• Steel trusses are prone to failure during fire.
  – A 100-ft-long beam/truss can elongate as much as 9” (23 cm) when heated to 1000ºF.

Walls

• Walls
  – Are the most visible part of a building
  – Are constructed of a variety of materials
  – Are:
    • Load-bearing
    • Nonbearing
    • Specialized

Load-Bearing Walls

• Load-bearing walls
  – Provide structural support
  – Are either interior or exterior
  – Support both “dead load” and “live load”
  – If damaged can result in collapse.
Nonbearing Walls

- Nonbearing walls
  - Support only their own weight
  - Can be breached or removed without compromising structural integrity
  - Are either interior or exterior

Specialized Walls

- Party walls
  - Are common to two properties
  - Are almost always load-bearing
  - Are often fire walls
- Fire walls
  - Are designed to limit horizontal fire spread
  - Extend from foundation through roof
  - Are constructed of fire-resistant materials

Specialized Walls

- Fire partitions
  - Interior walls that extend from a floor to underside of floor above
- Fire enclosures
  - Fire-rated assemblies for vertical openings
- Curtain walls
  - Nonbearing exterior walls attached to the outside of a building
Doors

- Doors
  - Can be used for entry, exit, light, and ventilation
  - Are mostly constructed of wood or metal
    - Hollow-core wood doors offer little fire resistance.
    - Solid-core doors provide some fire resistance.
    - Metal doors are more durable and fire resistant

Window Assemblies

- Window assemblies are used for light, ventilation, entry, and exit
- The window type depends on a variety of factors.

Fire Doors and Fire Windows

- Fire doors and fire windows
  - Are constructed to prevent the spread of flames, heat, and smoke
  - Must meet NFPA 80
  - Are labeled according to approved use
Fire Doors and Fire Windows

• Fire windows are used when a window is needed in a required fire-resistant wall.

Interior Finishes and Floor Coverings

• Finishes and coverings are exposed interior surfaces of a building.
• Fire fighters should know the hazards posed by different interior finishes.
  – Most are plastic derived from petroleum products.

Manufactured Housing

• Manufactured housing
  – Includes mobile and modular homes
  – Uses lightweight building components
    • Most components are combustible
  • The death rate in mobile home fires is three times that of other types of single-family homes.
Buildings Under Construction or Demolition

- Construction or demolition sites pose special problems for fire fighters.
- Built-in fire protection features are often missing.
- Fire-resistant enclosures can be missing.
- Buildings under construction or demolition are often unoccupied for long periods.

Preincident Planning and Incident Size-Up

- Preincident planning allows fire departments the ability to:
  - Determine the type of construction

- It is not possible to preplan every property
  - Perform incident size-up
  - Learn the general characteristics of building types in area
  - Keep up with changes in building construction
Summary

• Fire fighters must understand the basic types of building construction.
• Using a structure’s occupancy classification, fire fighters can predict who is in the building.
• Building contents are related to the occupancy of the structure.

Summary

• Many materials are used in building construction, and each material reacts differently to heat and fire.
• The five types of building construction each have their own strengths and weaknesses and differing levels of resistance to fire.

Summary

• Buildings contain a variety of parts or components. These components are made from several materials, and each react differently to fire.
Given information from discussion, handouts, and reading materials, analyze hazards and provide a size up on an emergency scene and describe how to safely and efficiently respond to an emergency.

Introduction

- Response
  - A series of actions that begins when a crew is dispatched to an alarm and ends with the crew's arrival at the emergency scene
Introduction

• Response actions include:
  – Receiving the alarm
  – Donning personal protective equipment (PPE)
  – Mounting the apparatus
  – Transporting equipment and personnel to the emergency incident

Introduction

• Size-up
  – Is a systematic process of gathering information and evaluating the situation
  – Begins at alarm receipt
  – Continues during response
  – Includes initial on-scene observations

Introduction

• The Incident commander (IC) and company officers are responsible for obtaining information to manage the incident
  – Fire fighters are involved in the process of gathering and processing information.
Response

- Response begins with preparation for response.
  - Ensure that PPE is complete, ready for use, and in good condition.
  - Ensure PPE is in designated location.

Response

- Conduct the daily check of your self-contained breathing apparatus at the beginning of each tour of duty.
- Recheck PPE and tools thoroughly after each emergency response.

Alarm Receipt

- The emergency response process begins when an alarm is received at the fire station.
- Often a communications center dispatches individual units.
- Most departments have both a primary and back-up method of transmitting alarms.
Alarm Receipt

- Dispatch information will include:
  - Incident location
  - Type of emergency
  - Units due to respond

Alarm Receipt

- Computer-aided dispatch systems often provide additional information.
- The telecommunicator provides additional information when available.
  - Additional information is sent in dispatch messages to later-responding units or transmitted by radio while en route
  - Information can help in planning.

Alarm Receipt

- Response to alarm should be prompt and efficient.
  - Walk briskly to the apparatus.
    - Do not run.
  - Shut off appliances.
  - Wait until apparatus doors are fully open before leaving.
Riding the Apparatus

• Don PPE before mounting apparatus.
• Secure all equipment properly.
• Be careful mounting apparatus.
• Wear your seat belt and/or harness.
• Be aware that noise produced by sirens can damage hearing.
  – Wear hearing protection if provided.

Riding the Apparatus

• During transport, limit conversation.
  – Listen for instructions and additional information.
• Consider factors that could affect the incident:
  – Time of day or night
  – Temperature
  – Location and type of incident

Emergency Response

• The fire apparatus driver must exercise caution while driving.
• Never compromise safety for faster response time.
• Fire apparatus drivers have special training.
  – Fire apparatus drivers must always consider the actions of other drivers first.
Emergency Response

- Personal vehicles
  - Fire fighters who respond in personal vehicles must follow laws, regulations, and standard operating procedures (SOPs).
  - Some areas allow volunteer fire fighters to use colored lights to request a right of way.

Prohibited Practices

- Do not ignore departmental SOPs.
- Do not unfasten your seat belt.
- Do not dismount until the vehicle comes to a complete stop.
- Never stand while riding.
- Do not hold onto a moving vehicle.
- Do not ride on the rear step.

Dismounting a Stopped Apparatus

- Ensure apparatus comes to a full stop.
- Check for traffic before opening doors.
- Check for other hazards present
- Grab a handrail and step down.
Traffic Safety on the Scene

• Be aware—constantly!
  – Drivers may not see fire fighters.
• Follow departmental SOPs for closing roadways.
• Be aware that highways are very dangerous.
  – Use traffic cones or other devices.
• Wear reflective vests over PPE.

Arrival at the Incident Scene

• Fire fighters work in assigned teams.
• Teamwork and discipline are essential.
• Apparatus-responding fire fighters make up the crew assigned to that vehicle.
• Independently arriving fire fighters report to the IC to be assigned to a company or crew.

Freelancing

• Freelancing
  – Is the dangerous practice of acting independently of command instruction.
  – Is unacceptable and is not tolerated.
  – Can compromise fire fighter safety.
• Do not respond to an emergency incident unless you have been dispatched.
Personnel Accountability System

• A personnel accountability system
  – Should be used to track every fire fighter at every incident scene
  – Maintains an updated list of the fire fighters assigned to each vehicle or crew
  – Tracks each crew’s assignment

Personnel Accountability System

• Personal accountability tags (PATs)
  – Tag information may include:
    • Name
    • ID number
    • Photograph
    • Medical history

Controlling Utilities

• Controlling utilities is one of the first tasks that must be accomplished.
• Departmental SOPs must be followed.
• The task is often assigned to a certain company or crew.
  – However, all fire fighters should know how to shut off building utilities.
Electrical Service

- Firefighters should
  - Know what types of electrical drops and meters are in use in their area.
  - Work with utility companies for specific training.
- High-voltage systems require electric company or trained personnel from the premises to shut off electricity.

Electrical Service

- Call the electric company to shut down power from a utility pole if:
  - Outside wires are damaged by fire
  - Working with ladders or aerial apparatus
  - A risk of explosion exists
- Turn off power by locating the circuit breaker box.

Gas Service

- Natural gas and liquefied propane (LP) gas is used for heating and cooking
  - Natural gas is delivered through underground pipes
  - LP gas is stored in a tank on premises or through underground pipes
Gas Service

- There is usually a single valve for the entire building
  - It is often located outside the building
  - It may be in basements of older buildings

Gas Service

- The valve for the LP gas system is usually located at the storage tank.
  - It often has a distinctive handle that indicates direction to turn to open or close valve.
  - To close, rotate handle to fully closed position.
- Do not reopen system—call in utility.

Water Service

- Water service can usually be shut off by closing one valve at the entry point.
- There is usually also a valve inside the basement of the building where the water line enters.
  - In warmer climates, the valves may be located above ground.
Size-Up

- Size-up
  - Is evaluating an emergency situation to determine what actions need to be taken and what resources are needed
  - Is one of the most important steps to take at an emergency scene
  - Is a key factor in determining if the emergency operation will be a success or failure

Size-Up

- Fire fighters must understand how to formulate an operational plan
  - How to gather and process information
  - How this information can change plans during the operation
- Fire fighters are often asked to obtain information or report observations for ongoing size-up

Managing Information

- Information must be continually reassessed to ensure the action plan is still valid.
- There are two categories of information:
  - Facts
  - Probabilities
Facts

• Facts are data elements that are accurate and based on prior knowledge, a reliable source of information, or an immediate, on-site observation
• Initial dispatch information contains facts.
  – Location
  – Nature of the situation

Facts

• Weather conditions
  – Snow and ice delay the arrival of fire apparatus.
  – Strong winds can cause rapid extension or spread of a fire.
  – High heat and humidity may cause heat casualties.

Facts

• The preincident plan
  – Provides details about a building’s construction, layout, contents, special hazards, and fire-protection systems
**Facts**

- Basic facts about a building can be observed on arrival.
  - The Officer considers the size, height, and construction of the building.
  - The action plan for a single-story, wood-frame dwelling is different than that for a steel-frame high-rise tower.

**Facts**

- The age of the building is another fact to consider.
  - Building and fire safety codes change over time.
  - Balloon-frame construction can provide a path for fire spread.
  - Newer buildings use trusses.

**Facts**

- Fire size and location dictate hose line placement, ventilation sites, and rescue priorities.
  - Direct observations are not complete.
  - Smoke can obscure the view of fire.
Facts

- The IC needs to gather as many facts as possible.
  - Company officers report observations to the IC.
  - The IC may request a reconnaissance report.
    - An inspection and exploration of a specific area

Probabilities

- Probabilities are outcomes that can be reasonably predicted to occur based on facts and previous experience.
- Fire fighters will anticipate what is likely to happen in various situations.
- The attack plan is based on probabilities.

Probabilities

- The IC quickly identifies the probabilities that apply to a given situation.
- Convection, conduction, radiation, smoke conditions, and fire conditions enable the IC to predict fire extension.
- The IC also evaluates the potential for building collapse.
Resources

- Resources are all of the means available to fight a fire or conduct emergency operations
  - Requirements depend on the incident.
  - Availability depends on the capacity of a fire department.

Resources

- Basic resources are personnel and apparatus
- Resources also include:
  - Water supply
  - Specialized equipment
  - Food and fluids for rehabilitation
  - Fuel for apparatus

Mutual Aid Agreements

- Fire departments agree with surrounding jurisdictions to assist each other if a situation requires more resources than the local community has.
Incident Action Plan

• The Incident Action Plan outlines the steps needed to control the situation and is
  – Based on information gathered during size-up
  – Revised and expanded during the incident

Incident Action Plan

• The IAP is based on five basic fireground priorities:
  – Save lives.
  – Protect exposures.
  – Confining the fire.
  – Extinguish the fire.
  – Salvage property and overhaul the fire.

Rescue

• Rescue is always the highest priority!
• The need for rescue depends on:
  – Type of occupancy
  – Time of day
  – Degree of risk to the occupants’ lives
Rescue

- People can survive up to 212°F; death occurs at 350°F in 3 minutes.
  - Today’s fire temperatures can rise higher than 500°F in 3 to 4 minutes.
  - Often, the best way to protect lives is to extinguish the fire quickly.

Exposure Protection

- Fire fighters must
  - Keep the fire from spreading beyond the area of origin or involvement.
  - Keep the fire from spreading from the structure of origin to an exposure.
- The IC must sometimes weigh potential losses.

Confinement

- The focus is on confining fire to a specific area.
- The IC defines a perimeter and plans operations so the fire does not expand beyond the area.
**Extinguishment**

- Depending upon the size of the fire and the risk, the IC mounts either an offensive attack or a defensive attack
  - An offensive attack
    - Is used with most small fires
  - A defensive attack
    - Is used when the fire is too large or dangerous to extinguish from inside the structure

**Ventilation**

- Ventilation
  - Is all activity related to smoke, heat, and products of combustion
  - Can be a stand-alone strategy
  - Can be used in combination with other tactics

**Salvage and Overhaul**

- Salvage
  - Is the removal or protection of property that could be damaged during firefighting or overhaul
  - Is aimed at reducing smoke and water damage
Salvage and Overhaul

- Overhaul
  - Overhaul ensures that the fire is completely out.
  - Floors, walls, ceilings, and attic spaces are checked.
  - Debris is removed and doused.

Summary

- Response actions include receiving the alarm, donning PPE, mounting the apparatus, and transporting equipment and personnel to the emergency incident.
- Size-up gathers information and evaluates the incident.
- Be prepared to respond to an emergency at all times.

Summary

- Response begins when the alarm is received at the fire station.
- Don PPE before mounting the apparatus.
- Traffic safety should be a major concern.
- Work in assigned teams and use a guided plan for the incident.
Summary

- Check into the personnel accountability system.
- Control all utilities.
- Conduct size-up to bring the emergency incident under control.
- Size-up relies on facts and probabilities.
- The preincident plan helps create a plan.

Summary

- The IC operates from a command post outside the structure.
- Probabilities are events and outcomes that can be predicted or anticipated.
- Fire fighter resources include all means to fight a fire or conduct emergency operations.

Summary

- An incident action plan covers five fire-ground objectives:
  - Save lives: keep fire fighters safe and rescue victims.
  - Protect exposures.
  - Confine the fire.
  - Extinguish the fire.
  - Salvage property and overhaul the fire.
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.

Introduction

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

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.

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)
### 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

---

### 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

---

### The Protective Hood

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

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

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.
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

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

Additional PPE

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

Work Uniforms

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

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.
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.

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.

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
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.

Respiratory Hazards of Fires: Smoke

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

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>
<thead>
<tr>
<th>Oxygen Concentration</th>
<th>Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>21%</td>
<td>Normal breathing air</td>
</tr>
<tr>
<td>17%</td>
<td>Judgment and coordination impaired; lack of muscle control</td>
</tr>
<tr>
<td>13%</td>
<td>Headache, dizziness, nausea, fatigue</td>
</tr>
<tr>
<td>9%</td>
<td>Unconsciousness</td>
</tr>
<tr>
<td>6%</td>
<td>Respiratory arrest, cardiac arrest, death</td>
</tr>
</tbody>
</table>

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
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!

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

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.
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

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

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
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

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

Physical Limitations of the User

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

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

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
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

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.

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)
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

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.

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.
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.

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.

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.
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.

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

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.
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.

Refilling SCBA Cylinders

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

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

• 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.

Summary

• PPE for wildland fires includes a jacket and pants made of fire-resistant materials, helmet, eye protection, and pigskin or leather gloves.
• The two main types of SCBA are open-circuit and closed-circuit devices.
• SCBA limits the amount of air in the cylinder.
Summary

• Breathing through an SCBA is different than breathing normally and can be stressful.
• 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 7-1: Ropes and Knots

Student Performance Objective

Given information from discussion, handouts, and reading materials, analyze fire department knots.

Introduction

- Ropes are widely used in the fire service.
- Ropes may be your only means of rescue
- A firefighter must be able to tie simple knots accurately and without hesitation.
Types of Rope

- Life safety rope
  - Used solely for supporting people
- Utility rope
  - Used in most cases when it is not necessary to support a person

Life Safety Rope

- Life safety rope
  - Is never used as utility rope
  - Must be used when supporting the weight of one or more persons
- NFPA 1983 specifies design, construction, and performance criteria.

Types of Life Safety Rope

- One-person rope
  - Light duty life safety rope
- Two-person rope
  - General duty life safety rope
Personal Escape Rope

- Personal escape rope
  - Is used for self-rescue in extreme situations
  - Is designed for the weight of one person
  - Should be replaced after one use
  - Is used only as a last resort

Utility Rope

- Utility rope
  - Is not used to support a person
  - Is used for hoisting, lowering, and securing equipment
  - Requires regular inspection

Rope Materials

- Ropes can be made of many types of materials.
- The earliest ropes were made from natural vines woven together.
- Now ropes are made of synthetic material.
Natural Fibers

- Natural fiber ropes were often made of manila.
- Natural fiber ropes are currently used for utility, not life safety tasks

**TABLE 10-1**

<table>
<thead>
<tr>
<th>Drawbacks to Using Natural Fiber Ropes</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Lose their load-carrying ability over time</td>
</tr>
<tr>
<td>- Subject to mildew</td>
</tr>
<tr>
<td>- Absorb up to percent of their weight in water</td>
</tr>
<tr>
<td>- Degraded quickly</td>
</tr>
</tbody>
</table>

Synthetic Fibers

- Nylon was first manufactured in 1938.
- Synthetic fibers have been used for ropes ever since.

**TABLE 10-2**

<table>
<thead>
<tr>
<th>Advantages to Using Synthetic Fiber Ropes</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Thinner without sacrificing strength</td>
</tr>
<tr>
<td>- Less absorbent than natural fiber ropes</td>
</tr>
<tr>
<td>- Greater resistance to rotting and mildew</td>
</tr>
<tr>
<td>- Longer-lasting than natural fiber ropes</td>
</tr>
<tr>
<td>- Greater strength and increased safety</td>
</tr>
<tr>
<td>- Some are more fire-retardant than natural fiber ropes</td>
</tr>
</tbody>
</table>
Synthetic Fibers

• Life safety rope is always synthetic.
  – Nylon
  – Polyester
  – Polypropylene

Rope Construction

• There are several types of rope construction.
• The best choice depends on specific application.

**Drawbacks to Using Synthetic Fiber Ropes**

- Can be damaged by prolonged exposure to ultraviolet light
- Can be damaged by exposure to strong acids or alkalis
- Susceptible to abrasion
Table 10-4: Properties of Rope Materials

<table>
<thead>
<tr>
<th>Type</th>
<th>Material</th>
<th>Positive Properties</th>
<th>Negative Properties</th>
<th>Application</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>Manila</td>
<td>No real advantages over synthetic rope</td>
<td>Absorbs water easily, cannot bear as much weight as synthetic rope, noncontinuous fibers, easily degraded</td>
<td>Utility rope</td>
</tr>
<tr>
<td>Synthetic</td>
<td>Nylon</td>
<td>High melting temperature</td>
<td>Can be damaged from exposure to sunlight, oils, gas, acids, bases, or fumes</td>
<td>Life safety rope, utility rope</td>
</tr>
<tr>
<td>Polyester</td>
<td></td>
<td>Good abrasion resistance, less absorbent than natural rope, greater resistance to rotting and mildew, lasts longer than natural rope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polypropylene</td>
<td></td>
<td>Does not absorb water, floats</td>
<td>Hard to knot, low melting point</td>
<td>Water rescue rope, utility rope</td>
</tr>
</tbody>
</table>

Twisted Rope Construction

- Twisted ropes are also called laid ropes
- Individual fibers are twisted into strands
- Strands are twisted to make the rope.
- Both natural and synthetic fibers can be twisted.

Braided Rope Construction

- Strands are woven like hair braiding
- All of the strands are exposed to abrasion
- The fibers will stretch
- Double-braiding only exposes the outer fibers
Kernmantle Rope Construction

- Kern is the center core and provides 70% of the rope’s strength.
- Mantle is the sheath-like braided covering that protects kern from dirt and abrasion.

Kernmantle Rope Construction

- The kern and mantle are synthetic.
- Kernmantle construction produces a very strong and flexible rope that is thin and lightweight
  - Well suited for rescue work

Dynamic and Static Rope Construction

- Dynamic rope
  - Is designed to be elastic
  - Is usually used by mountain climbers
- Static rope
  - Will not stretch under load
  - Is more suitable for rescue situations
Dynamic and Static Kernmantle Rope Construction

• Dynamic kernmantle rope
  – Dynamic kernmantle rope is constructed with overlapping or woven fibers in the core
  – When loaded, the fibers pull tighter.

