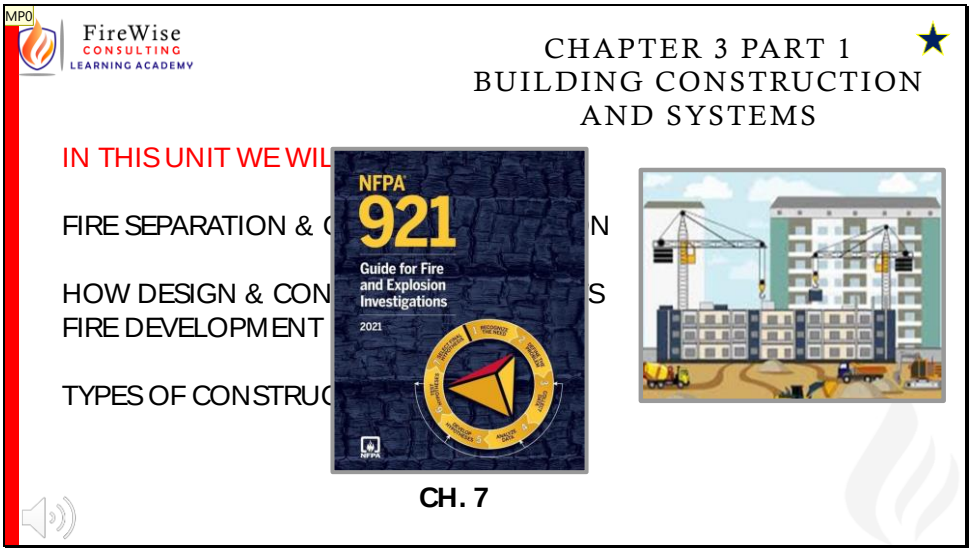
Slide 1



Welcome to **Part 1 of** Chapter **3**, **Building Construction and Systems**. If you are following us in NFPA 921 (2021) edition we will be covering Chapter 7.

In this Unit we will discuss fire separation and compartmentation.
How design and construction affects fire development.
The 5 types of construction identified in NFPA 220

Slide 2

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CHAPTER 3 PART 1
BUILDING CONSTRUCTION
AND SYSTEMS

IN THIS UNIT WE WILL DISCUSS:

EFFECTS OF WEATHER

CONSTRUCTION MATERIALS

TYPES OF FIRE PROTECTION SYSTEMS

STRUCTURAL INTEGRITY

HVAC SYSTEMS

How the effects of weather on the building can contribute to the spread of fire.
The type, amount and arrangement of construction materials.
Types of fire protection systems.
The structural integrity of the building**; and**
Heating, Ventilation, and air conditioning systems.

Slide 3

The safety of you and the safety of others working with you in an investigation must always be the top priority.
Before you enter a structure that has been damaged by fire to conduct a fire investigation, make absolutely sure it is safe to enter.
You may need to seek assistance from a local building inspector or a professional engineer to confirm that the building is safe to enter.
If unsure, don't go near!

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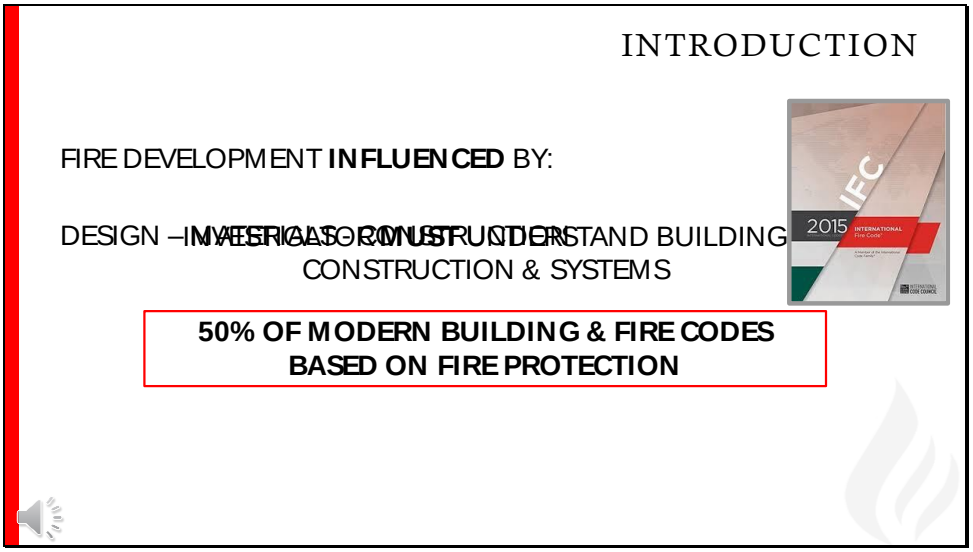

As you start a fire investigation, you should determine what are the fixed factors that could have influenced fire development?
Some of the fixed factors are:
The design of the building.
The type of materials used; and
The type of construction.
50% of modern building and fire codes are based on fire protection. The year the building was built will reveal information about the building and fire code it was built in compliance with.
As an investigator, you must have an understanding of building construction and systems.

Slide 5

A Fire Investigator must understand building construction and systems and how they affect fire development, intensity and spread.
Your personal safety and the safety of the public is the top priority. This includes wearing PPE and having others with you checking on your well-being at timed intervals.
When conducting a fire investigation, the integrity of the building must constantly be monitored for indications of collapse.
Other hazards must be identified and communicated to all personnel involved in the investigation.
The public should be excluded and only properly equipped personnel who are part of the investigation team should be allowed on the scene.

