THE BEHAVIOR OF FIRE AND FIRE PREVENTION

TERMINAL OBJECTIVES

The students will be able to:

1. *Describe how fire prevention inspection can affect the elements that contribute to fire cause and spread.*
2. *Explain the role of codes and standards in the fire inspection process.*
3. *Identify the source of authority, if any, for inspections conducted by their organization.*

ENABLING OBJECTIVES

The students will:

1. *Define fire.*
2. *Describe factors that affect fire ignition, growth, and spread.*
3. *Define the elements of the fire tetrahedron.*
4. *Identify the three components of a fire cause.*
5. *Identify sources of codes and standards used in fire prevention.*
6. *Define the terms codes, standards, recommended practices, manuals, and guides.*
7. *Describe typical situations where permits are required.*
8. *Recognize the need for legal authority to enforce codes.*

FIRE AND FIRE BEHAVIOR

Definition: Everyone knows something about fire. We have all observed the flame from a match, lighter, or candle. Most people have watched wood burning in a campfire or fireplace. Firefighters are familiar with much larger fires.

From these observations it is clear that fire produces heat and light. That fires need air and that fuel is consumed also is common knowledge. Firefighters and inspectors need a more scientific understanding of fire.

The IFSTA's *Essentials of Fire Fighting* manual used for basic firefighter training defines fire:

> Fire is actually a byproduct of a larger process called combustion. Fire and combustion are two words used interchangeably by most people; however, firefighters should understand the difference. Combustion is the self-sustaining process of rapid oxidation of a fuel, which produces heat and light. Fire is the result of a rapid combustion process.

Fire Triangle

The fire triangle helps make the process and the methods of control understandable. The triangle shows the components of heat, fuel, and oxygen as necessary for a fire.

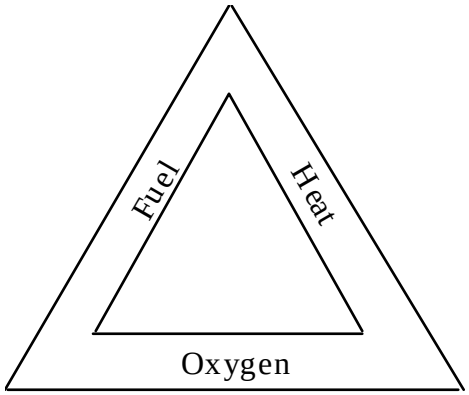

Figure 1
Fire Triangle

Fire Tetrahedron

As the knowledge of fire developed, it was determined that a fourth element also was necessary. The four-sided tetrahedron shows a chemical chain reaction as the fourth component. There is no fire if all of the elements do not come together, and extinguishment occurs by removing one of the elements. The tetrahedron resembles a pyramid. The three standing sides are heat, fuel and oxygen. The fourth side or base is the uninhibited chain reaction.

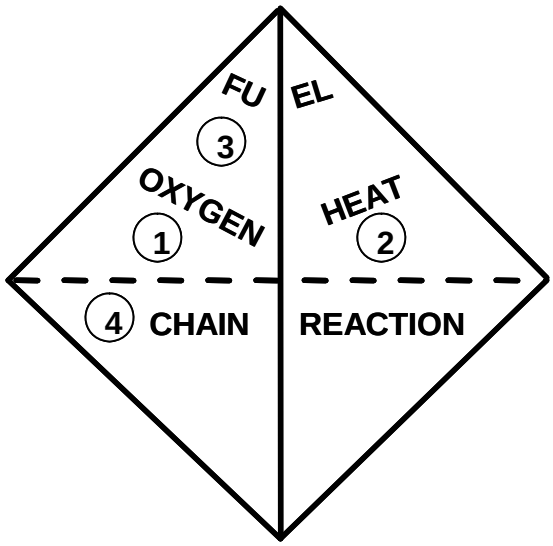

Figure 2
Fire Tetrahedron

Except for a few very specialized situations, oxygen in sufficient quantity is always present in the air. Inhibiting the chain reaction is a fire extinguishing technique that is not adaptable to general fire prevention. Therefore, most fire prevention activities deal with controlling the elements of heat and fuel. Of these two, managing the heat element is more common because of the quantities of combustibles present in our world. That does not diminish the importance of containing or controlling flammable liquids and other hazardous fuels.

Fire Cause Has Three Parts

Before one can prevent fires, one must know the reasons fires occur. Therefore, the cause of all fires should be determined, if practical. Frequently fire causes are listed as short circuit, cigarette, hot water heater,

or some other word or very short phrase. While these descriptions may be satisfactory for a news report, they do not identify what actually happened. For any fire, especially an unwanted fire, to occur there must be heat, fuel, and oxygen, and there must be some act or omission that brings them together in the proper proportions. When a fire cause is described it should identify the heat, the fuel, and the act or omission. For example: Cigarette dropped on soft furniture by an individual who fell asleep while smoking. Or, cigarette butts placed in plastic trashcan after party. Both had cigarettes as the source of heat, but these are two very different fire causes.

Fire Prevention Angle

Some fire prevention theorists have suggested the use of a new symbol to help focus the efforts of the fire prevention process. This symbol retains the heat and fuel elements of the fire triangle but removes the oxygen element to the background. The reason is that, with very rare exceptions, oxygen is available in sufficient quantities for combustion. There are a few industrial processes that are conducted in an oxygen-free atmosphere to avoid oxidation or combustion. But the work of a fire inspector is directed to managing either the fuel or the heat source or both. The job of the inspector, to put it very simply, is to prevent fuel and heat from mingling in an atmosphere of oxygen.