• Static kernmantle rope
  – Has a core constructed with fibers parallel to each other
  – Has little elasticity and limited elongation

Rope Strength

• Life safety ropes are rated to carry a specific amount of weight.
• The required minimum breaking strength is based on a loading of 300 lbs. per person.
• The safety factor allows for reductions in strength resulting from knots, twists, abrasions, and other causes.
• The safety factor allows for shock loading if a weight is applied suddenly.

Rope Maintenance

• All ropes require proper care.
• There are four parts to maintenance:
  – Care
  – Clean
  – Inspect
  – Store
Care for the Rope

Clean the Rope

• Use mild soap and water for synthetic fibers.
• Do not use bleach.
• Follow manufacturer’s recommendations.
• Do not pack or store wet or damp rope.

Inspect the Rope

• Inspect life safety rope after each use and on a regular schedule when unused.
• Look for cuts and damage as you run it through your fingers.
Inspect the Rope

- Life safety rope that can no longer be used must be destroyed.
  - Sometimes it can be downgraded to utility rope if clearly marked.
  - A record must be kept for each piece of life safety rope.

Inspect the Rope

<table>
<thead>
<tr>
<th>TABLE 10-8</th>
<th>Signs of Possible Rope Deterioration</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Degradation</td>
<td></td>
</tr>
<tr>
<td>• Shrink markings from heat or friction</td>
<td></td>
</tr>
<tr>
<td>• Damaged sheath</td>
<td></td>
</tr>
<tr>
<td>• Core fibers poking through the sheath</td>
<td></td>
</tr>
</tbody>
</table>

Store the Rope

- Avoid temperature extremes and keep rope out of sunlight and away from fumes of gasoline, oils, and hydraulic fluids.
- Use a separate apparatus compartment.
Store the Rope

• Do not place heavy objects on the rope.
• Rope bags may be used or rope may be coiled.
• If shock loaded, inspect rope and consider removing from service.

Knots

• Knots are ways of fastening ropes and webbing to objects or each other.
• Fire fighters must know how and when to use knots.
  – Knots are used for multiple purposes.
  – Knots reduce rope load-carrying capability.

Knot Terms

• The working end
  – Used in forming knots
• The running end
  – Used in lifting or hoisting
• The standing part
  – Between the working and the running end
Knot Terms

- **Bight**
  - Reverses direction to form U-bend

- **Loop**
  - Makes a circle in the rope

- **Round turn**
  - Makes a loop with parallel ends

Nine Basic Fire Service Knots

- Safety knot (overhand knot)
- Half hitch
- Clove hitch
- Figure eight
- Figure eight on a bight
- Figure eight with a follow-through
- Figure eight bend
- Bowline
- Bend (sheet or Becket bend)

Safety Knot

- The safety knot
  - Secures the leftover working end of the rope to the standing part of the rope.
  - Ensures primary knot will not become undone
  - To test, try sliding it on the standing part of the rope.
    - A knot that is tied correctly will slide.
Hitches

- Hitches
  - Wrap around an object
  - Are used to secure the working end to a solid object or to tie a rope to an object before hoisting it

The Half hitch
- The half hitch is not secure by itself
- The half hitch is used only in conjunction with other knots.
- Long objects may need several half hitches.

The Clove hitch
- Is used to attach rope to a round object
- Will hold if tension is applied

Loop Knots

- Loop knots
  - Are used to form a loop in the end of a rope
  - May be used for hoisting tools, securing a person, or identifying the end of a stored rope.
  - Will not slip easily but are easy to untie
Loop Knots

- The figure eight knot
  - Is used to produce a family of other knots
  - Is seldom used alone
- The figure eight on a bight
  - Creates a secure loop at the working end
  - Can be used to attach rope to a fixed object or a piece of equipment

Loop Knots

- The figure eight with a follow-through
  - Is useful for attaching a rope to a fixed ring or a solid object with an "eye"
- The figure eight bend
  - Is used to join two ropes together
- The bowline
  - Is used to secure a rope to an object or anchor point

Bends

- Bends are used to join two ropes together
  - The sheet bend or Becket bend can be used to join two ropes of unequal size.
  - The water knot or ring bend is used to join webbing of the same or different sizes together.
Methods of Knot Tying

- Find a method and use it all the time.
- Your department may require a specific method.
- You should be able to tie knots while wearing gloves or in the dark, and behind your back.

“Dressing” a Knot

- Knots should be “dressed” by tightening and removing twists, kinks, and slack.
- Always secure loose ends.
- Knot-tying should be practiced.

Hoisting

- In an emergency, you may have to raise or lower tools and equipment.
  - It is important that the object is properly secured.
  - Coworkers must be able to quickly remove the object.
- When lowering, be sure no one is under the object.
Hoisting

• An axe should be hoisted in a vertical position with the head of the axe down.
• A pike pole should be hoisted in a vertical position with the head at the top.
• A ladder should be hoisted in a vertical position.

Hoisting

• It is almost always preferable to hoist a dry hose line.
  – Water adds considerable weight.
  – Fold the hose back on itself and place the nozzle on top of the hose.

Hoisting

• Several types of tools and equipment can be hoisted using the same technique.
  – Rope is secured to the object.
  – A figure eight closes the loop.
• Practice hoisting the actual tools and equipment used in your department.
**Hoisting**

- Always use utility rope for hoisting tools and equipment.
- If a life safety rope gets oily or greasy, it should be taken out of service and destroyed.

**Summary**

- There are two primary types of fire service rope:
  - Life safety
  - Utility
- Life safety ropes are rated for one or two persons.
- A personal escape route is designed to be used once by one fire fighter.

**Summary**

- Ropes can be made of natural or synthetic fiber.
- There are three common types of rope construction:
  - Twisted rope
  - Braided rope
  - Kernmantle rope
- All ropes need proper care to perform in an optimal manner.
Summary

• There are four principles to care for a rope.
• There are five questions to ask when inspecting a safety rope.
• A rope record for a life safety rope includes many important details.
• Ropes should be protected.

Summary

• Knots are prescribed ways of fastening lengths of rope or webbing to objects or to each other.
• It is important to learn the terms used to refer to parts of a rope.
• A fire fighter should know the nine ways to tie a knot.
Student Performance Objective

Given information from discussion, handouts, and reading materials, describe the health and safety programs that support the fire service.

Introduction

- Firefighting is inherently dangerous.
- Departments must do what they can to reduce known hazards and dangers.
- The final responsibility for personal safety falls on the individual fire fighter.
Causes of Fire Fighter Deaths and Injuries

- Each year 80 to 100 fire fighters are killed in the line of duty in the United States.

According to the National Fire Protection Association (NFPA), 71,875 fire fighters were injured in the line of duty in 2010.
Injury Prevention

• Every team member is responsible for preventing injuries.
• The priority of safety on the fire ground is:
  – Self (personal safety)
  – Other team members
  – Everyone else

Injury Prevention

• A successful safety program will address:
  – Standards and procedures
  – Personnel
  – Training
  – Equipment

Standards and Procedures

• Fire service safety is governed by:
  – NFPA 1500
  – State and federal agencies programs, such as the Occupational Safety and Health Administration
• Every department should have standard operating procedures (SOPs).
Standards and Procedures

• The Incident Command System (ICS) is used in the command and control of emergency incidents.
• Each department should have a health and safety committee.

Personnel

• A safety program is only as effective as the individuals who implement it.
• Freelancing is extremely dangerous and has no place on the fire ground.

Personnel

• The incident safety officer
  – Is a designated member of the fire department
  – Has as his or her primary responsibility, safety
  – Reports directly to the IC
  – Has the authority to stop any action deemed to be unsafe
Training

- Knowledge and skills from training are essential for safety.
- Firefighters must continually seek out additional courses and work to keep their skills current.

Equipment

- Firefighters must know how to use equipment properly and operate it safely.
- Equipment must be properly maintained.
- Manufacturers’ operating instructions and safety procedures must be followed.

Reducing Fire Fighter Injuries and Deaths

- Reducing injuries and deaths requires the effort of every firefighter.
- Most reported injuries and deaths are the result of preventable situations.
- The goal of the National Fallen Firefighters Foundation is to reduce line-of-duty deaths.
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 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

- A healthful lifestyle includes:
  - A balanced diet
  - Weight training
  - Cardiovascular exercises
Safety and Health

• Get adequate amounts of sleep.
• Spend at least an hour a day in physical fitness training.
• Drink up to a gallon of water each day.
• Avoid tobacco products entirely.
• Never work under the effects of alcohol or drugs.

Employee Assistance Programs (EAPs)

• EAPs provide help with a wide range of problems
• Fire fighters who use an EAP can do so with complete confidentiality and without fear of retribution.

Safety During Training

• Proper gear and teamwork are important.
• Do not attempt anything beyond your ability or knowledge.
• Do not freelance during training!
• An injured fire fighter should not return until medically cleared for duty.
Safety During the Emergency Response

- Walk quickly to the apparatus; do not run.
- Properly position personal protective gear.
- Comply with all traffic laws.

Safe Driving Practices

- Motor vehicle collisions are the second leading cause of fire fighter deaths.
- Emergency driving requires added considerations.
- Collisions consist of a series of separate collision events.

Laws and Regulations Governing Emergency Vehicle Operation

- Emergency vehicle operators are subject to traffic regulations.
- Exemptions are legal only when operating in emergency mode.
- Operators can be found liable.
- An exemption does not relieve the driver from reasonable care.
Standard Operating Procedures (SOPs) for Personal Vehicles

- The use of personal vehicles to respond to fire and Emergency Medical Services (EMS) calls constitutes a fire department function.
- Fire departments should have SOPs that dictate the use of personal vehicles.

Safe Driving Begins With You

- The attitude and ability of the vehicle operator is a major factor in vehicle crashes.
- Know the state and local laws relating to motor vehicle operations.
- Emergency driving requires good reactions and alertness.

Vehicle Collision Prevention

- Anticipate the road and road conditions.
- Make allowances for weather conditions.
- Be alert for other emergency vehicles.
- Drive with a cushion of safety.
The Importance of Vehicle Maintenance

- It is important to perform regular maintenance on fire department vehicles and your personal vehicle.

Safety at Emergency Incidents

- Wait for the officer in command to "size-up" the situation before acting.
  - Follow the officer's instructions.
  - Do not freelance.

Teamwork

- Maintain a minimum of two fire fighters in each team.
- Never work alone.
Teamwork

- A back-up team needs to be in place any time fire fighters are in a hazardous area.
- A designated rapid intervention team should be outside the hazardous area.

Accountability

- The accountability system should record:
  - The individuals assigned to each team
  - Assignments for each team
  - The team’s current activities
- Both passport and accountability-tag systems provide an up-to-date accounting of everyone who is working at the incident.

Accountability

- Fire fighters must learn the department’s accountability system
  - How to work within it
  - How it works within the ICS
Incident Scene Hazards

- Be aware of your surroundings.
- Always operate within established boundaries and protected work areas.
- Remember that changing fire conditions will affect safety.
- Do not let down your safety guard.

Using Tools and Equipment Safely

- Learn to use tools and equipment properly before using them at an emergency.
- Practice doing basic repairs on tools and equipment at the fire station until you can perform them quickly and safely.

Electrical Safety

- Always check for overhead power lines when raising ladders.
- Turn off electric power supply to the building.
- Consider a downed line energized until it is confirmed dead.
**Lifting and Moving**

- Do not try to move something that is too heavy alone—ask for help.
- Prevent back injuries by always bending at the knees and using the legs to lift.

**Working in Adverse Weather Conditions**

- Dress appropriately for adverse weather conditions.
- Watch your footing on slippery surfaces.

**Rehabilitation**

- Rehabilitation provides periods of rest and recovery for emergency workers
- Personnel should not be released until they are rested, refreshed, and ready for another work cycle.
Violence at the Scene

- Do not proceed to the scene until the police have declared it safe.
- If confronted with a potentially violent situation, do not respond violently.

Mental Well-being

- A critical incident stress debriefing (CISD) provides a forum for personnel to discuss anxieties, stress, and emotions triggered by difficult calls.
- Some departments have CISD staff available 24 hours a day.

Safety at the Fire Station

- Be careful when working with:
  - Power tools
  - Ladders
  - Electrical appliances
  - Pressurized cylinders
  - Hot surfaces
Safety Outside Your Workplace

• Follow safe practices when you are off-duty.
• An unintentional injury can end your career as a fire fighter.

Summary

• Every fire fighter must have a strong commitment to safety and health.
• Fire fighters must always consider their personal safety and the safety of team and everyone else at the scene.
• A successful safety program must have standards and procedures, personnel, training, and equipment.

Summary

• Safety and well-being are directly related to personal health and fitness.
• Employee assistance programs are available to provide fire fighters with support or assistance.
• Four general principles govern emergency vehicle operation.
Summary

• Emergency driving requires good reactions and alertness.
• Safe driving practices will prevent most vehicle collisions.
• The accountability system tracks personnel and assignments at the scene.

Summary

• A critical incident stress debriefing (CISD) is a forum in which firefighting and EMS personnel can discuss anxieties, stress, and emotions.
• An unintentional injury can end your firefighting career.
Lesson 9-1: Portable Fire Extinguishers

Student Performance Objective

Given information from discussion, handouts, and reading materials, describe the purpose and use of portable fire extinguishers.

Introduction

- Portable fire extinguishers
  - Are required in a variety of occupancies.
  - Vary in size and type of agent used.
  - Are designed for different purposes.
Introduction

Purposes of Fire Extinguishers

• Fire extinguishers
  – Extinguish incipient fires
  – Control fires where traditional methods are not recommended
  – Provide discharge patterns for specific fuels

Use of Portable Fire Extinguishers

• Most fire departments carry at least one portable fire extinguisher; many carry two or more.
• One advantage of fire extinguishers is their portability
• One disadvantage of fire extinguishers is that they are “one-shot” devices
Special Extinguishing Agents

• As a fire fighter, you must know:
  – Which fires require special agents
  – What type should be used
  – How to operate the different types

Classes of Fires

• It is essential to match the extinguisher and the fire
  – Some agents are more efficient on certain fires.
  – Some agents will not control certain fires.
  – Some agents are dangerous when applied to certain fires.

Class A Fires

• Class A fires involve ordinary combustibles and natural vegetation
• Water is the most common extinguishing agent.
Class B Fires

- Class B fires involve flammable or combustible liquids and flammable gases
- Several different types of extinguishing agents are approved.

Class C Fires

- Class C fires involve energized electrical equipment
  - Can generate tremendous heat that ignites nearby Class A or B materials
- Agents that will not conduct electricity must be used.

Class D Fires

- Class D fires involve combustible metals
- Special techniques and agents are required.
  - Normal agents can react violently.
Class K Fires

- Class K fires involve combustible cooking oils and fats
- Some restaurants still use Class B extinguishers.

Classification of Fire Extinguishers

- Portable fire extinguishers are classified and rated based on their characteristics and capabilities
- Underwriters Laboratories, Inc., develops standards for ratings and classification.
- Extinguishers are rated for safety and effectiveness

Classification of Fire Extinguishers

- The classification system uses letters and numbers.
  - Letters indicate the class of fire for which the extinguisher can be used.
  - Numbers indicate the extinguisher’s effectiveness.
Classification of Fire Extinguishers

- Standard test fires are used to rate the effectiveness of fire extinguishers
  - May involve different agents, amounts, application rates, and application amounts

Labeling of Fire Extinguishers

- A traditional lettering system has been used for many years.

- A pictograph system has recently been developed.
Fire Extinguisher Placement

- NFPA Standard 10 lists recommendations for placing and mounting portable fire extinguishers.
- Occupancy regulations specify area protected, travel distance, and types of extinguishers provided.

Fire Extinguisher Placement

- Two factors to consider to determine the type of extinguisher are the
  - Class of fire likely to occur
  - Potential magnitude of an incipient fire

Fire Extinguisher Placement

- Extinguishers should be mounted so they are readily visible and easily accessed.
Classifying Area Hazards

- Areas are divided into risk classifications according to the amount and type of combustibles that are present.
- The recommended classifications are guidelines based on typical situations.

Light or Low Hazard Areas

- Light or low hazard areas
  - Are areas where most materials are noncombustible or arranged so a fire is not likely to spread
  - Contain limited amounts of Class A and Class B combustibles

Ordinary or Moderate Hazard Areas

- Ordinary or moderate hazard areas
  - Contain more Class A and Class B materials than light hazard locations
  - Include warehouses that contain Class I and Class II commodities
Extra or High Hazard Areas

• Extra or high hazard areas
  – Contain more Class A and Class B materials
  – Include areas used for manufacturing or handling flammable liquids; warehouses containing products that are not Class I or Class II commodities

Determining the Appropriate Placement of Fire Extinguishers

• Consider the types and quantities of fuels found in the area.
• Remember that some areas may need extinguishers with more than one rating or more than one type of fire extinguisher.

Methods of Fire Extinguishment

• Fires require fuel, heat, and oxygen.
• Rapid oxidation occurs when a fuel is combined with oxygen
• Combustion occurs when fuel is heated to its kindling temperature
Methods of Fire Extinguishment

- Extinguishers stop burning by:
  - Cooling the fuel
  - Cutting off the supply of oxygen
  - Interrupting the chain of reaction

Types of Extinguishing Agents

- An extinguishing agent is the substance contained in a portable fire extinguisher that puts out a fire.
- Various chemicals are used.
- The best agent for a particular hazard depends on several factors.
  - Types of materials involved
  - Anticipated size of the fire

Types of Extinguishing Agents

- Water
- Dry chemicals
- Carbon dioxide
- Foam
- Wet chemicals
- Halogenated agents
- Dry powder
Water

- Water
  - Is efficient, plentiful, and inexpensive
  - Is effective on Class A fires
    - Is less effective on other classes
  - Has the disadvantage that it freezes at 32°F (0°C)
    - Load-stream extinguishers, wetting agents, or water mist can be used.

Dry Chemical

- Dry chemical extinguishers deliver a stream of finely ground particles
- Different chemical compounds are used to produce extinguishers of varying capabilities and characteristics
- The dry chemical extinguishing agents work in two ways
  - Interrupt chemical chain reaction
  - Absorb large quantities of heat

Dry Chemical

- Dry chemical extinguishers have several advantages over water extinguishers
- Ordinary: Suitable for Class B and C fires
- Multipurpose: Rated for Class A, B, and C fires
Dry Chemical

- Additives prevent packing and caking.
- The chemicals are corrosive, a disadvantage.
- The five primary compounds used as dry chemical extinguishing agents are:
  - Sodium bicarbonate
  - Potassium bicarbonate
  - Urea-based potassium carbonate
  - Potassium chloride
  - Ammonium phosphate

Carbon Dioxide

- Carbon dioxide
  - Forms a dense cloud displacing air surrounding the fuel
  - Interrupts combustion by:
    - Reducing the oxygen
    - Disrupting liquid fuel’s ability to vaporize

Carbon Dioxide

- Carbon dioxide
  - Is stored under pressure as a liquid
  - Is rated for Class B and C fires only
  - Does not conduct electricity; is not corrosive; does not leave any residue
Carbon Dioxide

• Limitations include:
  – Heavier weight
  – Limited range
  – Limited use in certain weather conditions
  – Effect on air in confined spaces
  – Unsuitability for use on certain fires

Foam

• Foam fire extinguishers discharge water-based foam concentrate solution and are used on Class A or B fires.
  – Class A foam extinguishers for ordinary combustible fires extinguish fires in the same way that water extinguishes fires.
  – Class B foam extinguishers discharge a foam solution that floats across the surface of a burning liquid and prevents the fuel from vaporizing.
    • Additives depend on compatibility with fuels.

• Some foams are approved for polar solvents.
• Foam extinguishers are not suitable for Class C fires and cannot be stored or used at freezing temperatures.
Wet Chemical

- Wet chemical extinguishers are the only type of extinguisher to qualify under the new Class K rating requirements.
- The wet agents convert the fatty acids in cooking oils or fats to a soap or foam, a process known as saponification.
- Wet chemical agents create a thick blanket to smother the fire.
- Clean-up is easy.