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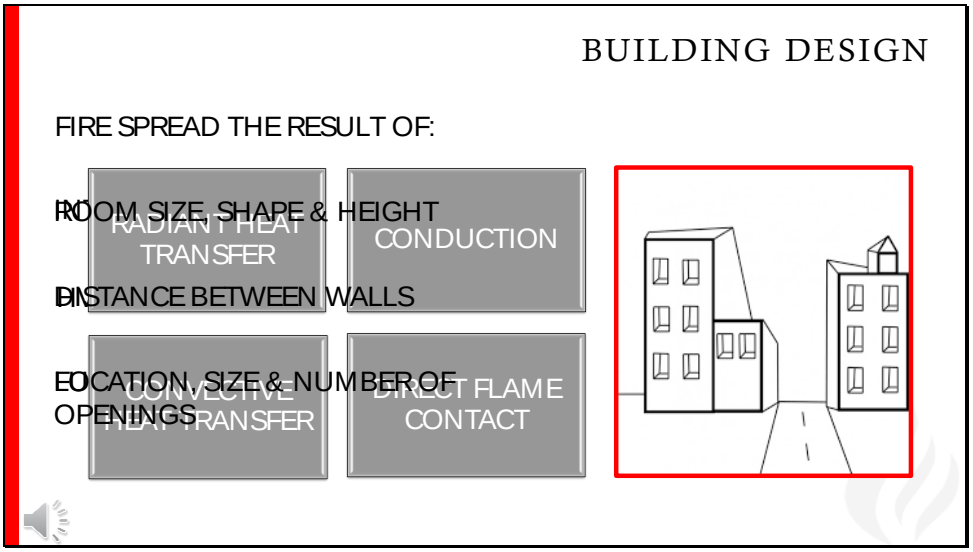
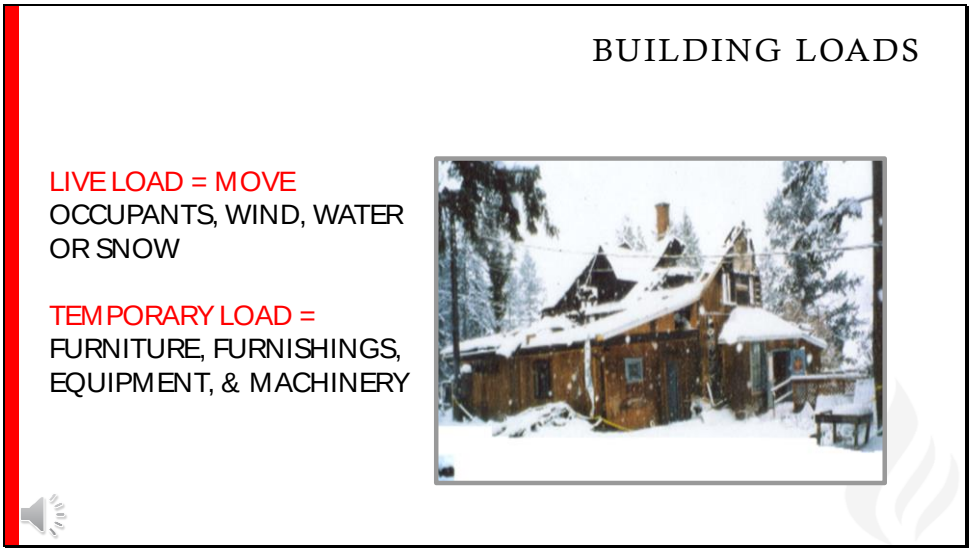


Fire spread and development are largely the result of radiant heat transfer, conduction or convective heat transfer, or direct flame contact.
In compartment fires, the following factors significantly affect fire spread:
The size, shape and height of a room.
The distance between walls.
The location, size and number of openings.
The interior finish.
HVAC systems, and
Fuel packages.

Slide 7



Buildings are designed to support a specific amount of weight, called load.
A live load is a load that can move. Some examples of live loads are occupants, wind, water or snow.
Temporary loads such as furniture, furnishings, equipment, and machinery are examples of temporary live loads.

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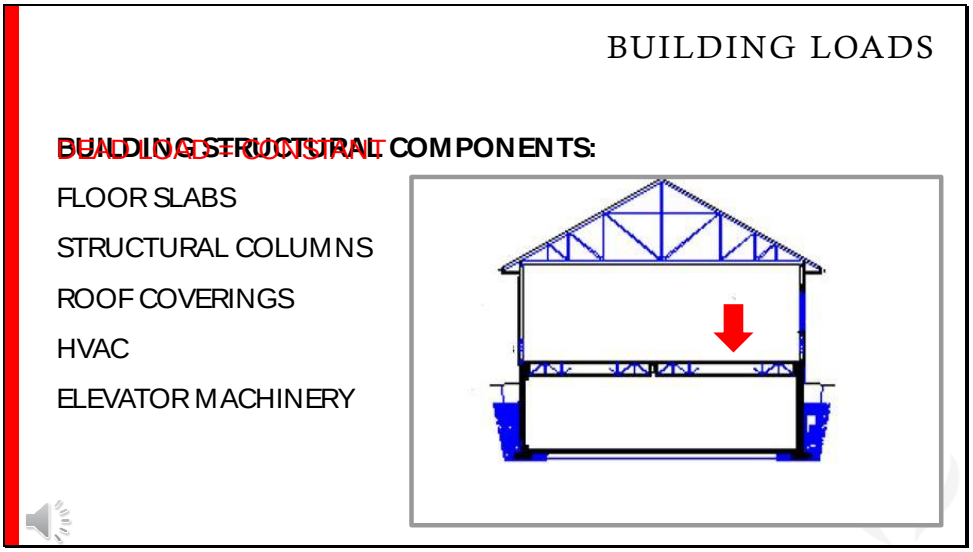
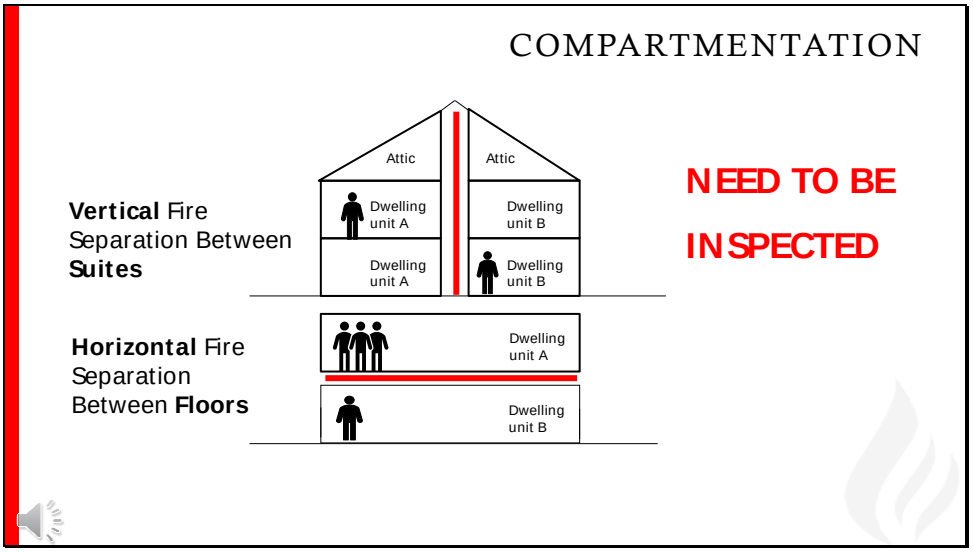


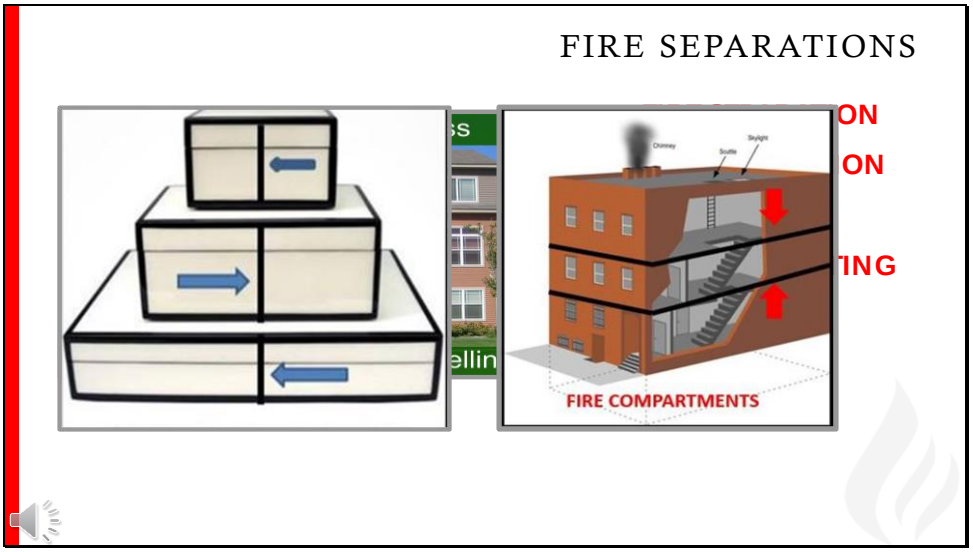
Dead loads are constant and immobile. They may include the building structural components such as floor slabs, structural columns, roof coverings, HVAC mechanical units, elevator machinery and other building systems.
Additional loads applied beyond the design parameters of the structure may create instability. Examples of this are extreme snow or wind loads, additional contents or mechanical components, and water from firefighting operations.