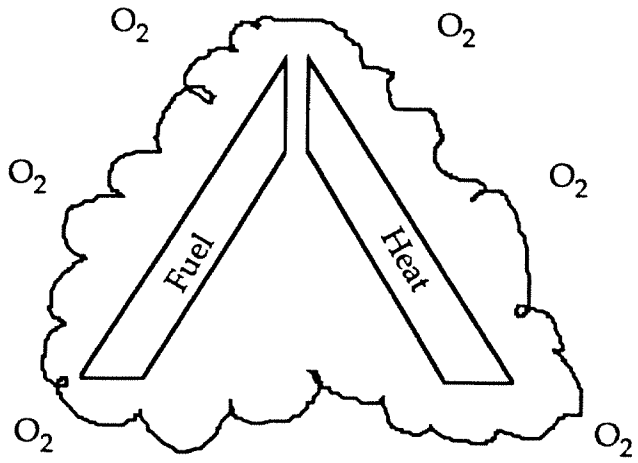

Figure 3
Fire Prevention Angle

The safety can used for flammable liquids is an excellent example of fuel management. Most hardware stores sell a cheap red metal can with a screw-on lid for gasoline. It keeps the gasoline clean and, under normal conditions, keeps vapors within the can. A safety can has a spring-loaded lid that will allow vapors to escape if the can is heated. It also has a screen inside the discharge opening to prevent flames or sparks from entering the can when the lid is open.

Under fire conditions the safety can will vent vapors and flames will burn around the lip of the opening. This will continue until the gasoline is consumed or the exterior heat source is removed. The cheap can will not release vapors until the internal pressure causes the can seam to fail. At that point there is an instantaneous release of all gasoline into the fire.

FIRE GROWTH AND SPREAD

Factors Affecting Fire Growth

After the four elements combine to produce a fire, the ultimate size of the fire depends on the nature and amount of fuel and the continuing presence of oxygen. The presence or absence of fire suppression activities also may affect the outcome.

A fire in a clothes dryer may consume all fuel within the dryer without heating other fuels in the room enough to spread the fire. The fire ends when the fuel is spent. In a similar situation, a basket of clothing resting on the dryer may be ignited. This may allow a number of fire scenarios to occur.

- Fire may spread throughout the structure.
- Fire may be confined to the laundry room by surrounding construction.
- Fire may not spread because of the absence of other combustibles.
- A sprinkler head may activate and extinguish the fire.
- A firefighting organization may extinguish the fire at any point between its original ignition and flashover.

Area of Origin

Fire growth depends on combustion characteristics within the room. Factors that influence the likelihood of full involvement are fuel load (type of materials and their distribution); interior finish; air supply; and size, shape, and construction of the room.

Fire Development

Fire development is not a consistent progression from ignition to full involvement. Risk of a full involvement depends on the ability of the flame to reach the ceiling. If the flames cannot reach the ceiling, fire growth potential is usually low. Where, because of room content and density or interior finish, fire spreads to ceiling height, then fire growth potential is comparatively high. Fire growth depends on **different** factors as it progresses. Growth and development are complex issues.

Flashover

Flashover occurs when all combustible materials in a fire area are burning. Flashover in an enclosure is likely to occur if the temperature of the upper gas layer reaches approximately 1,100°F (593°C). This depends on four factors:

- heat released by the burning fire;
- ventilation of the enclosure;
- dimensions of the enclosure; and
- combustibility of interior finish.

Fire Spread Factors

Fire hazards can be thermal (heat and flame) or nonthermal (smoke and gases). Heat and flame are transferred through radiation and conduction. Heated gases and smoke are spread by convection and air handling systems.

Recognizing the hazards posed by each component and the dangers posed by products is a challenge for the fire inspector.

Methods of Fire Spread

Rapid flame spread over finish materials or building contents is the primary concern. The ability of the fire service to contain or extinguish a fire is reduced significantly if the fire can spread vertically to two or more floors. Vertical fire spread is influenced principally by architectural and structural design.

Radiation is energy traveling through space or materials as an electromagnetic wave (light, radio waves, or X-rays). Radiated heat travels at the speed of light and in a straight line.

Heat and flame can move quickly through the building. Your eyes see only a fraction of the energy being emitted by radiation. It is hard to determine the intensity of heat transfer. The receiving surface will absorb most of the radiant heat, if the surface is black or dark in color. Most nonmetallic materials are effectively "black" to radiant heat even if they appear light. Radiant heat energy transmitted from a point source to a receiving surface will vary inversely with separation distance. That is, doubling the distance will decrease the radiant heat by a factor of four.

Conduction is the transfer of heat through a material. For heat conduction these three are the most important physical properties of a material:

- Thermal conductivity: the degree to which an object will transfer heat. For example, steel is a better conductor of heat than wood.

- Density: the mass per unit volume.

- Specific heat: the amount of heat a substance absorbs as its temperature increases.

Convection is the transfer of heat by its absorption by a fluid at one point followed by motion of the fluid and rejection of the heat at another point. Heat transfer is the method most responsible for the spread of fire. Heat generated in a room is initially transmitted by convection (air), then by conduction. Heated air expands and rises upward and outward, resulting in extension of a fire.