Halogenated Agents

- Halogenated agents
  - Are produced from a family of liquefied gases
  - Are called “clean agents”
  - Are twice as effective as carbon dioxide
  - Are categorized into
    - Halons: Use limited by Montreal Protocol
    - Halocarbons: Replaced halons

Halogenated Agents

- Halogenated agents are stored as liquids and discharged under high pressure.
  - Vapor mist disrupts the chain reaction.
  - The agents dissipate rapidly in windy conditions
  - The agents displace oxygen in confined spaces
- Halon 1211 should rarely be used.
Dry Powder

- Dry powder extinguishing agents
  - Are used on combustible metal fires (Class D)
  - Are stored in granular or powdered form
  - Form a solid crust over burning metal
- Commonly used agents are sodium chloride or graphite powder
- Class D agents must be applied very carefully so the molten metal does not splatter

Fire Extinguisher Design

- Portable fire extinguishers use pressure to expel their contents.
- Many extinguishers require pressurized gas to expel the agent.
  - Some agents are self-expelling.
  - Hand-operated pumps expel water or water with additives.

Portable Fire Extinguisher Components

- Most hand-held extinguishers have six basic parts:
  - Cylinder or container
  - Carrying handle
  - Nozzle or horn
  - Trigger
  - Locking mechanism
  - Pressure indicator
Portable Fire Extinguisher Components

- The cylinder or container
  - Is the body of the extinguisher
  - Holds the extinguishing agent
- Nitrogen, compressed air, or carbon dioxide is used to pressurize the cylinder

Portable Fire Extinguisher Components

- The handle
  - The handle is used to carry an extinguisher and to hold it during use.
  - Extinguishers weighing more than 3 lbs must have handles.
  - The handle is usually located below the trigger mechanism.

Portable Fire Extinguisher Components

- The nozzle or horn
  - Expels the agent
  - Is attached directly to valve assembly or at the end of a short hose
- Foam extinguishers have a special aspirating nozzle.
Portable Fire Extinguisher Components

- The trigger
  - Is a mechanism that is squeezed or depressed to discharge the extinguishing agent
  - Is usually a lever located above the handle
- Cartridge/cylinder models usually have a two-step operating sequence.

Portable Fire Extinguisher Components

- The locking mechanism
  - Prevents unintentional discharge
  - In its simplest form is a stiff pin
    - A tamper seal secures the pin and discourages people from tinkering with the extinguisher

Portable Fire Extinguisher Components

- The pressure indicator
  - The pressure indicator shows whether a stored-pressure extinguisher has sufficient pressure to operate.
  - Most extinguishers use a needle gauge.
  - Extinguishers pressurized by a cartridge lack a pressure gauge.
Wheeled Fire Extinguishers

- Wheeled fire extinguishers
  - Are large units mounted on wheeled carriages
  - Typically contain 150 to 350 pounds of agent
  - Usually have long delivery hoses which allow operators to attack the fire from multiple sides
  - Are most often installed in special hazard areas

Fire Extinguisher Characteristics

- Portable extinguishers vary according to:
  - Extinguishing agent
  - Capacity
  - Effective range
  - Time it takes to completely discharge agent
- Extinguishers also have different mechanical designs.

Water Extinguishers

- Water extinguishers
  - Are used to cool burning fuel below its ignition temperature
  - Are intended primarily for Class A fires
Water Extinguishers

• Stored-pressure water type extinguishers
  – Are used for incipient Class A fires
  – Have contents that can freeze
  – Can be recharged at any location that provides water and compressed air

Water Extinguishers

• Loaded-stream water-type extinguishers
  – Discharge a solution of water containing an alkali metal salt
  – Are usable to ~40°F
  – Come most commonly in the 2.5-gallon unit.

Water Extinguishers

• Wetting agent and Class A foam water-type extinguishers
  – Expel a solution that reduces surface tension
  – Allow water to penetrate Class A
  – Should not be exposed to temperatures below 40°F
**Water Extinguishers**

- Pump-tank water-type extinguishers
  - Range from 1-A rated, 1.5-gallon units to 4-A rated, 5-gallon units
  - Use nonpressurized storage
  - Have pressure to expel via a hand-operated piston pump
  - Sit upright on the ground
  - Can be used with antifreeze solution

- Backpack water-type extinguishers
  - Are used primarily for brush and grass fires
  - Have a wide mouth opening that allows easy refill.
  - Have a filter that keeps contaminants from entering the tank

**Dry Chemical Extinguishers**

- Dry chemical extinguishers contain a variety of agents in granular form
  - Ordinary models extinguish Class B and C fires.
  - Multipurpose models extinguish Class A, B, and C fires.
- All can be used on Class C fires, but the residue damages electronics.
Dry Chemical Extinguishers

- The range of discharge is from 5' to 30' depending on size.
- The trigger allows intermittent discharge.
- Extinguishers do not retain internal pressure for extended periods.

Dry Chemical Extinguishers

- Ordinary dry chemical extinguishers
  - Are available in hand-held models or wheeled units
- Multipurpose dry chemical extinguishers
  - Use ammonium phosphate as an agent
  - Are available in hand-held models or large wheeled units
  - Should never be used for Class K fires

Carbon Dioxide Extinguishers

- Carbon dioxide extinguishers
  - Are rated for Class B and C fires
  - Envelope the fuel in a cloud of inert gas
    - Also cools the burning material
- Carbon dioxide gas is colorless, odorless, nonconductive, and inert
Carbon Dioxide Extinguishers

- Carbon dioxide is both an expelling and extinguishing agent
- Carbon dioxide extinguishers
  - Have relatively short discharge ranges
  - Are not recommended outdoors or near strong air currents

Class B Foam Extinguishers

- An aspirating nozzle discharges a solution of water and aqueous film-forming foam and film-forming fluoroprotein agent.
- A foam blanket floats over the surface of the liquid.
- Class B foam agents are effective for Class A and B fires but not suitable for Class C or K fires.
- Foam extinguishing agents are not effective at freezing temperatures.
Wet Chemical Extinguishers

- Wet chemical extinguishers are used to protect Class K installations.
  - Commercial facilities use fixed, automatic systems.
  - Portable Class K wet chemical extinguishers are available in two sizes.
  - These extinguishers do not have numerical ratings.

Halogenated-Agent Extinguishers

- Halogenated-agent extinguishers
  - Include both halon and halocarbon agents
  - Are available in hand-held models rated for Class B and C fires
  - Have an agent discharged as a streaming liquid
  - Are nonconductive and leave no residue

Dry Powder Extinguishing Agents

- Dry powder extinguishing agents are intended for Class D fires involving combustible metals.
- Agents and techniques to extinguish Class D fires vary greatly.
- Each dry powder extinguishing agent is listed for use on specific combustible metal fires.
Dry Powder Extinguishing Agents

- Dry powder fire extinguishers
  - Adjustable nozzles allow the operator to vary the flow of agent
- Bulk dry powder agents
  - Are applied manually using a shovel or scoop

Use of Fire Extinguishers

- Six basic steps for extinguishing fires:
  - Locate the fire.
  - Select the proper extinguisher.
  - Transport the extinguisher to the fire.
  - Activate the extinguisher to release the agent.
  - Apply the extinguishing agent.
  - Ensure personal safety.

Locating a Fire Extinguisher

- Know the types and locations of extinguisher on apparatus.
- Know where extinguishers are located in and around the fire station.
- Have at least one extinguisher in your home and another in your personal vehicle.
Selecting the Proper Extinguisher

• Selecting the proper extinguisher requires an understanding of the classification and rating system.
• Firefighters must quickly determine whether a fire can be controlled by an extinguisher.
• Firefighters should also determine the appropriate type of extinguisher to place in a given area.

Transporting a Fire Extinguisher

• The best method of transporting a fire extinguisher depends on the size, weight, and design of the extinguisher.
• Carry fixed nozzle units in the stronger hand.
• Carry units with a hose between the trigger and the nozzle with the weaker hand.

Basic Steps of Fire Extinguisher Operation

• The PASS acronym:
  – Pull the safety pin.
  – Aim the nozzle at the base of the flames.
  – Squeeze the trigger to discharge agent.
  – Sweep the nozzle across the base of the flames.
Ensure Your Personal Safety

• Approach fire with an exit behind you.
• Have a planned escape route.
• Never let fire get between you and the exit.
• Never turn your back on the fire.
• Watch the fire for rekindle.
• Wear appropriate PPE and SCBA.

Care of Fire Extinguishers

• Extinguishers must be regularly inspected and properly maintained.
• Records must be kept so that inspections and maintenance are performed on schedule.
• Individuals assigned to these functions must be properly trained.
• Manufacturers' recommendations must always be followed.

Inspection

• Check extinguishers on apparatus once per month.
• Check tamper seals.
• Weigh or “heft” to determine fullness.
• Examine for obvious physical damage, corrosion, or leaks.
**Inspection**

- Check pressure gauge.
- Confirm proper identification.
- Check hose and nozzle for damage or obstructions.
- Check the hydrostatic test date.

**Maintenance**

- Maintenance
  - Includes internal inspections and repairs
  - Must be performed periodically
  - May be performed only by qualified personnel

**Common Indicators of Need for Maintenance**

- The pressure gauge reads outside normal range
- The inspection tag is out-of-date
- The tamper seal is broken
- Anything indicates that the unit is not full
- There is an obstructed hose or nozzle assembly
- There is physical damage, corrosion, or rust
- There is leakage around the discharge valve or nozzle assembly
Recharging

• Recharge fire extinguisher after every use
• Replace the extinguisher only when properly recharged.
  – Extinguishing agent refilled
  – Expulsion agent recharged
• Install a tamper seal after recharging

Hydrostatic Testing

• Hydrostatic testing measures an extinguisher’s ability to withstand internal pressure
• Testing is done in a special test facility
  – Above-normal pressure is applied to a water-filled cylinder

Hydrostatic Testing

• The date of the most recent hydrostatic test must be indicated on the outside of the extinguisher
• All out-of-date extinguishers must be tested at an appropriate facility.
Summary

• Fire extinguishers put out hundreds of fires every day.
• Fire fighters use fire extinguishers to control small fires.
• Portable fire extinguishers are used to:
  – Extinguish incipient-stage fires
  – Control fires where traditional methods are not recommended

Summary

• Fire extinguishers are one time use only.
• The five classes of fires are: Class A, B, C, D, and K.
• Portable fire extinguishers are classified and rated based on their characteristics and capabilities.
• Fire extinguisher classification uses both letters and numbers.

Summary

• Traditional lettering system for fire extinguishers are Class A, Class B, Class C, Class D, and Class K.
• The pictograph system uses symbols for classifying fire extinguishers.
• NFPA 10 lists requirements for placing and mounting portable fire extinguishers.
• There are three risk classifications.
Summary

• Extinguishers stop fire by cooling fuel, cutting off supply, or a combination.
• Portable fire extinguishers use seven basic types of extinguishing agents.
• Portable fire extinguishers vary according to their agent, capacity, range, and the time it takes to discharge.

Summary

• There are six basic steps in extinguishing a fire with a portable fire extinguisher.
• There are four steps to activating a fire extinguisher.
• Use a fire extinguisher with an exit and the wind at your back.
• Inspect and maintain fire extinguishers.

Summary

• Fire fighters inspecting extinguishers should follow specific guidelines.
• There are common indications that an extinguisher needs maintenance.
• A fire extinguisher must be recharged after every use.
• Most fire extinguishers are pressurized vessels.
Student Performance Objective

Given information from discussion, handouts, and reading materials students will describe the characteristics and use of fire service ladders.

Introduction

• The fire service ladder is one of the most basic fire fighter tools.
• Ladder technology has not changed much over the years.
• Every fire fighter must be proficient in working with ladders.
Primary Functions of a Ladder

• A ladder
  – Provides a vertical path between grades
  – Provides an escape path and a means to evacuate people
  – Can be used as a working platform
  – Can bridge a small opening

Secondary Functions of a Ladder

• A ladder
  – Provides stable footing and distributes weight on pitched roofs
  – Creates a ladder structure to raise or lower people or objects
  – Provides a platform for equipment
  – Creates a ramp for equipment or patients
  – Creates a water chute

Ladder Construction

• Fire service ladders are similar to other types of ladders.
  – But are specialized tools, not general purpose ladders
• Fire service ladders
  – Must be of heavy-duty construction
  – Require more frequent and thorough maintenance
Basic Ladder Components

• Beams
• Rail
• Truss block
• Rung
• Tie rod
• Tips
• Butts
• Roof hooks
• Heat sensor labels
• Protection plates

Beams

• Beams run the length of most ladders
• There are three types of beam construction:
  – Trussed beam
  – I-beam
  – Solid beam

Rail and Truss Block

• A rail
  – Is the top or bottom section of a trussed beam
  – May also refer to the top and bottom surfaces of an I-beam
• The truss block
  – Is a piece that connects the two rails of a trussed beam
Rung and Tie Rod

- **Rungs**
  - Are crosspieces that span the two beams of a ladder
  - Serve as steps and distribute the user’s weight
- **The tie rod**
  - Is a metal bar that runs from one beam of the ladder to the other to keep the beams from separating

Tip, Butt, and Butt Spurs

- **The tip**
  - Is the very top of the ladder
- **The butt**
  - Is the end of the ladder that is placed against the ground
- **Butt spurs**
  - Are metal spikes attached to the butt of a ladder

Butt Plate and Roof Hooks

- **The butt plate or footpad**
  - Is an alternative to a simple butt spur
  - Incorporates both a spur and a cleat or pad
- **Roof hooks**
  - Are spring-loaded, retractable, curved metal pieces attached to the tip of a roof ladder
  - Are used to secure the ladder to the peak of a pitched roof
Heat Sensor Label and Protection Plates

- The heat sensor label
  - Identifies when the ladder has been exposed to specific heat conditions
  - Changes color when exposed to a particular temperature
- Protection plates
  - Are reinforcing pieces placed at chaffing and contact points to prevent damage

Extension Ladder Components

- Bed section
- Fly section
- Guides
- Halyard
- Pawls
- Pulley
- Stops
- Staypoles

Bed Section and Fly Section

- The bed section
  - Is the widest section
  - Serves as the base
- The fly section
  - The fly section is the part that is raised or extended from the bed section
  - Each fly section extends from the previous section
Guides and Halyard

• Guides
  – Are strips of metal or wood that guide a fly section as it is extended

• The halyard
  – Is the rope or cable used to extend or hoist the fly sections

Pawls and Pulley

• Pawls
  – Are mechanical locking devices used to secure the fly sections of an extension ladder

• The pulley
  – Is a small grooved wheel used to change the direction of the halyard pull

Stops and Staypoles

• Stops
  – Are pieces of wood or metal that prevent the fly sections from overextending and collapsing

• Staypoles
  – Are long metal poles attached to the top of the bed section
  – Help stabilize the ladder as it is raised and lowered
Aerial Apparatus

• Aerial ladders
  – Are permanently mounted, power-operated ladders
  – Have at least two sections
  – Built on a straight chassis are called straight-stick aerials
  – Built on a tractor trailer chassis are called tillered aerials

Aerial Apparatus

• Elevating platform
  – An elevating platform includes a passenger-carrying platform attached to the tip of a ladder or boom
  – The ladder or boom must have at least two sections
    • Telescoping
    • Articulating

Portable Ladders

• The number and lengths of ladders used by a department depend on the maximum height of buildings in the response area.
• Generally, portable ladders are limited to a length of 50 feet.
A Straight Ladder

- A straight ladder
  - Is a single-section, fixed-length ladder
  - May also be called a wall ladder or single ladder
  - Is commonly 12 to 14 feet long but can be up to 20 feet long

Roof Ladders

- A roof ladder
  - Is a straight ladder with roof hooks
  - Is sometimes called a hook ladder
  - Provides stable footing
  - Is usually 12 to 18 feet long

Extension Ladders

- An extension ladder
  - Is of adjustable length
  - Has multiple sections
  - Is usually heavier than a straight ladder of the same length
Bangor Ladders

- A Bangor ladder is an extension ladder with staypoles
- Staypoles are planted in the ground on either side for additional stability.

Combination Ladders

- A combination ladder
  - Is convertible from a straight ladder to an A-frame stepladder
  - Is generally 6 to 10 feet in A-frame configuration and 10 to 15 feet in the extension configuration

Folding Ladders

- A folding ladder
  - Is also called an attic ladder
  - Is a narrow, collapsing ladder
  - Is designed to allow access to attic scuttle holes and confined areas
Fresno Ladders

- A Fresno ladder
  - Is a narrow, two-section ladder
  - Is designed to provide attic access
  - Is commonly available in 10 to 14 feet lengths

Inspection, Maintenance, and Service Testing

- NFPA 1931 establishes requirements for ladder construction.
- NFPA 1932 provides general use guidance.
  - Regular inspection, maintenance, and testing

Inspection

- A ground ladder is visually inspected monthly or after each use
  - Check all components for splintering, cracking, deformity, breaks, gouges, fraying, or other conditions
  - Ensure components fit snugly and operate smoothly.
  - Check heat sensor label
- If deficiencies are revealed, remove ladder from service and repair it.
Maintenance

• Basic maintenance tasks:
  – Clean and lubricate the dogs and slides.
  – Replace worn halyards and wire rope.
  – Clean and lubricate roof hooks.
  – Maintain finish.
  – Replace ladder in storage racks.

Cleaning

• Clean ladder regularly and after each use with warm, soapy water and a soft-bristle brush.
• Dry ladder before storing it.

Service Testing

• NFPA 1932 requires periodic testing.
• Test new ladders before use and annually thereafter.
• Test ladders after any repairs.
• Maintain service and testing records.
Ladder Safety

• Several potential hazards are associated with ladder use.
• Use with caution and follow manufacturers’ recommendations.

General Safety Requirements

• Use full personal protective equipment (PPE) around ladders.
• Fire fighters must be able to work with and on ladders while wearing self-contained breathing apparatus.

Lifting and Moving Ladders

• Teamwork is essential when moving ladders.
• Ask for help lifting or moving heavy ladders.
Placement of Ground Ladders

- Survey area before placing ladders
- Always check for overhead wires and other obstructions.
- Place ladder on stable and level surface.
- Avoid heat and direct flame.

Working on a Ladder

- Check climbing angle before climbing.
- Ensure dogs are locked and halyard is tied before climbing.
- Secure the base by heeling/footing.

Working on a Ladder

- Do not exceed ladder's rated weight.
- Distribute weight along the length of the ladder.
- Be prepared for falling debris.
- Be prepared to climb down quickly.
Rescue Operations

- Anticipate actions of people you are trying to rescue.
  - Do not let people jump to the ladder.
  - Do not let more than one person on each section.
- Make verbal contact with victim.
- Safeguard victims as they climb down.

Ladder Damage

- Ladders may be easily damaged while in use.
- Remove from service any ladder used outside of normal limits.
  - Even if no damage is visible

Ladder Selection

- Ensure ladder is long enough.
  - Floor-to-floor height (residential): 8 to 10 feet
  - Floor-to-windowsill height (residential): 3 feet
  - Floor-to-floor height (commercial): 12 feet
  - Floor-to-windowsill height (commercial): 4 feet
Ladder Selection

• Selecting a ladder based on what it will be used for
• Roof access
  – The ladder tip should extend several feet or five rungs above rooftop.

Ladder Selection

• Window access
  – The ladder tip should be at the side of and even with the top of a window.
• Window rescues
  – The ladder tip should be at the windowsill.

Ladder Selection

• The proper climbing angle is 75° to the ground.
  – The ladder will need to be slightly longer than the vertical distance between the ground and the target.
  – Generally a ladder requires approximately one additional foot for each 15° of vertical height
Removing the Ladder From Apparatus

- Know what ladders are stored and where.
- Know how to remove them and how many people are needed.
- Do not lay ladders near exhaust pipes.
- Ladders can be stored on hydraulic lifts.

Lifting Ladders

- Use sufficient assistance to lift heavy ladders.
- Know the lifting commands and procedures.
- Bend at the knees and keep your back straight when lifting.