Slide 9



A properly designed and constructed building will have compartments which contain a fire and restrict its spread.
Vertical fire separations between suites or compartments contain a fire from spreading between units horizontally.
Horizontal fire separations without breaches restrict the spread of smoke, heat and flames from spreading vertically.
Fire separations need to be examined to see if they were effective in restricting fire development as intended.

Slide 10



Fire separations along with early fire detection and adequate exiting are the three most import aspects of a fire safe building. Fire separations are structural elements made in accordance to building code requirements that prevent the spread of fire for a given period of time. Fire separations are provided in buildings to limit the spread of fire and the premature collapse of the building under fire conditions.

Rooms, areas and suites in buildings are usually separated into fire compartments. These compartments contain the fire and reduce fire spread allowing people to escape. They also contain the fire until the fire department arrives and extinguishes the fire.

Think of a fire compartment like a box. Most multi-tenant buildings have many fire compartments (boxes), which are situated side by side and on top of each other. Generally, each fire compartment has walls, a floor and a ceiling. The walls are fire separations that limit the spread of fire horizontally from one fire compartment to an adjoining fire compartment. The top and bottom of each fire compartment are floor ceiling assemblies that separate one story from another. The floor and ceiling assemblies limit the spread of fire vertically from one fire compartment or from one floor in the building to another.

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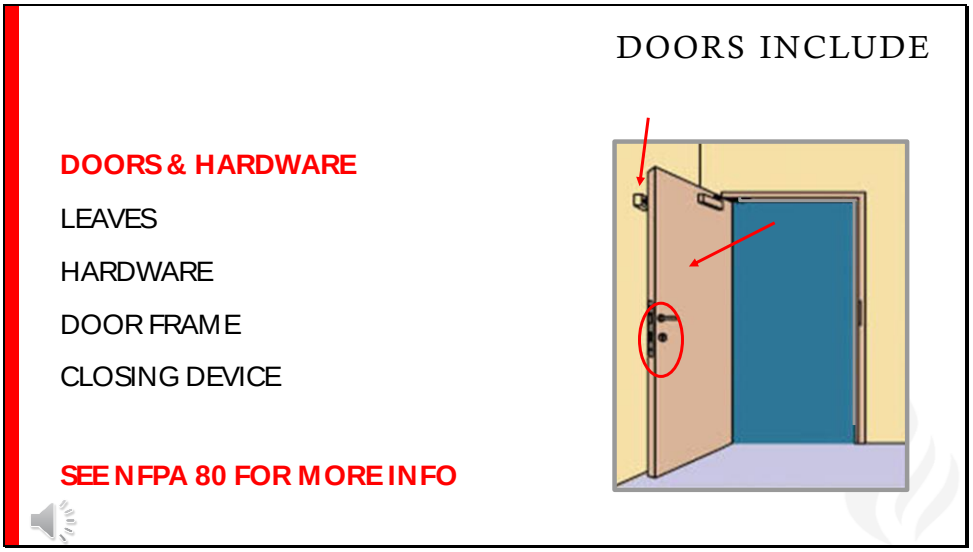
Fire doors are a weak point in any fire separation because their primary function is to allow traffic to pass from one room into another. It is therefore important for fire doors to be kept closed when not in use. Fire doors are required to be self-closing and therefore have door closing devices which can pose significant obstacles to the young, elderly, infirm or disabled. Experience shows that convenience usually takes precedence over safety and building users often seek to disable or otherwise undermine devices that inconvenience them in carrying out their work. Doors are often held open by wedges or other devices. This practice is not only unsafe but also illegal. Check all areas of the building during your investigation to see if damaged or impaired fire separations contributed to fire spread.

Slide 12



Doors and hardware include four parts. They are the leaves, the hardware, door frame and closing device.
A door leaf is a single, independently moving panel of a door. The single-leaf door is the most common variety of door. It features a single panel that fills an entire doorway space.
For more information on doors, please refer to the current edition of NFPA 80 Standard for Fire Doors and Other Opening Protectives.

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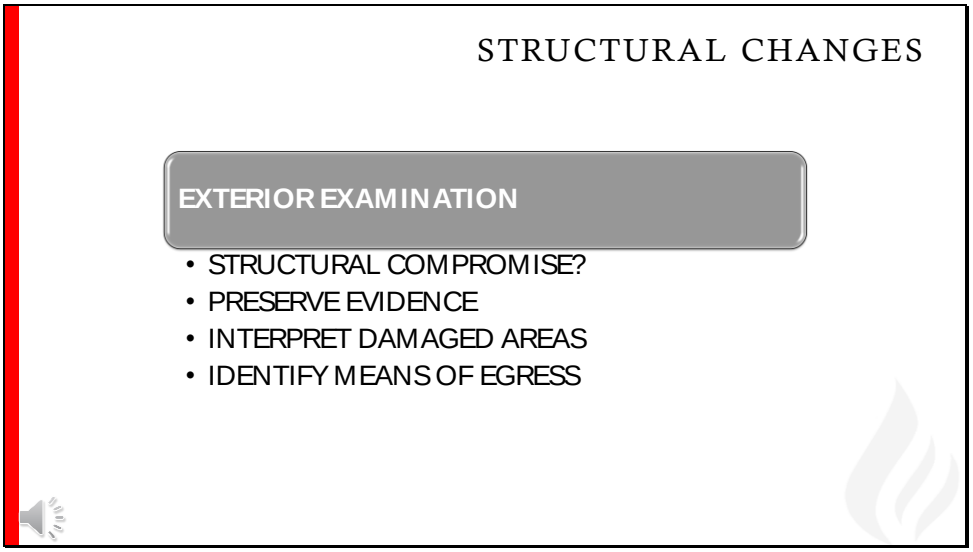
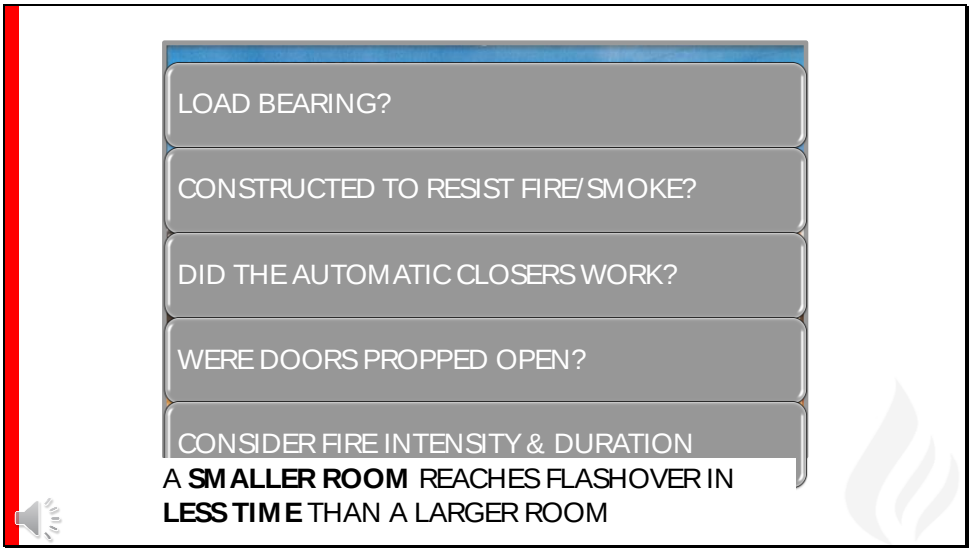


Structural changes can occur deliberately, as during a renovation, or during a fire.