The primary function of the heating, ventilating, and air conditioning (HVAC) system is to maintain a controlled environment for building occupants or equipment. These systems also may contribute **actively** or **passively** to the overall building fire protection design. A system may simply shut down and protect openings or it may actively protect by pressurizing exits or exhausting smoke from the fire area.

Fuels, which range from wood, paper, and other ordinary combustibles to exotic rocket propellants, exist in three physical states: solid, liquid, and

gas. For most combustibles the flame reaction occurs in the gas or vapor phase. Most solid fuels and some liquid fuels must be heated to produce sufficient vapors to permit ignition. Kerosene must be heated to more than 100°F (37.8°C) to ignite. Gasoline produces sufficient vapors at temperatures below 0°F (-17.8°C).

Wood and other similar fuels produce flammable gases through the process of pyrolysis. Pyrolysis is a decomposition process caused by heat.

The amount of heat produced on burning is determined almost entirely by the chemical composition of the material. The rate of heat production is determined by the physical form of the material. Hydrocarbon-based materials consume 50 percent more oxygen, and thus produce about 50 percent more heat than equivalent amounts of other materials. On a pound-for-pound basis, hydrocarbons produce twice the heat. For example, 16,000 Btus per pound result from burning plastics versus 8,000 Btus per pound from burning wood.

One of the primary factors that affects burning of solid fuel is the surface-to-mass ratio, i.e., the amount of surface area compared to the fuel mass. A single 16-inch diameter log will not burn in a fireplace, but split into four quarters it will make an excellent fire. The mass of the log did not change, but its surface area has more than doubled. Increased surface area permits easier heat transfer and faster pyrolysis. The small pieces of wood called kindling used to start fires illustrate this principle.

The orientation of solid fuels also is important. Fire spreads more rapidly up vertical surfaces than across horizontal surfaces. Fire burns upward faster and more easily because hot fire gases rise.

The burning of most fuels produces heat, light smoke, and fire gases. A few fires, for example, a butane lighter flame, burn without visible smoke. The smoke encountered in a typical fire in a building contains a variety of gases, particles, vapors, and tiny liquid droplets. Carbon monoxide and many of the other components of the smoke are toxic to life.

Heat from the fire also is dangerous to life and is the factor responsible for the spread of the fire.

FIRE PREVENTION

In 1966, a group of fire service leaders met in Racine, Wisconsin, to assess the state of fire and life safety in the United States. This meeting, called Wingspread I, was the first in a series of meetings, conferences, and reports directed at reducing the nation's fire problem. Wingspread I led to the creation of the National Commission on Fire Prevention and Control. *America Burning*, the report from that commission published in 1973, recommended the creation of the National Fire Academy.

One of the main themes of *America Burning* was the need to make fire prevention the highest priority. Two generations have passed since *America Burning* and progress has been made. However, the effort to improve fire and life safety is still unfinished. Fire prevention is not the number one priority of all organizations.

Fire threatens the lives and property of everyone in a community. Therefore, everyone can (and should) play a role in fire prevention. The head of a household who decides to buy (or not to buy) a smoke detector; the child who has learned (or has not learned) what steps to take if his or her clothing catches fire; or the restaurant patron who makes a point of checking exits (or not checking) in a crowded establishment before enjoying a meal are undertaking (or not undertaking) fire prevention activities.

People who have been firefighters for any length of time know that often when they respond it is already too late to save lives and property. It should logically follow that fire prevention is a more positive way to reduce these losses. Fire prevention is the responsibility of every member of the fire service.

Fire prevention is not a simple term to define. Over the years it has grown to encompass many activities. Preventing unwanted fires from starting is certainly one part of the definition. Installing automatic systems to detect and extinguish fires, identifying and prosecuting arsonists, providing exits and other life safety features, and educating the public to prevent or react to fires are all part of the process.

The Three "Es"

There are three time-proven methods that are effective in reducing accidents and keeping them to a minimum. These methods are commonly referred to as the "Three Es of Safety": Engineering, Education, and Enforcement.

Figure 4
Three Es of Safety

Engineering

This method usually is the quickest to accomplish. Safety engineering involves the use of qualified personnel who are familiar enough with a given job, a piece of equipment, or an activity to make a valid assessment of the safety factors involved in the job, operation of a piece of equipment, or participation in a given activity. The five basic principles of engineering for safety are knowing the hazards, finding the hazards, eliminating those hazards which can be eliminated, guarding against those hazards which cannot be eliminated, and avoiding the creation of new hazards.

Knowing the Hazards

Knowing the hazards obviously requires the skill and experience of someone who has worked with the particular job, piece of equipment, or activity. Such a person is required to analyze the specific job and determine the specific safety requirements. Many safety requirements for many jobs, equipment operations, and activities already have been established and are set forth in codes, standards, and recommended practices.

Finding the Hazards

Finding the hazards in a given job, operation, or activity involves the use of personnel who have the skills and ability to detect the hazards. You would not expect to see a recruit training other recruits in the use of a fire extinguisher. You would expect to see a seasoned officer or instructor performing this function.

Eliminating the Hazards

Elimination of unnecessary hazards does not imply that a particular job, operation, or activity must be avoided. Obviously, many hazardous activities must be performed. The objective is to reduce or remove the unnecessary hazards. This can be done by correcting, changing, or modifying a mechanical feature of the job, operation, or activity (e.g., providing automatic shutoff nozzles on a gas pump).