Carrying Ladders

- Basic types of carries:
  - Single-fire fighter carry
  - Shoulder carry
  - Suitcase carry
  - Flat carry
  - Flat shoulder carry
- Carries can be done in combinations of two, three, or four fire fighters.
Placing a Ladder

• Site selection
  – The general area for ladder placement is chosen by the officer in charge
  – The specific area for placement is chosen by the fire fighter at the butt end of the ladder

Placing a Ladder

• Ladders
  – Should be placed on a stable, level surface
  – Should not be placed on manhole covers or trap doors
  – Must be free from overhead obstructions
  – Should be at least 10 feet from power lines
  – Should be placed away from doors and other high-traffic areas

Placing a Ladder

• Climbing angle
  – The best angle is 75°.
  – The ladder should be an arm’s length away when standing vertically.
  – The vertical reach should be 4 times the distance from the base of the structure.
  – Check the inclination guide if it is available to help with placement.
Raising a Ladder

- Use a beam raise when the ladder must be raised parallel to the target.
- Use a rung raise when the ladder must be raised perpendicular to the target.
- Combinations of one, two, three, and four firefighters can be used for a raise.

Raising a Ladder

- Tying the halyard
  - Keeps it out of the way
  - Provides a backup to the dogs for securing the fly section
- Fly section orientation
  - The ladder manufacturer will specify whether the fly should face in or out.
  - Metal or fiberglass ladders are generally used fly section out.

Securing the Ladder

- Heel the ladder.
  - Standing under ladder, pull back into structure.
  - Place a foot against each beam.
- Tie the ladder off.
Climbing the Ladder

- Ensure ladder is properly secured.
- Check climbing angle.
- Climb slowly; avoid bouncing.
- Wear proper PPE and lower face shield.
- Hoist tools by rope if possible.
- Do not overload ladder.

Dismounting a Ladder

- Ensure roof or floor is solid and stable before dismounting.
- Maintain contact with ladder at three points.
  - Do not shift weight until you have tested the footing.

Working From a Ladder

- Use a ladder belt or a leg lock to secure yourself to the ladder.
- Do not attempt work from a ladder without properly securing yourself first.
Placing a Roof Ladder

• Open roof hooks on the ground.
• Place on ground ladder with hooks up.
• Slide or hoist the roof ladder upward.
• Once on the roof, slide the roof ladder into position and flip it over when hooks clear the peak of the roof.
• Secure the roof ladder.

Inspect a Chimney

• Many calls are received due to chimney-related emergencies
• Access can be hazardous.

General Safety Rules

• Wear appropriate PPE.
• Choose the proper ladder for the job.
• Choose the proper number of people.
• Lift with your legs.
• Use proper hand and foot placement.
• Look overhead for wires and obstructions.
General Safety Rules

• Allow the heel person to take charge of raising and lowering the ladder.
• After extending an extension ladder, check the pawls and halyard.
• Check the ladder for the proper angle.
• Ensure that the wall or roof will support the ladder before climbing it.

General Safety Rules

• Remain aware of hazards to yourself and to others.
• Maintain hand contact with the ladder.
• Use an appropriate leg lock or ladder belt.

Summary

• Ladders provide safe access and egress.
• Ladders can be used for secondary functions.
• The beam and rung are two main structural components of the ladder.
• Three basic types of ladder beam construction are trussed beam, I-beam, and solid beam.
Summary

- Wooden ladders have solid beams.
- The rung spans two beams of the ladder.
- Portable ladders contain a rail, truss block, tie rod, tip, butt, butt spurs, butt plate, heat sensor label, and protection plate.
- Extension ladders are two or more ladder sections and have additional components.

Summary

- Aerial and portable are the two general categories of ladders.
- Portable ladders include general-purpose ladders.
- Fire apparatus are required to carry at least one roof ladder, one extension ladder, and one folding ladder.

Summary

- A straight ladder is a single-section, fixed-length ladder.
- A roof ladder is a straight ladder.
- An extension ladder is an adjustable-length ladder with multiple sections.
- Bangor ladders are extension ladders.
- A combination ladder can be converted.
Summary

• A folding ladder is a collapsible ladder.
• A Fresno ladder is a narrow, two-section extension ladder.
• Portable ladders must be inspected, maintained, and service tested.
• All fire fighters should be able to perform routine ladder maintenance.

Summary

• Service testing portable ladders must follow NFPA 1932.
• Follow safety precautions.
• Ladder tips should be placed at the top of the ladder or below the window sill.
• Communication is key in coordinating ladder efforts.
Lesson 13-1: Water Supply

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.

Introduction

• Putting water on a fire cools and extinguishes it.
• Water is obtained from:
  – Municipal water systems
  – Static water sources
Rural Water Supplies

• Residents of rural areas usually depend on wells or cisterns to provide water.
• No hydrants in these areas, so water must be obtained from other sources.

Static Water Sources

• Static sources include:
  – Rivers or streams
  – Lakes, ponds, oceans
  – Canals or reservoirs
  – Swimming pools
  – Cisterns

Static Water Sources

• Static sources must be accessible to a fire engine or portable pump
  – Driving closely if there is a road or hard surface within 20 ft of the source
  – Installing a dry hydrant permanently
Mobile Water Supply Apparatus

- Mobile water supply apparatus
  - Are designed to carry large volumes of water
  - Generally carry 1000 to 3500 gallons
  - May be used to pump water directly into the attack engine

Portable Tanks

- Portable tanks
  - Are carried on fire apparatus
  - Typically hold 600 to 5000 gallons of water
  - Tankers are used to fill the portable tanks.

- The pump operator drafts from the tanks.
- Dump valves on the tankers allow them to off-load up to 3000 gallons per minute.
Tanker Shuttles

- Tanker shuttles are used to deliver a large volume of water in a long period of time
- The number of tankers needed depends on:
  - The distance between fill site and fire scene
  - The time it takes to dump and to refill
  - The flow rate required at the fire scene

Municipal Water Systems

- Municipal water systems provide clean water for public use and fire protection.
- Systems includes water sources, treatment facilities, and a distribution system.

Water Sources

- Water sources include:
  - Wells
  - Rivers or streams
  - Lakes
  - Reservoirs
- Many systems draw water from several sources.
Water Treatment Facilities

• Water treatment facilities remove impurities
• All water must be suitable for drinking.
• Chemicals are used to kill bacteria and harmful organisms.

Water Distribution Systems

• Water distribution systems
  – Deliver water from treatment facilities to the end user
  – Include water mains, pumps, storage tanks, and reservoirs
• Water pressure requirements differ
  – Pressure is usually produced by pumps.

• Water pressure may also be produced by gravity.
  – Gravity-feed system
  – Elevated water storage towers
Water Distribution Systems

• Water mains typically follow a grid system.
• Older systems may have dead-end mains
  – Water enters from only one direction.
  – The available water supply is limited.

Water Distribution Systems

• Water main valves
  – Control valves: Located throughout system to shut down sections
  – Shut-off valves: Used to shut off water flow to individual customers or to hydrants

Fire Hydrants

• Fire hydrants
  – Provide water for firefighting purposes
  – Are installed on both public and private water systems
  – Consist of an upright steel casing attached to the underground distribution system
Wet-Barrel Hydrants

- The barrel always has water in it.
- Each outlet is individually controlled.
- Additional lines can be added while water is flowing.

Dry-Barrel Hydrants

- Dry-barrel hydrants are used in cold climates.
- The hydrant valve is located at the base of the barrel.
- Water flows into the hydrant only when it is needed.

Draining a Dry-Barrel Hydrant

- After each use, water drains out through an opening in the bottom of the barrel.
  - When valve is open, drain hole is closed.
  - When valve is closed, drain hole is open.
- Hydrants may not drain if they are clogged.
- A fully opened hydrant allows for maximum flow.
Fire Hydrants Locations

- Fire hydrants are located according to local standards and nationally recommended practices
  - Every 500 feet in residential areas
  - Every 300 feet in high-value commercial and industrial areas
  - At every intersection
  - Based on occupancy, construction, and size of the building

Fire Hydrant Operation

- Firefighters must be proficient in operating a fire hydrant.
- Individual fire departments may have their own variations on this procedure.
- Always follow the standard operating procedures for your department.

Inspecting Fire Hydrants

- Check for visibility and access.
- Check for exterior damage.
- Ensure barrel is dry and free of debris.
- Ensure all caps in good working order.
- Open valve for water flow.
- Shut down and ensure proper draining.
- Replace cap.
Testing Fire Hydrants

- Fire-suppression companies are often assigned to test the flow from hydrants.
- Testing procedures are simple, but an understanding of hydraulics and attention to detail are required.

Flow and Pressure

- Flow: The quantity of water moving through a pipe, hose, or nozzle measured by its volume per minute
- Water pressure: The energy level measured in pounds per square inch

Flow and Pressure

- Static pressure: The pressure when no water is moving
- Normal operating pressure: The pressure during a period of normal consumption
Flow and Pressure

- Residual pressure: The amount of pressure that remains in the system when water is flowing.
- Flow pressure: Measures the quantity of water flowing through an opening during a hydrant test.

Hydrant Testing Procedure

- Hydrant testing requires:
  - Two adjacent hydrants
  - A Pitot gauge
  - An outlet cap with a pressure gauge

  - Place cap gauge on outlet of first hydrant.
  - Open hydrant valve and record pressure reading as the static pressure.
  - At second hydrant, remove cap and open valve.
Hydrant Testing Procedure

• Place pitot gauge in stream.
• At the same time, record residual pressure at the first hydrant.
• Calculate or look up in tables to determine flow.

Fire Hydraulics

• Fire hydraulics deal with properties of energy, pressure, and water flow as related to fire suppression.

Flow

• Flow
  – Is the volume of water that is being moved
  – Is measured in gallons per minute
• Metric is measured in liters per minute
Pressure

- Pressure
  - Is the amount of energy in a body or stream of water
  - Is measured in pounds per square inch (psi)
  - Is necessary in order to push water through a hose or to lift water up to a higher level

Friction Loss

- Friction loss is the loss of pressure as water moves through a pipe or hose
- The loss represents the energy required to push the water.
  - With any combination of flows and diameter, friction loss is proportional to the distance.

Elevation Pressure

- Elevation affects water pressure.
- Elevated water tanks supply pressure to pipes due to elevation.
Water Hammer

- Water hammer
  - Is a surge in pressure caused by a sudden stop in the flow of water
  - Can damage hose, couplings, and plumbing
- To prevent water hammer, open and close valves slowly.

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

Sizes of Hose

- Range in size
  - Small-diameter hose (SDH): 1" to 2"
  - Medium-diameter hose (MDH): 2\(\frac{1}{4}\)" to 3\(\frac{1}{4}\)"
  - Large-diameter hose (LDH): 3\(\frac{1}{4}\)" or more
Pressure Testing

- Attack hose
  - Tested annually
  - Tested to 300 psi
- Supply hose
  - Tested annually
  - Tested to 200 psi

Hose Construction

- Hose
  - Is frequently constructed of an inner waterproof liner and one or two outer layers
  - Can be double-jacket or rubber-jacket

- Inner waterproof liner
  - Prevents water leakage
  - Provides smooth surface to reduce friction
  - Is attached to outer covering
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

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

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.
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.

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.

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
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.

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

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.
Causes of Hose Damage

- Mechanical damage
- Heat and cold
- Chemicals
- Mildew

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.

Hose Appliances

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

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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

Hose Appliances

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

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

Hose Rolls

• A hose roll is an efficient way to transport a section of fire hose
• Hose can be rolled in many different ways, depending on how it will be used.
  – Straight hose roll
  – Single-doughnut hose roll
  – Twin-doughnut hose roll
  – Self-locking twin-doughnut hose roll

Fire Hose Evolutions

• Fire hose evolutions are standard methods of working with fire hose to accomplish different objectives.
• Every fire fighter should know how to perform all of the standard evolutions.
• Hose evolutions are divided into supply line operations and attack line operations.
Supply Line Operations

• The objective of laying a supply line is to deliver water from a water source to an attack engine.
• Laying a supply line can be done using a
  – Forward lay: starts at hydrant; proceeds toward fire
  – Reverse lay: starts at fire; proceeds toward hydrant

Supply Line Operations

• The forward hose lay
  – Allows the first engine to establish a water supply without assistance
  – Places the attack engine close to the fire
  – Can be used with medium- or large-diameter hose

Supply Line Operations

• The four-way hydrant valve
  – A four-way hydrant valve is used when a supply engine may be needed at the hydrant.
  – When the four-way is placed on the hydrant, water initially flows from the hydrant through the valve to the supply line.
  – A second engine can then hook to the four-way and boost pressure to the supply hose.
Supply Line Operations

• The reverse hose lay
  - Hose is laid from the fire to the hydrant.
  - This evolution can be used when attack engines begin attack without a supply line.
  - A later-arriving company stops at the attack engine and lays line to the hydrant.

Supply Line Operations

• The split hose lay
  - Is performed by two engines
  - Is used when hose must be laid from two directions
  - Requires coordination by two-way radio

Loading Supply Hose

• Supply hose can be loaded in different ways.
• The hose must be easily removable from the hose bed.
• Many hose beds are several feet above the ground.
Loading Supply Hose

• The flat hose load
  – The flat hose load is the easiest method of loading supply hose.
  – The flat hose load can be used for any size of hose.
  – Hose should lay out flat without twists or kinks.

Loading Supply Hose

• The horseshoe hose load
  – Is accomplished by standing the hose on edge and placing it around the hose bed in a U-shape.
  – Contains fewer sharp bends than other loads.
  – Cannot be used for large diameter hose.
  – Causes more wear on the hose.

Loading Supply Hose

• The accordion hose load
  – Is accomplished by laying hose side-to-side in the hose bed.
  – Is easy to load in the hose bed.
  – Creates sharp bends and more wear on the hose.
  – Is not recommended for large diameter hose.
Connecting an Engine to a Water Supply

- Supply hose must be used to deliver water from the hydrant to the engine.
- In most cases, soft suction hose is used to connect directly to a hydrant.
- Connection can also be made with a hard suction hose.

Supply Hose Carries and Advances

- The best technique for carrying and advancing fire hose depends on:
  - The size of the hose
  - The distance it must be moved
  - The number of fire fighters available

Supply Hose Carries and Advances

- The working hose drag
  - The working hose drag is used to deploy hose from a hose bed and advance the line a short distance
  - Several fire fighters may be needed for the task.
Supply Hose Carries and Advances

- The shoulder carry
  - Is used to transport full lengths of hose over a longer distance
  - Is useful for advancing a hose line around obstructions
  - Requires practice and good teamwork

Connecting Supply Hose Lines to a Standpipe System

- Fire department connections are provided so that the fire department can pump water into a standpipe or sprinkler system.

Connecting Supply Hose Lines to a Standpipe System

- There are two types of standpipe systems:
  - A dry standpipe system depends on the fire department to provide all of the water.
  - A wet standpipe system has a built-in water supply
Replacing a Defective Section of Hose

• A burst hose line should be shut down as soon as possible.
• After the flow has been shut off, remove the damaged section of hose and replace it with two sections of hose.

Replacing a Defective Section of Hose

• To put the hose back into service, the hose must be drained of water.
• Hose should be unloaded and reloaded on a regular basis to place the bends in different portions of the hose.

Summary

• In rural areas, fire departments depend on static sources for water supply.
• Municipal water systems supply water via hydrants.
• The water supplied in a municipal system is drawn from an outside source, treated, and carried through a distribution system.
• The two types of fire hydrants are wet- and dry-barrel.
Summary

- The locations of fire hydrants are determined by local standards and national practices.
- Fire fighters must know how to operate fire hydrants.
- Basic water terms must be known to understand fire hydrant testing procedures.
- Fire hoses are used as supply and attack hoses and are available in different sizes.

Summary

- Fire hoses are constructed with an inner liner surrounded by an outer layer.
- 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.

Summary

- Common causes of hose damage are mechanical, heat and cold, chemical, and mildew.
- Several types of hose appliances are available.
- Rolled hose is easy to manage.
- A supply line delivers water from a hydrant or static source to an attack engine.
Summary

• Hose can be loaded in several different ways.
• Many techniques are used to carry and advance supply hose.
• A hose line should be laid out and positioned nearest the location where it will be operated before being charged with water.
Student Performance Objective

Given information from discussion, handouts, and reading materials students will describe how to control fire safely and effectively.

Introduction

• Fire hoses are used for two main purposes:
  – Supply hose
  – Attack hose
• Attack lines discharge water from an attack engine.
**Attack Hose**

- Medium-diameter hoses are used to:
  - Extinguish larger fires
  - Deliver water to a master stream device or a fire department connection
- Large-diameter hoses are:
  - Used to supply master stream devices
  - Mounted on an aerial ladder

**Attack Hose**

- Attack hose
  - Must withstand high pressure and high temperatures
  - Must be tested annually

**Sizes of Attack Lines**

- 1½” or 1¾” attack hose
  - Is often used as the primary line for structure fires
- 2½” attack hose
  - Is used for fires that are too large to be controlled by a 1½” and 1¾” hose line.
Sizes of Attack Lines

- Booster hose
  - Is used for small outdoor fires and trash dumpsters.
- Forestry lines
  - Are small-diameter hoses that can extend for hundreds of feet

Attack Line Evolutions

- Attack lines are used to deliver water from an attack engine to a nozzle.
- Evolutions are methods of working with attack lines in a variety of situations.
- Most engines are equipped with preconnected attack lines.

Preconnected Attack Lines

- Preconnected attack lines
  - Are intended for immediate use as attack lines
  - Are predetermined lengths of hose with nozzles already attached and are connected to discharge outlets on the fire engine
  - Should be loaded in the hose bed so they can be quickly stretched from the engine to the fire
**Wyed Lines**

- To reach a fire that may be far from the engine, it may be necessary to first advance a larger diameter line.
  - This is accomplished by attaching a gated wye or a water thief to the end of the line.

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**Advancing Attack Lines**

- An attack line is usually advanced in two stages to attack an interior fire
  - Laying out the hose to the building entrance
  - Advancing the line into the building
- Flake extra hose in a serpentine pattern.

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**Advancing Attack Lines**

- Signal the driver to charge the line.
- Make sure the nozzle is set to deliver the appropriate stream.
- Recheck your and your partner's personal protective equipment.
- Advance the line as soon as your officer directs you.
Advancing Attack Lines

- As you move inside, stay low.
- If you cannot see, use your hands to feel the pathway in front of you.
- Communicate with the other members of the team as you advance.

Advancing an Attack Line
Up a Stairway

- Arrange extra hose close to the bottom of the stairs.
- Make sure all of the team is ready.
- Shut down the hose line while moving up the stairs to get to the top more quickly.

Advancing an Attack Line
Down a Stairway

- Keep as low as possible.
- Never advance toward a fire unless your hose line is charged.
- Move down the stairway feet first.
Advancing an Attack Line
Up a Ladder

• Position the line before it is charged.
• Feed additional hose up the ladder until sufficient hose is inside.
• Secure the hose to the ladder with a hose strap.

Operating an Attack Line
From a Ladder

• A hose stream can be operated and directed into a building through a window or other opening.

Extending an Attack Line

• There are two ways to extend a hose line:
  – Disconnect the hose from the discharge gate and add the extra hose at that location.
  – Add the hose to the discharge end of the hose.
Advancing an Attack Line from a Standpipe Outlet

- Before opening the door, flake out the hose line so it will be ready to advance.
- Before charging the hose line, flake out the hose on the stairs.
- When the hose line is charged and advanced, gravity will help move the line.

Replacing a Defective Section of Hose

- Shut down as soon as possible.
- Remove the damaged section and replace it with two sections of hose.
  - Ensures that the replacement hose is long enough to replace the damaged section.