An exterior examination during the fire investigation is necessary (and should be repeated when doing the initial interior survey):
a. To determine whether there is structural compromise that could pose a hazard to the investigator
b. To preserve any evidence noted
c. To interpret the fire damaged areas visible from the exterior
d. To identify means of entry and egress

Slide 14

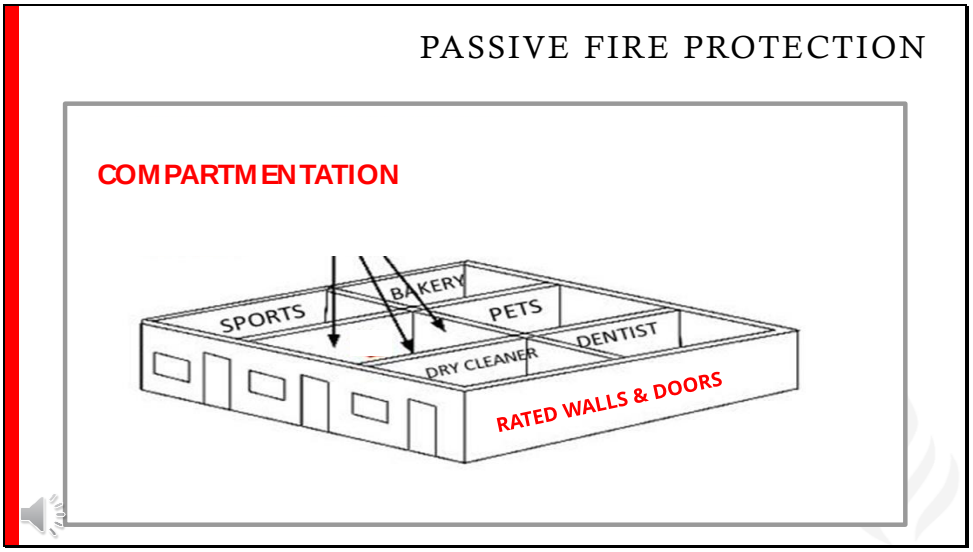


When conducting a fire investigation the investigator should have a minimum of two ways out of any area being processed.

The geometry of a room is important in fire development. A smaller room reaches flashover in less time than a larger room.

In this example there may have been compartmentation issues:
Examine walls to determine which are load-bearing; removal of any structural elements along these walls could lead to collapse.
Examine walls to determine if they were constructed to resist passage of fire and/or smoke.
Examine fire doors to determine whether automatic closers worked. If doors were propped open, were they propped before the fire or during firefighting activities?
Consider fire intensity and duration. Was the heat generated sufficient in temperature and duration to cause a properly designed separation to fail?

Slide 15



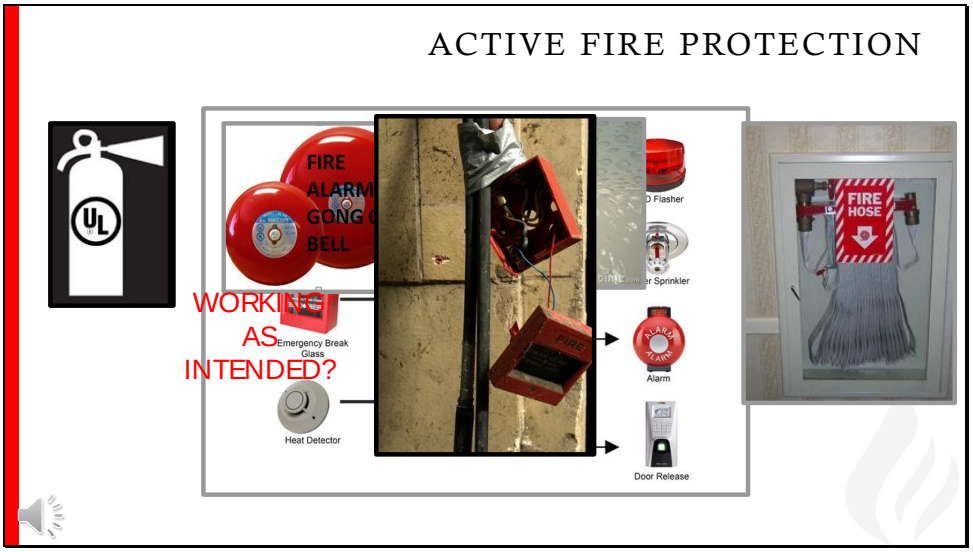
Passive Fire Protection includes compartmentalization of the overall building through the use of fire-resistance rated walls and doors. Organization into smaller fire compartments, consisting of one or more rooms or floors, prevents or slows the spread of fire from the room of fire origin to other building spaces, limiting building damage and providing more time to the building occupants for emergency evacuation or to reach an area of refuge.

Slide 16

In this case, a strip mall burned that contained six separate compartments. The fire started in the concealed space above the ceiling. The fire spread across the underside of the roof resulting in a total loss of the building. Had there been continuous fire separation to the underside of the roof between compartments, fire development may have been slowed, and the fire department may have been able to save a portion of the structure. Fire investigators must determine if faulty construction aided the spread of fire.

In another case, a lack of fire separation between floor levels allowed smoke and hot gasses to travel throughout a residential apartment building resulting in the deaths of two elderly people. Their suite was undamaged from direct flame contact but they died as a result of smoke inhalation. Had the fire separations been in working order it is highly unlikely they would have perished.

Slide 17



Active fire protection systems are characterized by items and/or systems, which require a certain amount of motion and response in order to work. Examples include portable fire extinguishers, standpipe and hose, fire alarms and sprinkler systems. Are they in place and working as intended? Have they been serviced as required? Are there signs of tampering?