Compensating for Hazards

Compensating for hazards which cannot be removed requires the teaching of correct procedures involved in doing the job, operating the equipment, or engaging in the activity. It also involves making the individuals aware of the hazards and ensuring that they have the necessary skills to compensate for the hazards. Installation of automatic fire sprinkler systems is one of the most effective methods of compensating for a multitude of fire hazards.

Preventing New Hazards

Preventing the creation of unnecessary hazards necessitates continuous supervision by competent personnel to ensure that the job, operations, and activities are being conducted in the most efficient manner. (The most efficient way to do something is usually the *safest* way to do it.) Periodic evaluation of jobs, operations, and activities also is essential to ensure that hazards "do not creep in." For example, the introduction of fire retardant chemicals into a material to reduce flame spread can increase the density or toxicity of the smoke.

Education and Training

Stated simply, learning is the process by which behavior is activated or changed. Education and training are the means for developing safe behaviors. Compared to engineering and enforcement, education for safe living is a long, slow procedure and sometimes the results are hard to see; nevertheless, it is the "E" which gives the most durable and long-lasting results. Training is the process of developing skill in doing a job, performing an operation, or engaging in an activity. Education is the process of teaching discretion in the performance of a job, operation, or activity.

There are three aspects of safety education and training: the development of positive safety attitudes; imparting the knowledge necessary for safe performance of various jobs, operations, and activities; and the development of the skill to the level necessary for safe performance. The third aspect, skill development, is accomplished through training. The other two aspects fall in the realm of education.

Safety Knowledge

Knowledge of the rules and regulations governing specific jobs, operations, and activities is essential for safe performance. A high degree of skill in manipulating a motor vehicle is not sufficient for safe driving. The driver also must have knowledge of traffic regulations, stopping distances at various speeds and under varying road and weather conditions, warning signals indicating defective brakes and tires, the effects of alcohol and fatigue on alertness and perception, and a long list of other pertinent factors. Having the appropriate knowledge also assists in the development of proper attitudes toward safety. Knowledge leads to understanding, and understanding leads to favorable attitudes.

Safety Attitudes

The area of attitudes constitutes the least understood and most difficult safety problem. An attitude may be defined simply as "the way a person feels about something." In this sense, then, "attitudes are caught, not taught." All the knowledge in the world does not assure a favorable attitude. Certain needs must be fulfilled before favorable attitudes will develop:

- Belonging. A person who feels he or she is a participating member of the group will develop desirable attitudes toward the objectives of the group (in this case, safety).

- Security and trust. A person who feels secure and trusted by the group will strive to reach group-determined objectives.

- Self-esteem. A person who feels he or she is respected by the group will go along with group objectives.

A positive attitude toward safety also will lead to greater acceptance of the safety knowledge and skills provided in training.

Enforcement

Most accidents can be prevented through adequate safety engineering and education. However, there are some people who are a hazard to themselves and others because of their failure to comply with accepted standards. For these persons, strict enforcement of safety rules, backed by prompt corrective action, is necessary. No organized accident prevention effort can be successful without effective enforcement, because accidents are frequently the direct result of violations of safety principles. Fire prevention codes provide the tools necessary to correct problems that cannot be solved through education. The codes provide both engineering and enforcement tools.

CODES AND STANDARDS

The first construction requirements date back more than 5,000 years and had very limited application. Greek and Roman law began to incorporate requirements for height, size, setbacks, and other features of buildings. In 1189 a document called "Henry Fitz-Elwyne's Assize of Buildings" was published. With it began the development of modern construction codes in European history.

Events drove much of the development of codes and standards. For example, the Great Fire of London in 1666 caused Parliament to pass an act that included what we would call a building code. Codes in the United States were patterned on the European model.

Most officials, builders, and craftspersons in North America were of European origin and brought their knowledge of the European system with them.

In 1631, the Governor of Massachusetts issued an order banning thatched roofs to prevent fire from spreading from house to house. The development of cities like New York, Boston, and Philadelphia created a need for building codes. The first truly North American code was issued in New York in the late 1850s. By the end of the 19th century many cities had adopted building codes. Each city prepared and published its own code.

Published Codes

The first model building code was published by the National Board of Fire Underwriters in 1905. This organization, later called the American Insurance Association (AIA), distributed model codes until late in this century. The model code theory is that a group of experts, with provisions for input from a wide source, can develop a code that is a model for jurisdictions to follow. Model codes make it easier for architects and other development professionals to work in more than one jurisdiction.

Between 1915 and 1940 the three major building code development organizations emerged. The Building Officials and Code Administrators International (BOCA) began in 1915. The BOCA Basic/National Codes are used primarily in the Northeast, Midwest, and mid-Atlantic. BOCA originally published the Basic Codes and AIA published the National Codes. When AIA stopped publishing, BOCA started using the name National Building Code.

The other two model building code publishers are the International Conference of Building Officials (ICBO) and the Southern Building Code Congress International (SBCCI). ICBO was formed in 1922 and publishes the Uniform Codes used in the West, Midwest, and Southwest. SBCCI publishes the Standard Codes. These codes are used primarily in the Southeast and Southwest. Use of these codes is not restricted by region, and any jurisdiction can use any code.

BOCA:	**Building Officials and Code Administrators International** BOCA Basic/National Codes used mainly in Northeast, Midwest, and mid-Atlantic.
ICBO:	**International Conference of Building Officials** Uniform Codes (except Uniform Fire Codes) used primarily in Midwest, West, and Southwest.
SBCCI:	**Southern Building Code Congress International** Standard Codes used primarily in Southwest and Southeast.