Nozzles

- Nozzles
  - Give fire streams shape and direction
  - Are classified into groups:
    - Low-volume
    - Handline
    - Master stream
Nozzle Shut-offs

- Nozzle shut-offs enable a person at the nozzle to start or stop the flow of water.
- The most common is a quarter-turn valve.
- There are two different types of nozzles:
  - Smooth-bore nozzles produce a solid column of water
  - Fog-stream nozzles separate the water into droplets

Smooth-Bore Nozzles

- Smooth-bore nozzles
  - Consist of shut-off valves and smooth bore tips
  - Fit handlines and master stream devices

Smooth-Bore Nozzles

- The advantages of smooth-bore nozzles are that they
  - Have longer reach than combination fog nozzles
  - Are capable of deeper penetration
  - Operate at lower pressures
  - Extinguish fire with less air movement
Smooth-Bore Nozzles

- The disadvantages of smooth-bore nozzles are that they
  - Do not absorb heat as readily as fog streams
  - Are not as effective for hydraulic ventilation
  - Cannot change settings to produce a fog pattern

Fog Stream Nozzles

- Produce fine droplets of water
- Absorb heat quickly
  - Can create a water curtain to protect fire fighters from heat

Fog Stream Nozzles

- Advantages:
  - Can be used to exhaust smoke and gases through hydraulic ventilation
- Disadvantages:
  - Move large volumes of air, which can push hot steam and gases onto fire fighters
  - Can push fire into unaffected areas
Fog Stream Nozzles

- Types of fog stream nozzles:
  - Fixed gallonage: Deliver a preset flow in gallons per minute at the rated discharge pressure
  - Adjustable gallonage: Allow the operator to select a desired flow
  - Automatic adjusting: Deliver a wide range of flows

Other Types of Nozzles

- Piercing nozzle
- Cellar nozzle
- Water curtain nozzle

Nozzle Maintenance and Inspection

- Nozzles should be:
  - Checked after each use
  - Kept clean and clear of debris
- Inspect fog nozzle fingers
Summary

- Attack hoses carry water from the engine to a nozzle onto the fire.
- Attack hoses operate at high pressure.
- Hoses used to attack interior fires are either 1½” or 1¾” in diameter.
- Attack hoses must be tested annually.

Summary

- A 1½” hose can flow between 60 and 125 gallons per minute.
- A 2½” hose is used on large fires.
- Booster hoses contain a steel wire, giving it a rigid shape.
- Attack lines are stretched from the attack engine to the fire.

Summary

- Attack lines are loaded so they can be quickly and easily deployed.
- Preconnected hose lines can be placed in different locations on a fire engine.
- Hoses may need to be split into two lines in order to reach a fire that is far away.
- Attack evolutions have a specific structure.
Summary

- Nozzles give fire streams shape and direction.
- Nozzle shut-off enables the fire fighter to start or stop the flow of water.
- Smooth-bore and fog-stream are the two different types of nozzles.
- There are three specialized nozzles.
Student Performance Objective

Given information from discussion, handouts, and reading materials, describe the purpose and use of firefighting small tools and equipment.

Introduction

- Tools are used for a wide range of activities.
- Firefighters must know how to use tools and equipment
  - Effectively
  - Efficiently
  - Safely
  - In dark, limited-visibility environments
General Considerations

- Hand tools
  - Extend or multiply body actions
  - Increase task effectiveness
  - Use simple machine principles
- Power tools
  - Are powered by electric motors or internal combustion engines
  - Are faster and more efficient

Safety

- Safety is the prime consideration for use of tools and equipment.
- Safe equipment avoids unintentional injury.

Safe Operation Requires Approved PPE

- Helmet
- Firefighting hood
- Eye protection
- Face shield
- Gloves
- Turnout coats
- Bunker pants
- Boots
- Self-contained breathing apparatus (SCBA)
- Personal alert safety system (PASS)
Conditions of Use/Operating Conditions

• As proficiency increases, practice under more realistic conditions.
• Be able to use tools with no visibility.
• Be able to work safely while wearing PPE.

Effective and Efficient Use

• Use the least amount of energy to accomplish the task.
• Complete the task safely and quickly.
  – Many are surprised by the strength and energy required for tasks.
• Learn which tools are used during various fireground operations.

Effective and Efficient Use

• Fire departments may have standard operating guidelines specify tools and equipment needed for specific situations
• Some carry a selection of tools and equipment in the pockets of bunker pants.
Functions

- Rotating
- Pushing or pulling
- Prying or spreading
- Striking
- Cutting
- Multiple use

Rotating Tools

- Rotating tools apply rotational force to make something turn
- The most common rotating tools are screwdrivers, wrenches, and pliers
- Fire apparatus carry tool kits with a wide selection

Rotating Tools

- There are various sizes and types of screw heads
- Spanner wrenches are used for couplings.
- Hydrant wrenches are used for hydrants.
Common Rotating Tools

- Box-end wrenches
- Gripping pliers
- Hydrant wrenches
- Open-end wrenches
- Pipe wrenches
- Screwdrivers
- Socket wrenches
- Spanner wrenches

Pushing/Pulling Tools

- Extend the fire fighter’s reach
- Increase the power exerted on an object
- Have many different uses in fire department operations

Pike Pole

- The pike pole
  - Is a wood or fiberglass pole with a sharpened point metal head attached to one end
  - Is primarily used to pull down ceilings
  - Comes in different sizes
  - Comes with handles of varying length and with different head configurations
Pike Pole

- The most common sized pike pole is 4 to 6 feet for use on 10-foot ceilings
- Head designs vary for different ceiling types.

Common Pushing/Pulling Tools

- Ceiling hook
- Clemens hook
- Drywall hook
- Multipurpose hook
- Pike pole
- Plaster hook
- Roofman’s hook
- San Francisco hook

Prying/Spreading Tools

- Prying/spreading tools may be as simple as a pry bar or complex as a hydraulic spreader
- There are many variations.
Common Prying/Spreading Tools

- Claw bar
- Crowbar
- Flat bar
- Halligan tool
- Hux bar
- Kelly tool
- Pry bar

Striking Tools

- Used to apply impact force
- Used to gain entry or make openings
Common Striking Tools

- Hammer
- Mallet
- Sledgehammer
- Pick-head axe
- Flat-head axe
- Maul
- Battering ram
- Chisel
- Spring-loaded center punch

Common Striking Tools

Cutting Tools

- Cutting tools have a sharp edge to sever an object
- Cutting tools range from knives to saws and torches
- Each cutting tool is designed for certain materials.
- Fire fighters can be injured and tools ruined if used incorrectly.
Common Cutting Tools

- Axes
- Bolt cutters
- Chain saws
- Cutting torches
- Hacksaws
- Handsaws
- Hydraulic shears
- Reciprocating saws
- Rotary saws
- Seatbelt cutter

Saws

- There are two main categories of saws
  - Manual
  - Mechanical
- Handsaws include
  - Hacksaws
  - Carpenter’s handsaw
  - Keyhole saw
  - Coping saw
Mechanical Saws

- There are three main types of mechanical saws:
  - Chain, rotary, and reciprocating
- Power saws
  - Are faster than handsaws
  - Conserve firefighter energy
  - Must be used only by trained operators

Chain Saws

- Chain saws are gasoline powered or powered by electricity
- Special chains are good for cutting ventilation openings.

Rotary Saws

- Rotary saws are gasoline powered or electric
- Saws may have a round metal blade with teeth or a flat abrasive disk
- The choice of blade depends on the type of material to be cut.
Reciprocating Saws

- Reciprocating saws are powered by electricity or battery.
- There are different blades for different materials.
- Reciprocating saws are most commonly used to cut metal during vehicle extrication.

Hydraulic Shears

- Operators of hydraulic shears require extensive training.
- Hydraulic shears:
  - Are used with hydraulic spreaders and rams for vehicle extrication.
  - Quickly cut metal posts and bars.

Cutting Torches

- Cutting torches heat heavy steel objects until they melt and can be cut through (5700°F).
- Specialized training is required.
- Cutting torches cannot be used around flammable fuels.
Multiple Function/Special-Use Tools

- Multiple-function tools reduce the tools needed to achieve a goal
- Special-use tools perform other functions:
  - Rakes
  - Brooms
  - Shovels

Phases of Use

- The basic steps of fire suppression include
  - Response/size-up
  - Forcible entry
  - Interior attack
  - Search and rescue
  - Rapid intervention
  - Ventilation
  - Overhaul

Response/Size-Up

- Consider the information from dispatch.
  - May indicate the nature and gravity of the situation and problems that might arise
- Begin considering tools needed.
- On arrival, the company officer will size-up and develop action plans following standard operating procedures (SOPs).
**Forcible Entry**

- Locked or blocked entries and security systems
- Typical tools for forced entry
  - Axe
  - Prying tool
  - K tool
  - Other prying tools

**Interior Attack**

- Interior attack involves multiple tasks performed simultaneously or in rapid succession
- Specialized tools should be carried for particular assignments.
- A basic set of tools includes a prying, striking, cutting, and pushing tool, and a hand light.

**Interior Attack Team Tools**

- The interior attack team is responsible for advancing hose lines and locating and extinguishing the fire.
Rapid Intervention Crew (RIC)

- The RIC is ready to immediately assist lost, trapped, or injured fire fighters.
- All equipment should be staged.
- Special equipment includes a thermal imaging camera, portable lighting, lifelines, prying tools, striking tools, cutting tools, SCBA, and spare air cylinders.

Ventilation

- Ventilation is similar to forcible entry
- Power saws and axes are common
- Fans are used to remove smoke or introduce fresh air.
- Horizontal ventilation requires opening doors and windows.
- Interior openings may be created.

Ventilation

- Vertical ventilation requires openings in the roof.
- Special tools needed include positive pressure fans, exhaust fans, cutting tools, and long pike poles.
Overhaul

- Overhaul is the process of examining the fire scene to extinguish hidden fires.
- Burned debris must be removed.
- Simple hand tools are used.
- Tools that can shut off activated sprinkler heads are needed.

Overhaul

- Pike poles are used to pull ceilings and open walls
- Axes and saws are used to open walls
- Prying and striking tools are used to open closed spaces

Overhaul

- Shovels, brooms, and rakes are used to clear debris
- Water vacuums remove water
- Thermal imaging is used to “see” hot spots
Tools Used in Overhaul

- Pushing tools
- Prying tools
- Striking tools
- Cutting tools
- Debris-removal tools
- Water-removal equipment
- Ventilation equipment
- Portable lighting
- Thermal imaging camera

Maintenance

- Maintain tools and equipment to ensure readiness.
  - Tools and equipment must be ready for use before you respond to an emergency incident.
- Follow manufacturer’s instructions for cleaning and maintenance
- Use equipment only for its intended purpose.

Hand Tool Maintenance

- Remove all dirt and debris.
- If appropriate, use soap and water.
- Dry tools completely.
- Sharpen cutting tools.
- Avoid painting tools.
- Learn how to use cleaning solutions.
Summary

- Tools and equipment are used in almost all fire suppression and rescue operations.
- Hand tools extend or multiply actions of the body and increase effectiveness.
- Power tools use external power and are faster than hand tools.
- Always wear PPE when using tools/equipment.

Summary

- Most tools/equipment fit into the following category:
  - Rotating (assembly/disassembly)
  - Pushing or pulling
  - Prying or spreading
  - Striking or cutting
  - Multiple-use tools
- Forcible entry tools gain entrance to a locked building.

Summary

- Interior attack teams advance hose line, find fire, and apply water to flames.
- An RIC carries special equipment.
- Ventilation provides entrance of fresh air and exit for hot gases and combustion products.
Summary

• During overhaul the fire scene is examined carefully.
• Overhaul operations use special equipment.
• Properly maintain tools and equipment.

• Test power tools frequently and service regularly.
• Read and follow manufacturers’ manuals and instructions for care/inspections.
Lesson 17-1: Ventilation

Student Performance Objective

Given information from discussion, handouts, and reading materials students will describe the theory and practices of fire service ventilation.

Introduction

- Ventilation
  - Is the process of removing smoke, heat, and toxic gases from a burning building and replacing them with cooler, cleaner, more oxygen-rich air
Introduction

- The ventilation process has two components:
  - The removal of smoke, toxic gases, hot air
  - The addition of cooler, cleaner, oxygen-rich air
- Modern construction uses lightweight and manufactured building components
- Firefighters may assume the fire is small, fuel is gone, or fire is in decay

Fire Behavior and Ventilation

- Proper ventilation:
  - Can facilitate locating and rescuing victims
  - Enables hose teams to advance and locate the source of fire
  - Prevents fire spread

Fire Behavior and Ventilation

- Lack of ventilation can contribute to:
  - Violent backdrafts
  - Delay in extinguishing fire
  - Unnecessary fire extension
  - Injury to firefighters and civilians
  - Increased property damage
Fire Behavior and Ventilation

- The primary method of fire spread is convection.
- Mushrooming occurs when the products of combustion reach the highest point.

Benefits of Proper Ventilation

- Proper ventilation can
  - Help firefighters locate trapped occupants faster
  - Provide fresh air to occupants
  - Enable firefighters to advance hose lines rapidly and safely
  - Reduce backdraft and flashover
  - Limit fire spread
  - Reduce property loss

Benefits of Proper Ventilation

A. Vented structure.
B. Unvented structure.
Backdraft

- Backdraft occurs when a building is charged with hot gases and oxygen has been consumed.
- When air is introduced, fuel can ignite and explode.

Firefighters should
- Release heat and unburned particles without allowing the entry of clean air.
- Ventilate as high as possible.

Flashover

- Both ventilation and cooling are needed to relieve potential flashover conditions.
- Flashover occurs when:
  - The air in the room is very hot.
  - All combustibles are near their ignition point.
- Applying water cools the atmosphere.
- Ventilation draws heat and flames away.
Factors Affecting Ventilation

• Convection
  – Heated gases will always follow the path of least resistance.
  – Ill-fitting and tight-fitting windows can cause dangerous fire conditions.

Factors Affecting Ventilation

• Firefighters can use mechanical ventilation to direct the flow of combustion gases
  – Negative-pressure
  – Positive-pressure
  – Hose streams
• Fire fighters should evaluate for signs of backdraft before creating ventilation.

Factors Affecting Ventilation

• Wind and atmospheric forces
  – Wind speed and direction
  – Temperature and humidity
Building Construction Considerations

- The way a building is constructed will affect ventilation operations.

Fire-Resistive Construction

- Fire-resistive construction refers to buildings with noncombustible structural components
- There are still potential paths of fire spread
  - Heating and cooling ducts, plumbing and electrical chases
  - Elevator shafts
  - Stairwells
- Fire-resistive buildings generally have roofs supported by steel or concrete roof decks

Ordinary Construction

- Ordinary construction buildings
  - Have exterior walls made of noncombustible material
  - Have interior walls/floors of wood construction
  - Have roofs with wood decking and wood structural support
Ordinary Construction

- Paths of fire spread
  - Plumbing and electrical chases
  - Void spaces in walls
  - A cockloft

Wood-Frame Construction

- Combustible exterior walls
- Paths of fire spread
  - Attics and cocklofts
  - Wood truss roofs and floors
- Construction types
  - Balloon-frame
  - Platform

Location and Extent of Smoke and Fire Conditions

- Factors to consider
  - Size of the fire
  - Stage of combustion
  - Location within the building
  - Available ventilation options
Location and Extent of Smoke and Fire Conditions

- Where to ventilate
  - Ventilate as close to the fire as possible
  - If unable to vent close to the fire:
    • Predict how the location will affect the fire.
    • Anticipate the fire spread.

Location and Extent of Smoke and Fire Conditions

- Determine fire size, intensity, and fuel.
  - Light smoke, moving lazily—small fire of ordinary combustibles
  - Large amount of black rolling smoke—petroleum-based fire
- Cool days may cause smoke inversion.
- Sprinkler activation may cause fog.

Types of Ventilation

- There are two basic types of ventilation
  - Horizontal
    • Uses horizontal openings in a structure such as doors and windows
  - Vertical
    • Involves openings in the roofs or floors
Horizontal Ventilation

- Horizontal ventilation
  - Is commonly used in residential fires and room-and-contents fires
  - Is generally fast and easy to use
  - Can be used from inside or outside the building

Horizontal Ventilation

- Horizontal ventilation
  - Uses horizontal openings such as windows and doors
  - Is most effective when the opening is directly to the outside
  - Is more difficult when there are no direct openings
  - Limits structural damage
- Only open doors when the hoseline is charged and the attack team is ready to advance.

Natural Ventilation

- Natural ventilation
  - Depends on convection currents, wind, and other natural air movements
  - Is used when air currents are adequate
  - Is used when ventilation is needed quickly
- Open the leeward side of the building first, then the windward.
Natural Ventilation

• Breaking glass
  – Try to open first.
  – Wear full PPE.
  – Ensure no one will be struck by the glass.
  – Always use a tool.
  – Keep hands above or to the side of glass.
  – Use a tool to clear remaining glass.

Natural Ventilation

• Doorways
  – Are large openings
  – May compromise entry/exit points
  – May be best for clean air points
  – Are good locations for mechanical ventilation devices

Mechanical Ventilation

• Negative-pressure ventilation
  – Limitations
    • Positioning
    • Power source
    • Maintenance
    • Air flow control
  – Advantages
    • Explosion-proof motors
**Mechanical Ventilation**

- Positive-pressure ventilation uses large, powerful fans that
  - Are quick and efficient
  - Increase safety for the firefighter
- The fans
  - May spread the fire
  - May increase carbon monoxide levels

**Mechanical Ventilation**

- Hydraulic ventilation uses a narrow fog or broken stream pattern
  - Advantages
    - Move several thousand cubic feet of air per minute
  - Disadvantages
    - Water damage
    - Safety hazards

**Vertical Ventilation**

- Vertical ventilation
  - Releases combustion products vertically
  - Occurs naturally if there is an opening
  - May be assisted by mechanical means
Vertical Ventilation

- Safety considerations
  - Determine roof construction first.
  - Be sure the ventilation opening is not between the fire fighters and their escape exit.
  - Have a charged hose line ready.
  - Leave the area once done.

Vertical Ventilation

- Safety considerations
  - “Sound” the roof
  - Walk on the areas of greatest support
  - Plan the order of the cuts
  - Make cuts from upwind
  - Have a clear exit path

Roof Construction

- All roofs have two components
  - A support structure
    - Solid beams of wood, steel, or concrete
    - A system of trusses of wood, steel, or wood and steel
  - A roof covering
    - Made of various weather-resistant materials
    - Supported by the roof decking
Effects of Roof Construction on Fire Resistance

- Support system failure
  - The supporting structure fails
  - There is often a sudden and total collapse of the roof
- Roof covering failure
  - Fire burns through the roof covering
  - The initial “burn through” spreads out, causing roof failure
  - In warmer climates roofs burn through quickly; in colder climates burn with little evidence

Solid Beam versus Truss

- Solid beam
  - Girders, beams, and rafters
- Truss
  - Lightweight components
  - Wood or steel bars
  - Triangular configuration

Roof Designs

- Flat roofs
  - Can be constructed with many types of supports, decking, and materials
- Pitched roofs
  - Have a visible slope for rain, ice, and snow runoff
Roof Designs

- Arched roofs
  - Are generally found in commercial structures
  - Use bowstring trusses in which fire can severely and quickly weaken structure

Roof Ventilation

- Objectives:
  - Provide largest opening
  - Put in appropriate location
  - Use least amount of time
  - Use safest technique

Before starting vertical ventilation, assess the following:
- Construction features
- Indications of fire damage
- Safety zones and exit paths
- Built-in roof openings

Types of Vertical Ventilation Openings

- Built-in roof openings
- Inspection openings
- Primary (expandable) openings
- Secondary (defensive) openings
Roof Ventilation

- Vertical ventilation is most effective at the highest point and over the seat of the fire
- An examination hole may be cut
- To provide a ventilation opening, cutting one hole is better than making several small ones
- The original hole should be a minimum of 4' × 4'

Tools Used in Vertical Ventilation

- Power saws
- Axes
- Halligan tools
- Pry bars
- Tin cutters
- Pike poles, other types of hooks
- Utility rope
Types of Roof Cuts

• The rectangular cut requires four cuts completely through the decking
  – Use care to not cut structural supports.
  – Stand upwind and have a safe exit.
  – If several layers exist, peel a layer at a time if necessary.

Types of Roof Cuts

• The louver cut
  – Is used for flat or sloping roofs with plywood decking
  – Is made with a power saw or axe
  – Can quickly create a large opening

Types of Roof Cuts

• The triangular cut
  – Is used to prevent metal decking from rolling away as it is cut.
  – Is made with a saw or axe.
  – May have to be made several times because of its small size.
Types of Roof Cuts

• The peak cut
  – The peak cut is used for peaked roofs with plywood sheeting.
  – A tool is used to reveal the roof covering along the peak.
  – A power saw or axe is used to make a series of vertical cuts.

Types of Roof Cuts

• The trench cut
  – Is used to stop the progress of a large fire in a narrow building
  – Creates large opening ahead of the fire
  – "Writes off" part of the building

Special Considerations

• Poor access or obstructions
• Multiple roofs and roof layers
• Boarded or sealed window openings
• Security measures such as steel bars and shutters
Ventilating Concrete Roofs

- Concrete roofs are generally flat and hard to breach.
- Concrete roofs may collapse from weakened support systems when exposed to fire.
- Because there are few options for ventilating concrete roofs, firefighters should search for alternative openings such as vents, skylights, and other roof penetrations.