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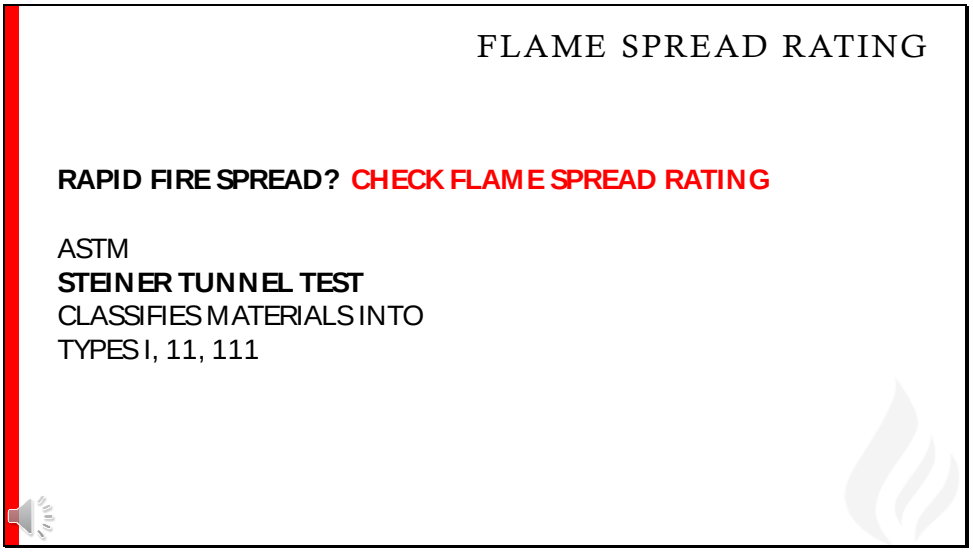
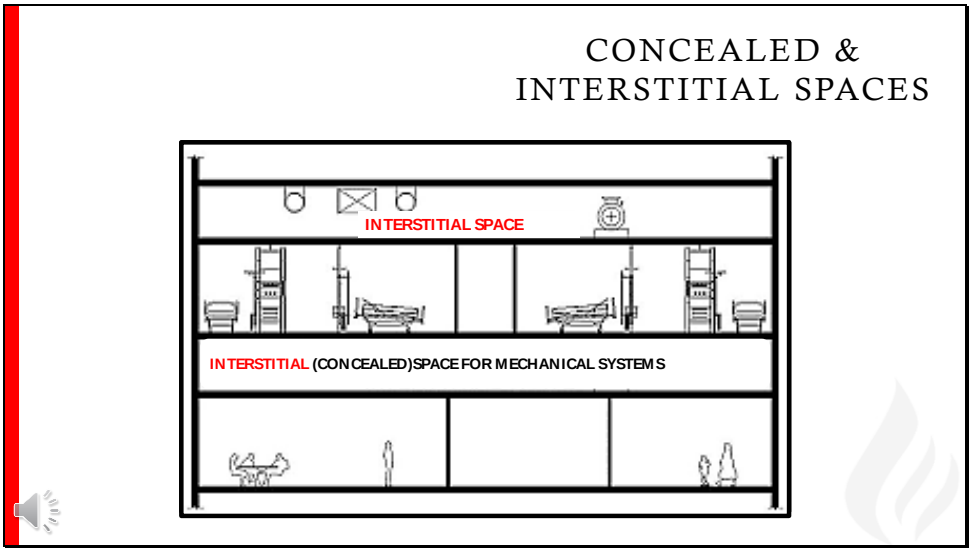
Placement of materials and total fuel loads or fuel package in a room are important. Chemical composition, thermal conductivity, and density impact fire growth and speed. Thermoplastics can greatly increase heat release rates.
They can ignite into flaming drops and pools, causing drop down damage and patterns.
Thermoset plastics pyrolyze directly to ignitable gases.
A rug on a wall rather than on the floor will burn faster and will increase fire spread. A trash can located three feet from a desk will burn differently than one located immediately next to a desk.

Slide 19



If the fire had rapid fire spread, check the flame spread rating of the interior finish materials.
Also check the amount or volume of materials making up the fuel load.
Finish and composition of furnishings play a major role in the speed and intensity of a fire.
The Steiner Tunnel Test, American Society Testing and Material (ASTM E 84) establishes flame spread indexes commonly used in fire codes.
There may be devastating effects when interior finishes or furnishings do not meet the code.

Slide 20



An interstitial space is an intermediate space located between regular-use floors, commonly located in hospitals and laboratory-type buildings to allow space for the mechanical systems of the building. By providing this space, rooms may be easily rearranged throughout their lifecycles and therefore reduce alteration cost.
Interstitial and concealed spaces can provide a mechanism for fire spread.
Generally, interstitial spaces lack fire stops, which may allow for fire spread.
Examine interstitial spaces to determine if fire stops were present and assess their integrity.
Modern building codes sometimes allow concealed spaces if they are constructed with non-combustible material. These “rated” concealed spaces are not designed for occupancy and may become a code-enforcement problem and fire-spread problem if they are used for the general storage of combustible items.
The original plans and designs for a structure may not match what was finally constructed (“as-built”).
Where possible, obtain a copy of the structure’s floor plan.
Determine whether the proper permits were obtained and inspections done for compliance.

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Concealed spaces in older buildings are often created to accommodate alterations or repairs to building systems.

In this case water lines are re-routed by a contractor but the holes in the fire separation were never repaired. A fire in this room would quickly spread into the concealed space creating a significant suppression problem for firefighters. People performing renovations or repairs should be required to repair fire separation as part of the contract.

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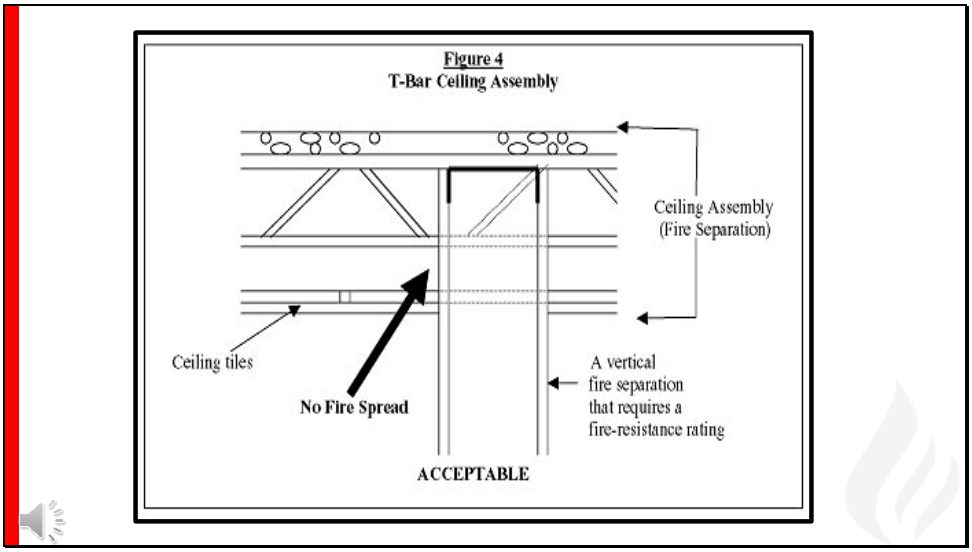
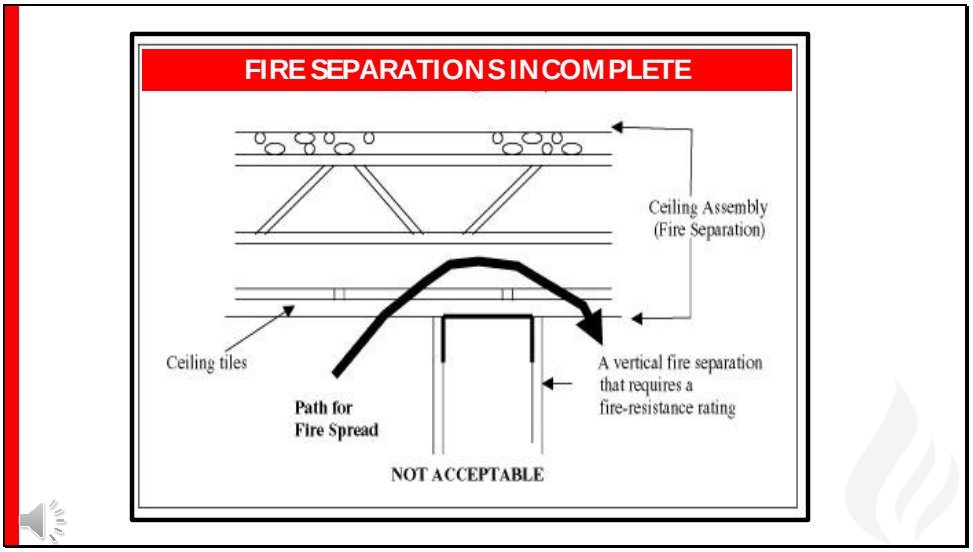
This is a fire separation door between a storage room and an exit corridor. For some reason the fire separation was voided by the installation of this louvered damper. It may be possible to install a damper in the door but it would have to be fire rated and close automatically in the event of a fire. These types of alternations should be identified during the investigation as they can contribute to fire spread. They may be acceptable as a fire separation but the door must be equipped with a self-closing device that returns the door to the closed and latched position after each use. The elephant's foot on the door should also be noted as a deficiency as this may be an indication of widespread use throughout the building.