Figure 5
Major Building Code-Development Organizations

There are two other important code development organizations, the National Fire Protection Association (NFPA) and the Council of American Building Officials (CABO). The NFPA is an organization of more than 60,000 individual members that was organized in 1896. Its mission is to use science, technology, and education to protect people and property from fire.

The NFPA does not publish a document titled Building Code. It does, however, publish

- NFPA 1, *Fire Prevention Code*;
- NFPA 70, *National Electrical Code*;
- NFPA 72, *National Fire Alarm Code*;
- NFPA 101, *Life Safety Code*; and more than 250 other codes and standards, manuals, and guides.

CABO was formed in 1972 to advance the model codes process and to work for uniform code regulations. BOCA, ICBO, and SBCCI are the member organizations. The CABO One- and Two-Family Dwelling Code is recognized by all three of the building code groups. There is one other group, the International Fire Code Institute. It is a subsidiary of ICBO and uses the Uniform Fire Code only. In addition, other associations and organizations prepare and distribute model codes or standards used to promote fire safety.

Approximately 75 percent of all current editions of the three model building codes relate to fire protection and safety concerns. The scope of these codes addresses all matters pertaining to the construction of new structures, additions, alterations, remodeling, or the change of use of an existing structure. This includes permanent or built-in fire protection equipment and other safeguards such as firewalls and separations.

Terminology

Let's take a moment to clarify some terms.

Codes

Codes are documents written in form and language appropriate for laws and ordinances. Requirements are mandatory provisions using the word "shall." They set forth minimum requirements to protect the health and safety of society and generally represent a compromise between optimal safety and economic feasibility. Codes generally include administrative provisions, definitions, and requirements.

Model Codes

A code that can be adopted by any jurisdiction, developed by a code development organization with a special interest in the subject.

Standards

Standards are documents containing strongly recommended provisions using the word "shall" to indicate requirements. Once adopted by a jurisdiction, standards become mandatory. They primarily provide technical, how-to details. A code might require a fire suppression system. A standard would list the requirements for design, construction, and installation of the system. The most extensive use of standards is their adoption into the code by reference, thus keeping the code to a workable size and eliminating duplication of effort. Examples of such standards are those that deal with the following items:

- extinguishing systems;
- flammable liquids;

- hazardous processes;
- combustible dusts;
- building materials;
- water systems; or
- mechanical systems, etc.

Recommended Practices

Recommended practices are only advisory provisions. They use the word "should" to indicate a recommendation in the body of the text. This indicates a recommendation which is advised but not required. They are published by nationally recognized organizations, and deal with maintenance and operational standards for the various systems required by the code. Recommended practices can be adopted into the code by reference and are usually used by the AHJ as the guide to determine compliance with the intent of the code writers.

Guides

Guides are advisory in nature and may give instructions, but do not contain mandatory provisions. They are written by nationally recognized organizations. Guides explain the codes' and standards' written intent. Guides provide methods by which the Authority Having Jurisdiction (AHJ) or testing agencies can assess the degree to which the system has met the intent of the standard.

Code:	**A document written as a law or an ordinance**
Guide:	**Something advisory but not mandatory**
Recommended Practice:	**Another form of advisory**
Standard:	**Document containing only recommended requirements which, when adopted, become legally binding**

Figure 6
Code Terminology

BENEFITS OF A CODE ENFORCEMENT SYSTEM

There are many benefits of a code enforcement system. Here are the major ones. A system

- reduces the incidence of fires and fire losses;
- lowers the threat of fire risk;
- improves life safety for the public;
- reduces hazards to firefighters and firefighting operations;
- controls hazardous conditions;
- promotes a more stable community;
- maintains community's economic structure;
- provides community fire safety awareness;
- allows code enforcement to become easier;
- balances the cost of fire protection between public and private sector;
- controls structural features, operating practices, and procedures related to life safety and property conservation; and
- controls and limits storage and handling of hazardous materials such as flammable liquids, propane, ammonium nitrate, sulfur, and phosphorous.

TYPES OF CODES

There are various types of codes, all having the same basic goal: to protect life and property. The fire safety codes regulate the height and area of buildings; building construction; plumbing, heating, and electrical wiring; automatic fire detection and suppression systems; hazardous activities and materials; and means of egress. They have provisions controlling the use of structures, the number of occupants, and the maintenance of fire safety features. Provisions cover buildings under construction and buildings being demolished.

These requirements exist in a number of different codes. The different codes make it easier for different agencies or individuals to enforce these codes. Typically they would include the building code, fire prevention code, electrical code, mechanical code, plumbing code, and others. Other local codes and ordinances, including housing, planning, and zoning, have an effect on the overall fire safety of a community. Of all the codes, the building code probably has the greatest impact on community fire risk.

Fire Prevention Code

The local fire department normally administers and enforces the fire prevention code. In rural communities a state agency, a county agency, or a regional agency may have this role, or there may be no fire prevention code. A fire prevention code is an ordinance regulating the storage, handling, production, and use of hazardous materials. The fire prevention code sets the requirements for testing and maintaining fire suppression and fire detection systems, regulating general fire safety requirements, and maintaining life safety features within a structure. It also authorizes the fire department, or some other agency, to assume responsibility for inspection, code enforcement, and code administration duties. This will become clearer as the course continues.