Ventilating Metal Roofs

- Discoloration and warping may indicate the seat of the fire.
- The tar roof covering can melt and leak into the building.
- Metal can roll down and create a dangerous slide directly into the opening.

Ventilating Basements

- Ventilating basements usually requires both horizontal and vertical ventilation.
- Make as many openings on one side as possible and allow fire fighters to enter from the other.
- A cellar nozzle or hose line may be needed.
Ventilating High-Rise Buildings

- Many high-rises have hard-to-break sealed windows.
- Newer buildings have smoke management capabilities in the HVAC.
- One stairwell should be designated as a rescue route.
- Positive-pressure fans can keep smoke out of the stairs.

Ventilating High-Rise Buildings

- A cold outer atmosphere and a heated interior will cause smoke to rise quickly through vertical openings.

Ventilating High-Rise Buildings

- A hot outer atmosphere and a cooled interior will cause smoke to push down the vertical openings.
Ventilating Windowless Buildings

- Windowless buildings trap heat and smoke
- Firefighters should
  - Treat fires in windowless buildings similarly to basement fires.
  - Ventilate high.

Ventilating Large Buildings

- Ventilating large buildings is more difficult than ventilating small ones
- Smoke cools as it travels, causing stratification.
- When possible, use interior walls and doors to create smaller areas.

Equipment Maintenance

- Keep equipment in good repair and operate at peak efficiency
- Read and follow manufacturers' instructions.
- Rotate fuel if it is not used regularly.
- Fill fuel tanks to recommended levels.
- Practice using ventilation tools.
Summary

• Ventilation removes smoke, heat, and toxic gases from a burning building.
• Flashback or backdraft is caused by the addition of oxygen-rich air to a smoke-filled and fuel-rich atmosphere.
• New construction leads to a large fuel supply.
• Ventilation can save lives and reduce property damage.

Summary

• An increase in fire produces more smoke, heat, and toxic gases.
• Convection controls the spread of the products of combustion.
• In convection, heated gases expand and become less dense than cooler gases.
• Proper ventilation includes improved visibility, removal of heat and steam, reduction of backdraft, and limited fire spread.

Summary

• Backdraft can be reduced by ventilation.
• Ventilation and cooling are needed to relieve potential flashover conditions.
• Convection currents carry smoke and superheated gases to uninvolved areas.
• The direction and force of the wind should be considered.
Summary

• Structural components in fire-resistant construction are made of noncombustible or limited-combustible materials.
• Ordinary construction buildings have exterior walls composed of noncombustible or limited-combustible materials.
• Wood-frame buildings contain void spaces.
• Fire fighters must be able to recognize when ventilation is needed.

Summary

• Vertical ventilation makes structural holes.
• Horizontal ventilation include natural and mechanical methods.
• Vertical ventilation allows the products of combustion to travel up and out.
• Fire fighters must evaluate all pertinent safety issues and avoid unnecessary risks.
• When working on a roof, fire fighters should have two safe exit routes.

Summary

• Roofs are composed of support structures and roof coverings.
• Roof designs can be flat, pitched, or arched.
• Vertical ventilation openings include built-in, inspection, primary, and secondary.
• Commercial or industrial structures have concrete roofs.
Summary

- Metal roofs conduct heat and are supported by lightweight steel metal joists.
- Venting a basement may include both horizontal and vertical.
- HVAC systems may be used to ventilate high-rise buildings.
- All equipment and tools must be in a ready state and be properly maintained.
Student Performance Objective

Given information from discussion, handouts, and reading materials students will describe forcible entry and breaching techniques used in the fire service.

Introduction

- Forcible entry
  - Is a method to gain access when normal means of entry cannot be used
  - Requires strength, knowledge, proper techniques, and skill
- Use an amount of force appropriate to the situation.
Introduction

- Arrange to secure the opening before leaving the scene.
- Consider the type of construction, entry points, securing devices, and best tools and equipment for the situation.
- Keep up with how new styles of windows, doors, locks, and security devices operate.

Forcible Entry Situations

- Forcible entry is required at emergency incidents where time is a critical factor
- The company officer selects the
  - Point of entry
  - Method to be used
- “Try before you pry!”

Forcible Entry Tools

- Firefighters must know:
  - Which tools are available
  - Uses and limitations of each tool
  - How to select the right tool
  - How to operate each tool
  - How to carry each tool
  - How to inspect and maintain each tool
General Tool Safety

- Always wear proper personal protective equipment (PPE).
- Use the right tool for the job.
- Keep tools clean and serviced.
  - Take broken tools out of service for repair.
- Keep tools in proper area or container.

General Carrying Tips

- Request assistance with heavy tools.
- Use your legs to lift heavy tools.
- Keep sharp edges away from your body.
- Carry long tools pointing down.
- Be aware of wires.

General Maintenance Tips

- All tools should be in a ready state.
  - Tools must be in working order, in their storage place, and ready for use.
- Tools require regular maintenance and cleaning to ensure readiness.
Types of Forcible Entry Tools

- Striking tools
- Prying/spreading hand tools
- Cutting tools
- Lock tools

Striking Tools

- Striking tools
  - Are used to generate an impact force directly on an object or another tool
  - Have heads usually made of hardened steel

Striking Tools

- The flat-head axe
  - One side is a cutting blade.
  - The other side is a flat striking surface.
  - Firefighters often use the flat side to strike a Halligan tool and drive a wedge into an opening.
Striking Tools

• The battering ram
  – Is used to force doors and breach walls
  – Is usually made of hardened steel and has handles
  – Requires two to four people to operate

Striking Tools

• The sledgehammer
  – Comes in various weights and sizes
  – Can have heads weighing from 2 to 20 lbs.
  – Has a handle that may be short or long
  – Can be used alone or with other striking tools

Prying/Spreading Hand Tools

• The Halligan tool
  – Is widely used
  – Is commonly used to perform forcible entry
  – Incorporates three tools: the adz, pick, and claw
Prying/Spreading Hand Tools

- The pry bar
  - Is made from hardened steel
  - Is commonly used to force doors and windows, remove nails, or separate building materials
  - Comes in various shapes to allow fire fighters to exert different amounts of leverage

- The pry axe
  - Is a multipurpose tool
  - Is used to cut and force open doors and windows
  - Includes the adz, pick, and claw
  - Consists of a body and a handle

- Hydraulic tools
  - Include:
    - Spreaders
    - Cutters
    - Rams
  - Require hydraulic pressure
Prying/Spreading Hand Tools

- Rabbet tool
  - The Rabbet tool is a small hydraulic spreader operated by a hand-powered pump
  - As the spreader opens, it applies a powerful force that opens doors

Cutting Tools

- Cutting tools are primarily used for cutting doors, roofs, walls, and floors
- There are both hand-operated and power cutting tools

- The axe
  - Comes in many different types
  - Uses a cutting edge to break into plaster and wood walls, roofs, and doors
  - Can be flat-head, pick-head, or multipurpose
Cutting Tools

• Bolt cutters
  – Bolt cutters are used to cut components, such as bolts, padlocks, chains, and chain-link fences.
  – Bolt cutters are available in several different sizes.
  – The longer the handle, the greater the cutting force.

Cutting Tools

• The circular saw
  – Gasoline-powered circular saws are used by most departments.
  – The circular saw is light, powerful, and easy to use.
  – Blades can be changed quickly.
    • Carbide-tipped blades
    • Metal-cutting blades
    • Masonry-cutting blades

Lock and Specialty Tools

• Lock and specialty tools
  – Are used to disassemble the locking mechanism on a door
  – Cause minimal damage to the door and the door frame
  – Can enable an experienced user to gain entry in less than a minute.
Lock and Specialty Tools

- K tool
- A tool
- J tool
- Shove knife
- Duck-billed lock breakers
- Locking pliers and chain
- Bam-bam tool

Doors

- Basic construction:
  - Door
  - Jamb
  - Hardware
  - Locking mechanism

Wood

- Slab Doors
  - Solid core
    - Solid wood core blocks covered by a face panel
  - Hollow core
    - Lightweight honeycomb interior
Wood

- Ledge Doors
  - Wood doors with horizontal bracing

- Panel Doors
  - Solid wood doors made from solid planks to form a rigid frame with solid wood panels set into the frame

Metal

- Hollow-core metal doors
  - Have a metal framework interior so they are lightweight

- Solid-core metal doors
  - Have a foam or wood interior to reduce weight without affecting strength

Glass

- Glass doors
  - Generally have a steel frame with tempered glass but may be tempered glass only with no frame
  - Are easy to force
  - Produce a large amount of broken glass
Types of Doors

- Inward-opening
- Outward-opening
- Sliding
- Revolving
- Overhead

Types of Doors

- Hinges indicate if a door is inward- or outward-opening.
  - Outward
    - Hinges are visible.
  - Inward
    - Hinges are not visible.

Door Frames

- There are two styles of wood-framed doors.
  - Stopped door frames
  - Rabbeted door frames
- Metal-framed doors are more difficult to force open.
Inward-Opening Doors

• Design
  – Inward-opening doors
    • Are made of wood, steel, or glass.
    • Have an exterior frame with a stop or rabbet.
  – Locking mechanisms range from standard door knob locks to deadbolt locks or sliding latches.

• Forcing entry:
  – Determine what type of frame the door has.
  – Use a prying tool near the locking mechanism to pry the stop away from the frame.
  – Use a striking tool to force the prying tool further into the jamb.

Outward-Opening Doors

• Design
  – Outward-opening doors
    • Are used in commercial occupancies and for most exits
    • Are designed for quick exit
    • Are made of wood, metal, or glass
    • Usually have exposed hinges
Outward-Opening Doors

- Forcing entry:
  - First check to see whether hinges can be disassembled or hinge pins removed.
    - If not, place adz end of prying tool into the door frame.
  - Use striking tool to drive adz end into jamb.
  - Leverage the tool to force the door outward away from the jamb.

Sliding Doors

- Design
  - Sliding doors
    - Are made of tempered glass in a wood or metal frame
    - Have two sections and a double track
  - A weak latch on the frame of the door secures the movable side.

Sliding Doors

- Forcing entry:
  - Check whether a security rod is in the track.
    - If not present, use a pry bar to lever door away from locking mechanism.
    - If necessary, break the glass.
Revolving Doors

- Design
  - Revolving doors are
    - Made of four glass panels with metal frames
    - Designed to collapse outward when certain pressure is applied
    - Usually adjacent to outward-opening doors

- Forcing entry
  - Should be avoided whenever possible
    - The opening will not be large enough to allow many people to exit.
  - Can be done by attacking the locking mechanism directly or by breaking the glass.

Overhead Doors

- Design
  - Overhead doors
    - Can roll up or tilt
    - Are made of wood or metal
    - May be hollow core or solid core
    - Are secured with cylinder locks, padlocks, or automatic openers
**Overhead Doors**

- Forcing entry:
  - Break out a panel or window and manually operate lock from within.
  - Always securely prop door open to prevent door closing.
  - Use emergency release cord for safety.
  - If a security roll-up door, cut a triangle-shape entry.

**Windows**

- Windows
  - Are usually easier to force than doors
  - Have frames made of wood, metal, and vinyl

- Breaking the glass is the easiest way to force a window but also the most dangerous.

**Windows**

- Safety
  - Wear PPE with face and eye protection.
  - Clear area of personnel.
  - Coordinate with fire attack to prevent flare-ups and backdrafts.
  - Completely clear frame of glass shards.
Glass Construction

- Regular glass
- Double/triple-pane glass
- Plate glass
- Laminated glass
- Tempered glass

Regular or Annealed Glass

- Regular or annealed glass
  - Is commonly used because it is inexpensive
  - In larger pieces is called plate glass
  - Is easily broken with a pike pole
- Watch out for shards.

Double- and Triple-Pane Glass

- Double- and triple-pane glass
  - Is used in many homes because it improves home insulation
  - Uses two panes with an air pocket between them
- The two panes need to be broken separately.
- Watch out for shards.
Plate Glass

- Commercial plate glass is stronger, thicker glass used in large window openings.
- Commercial plate glass can easily be broken with a Halligan tool or pike pole.
- Watch out for large shards.

Laminated Glass

- Laminated glass
  - Is also known as safety glass
  - Has a molded sheet of plastic between two sheets of glass
  - Is commonly used in vehicle windshields

Tempered Glass

- Tempered glass
  - Is specially heat-treated
  - Is four times stronger than regular glass
  - Is common in side and rear vehicle windows and commercial or sliding doors
  - Breaks into small pellets without sharp edges
**Wired Glass**

- Tempered glass with wire reinforcement
- Often used in fire-rated doors
- Difficult to break or force

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**Double-Hung Windows**

- **Design**
  - Two sashes move up and down
- **Forcing entry**
  - Open or break locking mechanism

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**Single-Hung Windows**

- **Design**
  - Only lower sash moves
- **Forcing entry**
  - Use same technique as double-hung window.
**Jalousie Windows**

- Jalousie windows
  - Have adjustable, overlapping sections of tempered glass
  - Are operated by hand crank
  - Are difficult to force
  - Should be avoided if possible

**Awning Windows**

- Awning windows are like jalousie windows, but have fewer panels
- To force entry, break lower panel and operate crank.

**Horizontal-Sliding Windows**

- Horizontal-sliding windows are similar to sliding doors.
- Force in the same manner as sliding doors (use a pry bar to break the latch).
- Attempt to locate another window if a security rod is present.
Casement Windows

- Casement windows
  - Are steel- or wood-frame
  - Crank open
  - Should be avoided
- To force, break glass, unlock, and open manually.

Projected Windows

- Projected windows can project inward or outward.
- Avoid forcing entry.
- To force entry, break a pane, unlock, and open the window manually.

Parts of a Door Lock

- Latch
- Operator lever
- Deadbolt
Parts of a Padlock

- Shackle
- Unlocking mechanism
- Lock body

Safety

- Keep cutting tools sharp.
- Use proper PPE.
- Have others stand away.

Cylindrical Locks

- Design
  - Locks and handles are set into predrilled holes
- Forcing entry
  - Place a pry bar near locking mechanism and lever it.
Padlocks

• Padlocks
  – Are the most common locks on the market today
  – Come in regular- and heavy-duty
  – Come with various unlocking devices

Padlocks

• Hockey puck lock
  – A hockey puck lock cannot be forced through conventional means
  – Locks must be twisted from their mounting tabs

Padlocks

• Forcing entry:
  – Cut the shackle or hasp.
  – Breaking the shackle is the best method.
  – If the padlock is made of case-hardened steel, many conventional methods will be ineffective.
Common Tools Used to Force Entry

- Bolt cutters
- Duck-billed lock breakers
- Bam-bam tools
- Locking pliers and chain

Mortise Locks

- Design:
  - The latch will lock the door.
  - The bolt can be used for added security.
- Forcing entry:
  - Mortise locks are difficult to force.
  - Use the through-the-lock technique.
Rim Locks and Deadbolts

- Rim locks and deadbolts
  - Are used as secondary locks
  - Have a bolt that extends at least 1” into the door frame
  - Are difficult to force
- Use the through-the-lock method.

Security Gates and Windows

- Security gates and windows
  - Are usually equipped with a lock or a locking mechanism
  - Are designed to keep criminals out but can make it difficult for fire fighters to gain access
- Remove the lock or cut the gate and bars.
Breaching Walls and Floors

- Breach only as a last resort.
- First consider whether the wall is load-bearing.
  - Breaching a load-bearing wall could cause collapse.
  - Non-weight-bearing walls can be removed safely.

Exterior Walls

- Exterior walls can be constructed of one or more materials
- Breaking through can be very difficult.

Interior Walls

- Interior walls are usually constructed of wood or metal studs covered by plaster, gypsum, or sheetrock.
- Breaching can be dangerous.
**Interior Walls**

- Locate a stud away from electrical outlets and switches.
- Make a small hole to check for obstructions.
- If area is clear, expand to reveal studs.

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**Floors**

- Most floors are wood or poured concrete.
  - Both can be difficult to breach.
    - This is truly a last resort.
- Use a rotary saw with the appropriate blade.

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**Vehicle Entry**

- Entry into a vehicle can be gained by breaking a side window.
  - Be as far away from a trapped child or pet as possible.
  - Use a spring-loaded center punch or other sharp object.
Systematic Forcible Entry

- Before taking action
  - Double check the address.
  - Look for a lockbox.
  - Evaluate the threat level.
  - Consider entry with least amount of damage.
  - Work in a coordinated fashion with team members.

Forcible Entry and Salvage

- Try to keep damage to a minimum.
- Secure the structure before leaving.
- Ensure the building owner is called to secure the building.

Summary

- Forcible entry is required where time is of the essence.
- “Try before you pry.”
- Four types of forcible entry tools are used:
  - Striking tools
  - Prying or spreading tools
  - Cutting tools
  - Lock and specialty tools
Summary

- Four major components to a door: door, jamb, hardware, and locking mechanism.
- Doors are constructed of wood, metal, or glass.
- Classification of doors include: inward, outward, sliding, revolving, and overhead.

Summary

- Window construction can be glazed, regular or annealed, double-pane, plate, laminated, or tempered.
- Window frame designs include double-hung, single-hung, jalousie, awning, horizontal-sliding, casement, and projected.

Summary

- Locks range from push-button to computer-operated.
- The three major parts of a lock are the latch, operator level, and deadbolt.
- All padlocks have shackles, an unlocking mechanism, and a lock body.
Summary

• The four categories of locks are cylindrical, padlocks, mortise, and rim.
• Consider whether a wall is load-bearing before breaching.

Summary

• Steps in systematic forcible entry:
  – Think.
  – Look for lockbox.
  – Evaluate situation.
  – Enter with least amount of damage.
  – Secure property during salvage.
Given information from discussion, handouts, and reading materials, the student will describe how to handle salvage covers, salvage techniques, and overhaul techniques.

Introduction

• Salvage protects property and belongings from damage.
• Overhaul ensures that a fire is completely extinguished.
• Salvage and overhaul are usually conducted in close coordination with each other.
Introduction

• Fire fighters must attempt to preserve evidence related to the cause of the fire.
• Fire fighters must be able to see where they are going, what they are doing, and whether any potential hazards are present.

Lighting

• Many incidents occur at night.
• Incidents may require power to be off.
• Types of fire service lights:
  – Spotlights: Narrow concentrated beam of light
  – Floodlights: Diffuse light over a wide area

Safety Principles and Practices

• Lights and equipment use household current (110-volt AC).
• All equipment must be properly grounded.
• Do not use equipment that is poorly insulated, worn, or undersized for load.
• Generators should be equipped with ground fault interrupters (GFIs).
Lighting Equipment

• Portable lights
  – Are used to illuminate the interior of the building or the fire scene

Lighting Equipment

• Junction boxes
  – Serve as mobile power outlets
  – Are protected by waterproof covers
  – Are often equipped with small lights to make them easy to locate

Lighting Equipment

• Connectors and plugs
  – Use a special connector that attaches with a slight clockwise twist.
  – Prevent unintentional unplugging or use in standard household outlets
Lighting Equipment

• Apparatus-mounted lights
  – Light towers

Battery-Powered Lights

• Battery-powered lights are used to illuminate the immediate work area.
• Every crew member should have a high-powered hand light.
• A personal flashlight should be kept with fire fighters’ PPE.

Lighting Methods

• Exterior lighting
  – Enables fire fighters to see what they are doing, recognize hazards, and locate victims.
  – Makes the scene visible to drivers
  – Provides some light inside the structure
Lighting Methods

• Interior lighting
  – Set up portable light at the entry point to serve as a beacon for disoriented fire fighters.
  – Illuminate interior areas as needed.
  – Provide ample illumination to facilitate operations and increase safety.
  – Use during daylight if needed.

Salvage

• Salvage
  – Is conducted to save property and reduce damage
  – Is aimed at limiting secondary losses from smoke and water damage

Salvage operations include
  – Expelling smoke
  – Removing heat
  – Controlling water runoff
  – Removing water from the building
  – Securing a building after a fire
  – Covering broken windows and doors
  – Patching ventilation openings
Salvage

- Protecting property is a responsibility of firefighters.
  - Property can be irreplaceable and/or of high sentimental value (e.g., photos).
  - Contents may be more valuable than the structure (e.g., computers, important files).