Slide 23



This is an example of how fire separations that were installed correctly will prevent the spread of fire.
In this example, a vertical fire separation is installed through the suspended or T-Bar ceiling and concealed space which connects with the horizontal fire separation.
Fire separations **normally** require a fire-resistant rating.
Fire-resistance ratings have long been used by UL, ULC, ASTM and building codes to measure the performance of various constructions for fire containment purposes. As applied to elements of buildings, the fire-resistance rating classifies the ability of an assembly to confine and isolate fire within a zone comprised of fire resistance-rated walls, ceiling and floor assemblies. The ratings relate to fire tests designed to determine how quickly fire can raise the temperature to unacceptable levels.

Slide 24



By contrast, this example shows an unacceptable installation of a vertical fire separation which does not extend through the T-Bar ceiling making a connection to the horizontal fire separation above.

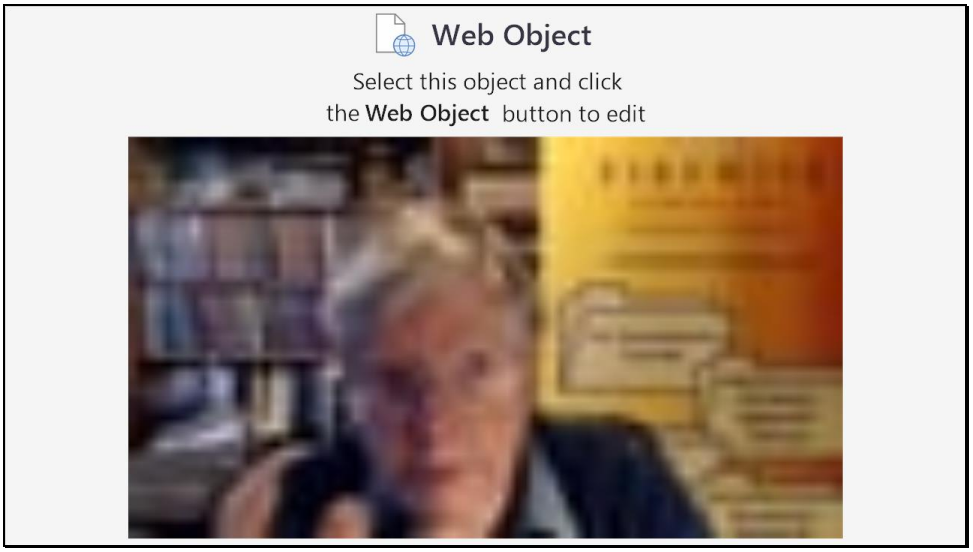
Fire investigators should consider the impact of concealed spaces when they conduct a fire investigation.

Failure to consider the effects of fire travel through concealed spaces may lead to misleading fire patterns.

The investigator should be aware that building specifications, plans and schematic drawings, prepared before construction are not always “as-built” condition. The pre-fire, current condition must be determined during the fire investigation.

Renovations and change of occupancies often result in original fire resistive features being modified, altered or eliminated allowing fires to spread in concealed spaces.

Slide 25



Another problem with building construction and renovations is exterior cladding. Over the last few years there have been a number of fires on the outside of buildings with perhaps the most noticeable being the Grenfell Tower fire in London. The fire started on the interior of the building and vented through a window causing the cladding to catch fire.

Dr. DeHaan: Building Systems

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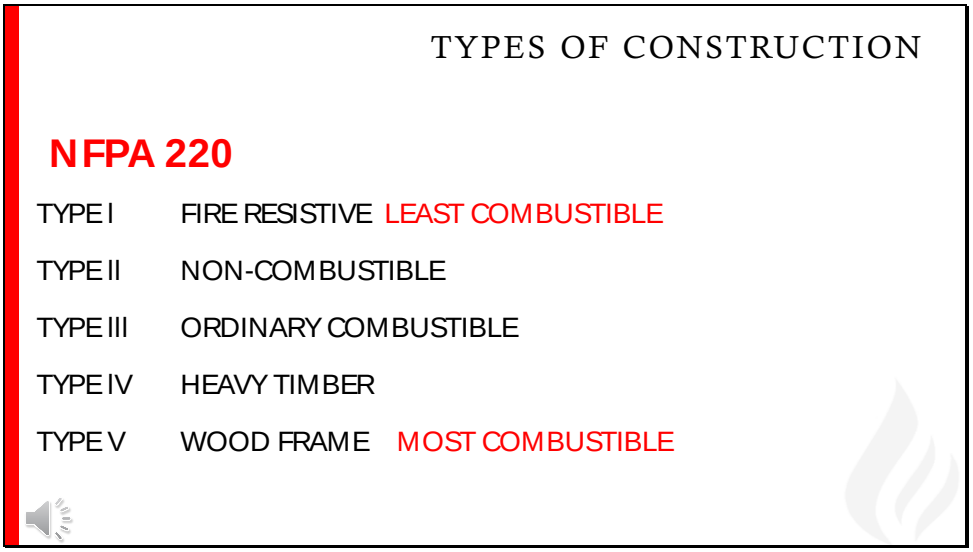

NFPA 220: Standard on Types of Building Construction, categorizes buildings by their type of construction.
They are:
Type I, Fire Resistive, which is the least combustible,
Type II, Non-combustible,
Type III, Ordinary combustible,
Type IV, Heavy timber; and
Type V, Wood frame, which is the most combustible.