Building Code

A building code is a legal document that establishes the building requirements necessary for the protection of public safety, health, and welfare. The use group of the occupancy, construction, height, and area are the basics of building code application. Exit requirements, fire detection systems, and special provisions then are added. Structural requirements are needed to provide for loads in the building, and for stresses caused by wind, snow, and earthquakes. Materials and construction methods also are included.

Mechanical Code

The mechanical code includes requirements for heating, ventilating, and air conditioning. Venting systems for commercial cooking equipment normally are included. Duct work, plenums, dampers, and smoke removal systems may be regulated in this code. Piping for gases, fuels, steam, and chilled water are part of the mechanical code.

Electrical Code

NFPA 70, *National Electrical Code*, is the code most state and local agencies use. The electrical code is the most uniform of any set of public safety regulations. The electrical code is primarily a fire prevention code. When properly installed and maintained, an electrical system should not

start fires or injure people. The electrical code regulates electrical power systems, wiring, electrical equipment, electric pumps, motors, and fans. It includes the requirements for fuses, circuit breakers, and interrupters.

Plumbing Code

This code deals primarily with the water supply, drainage, and sewage in buildings. It may be part of the regulations for water supply to fire protection systems.

Development Process for Model Codes

All of the consensus code development organizations have a system to develop and to amend their codes or standards. This consists of submitting suggested revisions to the appropriate committee. The proposed changes are reviewed and presented at the appropriate time for a hearing and, ultimately, for ratification by the membership.

The organizations named earlier play a major role in code development. Let's examine the major steps in this development process.

- Anyone can submit suggested changes to the model code group. Interested parties, including fire inspectors, may affect process by submitting comments and suggestions.
- A committee reviews the suggestions.
- The committee recommends approval or disapproval, or further study.
- The committee publishes its recommendations.
- A final document is recommended at a membership meeting.
- The final document is accepted and published, returned in part to committee for further work, or disapproved.

All of the model code documents require certain types of construction methods, materials, and equipment. Most code enforcement officials do not have one facility or expert to conduct the testing necessary to ensure that the construction methods, materials, and equipment meet the code

requirements. Instead they rely on outside testing and listing organizations. There are numerous testing and listing laboratories in the United States. Three of the most well-known are Underwriters Laboratories, Factory Mutual Research Corporation, and Southwest Research Institute.

Underwriters Laboratories (U/L) is located in Northbrook, Illinois. The U/L was founded in 1894 by William Henry Merrill. U/L not only conducts laboratory tests but is a leader in the development of testing criteria. It publishes the *Building Materials Directory, Fire Protection Equipment Directory, Fire Resistance Directory,* and other similar manuals. Items that are tested by U/L bear the U/L trademark and are identified as listed. They will be listed in the appropriate publication, which is available at no cost to code enforcement officials.

Factory Mutual Research Corporation (FMRC) is located in Norwood, Massachusetts. FMRC was founded in 1916. Like U/L, FMRC not only conducts laboratory tests but also is a leader in the development of testing criteria. FMRC is part of the Factory Mutual System which also includes insurance companies for highly protected risks (HPR). Unlike U/L, FMRC approves materials and equipment. This means that the material or equipment is approved for use in a facility insured by one of the Factory Mutual System Companies. Items tested by FMRC will bear the FM mark and will be listed in FMRC publications. FMRC publishes the *Approval Guide* and *Specification Tested Products Guide*. Both of these are available at no cost to code enforcement officials.

Underwriters Laboratories (U/L)

Factory Mutual Research Corporation (FM)

Southwest Research Institute

American Society for Testing and Materials

American National Standards Institute

American Petroleum Institute

American Society of Mechanical Engineers

Figure 7
Testing and Listing Organizations

Southwest Research Institute is located in San Antonio, Texas; it is a nonprofit organization founded in 1947. Like numerous other testing organizations, testing is conducted in accordance with criteria established by U/L and FMRC.

Four other groups are not as well known as the three just named, but we need to mention them.

The American Society for Testing and Materials (ASTM) is located in Philadelphia, Pennsylvania. ASTM has more than 140 standards writing committees, and produces voluntary consensus standards for materials, products, systems, and services. The standards written by ASTM are consensus standards, developed by ASTM committees and subject to approval by the membership. Quite often, ASTM, U/L, and NFPA will have identical standards criteria.

The American National Standards Institute (ANSI) is located in New York, New York. ANSI writes no standards of its own but approves standards written by other organizations. One criterion for this approval is that the standards be developed under an open process that gives those affected directly and indirectly an opportunity to express their views.

The American Petroleum Institute (API) is located in Washington, DC. API represents those individuals and companies involved in the petroleum industry. The institute writes several standards concerning the storage and handling of flammable and combustible liquids.

The American Society of Mechanical Engineers (ASME) is also located in New York. ASME publishes a number of codes and standards, including the widely used *Safety Code for Elevators and Escalators.*

In general, most jurisdictions use the nationally recognized model codes and standards developed at that level by committees representing many interest groups and people concerned with the enactment or enforcement of those codes and standards. Most codes establish minimum and reasonable requirements for fire protection and fire safety. Codes usually are adopted by reference.

There are various benefits of adopting a model code.

- Code groups can provide interpretation.
- A model code provides sound regulation.

- It is based on performance requirements.
- It is developed by broad-based technical committees.
- It has minimal initial costs.
- It promotes uniformity.
- It is updated and reviewed on a timely basis.
- It provides flexibility.