Safety Considerations During Salvage

- Wear full PPE, including self-contained breathing apparatus
- Beware of possible structural collapse
  - Weakened structural components
  - Extra water weight
  - Heavy objects

Salvage Tools

- Salvage covers
- Box cutters
- Floor runners
- Wet/dry vacuums
- Squeegees
Salvage Tools

- Submersible pumps and hose
- Sprinkler shut-off kit
- Ventilation fans
- Small tool kit

Preventing Water Damage

- Limit application.
- Deactivate sprinklers when fire is under control
- Use sprinkler wedges, stops, or control valves.

Replacing Sprinkler Heads

- Replacement heads must be of the same design, size, and temperature rating.
- The valve must be closed and the system drained.
Removing Water

- Channel to a drain or outside of building.
- Create an opening at floor-level in an exterior wall to allow water to drain to the outside.

Removing Water

- A water chute
  - Channels water to a drain or outside the structure
- A water catch-all
  - Is a temporary pond that catches dripping water and holds it in place

Removing Water

- Water vacuums
  - Water vacuums come in small or large sizes
  - Wet/dry shop vacuums can be used as a low-cost alternative
- Drainage pumps
  - Are electric or gas powered
Limiting Smoke and Heat Damage

- Keep smoke and heat out of uninvolved areas.
- Close doors after a room is searched.
- Perform rapid ventilation.
- Use salvage covers to protect contents.

Using Salvage Covers

- Begin on floor below the fire.
- Move contents to center of room.
- Place small objects in drawers.
- Cover with salvage cover.

Salvage Cover Maintenance

- Salvage covers must be adequately maintained to preserve their shelf life
  - Clean with a scrub brush and clean water.
  - Dry canvas covers before returning them to service.
  - After drying, inspect salvage covers for tears and holes.
Floor Runners

- Protect carpets and hardwood floors from the following:
  - Water
  - Debris
  - Fire fighters' boots
  - Firefighting equipment

Other Salvage Operations

- Move contents to a safe location within the structure.
- Move contents outside the structure.
- Place valuable items in the care of the owner or a law enforcement officer.
- Consult a fire investigator if necessary.

Overhaul

- Overhaul is the process of searching for and extinguishing hidden fire and embers.
- A single pocket of embers can cause a rekindle.
- The fire is not fully extinguished until overhaul is complete.
Overhaul

• The Overhaul Process
  – Identify and open any void spaces.
  – Expose any burned areas.
  – Soak materials that are still burning with water or remove them from the building.
• Overhaul is also required for nonstructure fires.

Safety Considerations: Overhaul

• Fire fighters may be fatigued.
  – Consider using a fresh crew for overhaul.
  – Provide adequate breaks for rehabilitation.
• Structural integrity may be compromised.
• Visibility may be limited.

Safety Considerations: Overhaul

• Hazards present in the overhaul area:
  – Wet or icy surfaces
  – Smoldering areas that can burst into flames.
  – Air that may not be safe to breathe.
  – Dangerous equipment used in close quarters
• Fire fighters must wear full PPE.
• A safety officer should be present.
Safety Considerations: Overhaul

• Firefighters must
  – Look for indicators of possible collapse.
  – Not compromise the structural integrity of the building.
• The IC may call for hydraulic overhaul or a fire watch.

Coordinating Overhaul With Fire Investigators

• Overhaul crews must ensure evidence is not lost or destroyed.
• Investigator should examine the area before overhaul commences.
• Burn patterns should be noted.
• Whether appliances are plugged in/on should be noted.
• If anything suspicious is found, overhaul should be delayed.

Where to Overhaul

• Fire-resistive construction
  – Utility shafts
  – Pipe chases
  – Doors or dampers that did not close tightly
• Wood-frame and ordinary construction
  – Every wall, ceiling, and potential void space.
Where to Overhaul

- Balloon-frame construction
  - Fire can spread from the basement to the attic without showing on other floors.
  - Careful overhaul of every floor is required.

Where to Overhaul

- Look for voids created by remodeling.
  - False ceilings
  - False doors

Where to Overhaul

- Look for:
  - Smoke
  - Embers
  - Burned areas
  - Discolorations
  - Peeling paint or cracked plaster

- Listen for:
  - Crackling sounds
  - Hissing sounds

- Feel for:
  - Heat (use back of hand)
Thermal Imaging

- Thermal imaging
  - Displays minute differences in temperature
  - Can quickly identify areas that need to be opened
  - Cannot rule out concealed fire

Overhaul Techniques

- Have a charged hose line available to douse sudden flare-ups.
- Extinguish any fire or embers.
- Drop smoldering objects into water.
- Remove smoldering contents to the outside.
- Adjust techniques to meet the situation.

Overhaul Tools

- Pike poles
- Ceiling hooksa
- Crowbars
- Halligan tools
- Axes
- Power tools
- Pitchforks
- Shovels
- Rubbish hooks
- Rakes
- Thermal imaging cameras
- Hose lines
Overhaul Tools

- Buckets, tubs, wheelbarrows, and carryalls are used to remove debris from a building.

Opening Walls and Ceilings

- A 6-foot pike pole is sufficient for most residential fires.
- Pike poles, power saws, and handsaws can be used to open a hole in a wall.
  - Pull wall section away by hand after cutting.

Summary

- Salvage and overhaul limit and reduce property loses from a fire.
- Lighting is required to illuminate the scene.
- Spotlights and floodlights are used.
- Electrical equipment must be grounded.
- Lights can be portable or mounted on apparatus.
Summary

- Electricity for lighting equipment is supplied by a generator, inverter, or a building’s electrical system.
- Salvage efforts prevent or limit secondary losses from smoke and water.
- Safety is the primary concern during salvage operations.
- To prevent water damage, limit the amount of water used.

Summary

- Sprinklers can be shut down by using sprinkler wedges or stops or shutting off the main control valve.
- Water can be removed using a salvage pump, water chute, water catch-all, water vacuum, or drainage pump.
- Salvage techniques limit smoke and heat damage.

Summary

- An object can be protected from water and smoke damage by removing it from the structure.
- Overhaul searches for and extinguishes any pockets of fire remaining.
- Injuries can occur during overhaul.
- Charged hose lines must always be ready for use during overhaul operations to suppress flare-ups and explosions.
Summary

• Evaluate the structural condition of a building before beginning overhaul.
• During overhaul, do not compromise the structural integrity of the building.
• The area of overhaul depends on building construction, contents, and size of the fire.
• Fire fighters should use their senses to determine where overhaul is needed.
Lesson 25-1: Search and Rescue

Student Performance Objective

Given information from discussion, handouts, and reading materials students will describe the various procedures and techniques to safely perform a search and rescue operation.

Introduction

• Saving lives is the fire department’s highest priority.
• Search: Locate living victims.
• Rescue: Physically remove a person from a dangerous environment.
Coordinating Search and Rescue Operations

• Fire fighters must plan and coordinate all activities to support search and rescue.
• The fire may need to be controlled before search and rescue can begin.

Search and Rescue Size-Up

• Evaluate the critical factors.
• Develop search and rescue plan based on conclusions.
• Conduct a risk-benefit analysis.

Search and Rescue Size-Up

• Evaluate occupancy factors.
  – Rescue occupants who are in most immediate danger.
  – Consider where occupants are located.
• Make observations.
  – Look for clues that indicate whether a building is occupied.
Search and Rescue Size-Up

- Consider occupant information.
  - Make sure everyone is accounted for.
- Consider the building size and arrangement.
  - Preincident plans include valuable layout information.
  - Note the floor numbering system.

Search Coordination

- Notify the IC:
  - When search is complete
  - If a victim is found
- Consider those who have escaped but still need assistance.

Search Priorities

- First: Immediate fire area and rest of floor
- Second: Area directly above the fire
- Third: Top floor down to floor above fire
- Last: Areas below the fire
Types of Searches

• Primary
  – A quick attempt to locate any potential victims who are in danger
• Secondary
  – A thorough search conducted after the situation is under control

Primary Search

• Remember that time is critical.
• Check areas where victims might be.
• Rely on sight, sound, and touch.
• Use hand tools to extend your reach.

Search Techniques

• Use standard techniques to search assigned areas quickly, efficiently, and safely
• Ensure one member from each team has a radio.
Search Patterns

- In small rooms, searchers should follow walls and reach toward the middle to feel for victims.
- In large rooms, one member should be in contact with the wall, whereas the other remains in contact with the first member.

Search Patterns

- The clockwise (left-hand) search:
  - Keep the left hand in contact with the wall.
  - Use the right arm to sweep the room.
  - Turn right at each corner until you return to the entry point.

Search Patterns

- The counterclockwise (right-hand) search:
  - Is the reverse of the clockwise search.
Search Patterns

- Check the door temperature.
- Enter and exit through the same door.
- Mark rooms to show they have been searched.

Thermal Imaging Devices

- Thermal imaging devices
  - Are used to show heat images
  - Can "see" a person and room contents through smoke
  - Are used to determine whether a door is hot

Search Ropes

- Search ropes
  - Are used to search large areas
  - Are used to search interconnected rooms
  - Are used to search areas with multiple aisles
  - Provide a reliable return path
  - Should be anchored at the entry point
The Officer-Led Search

- Search teams may consist of a fire officer and one to three fire fighters.
- The parallel-crawl-return is a method used during this type of search.

The Vent-Entry-Search

- The vent-entry-search
  - Is a process used when search teams have to enter and exit through a window
  - Is a high-risk activity
  - Should be performed only as directed by the incident commander (IC) and as part of the department Standard Operating Procedures.

The Secondary Search

- The secondary search
  - Is conducted to locate victims missed in the primary search
  - Is conducted when conditions improve
  - Is slow and methodical
  - Includes all areas of the building
Search Safety

• Firefighters are exposed to the same risks that endanger the lives of victims.
• Despite protective clothing and equipment, firefighters can still be injured.

Risk Management

• Balance the risks involved with the potential benefits.
  – High risk is only acceptable to save lives.
  – Limited risk is acceptable to save property.
  – If there is no chance to save lives or property, no risk is acceptable.

IC Considerations

• The IC must consider:
  – The stage of the fire
  – The condition of the building
  – The presence of other hazards
Search and Rescue Equipment

- Personal protective equipment
- Portable radio
- Hand light or flashlight
- Forcible entry tools
- Hose lines
- Thermal imaging devices
- Ladders
- Long ropes
- Tubular webbing or short rope

Determining Whether an Area is Tenable

- Determine life safety risk.
- Evaluate the structural stability.
- Evaluate the potential for backdraft or flashover conditions.

Rescue Techniques

- Rescue techniques include:
  - Assists
  - Carries
  - Drags
- Always use the safest and most practical means of egress.
Rescue Techniques

- Shelter-in-place
  - Consider when occupants are conscious and in an area that is protected.

- Exit assist
  - Consider when a victim is responsive and able to walk with little or no assistance.

Rescue Techniques

- Simple victim carries are used to move a victim who is conscious and responsive but unable to stand or walk
- Four simple carries can be used:
  - Two-person extremity carry
  - Two-person seat carry
  - Two-person chair carry
  - Cradle-in-arms carry

Rescue Techniques

- Emergency drags are used to remove an unconscious victim
- There are five emergency drags:
  - Clothes drag
  - Blanket drag
  - Webbing sling drag
  - Fire fighter drag
  - Emergency drag from a vehicle
Assisting a Person Down a Ground Ladder

- Assisting a person down a ground ladder:
  - Carries a considerable risk of injury to both firefighter and victim
  - Requires proper technique and physical strength and stamina
  - Requires that ladders be heeled or tied in

Removal of Victims by Ladders

- Aerial ladders have several advantages over ground ladders because they
  - Are stronger
  - Have a longer reach
  - Are wider and more stable
  - Reduce the risk of slipping and falling

Summary

- Search and rescue are almost always performed in tandem.
- The IC and fire fighters must plan and coordinate all fire suppression operations.
- Sometimes fire fighters must confine or control a fire.
- Size-up should include a specific evaluation.
Summary

• Search and rescue plans must consider risks and benefits of operation.
• Search and rescue includes seven specific factors.
• Never assume a building is occupied or unoccupied.
• There are several sources of information regarding potential building occupants.

Summary

• Search begins in the area of greatest risk.
• Primary search is a quick attempt to locate victims in danger.
• Fire fighters should use the walls when searching a room.
• Thermal imaging cameras search for victims in the dark.

Summary

• Search ropes can be used in large, open areas.
• Vent-entry-search uses the window as an entrance and exit.
• Secondary searches are conducted after a fire is under control.
• Fire fighters encounter situations of personal risk.
Summary

- There are several signs that indicate building collapse.
- Rescue removes people who are unable to escape from a dangerous situation.
- Specific groups of people may need to be rescued.

Summary

- Sometimes the best option is to shelter the occupants in place rather than remove them from the building.
- The simplest rescue is the exit assist.
- Four carry techniques can be used to remove a victim.

Summary

- The drag is the most efficient method to remove an unconscious person.
- When using the emergency drag, be sure to pull the victim in line with the long axis of the body.
- Assisting someone down a ladder involves a higher risk of injury.
Student Performance Objective

Given information from discussion, handouts, and reading materials students will describe the types and uses of personal accountability, the role of the rapid intervention crew, self rescue techniques and how to conserve air.

Introduction

- Fire fighter survival is the most important outcome in an operation.
- Survival depends on making the right decisions and performing the right actions.
- Learn to recognize dangerous situations.
Risk-Benefit Analysis

• The risk-benefit analysis
  – Attempts to predict and recognize potential risks fire fighters would face when entering a burning building and weighs against results that could be achieved.

Risk-Benefit Analysis

• Do not risk life by entering a burning building if:
  – The building is unoccupied
  – Occupants could not survive
  – No property of value can be saved
  – The property has no value

Risk-Benefit Analysis

• If there is a reasonable possibility that property can be saved, but no lives are at stake, fire fighters can be committed to an interior attack.
  – The combination of PPE, training, and SOPs is designed to allow fire fighters to work safely
Risk-Benefit Analysis

• It is only permissible to risk a fire fighter’s life when there is a real possibility of saving a life.
  – The determination that risk is acceptable does not justify taking unsafe actions.

Hazard Indicators

• Fire fighters must be capable of working safely in a hazardous environment.
• The danger of firefighting should never be thought of as routine.
  – Learn to routinely follow safe SOPs.

Hazard Indicators

• Recognize the many types of hazards and act appropriately.
  – Smoke indicates a hazard.
  – Be aware of indicators of less obvious hazards.
Hazard Indicators

- Building construction
  - Affects fire behavior
- Weather conditions
  - Can create hazards
- An occupancy
  - May have a warning placard

Standard Operating Procedures (SOPs)

- SOPs define how operations are conducted.
- Many SOPs are based on fire fighter health and safety
- SOPs must be learned and practiced.
  - When under pressure, people will revert to habits.

Rules of Engagement for Fire Fighter Survival

- Size up the tactical area.
- Determine the occupant survival profile.
- Do not risk your life for lives or property that cannot be saved.
- Extend limited risk to protect savable property.
- Extend vigilant and measured risk to protect and rescue savable lives.
Rules of Engagement for Fire Fighter Survival

• Go in together and come out together.
• Maintain continuous awareness.
• Monitor fire-ground communications.
• Report unsafe practices or conditions.
• Abandon your position and retreat before deteriorating conditions can harm you.
• Declare a mayday as soon as you think you are in danger.

Team Integrity

• Teamwork is essential.
• A standard company is three to five fire fighters and a company officer.

Team Integrity

• Team integrity means that a company arrives at a fire together, works together, and leaves together.
• Always use a buddy system.
  – Follow the two-in/two-out rule.
The Personnel Accountability System (PASS)

- The personal accountability system
  - Is a way to track everyone’s location and function
  - Tracks personnel from arrival to release
  - Tracks each member of a company

The Personnel Accountability System (PASS)

- The PASS can take many forms
  - A written roster or computer database
- A list of assigned company members is carried on each piece of apparatus
  - Tags for all members are affixed to a special board, called a passport, carried in the cab.

The Personnel Accountability System (PASS)

- A personnel accountability report (PAR) is a roll call taken by each supervisor
- Any time a fire fighter cannot be accounted for, he or she is considered missing until proven otherwise.
Emergency Communications Procedures

• Communication breakdown is a major cause of deaths and injuries to fire fighters.
• Ensure a message is stated clearly.
• Repeat a message back as confirmation.

Emergency Communications Procedures

• Reserved phrases, sounds, and signals should be a part of your SOPs.
• Phrases should be known and practiced by everyone in the department.
• In many areas, communication procedures are coordinated regionally.

Emergency Communications Procedures

• “Mayday” is used if a fire fighter is in danger.
  – To request help
  – To report a team member missing or in trouble
• Mayday takes precedence over all other radio communications.
Emergency Communications Procedures

- “Emergency traffic” is used to indicate an imminent fire-ground hazard.
- An emergency traffic message takes precedence over all other radio communications
  - Except mayday

Communications centers can emit a special tone over the radio.
  - Information is repeated to be certain it is heard correctly by all.
- All imminent hazards and emergency instructions should capture the attention of everyone at the incident scene.

Initiating a Mayday

- Analysis shows that fire fighters often wait until it’s too late to call for help.
- Failure to act promptly can be fatal in many situations.
- Do not hesitate to call for help when you think you need it.
Initiating a Mayday

- Follow SOPs for your department.
- Transmit “mayday, mayday, mayday.”
- Give LUNAR report: location, unit number, name, assignment, and resources needed.
- Activate PASS.
- Activate emergency button on radio.

The Rapid Intervention Crew (RIC)

- The RIC
  - Is established solely to rescue fire fighters
  - Is an extension of the two-in/two-out rule
    - A minimum of two fire fighters is required to establish an entry team.
    - A minimum of two additional fire fighters is required to remain outside the hazardous area.

The Rapid Intervention Crew (RIC)

- Outside fire fighters must be ready to assist at all times.
- SOPs dictate:
  - When a RIC is required
  - How it is assigned
  - Where it should be positioned
The Rapid Intervention Crew (RIC)

- The RIC should be in place when fire fighters are operating in immediately dangerous to life or health conditions.
- The RIC is deployed when there is a
  - Lost or missing fire fighter
  - Injured fire fighter
  - Trapped fire fighter

Fire Fighter Survival Procedures

- Your personal safety could depend on learning, practicing, and consistently following fire fighter survival procedures.

Maintaining Orientation

- It is very easy to become disoriented in a dark, smoke-filled building
  - Before entering, look at the building.
  - After entering, follow the walls and pay attention to where you go.
  - Always stay in contact with a hose line.
Maintaining Orientation

- Team integrity is an important factor in maintaining orientation.
- A guideline can be used.
  - Rope attached to an object on the exterior or a known fixed location
- Training sessions will build confidence.

Self-Rescue

- Call for assistance as soon as you think you are in trouble.
- If you are separated from your crew:
  - Follow a hose line back to an open doorway.
  - Descend a ladder.
  - Climb out through a ground floor window.
  - Notify the incident commander (IC).

Self-Rescue

- Fire fighters can breach a wall to escape from dangerous predicaments.
  - Expose the studs and reduce profile size to get body and self-contained breathing apparatus (SCBA) through.
  - The technique depends on the size of the fire fighter.
Self-Rescue

• Disentanglement may be needed if drop ceilings fall.
• Tools can be used to cut through wires or small cables.
  – Can be difficult if visibility does not allow the entangling material to be seen and identified.

Self-Rescue

• Some self-rescue methods involve using tools and equipment in manners for which they were not designed.
  – These are considered last resort methods.
  – The methods should only be taught by instructors and practiced with strict safety measures in place.
  – Several of these methods are very controversial.

Safe Locations

• A safe location is a temporary location that provides refuge to the fire fighter while awaiting rescue or finding a method of self-rescue
• Safety is relative.
• Know where to look for and how to recognize one.
Safe Locations

- Safe location provides time for:
  - The rescue team to reach fire fighters
  - A ladder to be raised to the window
  - Another group of fire fighters to control the fire
- Maintaining team integrity is important.

Air Management

- Air equals time.
  - Time in a hazardous atmosphere must include entry and exit time.
- The time rating on an SCBA is for low exertion.
  - Often a 45-minute supply is used in 20 to 25 minutes.