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Type one – Fire Resistive buildings are built with non-combustible materials for the structural members and must meet relevant NFPA or local building code fire resistance specifications. Structural materials include walls, (interior and exterior), partitions, columns, floors and roofs. The use of some combustible materials is permitted for non-structural elements such as roof coverings, some insulation materials, and limited amounts of wood interior finish and flooring. Due to the tactical challenges involved in fighting fires in high-rise buildings over 75 feet in height, they are designed and built to be the most fire resistive.

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TYPE 11 NON-COMBUSTIBLE

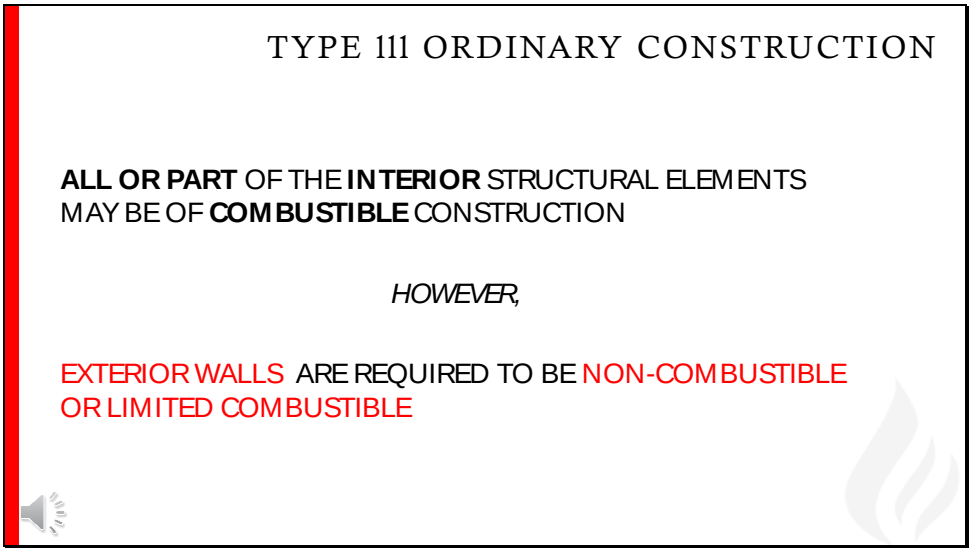
NON-COMBUSTIBLE OR **LIMITED COMBUSTIBLE**

WALLS AND ROOF ARE NON-COMBUSTIBLE

TILT-UP CONSTRUCTION

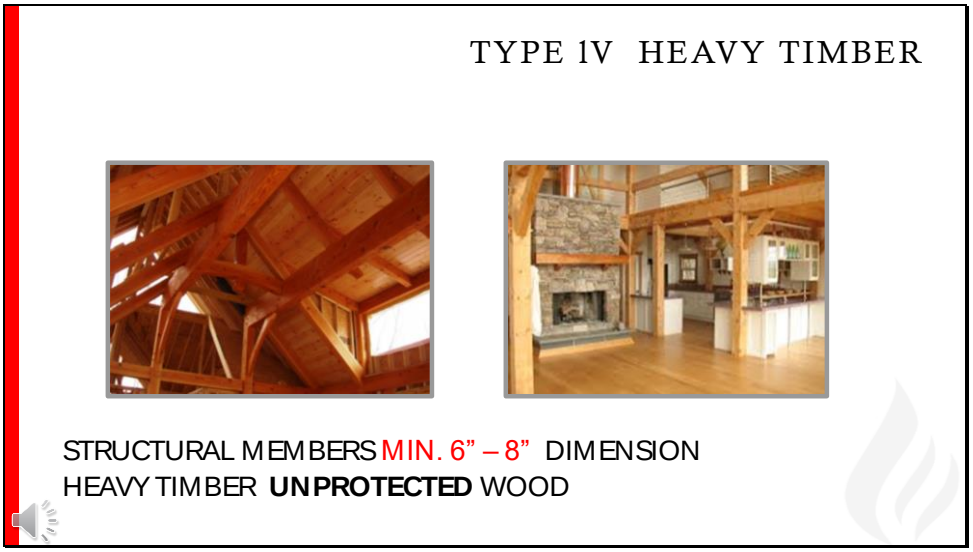
Type II – Non-combustible buildings are built using non-combustible or limited combustible structural elements, as permitted by the local building code, to have some degree of fire resistance; normally 1 or 2 hours for exterior walls and roof.
An example of this type of construction is the common tilt-up concrete building.

Slide 29



Type III – Ordinary Construction buildings may have all or part of interior structural elements using combustible materials or other materials as permitted by local codes. However, exterior walls must be of non-combustible materials and all concealed spaces must be appropriately fire-stopped.

Slide 30



Type IV – Heavy Timber buildings are constructed where the structural members; columns, beams, arches, floors and roofs, are entirely of unprotected wood, minimum of 6" – 8" dimension, with large cross-sectional areas.
No concealed spaces are permitted. Non-combustible or limited combustible materials with a minimum fire rating of 2 hours, can be used in both interior and exterior load-bearing walls.

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“Mill” construction was an early form of Timber Frame construction developed by the insurance industry. They often had masonry walls and heavy timber frame. Generally they were sprinklered with scuppers in the side walls of the structure, for purposes of draining water. The scuppers are usually placed at or near floor or ground level, and allow water to flow off the side of the open-air structure, instead of pooling within the walls.
Mill construction also denotes floor supports designed to fail during an extreme fire event leaving the supporting walls or posts intact.

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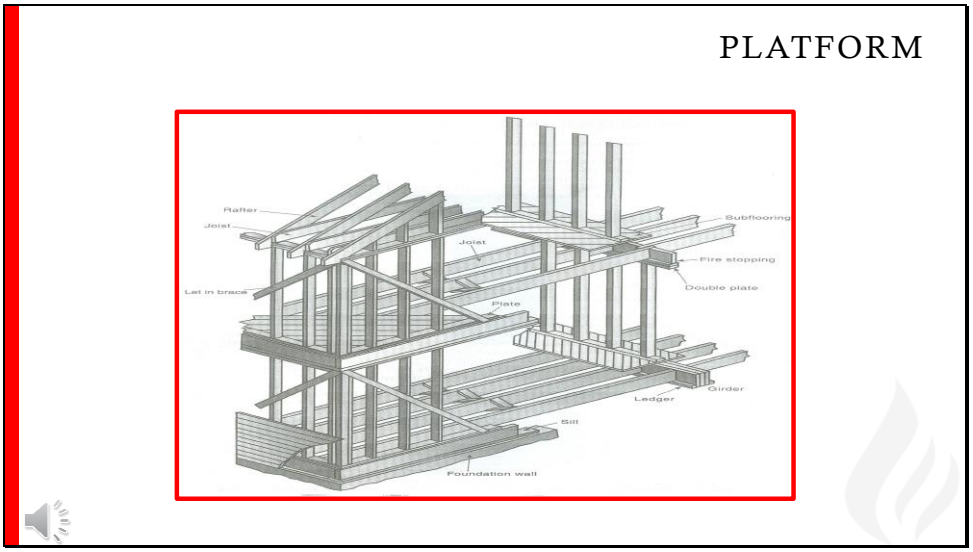
Type V – Wood Frame construction buildings have structural members made from wood or other combustible materials.
Wood frame construction is often associated with residential construction and contemporary light-weight commercial construction. Buildings with wood structural members and a masonry veneer or other type of material exterior are considered wood frame.
Wood frame construction has little fire resistance because flames and hot gases can penetrate into the spaces between joists or the studs, allowing fire spread outside of the area of origin.