The model code groups provide training, education, and certification for code enforcement personnel.

ESSENTIAL ELEMENTS OF A CODE ENFORCEMENT SYSTEM

Legally Adopted Code

To be effective, any code enforcement program must have a legally adopted code which establishes the minimum fire safety requirements in the community. These requirements must address the local community's fire problem. The community is made up of special interest groups which consist of citizens, private sector representatives, elected officials, and fire service personnel.

Through its leaders the community must examine the scope of the adopted code: does it apply to new and existing structures and conditions? It also must help determine if the code conflicts with any other locally adopted code requirements.

The code enforcement system must establish code administration requirements that address the following elements:

- the Authority Having Jurisdiction;
- the authority to inspect the structure;
- the authority to issue notices of violation or correction notices;
- establishing a charging or penalty clause for violation of the code; and
- establishing an administrative appeals process.

Codes and Standards Legally Adopted Locally

Historically, codes and standards are adopted locally by ordinance or are required by state statute. Only after a code has been legally adopted can it be enforced as law. These enforcement responsibilities include

- conducting an initial inspection;
- conducting periodic inspections;
- issuing notices of violations and corrections;
- conducting hearings;
- entering complaints in court;
- maintaining records;
- issuing certificates of occupancy; or
- issuing permits.

Fire Prevention Code Specifies Authority

It is critical that fire inspectors have a thorough understanding of the legal authority associated with code enforcement. This authority usually is established at the local or state level of government when laws or ordinances are passed under the powers granted through the U.S. Constitution, state constitutions, and local home rule or charter powers. The local authority is established when a fire or building code is legally adopted, and addresses when and where inspection authority begins and ends. These authorities usually relate to the following:

- when or where codes can be enforced;
- the right to conduct an inspection;
- the right of entry into a property;
- taking action to correct a code violation;
- writing corrective orders or citations;
- emergency powers;
- issuing permits; or
- penalty clauses.

Who is the "Authority Having Jurisdiction?"

The NFPA uses the term "Authority Having Jurisdiction" (AHJ) for the organization, office, or individual responsible for "approving" equipment, an installation, or a procedure. Other codes use different expressions, including Building Official, Code Official, Fire Official, and Fire Chief. In the process of adopting the code the legally responsible agency or individual must be defined. The municipal office or official designated AHJ may be the Fire Marshal, Chief of Fire Prevention Bureau, Chief Inspector, Code Administrator, or Building Inspector.

The code official (AHJ) is the administrator and code enforcement officer who is responsible for applying and enforcing the code requirements; for

conducting the necessary inspection to determine code compliance; and for determining alternate methods of satisfying the intent of the code.

Appeals Process

Most code enforcement programs include an appeals board. The purpose of the appeals board is to answer questions of interpretation and application, and to evaluate equivalencies. It is not the purpose of the appeals board to waive code requirements.

The board shall adopt reasonable rules and regulations for conducting its hearings. All proceedings shall become public record. The board also may require a fee for this hearing. The board should consist of members who are qualified to rule on matters pertaining to fire protection and fire prevention.

The members should address incorrect or unreasonable decisions, and grant variances from strict interpretations of law which would result in undue hardship.

The city or county attorney also should be an *ex officio* member to address legal matters or potential conflicts of interest.

The inspectors must be aware that their administratively issued notices of violations or corrections may be appealed through the appeals process established in the adopted fire codes. Usually notices of corrections that involve an emergency condition are not subject to appeal.

This discussion of the code enforcement process would not be complete without a brief look at permits.

PERMITS

The permit is an official document issued by the fire prevention division to authorize the performance of a specified activity. Permits are issued in the name of the fire official for the use, handling, storage, manufacturing, occupancy, or control of specified hazardous operations and conditions. The permit should be issued only if the condition meets code requirements.

The permit process provides the fire prevention official with information on what, where, how, or when specific hazards are being installed, stored, or used within the jurisdiction. The process allows cross-checking with building, zoning, public health, or other departments' requirements for the use outlined on the permit. Further, it allows the fire official to review and approve devices, safeguards, and procedures that may be needed to assure the safe use of hazardous materials. The lack of a required permit or failure to meet permit requirements constitutes a misdemeanor in legal terms and is grounds for stopping an operation in, or use of, a structure.

The permit is the property of the issuing agency, not of the permit holder. A license or permit authorizes, by law, the right of entry for inspection purposes to ensure compliance with the permit requirements. If an inspector operating under a fire code permit is refused entrance to perform a regulatory inspection, this refusal constitutes grounds to halt operation in, or use of, the structure involved.

Many local communities have established fees to issue permits. These charges should offset the community's cost for the time and resources required to approve the permit. Some communities actually make money on permits.

Certificates

A certificate is a written document issued by the authority of the fire official to any person or business. It grants permission to conduct or engage in any operation or act for which certification is required. Depending upon the needs of a jurisdiction, certificates of approval may be required before smoke or heat detectors, fire extinguishers, fireproofing materials, or other fire protection devices are offered for sale to the general public. This procedure is designed to ensure that only those fire protection appliances that will function in a satisfactory manner are offered for sale to the public.

Certificates of fitness are issued to individuals or businesses with demonstrated proficiency in skills, training, and testing in areas that affect fire safety. This includes pyrotechnics and persons who handle explosives; persons who install fire protection equipment and systems, including sprinklers; and persons who maintain fire extinguishers and fire detection systems.