Air Management

- Determine air use rate by participating in an SCBA consumption exercise.
- Know team members’ physical conditions and workload to help keep them safe.
Air Management

- Be aware of the SCBA limitations.
  - Do not enter a hazardous area unless your air cylinder is full.
  - Know your air supply.
  - Do not wait until the low-pressure alarm sounds.

Rescuing a Downed Fire Fighter

- Assess the fire fighter's condition.
- Make a rapid assessment.
- Notify the IC of your situation and location.
- Have the RIC deployed to your location.

Rescuing a Downed Fire Fighter

- Provide enough air to keep the fire fighter breathing for the duration of the operation.
- If the fire fighter has a working SCBA, determine how much air remains in the cylinder.
Rescuing a Downed Fire Fighter

- If there is very little air or no air in the SCBA, this is a critical priority.
  - Move the fire fighter out of the hazardous area immediately or provide an additional air supply.

Rehabilitation

- Rehabilitation
  - Reduces the effects of fatigue during an emergency operation
  - Helps retain the ability to perform at the current incident
  - Restores the capacity to work at later incidents

Rehabilitation

- At small incidents, rehabilitation can be set up on a tailboard with a water cooler
- At larger incidents, a complete operation should be established
Counseling and Critical Incident Stress

- Critical incidents challenge the capacity of individuals to deal with stress.
- Examples include
  - Line-of-duty deaths (police, fire/rescue, EMS)
  - Serious injury to a colleague
  - Events that are prolonged or end with a negative or unexpected outcome

Counseling and Critical Incident Stress

- Normal coping mechanisms help many firefighters.
- Sometimes firefighters react to critical incidents in ways that are not positive.
- Reactions will vary.

Counseling and Critical Incident Stress Management (CISM)

- Counseling and CISM are designed to prevent reactions from having a negative effect on the firefighter’s work and life
Critical Incident Stress Management (CISM)

- Stages of emotional reaction can include:
  - Anxiety
  - Denial/disbelief
  - Frustration/anger
  - Inability to function logically
  - Remorse
  - Grief
  - Reconciliation/acceptance

- Counseling helps fire fighters recognize and deal with these reactions in the most positive manner possible.

- Your fire department should have some type of CISM program in place.

Summary

- Risk-benefit analysis weighs the positive results that can be achieved against potential negative consequences.
- No property is worth the life of a fire fighter.
- You should be aware of hazard indicators.
- SOPs define the manner in which a fire department conducts operations.
- Fire fighters should know and understand the 11 rules of engagement.
Summary

• Team integrity means a company arrives at a fire together and leaves together.
• A personnel accountability report (PAR) is a roll call taken at an emergency incident.
• Mayday is used if a fire fighter is lost, is trapped, has an SCBA failure, or is running out of air.
• Emergency traffic is used to indicate imminent fire-ground hazard.

Summary

• RICs rescue fire fighters operating at emergency incidents.
• To remain oriented in a smoke-filled room, stay in contact with a hose or guideline.
• The first step in attempting self-rescue is to initiate mayday.

Summary

• A safe location provides refuge while awaiting rescue.
• Always follow the rule of air management.
• SCBA straps or a rescue harness may be used to help drag a downed fire fighter.
• Critical incident stress is a known hazard that emergency personnel can learn to handle.
Student Performance Objective

Given information from discussion, handouts, and reading materials, the student will describe the process of firefighter rehabilitation during and after an emergency incident.

Introduction

- You must take care of yourself so you can help others.
- To rehabilitate is to restore to a condition of health or to a state of useful and constructive activity.
Introduction

- Without rest and recovery firefighters may suffer from:
  - Fatigue
  - Headaches
  - Gastrointestinal problems

Factors, Cause, and Need for Rehabilitation

- Physiologic job stressors:
  - Going from sleep to full activity in seconds
  - Not having enough time to eat or drink
  - Physical demands
  - Extreme weather
  - Smoke-filled locations

Personal Protective Equipment

- PPE
  - Contributes to heat stress
  - Increases the amount of energy needed
  - Prevents most perspiration from evaporating
Dehydration

- Dehydration
  - Is the state in which fluid losses are greater than fluid intake
  - Reduces strength, endurance, and mental judgment
  - Should be prevented or corrected as quickly as possible

Energy Consumption

- The body burns carbohydrates and fats for energy during strenuous activity.
- Energy sources need to be replenished.
- The body should be refueled with a balanced diet.

Tolerance for Stress

- A well-rested, well-conditioned person has more endurance and can tolerate the stresses of firefighting.
The Body’s Need for Rehabilitation

- Rehabilitation allows the fire fighter to rest and recover.
- Proper rehabilitation:
  - Reduces risk of illness and injury
  - Improves the quality of decision making

Types of Incidents Affecting Fire Fighter Rehabilitation

- Rehabilitation should be addressed at all incidents.
- Not every incident needs to involve all components of a rehabilitation center.

Extended Fire Incidents

- Structure fires
  - Intense heat and stressful conditions cause rapid dehydration and fatigue.
- High-rise fires
  - Energy resources are drained quickly.
**Extended Fire Incidents**

• Wildland fires
  – Crews need to work in shifts so their bodies can recover.
  – Large fires may require hundreds of fire fighters and take weeks to extinguish.
  – Nutrition and rehydration are essential.

**Other Types of Incidents Requiring Rehabilitation**

• Hazardous materials incidents
• Long-duration search and rescue activities

**Other Types of Incidents Requiring Rehabilitation**

• Nonemergency events
  – Athletic events
  – Stand-by assignments
  – Large-scale training activities
Other Types of Incidents Requiring Rehabilitation

- Adverse weather conditions
  - Heat causes rapid dehydration and fatigue.
  - High humidity reduces evaporative cooling.
  - Cold weather can cause hypothermia.

A Model of Rehabilitation

- Relief from climatic conditions
- Rest and recovery
- Active or passive cooling or warming
- Rehydration and calorie replacement
- Medical monitoring
- Member accountability
- Release and reassignment

Relief From Climatic Conditions

- Whether rehabilitation takes place inside or outside depends on the weather.
- Firefighters should
  - Remove PPE and wet clothing.
  - Use a towel to dry off if needed.
Rest and Recovery

- Rest and recovery
  - Is the first step in rehabilitation
  - Is located away from the central activity of the emergency

Active or Passive Cooling or Warming

- Cooling or warming will stabilize the body's internal temperature.
- PPE and SCBA generate heat.
- Extreme cold can cause hypothermia.

Rehydration

- Rehydration replaces sweat lost during evaporation
- Rehydrate with proper fluids at a proper rate.
- Hydrate before reaching the fire ground.
Calorie Replacement

- Calorie replacement is needed after intense physical work.
- Firefighters must refuel to sustain peak performance levels.
- Eat a healthy, balanced diet.

Medical Monitoring

- Protocols may specify monitoring:
  - Heart and respiratory rate, blood pressure, temperature
  - Oxygen levels
  - Carbon monoxide

Medical Monitoring

- Be alert for:
  - Chest pain
  - Dizziness
  - Shortness of breath
  - Weakness
  - Headache
  - Cramps
  - Mental status change
  - Behavioral changes
  - Changes in speech
  - Changes in gait
Member Accountability and Reassignment

- Crew integrity should be maintained during rehabilitation.
- Release and reassignment can be performed once fire fighters are fit for duty.

Personal Responsibility in Rehabilitation

- Remember that safety begins and ends with you.
- Take care of yourself first, your team second, and others third.
- Know your own limits.
- Be responsible: participate in emergency incident rehabilitation.

Summary

- Rehabilitation is designed for emergency personnel to rest, cool off or warm up, receive fluids, and be evaluated.
- Stress, physical exertion, and weather extremes take a toll on the body.
- Rehabilitation corrects physical imbalances.
Summary

- PPE and SCBA add heat stress.
- Dehydration occurs when fluid losses are greater than fluid intake.
- The body needs nutrient-rich foods.
- Rehabilitation provides rest and recovery.
- Rehabilitation needs to be addressed at all incidents.

Summary

- Rehabilitation includes
  - Relief from climatic conditions
  - Rest and recovery
  - Active or passive cooling or warming
  - Rehydration and calorie replacement
  - Medical monitoring
  - Member accountability
  - Release

Summary

- Report the following signs:
  - Chest pain
  - Dizziness
  - Shortness of breath, weakness
  - Headache, cramps
  - Changes in mental status, behavior, speech, gait
- Know your limits.
Given information from discussion, handouts, and reading materials, the student will describe offensive and defensive strategies for fire suppression as well as special considerations for fires in large buildings, in basements, in concealed spaces, above ground level, in lumberyards, in energized equipment, and for flammable gases and liquids.

Introduction

• “Fire suppression” refers to the tactics and tasks to achieve extinguishment of the fire
• Fire suppression can be accomplished through a variety of methods
  – Remove fuel, oxygen, or heat
  – Break chemical chain reaction
  – Extinguish with water
Offensive Versus Defensive Operations

- Interior operations are offensive.
- Exterior operations are defensive.

Offensive Operations

- Offensive operations
  - Expose fire fighters to heat and smoke
  - Allow firefighters to get close enough to apply an extinguishing agent to overpower the fire
  - Cause the least amount of property damage
  - Are used when fires are small
  - Are usually performed using small handlines

Defensive Operations

- Defensive operations
  - Are usually performed using large handlines or master streams
  - Are used when the fire is too large for offensive attack or risk too great to fire fighters
  - Have as their objective to prevent fire from spreading
**Strategic Decisions**

- Strategic decisions
  - Must be made by the incident commander
  - Are made prior to operations beginning
  - Are clearly communicated to personnel
- There is no room for confusion between offensive and defensive operations.
- The strategy may change during the operation.

**Operating Hose Lines**

- Small handlines
  - One fire fighter can operate.
  - A second fire fighter is helpful for advancement and maneuverability.
- A large handline
  - Requires two or more fire fighters.
  - Can be operated by one fire fighter if it is well anchored.

**Operating Hose Lines**

- Master streams
  - Are operated from a fixed position
    - On the ground
    - On top of a fire apparatus
    - On an elevating device
  - Are used for defensive operations
Fire Streams

- The nozzle defines the pattern and the form of the water discharged.
- A fire stream can be produced by either
  - A smooth-bore nozzle
  - An adjustable nozzle

Fog Stream

- A fog stream
  - Divides water into droplets with large surface area
  - Absorbs heat very efficiently
  - Can lower heat levels very quickly
- Most adjustable nozzles can be adjusted from a straight stream to a narrow fog to a very wide fog

A Straight Stream

- A straight stream
  - Provides more reach than a fog stream
  - Keeps water concentrated
  - Is created by the narrowest setting on a fog nozzle
  - Consists of highly concentrated droplets
A Solid Straight Stream

- A solid straight stream
  - Is produced by smooth-bore nozzles
  - Has more reach and penetration than a straight stream
  - Consists of a continuous column of water

Points to Remember

- Air is moved along with the water.
- Fog streams move large amounts of air.
  - Thermal balance may be disrupted, pushing hot fire gases onto fire fighters.
- Straight streams move very little air, causing less thermal inversion.

Interior Fire Attack

- An interior fire attack is an offensive operation where fire fighters enter a structure
- There are three methods of attack:
  - Direct
  - Indirect
  - Combination
**Direct Attack**

- **Direct attack**
  - Is the most effective method
  - Uses a straight or solid stream
  - Delivers water directly to the seat of the fire
  - Is directed in short, controlled bursts of water

**Indirect Attack**

- **Indirect attack**
  - Is used when an area is ready to flash over
  - Directs a short burst of water to the ceiling
  - Uses a straight, solid, or narrow fog stream
  - Can cause serious injuries if too much water is used

**The Combination Attack**

- **The combination attack**
  - Employs both the indirect and direct method
  - Uses the indirect to cool the atmosphere, then the direct to extinguish
  - Should use only enough water as needed to control the fire to avoid unnecessary water damage
Large Handlines

- Large handlines
  - Can be used for both offensive and defensive attacks
  - Can extinguish larger interior fires and have greater reach
  - Are more difficult to maneuver

Large Handlines

- The one-fire fighter method
  - Control hose by forming a large loop of hose about 2 feet behind the nozzle.
- The two-fire fighter method
  - One should act as the nozzle operator, while the other serves as a backup.

Master Stream Devices

- Master stream devices
  - Produce high-volume water streams for large fires
  - Include portable monitors, deck guns, ladder pipes, and other devices
  - May be manually operated or by remote
  - Should never be directed into a building where fire fighters are inside
Deck Guns

- Deck guns are permanently mounted
- The driver/operator can usually open a valve to start the flow
- Sometimes a hose must be hooked up to operate

Portable Monitors

- Portable monitors
  - Are positioned wherever needed
  - Are connected to supply water
  - May be equipped with a strap or chain
  - Usually have a safety lock to limit use beyond 35°

Elevated Master Streams

- Elevated master streams are mounted on aerial ladders, aerial platforms, or hydraulic booms.
- A ladder pipe is mounted on an aerial ladder.
- Newer aerial ladders have fixed piping for water.
Protecting Exposures

- Protecting exposures
  - Means preventing fire spread
  - Is most important at large fires
  - Often, is done best by applying water directly to the exposed building exterior

Concealed-Space Fires

- Fires may burn in void spaces.
- The fires must be found and extinguished to prevent them from spreading

Basement Fires

- Ventilation must be planned and conducted early.
- Cellar fires can spread to upper floors in houses with balloon construction.
Fires Above Ground Level

- Vertical paths must be protected.
- Interior fire crews should always look for a secondary exit route.
- In high rises
  - Standpipes supply water
  - Equipment should be staged one to two floors below the fire.

Fires in Large Buildings

- Large buildings contain very large open spaces with smaller rooms and storage areas
- Fire loads differ based on contents
- Many large buildings contain large amounts of flammable materials

Fires in Large Buildings

- Fire fighters may become lost or disoriented.
- Tag lines can be used.
- A preincident plan can be essential.
- Prior knowledge of occupancy and hazards is helpful.
Fires in Buildings During Construction, Renovation, or Demolition

• Buildings under construction, renovation, or demolition are at greater risk of destruction by fire.
  – The buildings often have large quantities of exposed combustibles
  – If they are without windows and doors, the buildings may have unlimited oxygen supply
  – Fire systems may not be operational
• If no life hazards are involved, use defensive operations.

Fires in Lumberyards

• Fires in lumberyards are prime candidates for defensive operations.
• Lumberyards typically contain large quantities of combustibles.
• Plenty of air is available.
• Exposure protection is the primary objective.
• Collapse zones should be established.

Fires in Stacked or Piled Materials

• Materials may collapse without warning.
• Firefighters should approach stacked materials very cautiously.
• Partially burned or water-soaked material should be moved with equipment.
• Overhaul requires the materials to be separated.
Trash Container and Rubbish Fires

- Trash container fires
  - Usually occur outside of a structure
  - Can be extinguished with Class A foam
- Dumpsters can contain hazardous materials
- Deck guns can be used to extinguish the fire

Confined Spaces

- Underground vaults and transformer vaults on fire are too dangerous to enter.
- The utility company should be contacted.
- The Occupational Safety and Health Administration requires specially trained entry teams.
- The space may be oxygen-deficient or high in combustible gases.

Vehicle Fires

- Vehicles fires are very common fires.
- Firefighters should wear SCBA when fighting vehicle fires.
- A 1½” or 1¾” hose line should be used.
- Gas-filled components may burst.
- Other hazards should be considered.
- Firefighter lives should not be risked.
Attacking Vehicle Fires

- The only people within 50 feet should be firefighters in full PPE and SCBA
- Firefighters should
  - Approach from uphill and upwind side.
  - Extinguish all visible fire while advancing toward the vehicle.

Alternative-Fuel Vehicles

- Firefighters should watch for signs that a burning vehicle is powered by alternative fuels.
- Fully involved fires should be fought with unattended master streams.
- CNG (compressed natural gas) storage is usually located in the trunk.
- Hybrid vehicles have small gasoline-powered engines and large battery banks.

Fires in the Passenger Area

- If the doors won't open, stand to the windward side and break out one or more windows.
- Give special attention to cooling the steering column.
Fires in the Engine Compartment

- The engine compartment is filled with devices using petroleum products.
- Batteries contain sulfuric acid.
- Firefighters can direct water into wheel wells and through the front grill.

Fires in the Engine Compartment

- Pull the hood-release latch.
  - If successful, trip secondary latch.
  - If not, use a pry bar to pry up the hood.
  - Twist the hood-release cable with a gloved hand or a Halligan bar.
- Open the hood and extinguish fire.

Fire in the Trunk

- Make initial access if necessary by knocking out a tail light.
- Use a Halligan tool to force the lock for entry.
- Have a charged line ready.
- Approach with caution.
Overhauling Vehicle Fires

- Allow a few minutes for the steam and smoke to dissipate.
- Remember that air bags can deploy without warning.
- Apply water over and under all parts of the engine compartment.

Flammable-Liquid Fires

- Flammable-liquid fires are found in almost any type of occupancy.
- Most vehicle fires involve flammable or combustible liquids.
- Special tactics are required.

Two-Dimensional Flammable Liquid Fires

- Two-dimensional flammable liquid fires
  - Refer to a spill, pool, or container of liquid where only the top surface is burning
  - Can be controlled with the appropriate Class B foam
- Firefighters must watch for hot surfaces or open flames that may reignite.
Three-Dimensional Flammable Liquid Fires

- Three-dimensional flammable-liquid fires
  - Are fires where a burning liquid is dripping, spraying, or flowing over the edges of a container
  - Are more difficult to extinguish with foam
- A dry chemical or gaseous extinguishing agent is usually more effective.
- Firefighters should avoid standing in pools or contaminated runoff.

Suppression of Flammable Liquid Fires

- Larger flammable liquid fires may require the use of Class B foam.

Shutting Off Gas Service

- The method in which the gas is supplied must be located.
- After the service has been shut off, use a lockout tag.
Fires Involving Electricity

- The greatest danger in electrical fires is electrocution.
- Only Class C extinguishers should be used on energized equipment.
- Once the electricity is disconnected, most electrical fires are controlled as Class A fires.
- On structure fires the electrical service should be turned off quickly.

Electrical Fire Suppression

- The best approach is to wait until power is disconnected.
- If immediate action is required, use Class C agents only.
- For electronic equipment use halon or carbon dioxide (CO₂).

Electrical Fire Suppression

- Do not attack until power is disconnected.
- Transformers may contain polychlorinated biphenyls.
- Do not apply water to a burning transformer.
- CO₂ and dry chemicals may be used from above in underground vaults.
Summary

• Fire suppression is all tactics and tasks performed on the fire scene.
• Fire suppression methods are either offensive or defensive.
• The IC evaluates conditions constantly to determine the type of attack to be used.

Summary

• Fire fighters must be able to advance and operate a hose line to extinguish a fire.
• Do not have opposing hose lines.
• The most frequently used size hose for an interior attack is 1¾".

Summary

• Different fire streams are produced by different nozzles.
• Interior fire attacks require fire fighters to enter a building and discharge an extinguishing agent onto the fire.
• The most effective means of fire suppression is a direct attack.
Summary

• An indirect attack quickly removes as much heat as possible from the fire atmosphere.
• A combination attack uses both indirect and direct attack in a sequential manner.
• Large handlines can be used for offensive or defensive operations.

Summary

• Master stream devices produce high-volume water streams for large fires.
• Fires in ordinary and wood-frame construction can burn in combustible void spaces.
• Fires in below grade levels can cause the floor on the ground level to collapse.

Summary

• Stairways and other vertical openings between floors should be protected during a fire.
• Large buildings can cause disorientation.
• Buildings that are under construction, renovation, or demolition are at risk for destruction by fire.
Summary

• Lumberyard fires produce a lot of heat.
• Use caution when approaching fires in stacked materials.
• Use foam or a deck gun on trash container fires.
• Use caution when handling fires in confined spaces.

Summary

• Vehicle fires are the most common fires handled by fire departments.
• Many potential hazards exist related to vehicle fires.
• Overhaul of a vehicle fire is just as important as overhaul of a structural fire.

Summary

• Be alert for signs that a burning vehicle could be powered by an alternative fuel.
• Flammable-liquid fires may be encountered in almost any type of occupancy.
• Electrocution is the greatest danger posed by fires involving electrical equipment.
• Once electrical service has been turned off, electrical fires can be controlled using the same tactics as Class A fires.