Certification requirements may include a financial bond or liability insurance where conduct of the regulated activity is inherently hazardous.

Licenses

A license is permission granted by a competent authority to individuals about to engage in a business occupation or other lawful activity. Licenses are issued to provide knowledge of specific business locations, ensure compliance with particular standards, and add a source of revenue to the community. The fire prevention division may issue some licenses directly and may be involved in the check-off process for licenses issued by other municipal departments.

FIRE PREVENTION INSPECTION

A different approach to defining fire prevention might be to list fire prevention activities. The activities could include public fire safety education, fire prevention inspection and code enforcement, reviewing plans and specifications for new construction or alteration of structures, testing of automatic systems, fire cause investigation, and fire safety training of employees or other special groups.

Within a fire department, the duties normally carried out by a Fire Prevention Bureau relate to fire code enforcement, public education, and fire investigation. Each of these functional areas embodies complex and detailed activities and may well involve close ties with other local government agencies. In areas with small or volunteer fire departments, various state, regional, county, or local agencies may perform these activities. Some communities have not adopted a fire prevention code.

Fire prevention inspection is a key fire prevention activity. Trained professional inspectors can help to continue the progress toward a satisfactory level of fire and life safety.

A Systematic Process

Fire prevention inspection is a systematic examination of properties, facilities, or processes to eliminate conditions or activities that threaten life or that contribute to the cause or spread of fire. Fire prevention

inspection also is defined as a systematic examination to evaluate the level of compliance with legally adopted fire and life safety codes. The goals of both definitions are the same but they differ based on the presence or absence of a legally adopted code.

Trained Inspectors

A fire department inspector whose duty is to determine compliance with local fire and life safety codes and standards comes to mind first. However, an insurance company inspector who visits a plant to determine if the insurance company's standards are being followed is also a fire inspector.

There are many others whose duties include correcting fire and life safety deficiencies. Building and electrical inspectors are responsible for enforcing the fire safety provisions of their codes. Federal and state occupational safety inspectors enforce regulations that include fire and life safety provisions.

In this course the language and examples focus on a fire department inspector whose job is to establish compliance with the fire prevention code that applies to the community. The same basic techniques for recognizing and correcting deficiencies can be adapted for use by many different types of inspectors.

An inspector's behavior and the quality of his or her inspections are critical in establishing the overall level of fire and life safety at a facility. The inspector has several roles, including assuring compliance with standards, educating the owner or occupant, and establishing good relations between the inspector's organization and the enterprise being inspected. To fulfill all those roles requires a high level of professionalism.

The Inspector and the Code

The purpose of a fire prevention code is to provide reasonable protection of life and property from the hazards of fire and explosive materials. Fire codes exist to minimize hazards to life and property from fire and panic, exclusive of those hazards considered in building code regulations.

Code enforcement begins when the code is applied during the plans review and specifications process to assure compliance with fire safety

features of the building and fire prevention codes; and through the control of structures through inspection to assure proper exits, interior finishes, fixed fire protection equipment, and other related features; control of occupant capacity and smoking regulations; and control of sales and use of materials and equipment. The last function includes controlling or limiting the storage, handling, and use of explosives, fireworks, flammable liquids and gases, and other hazardous materials.

If the inspector is responsible for determining compliance with the fire and life safety codes and standards of the community, then the inspector must have a good working knowledge of those codes and standards. Although that information is outside the scope of this course, it is essential that you understand the codes or standards that apply before performing compliance inspections.

A good inspector, in addition to being well trained and knowledgeable of the codes, needs to have as goals both code compliance and a satisfied, educated customer. The inspector needs to be properly equipped and prepared before the inspection. The inspector needs to examine the property systematically and completely. The inspector must take notes and prepare an accurate report. Finally, the inspector must refer situations and conditions outside his/her expertise to appropriate authorities.

Educating the Consumer

Inspection activities are only one part of the process. The inspector also must take the time to educate the customer on the importance of good fire and life safety practices. Investments in safety have short-term costs for long-term benefits.

While this process frequently is referred to as "code enforcement," it is important to remember that legal enforcement efforts are required to gain compliance only when education and persuasion fail. In areas without codes, a sales pitch may be the only way to gain improvements.

Firefighters and Inspections

Firefighters also conduct preplanning and familiarization inspections. These inspections have a different goal than fire prevention inspections. Firefighters who make prefire planning or familiarization inspections can use the material from this course to recognize problems they should refer to the fire code compliance agency for possible action. Firefighters making fire prevention inspections can undertake preplanning and familiarization activities if they understand the difference and are careful to complete the requirements for each activity.

The rest of this course will cover some of the major aspects of fire inspections. It's only a start…any experienced inspector will be the first to say, "You never stop learning."

Activity 1

The Importance of Fire Prevention

Purpose

To introduce the importance of fire prevention.

Directions

View the fire scenes and note causes of fires.

1. What are your concerns when you see fires like these?

2. Can these losses be prevented or reduced?

3. How?

4. Are you familiar with a fire loss that could have been prevented?

Activity 2

Fire inspector's Role

Purpose

To understand the basic role of a fire inspector in fire prevention.

Directions

1. Answer the following questions as best as you can.

    a. List what fire inspectors can do to mitigate the fire problem.

    _____

    _____

    _____

    _____

    b. What can be addressed during an inspection?

    _____

    _____

    _____

    _____

2. Be prepared to report to the class.