Slide 33



Platform construction is the most common construction method currently used for residential and light-weight commercial construction.
Fire spread is a concern in this type of construction because combustible materials are used and there are concealed spaces in the structural elements which allows a fire to develop and spread without detection.

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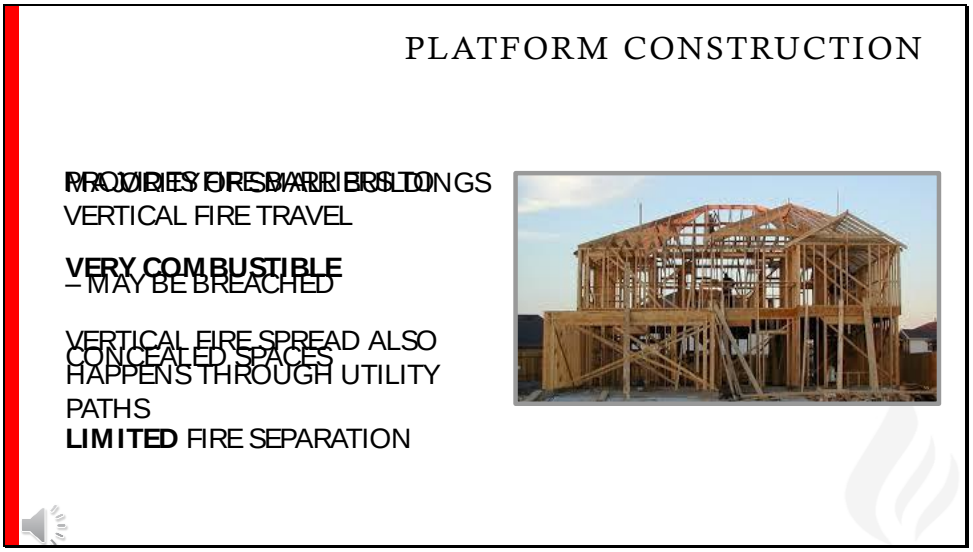

Platform construction is found in the majority of small buildings. They are very combustible, have concealed spaces and limited fire separation.
This type of construction inherently provides fire barriers to vertical fire travel as a result of the configuration of the stud channels. However, these barriers in wood frame construction are combustible and may be breached during a fire allowing the fire to spread to other spaces.
Vertical fire spread may also occur in platform construction through utility paths, such as electrical, plumbing, and HVAC. Openings for utilities in wall stud spaces may allow easy passage of fire from floor to floor.

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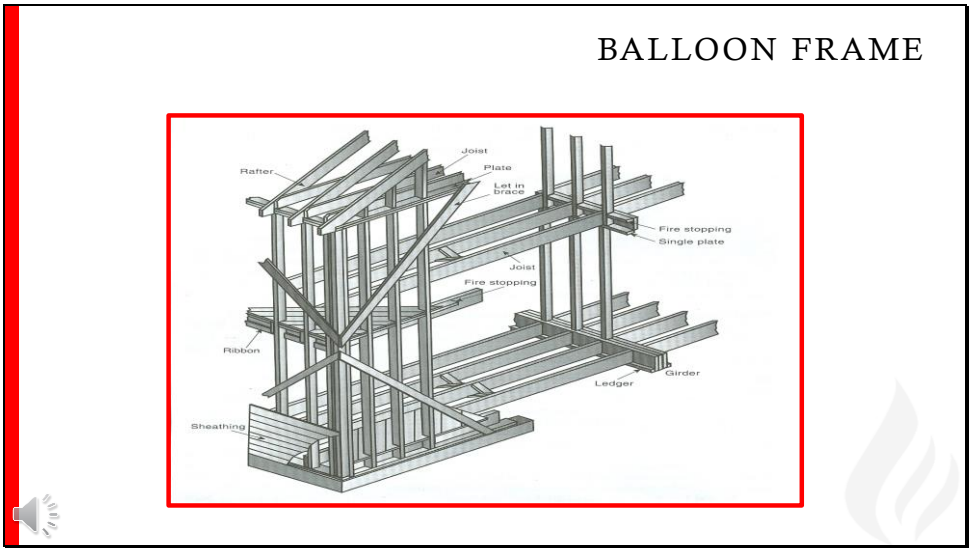
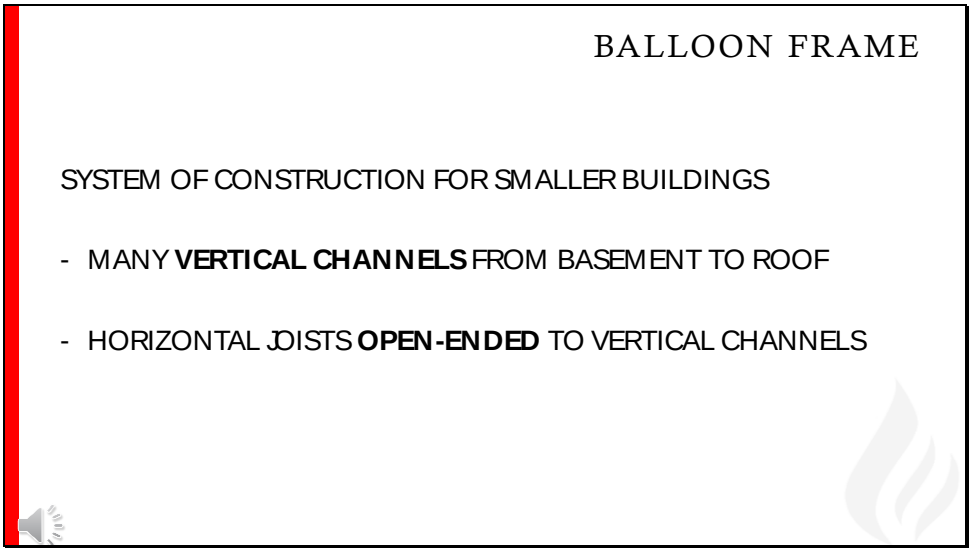
In balloon frame construction, the studs go from the foundation wall to the roofline. This type of construction is typical in many homes built prior to 1940. They were built without fire stopping, allowing a fire that has developed in the wall to rapidly extend into the attic.

Slide 36



In balloon frame construction the floor joists are attached to the walls by the use of a ribbon board. Where fire stopping is present, buildings of balloon frame respond similarly to buildings of platform construction. Almost all building codes require fire stopping of all vertical channels in balloon frame buildings. Fire stopping could include non-combustible materials such as brick or dirt, and more recently with insulation.
In some situations fire stopping could be removed to allow for convenient installation of utilities such as wiring, plumbing or HVAC.

Slide 37



At one time the balloon frame system of construction was widely used for smaller buildings. Because fire stopping was not required there were many vertical channels from the basement to the roof so fire extension easily occurred upward or downward.
Horizontal joists open ended to the vertical channels allowing fires to enter the vertical channels and rapidly spread from floor to floor and into the attic.

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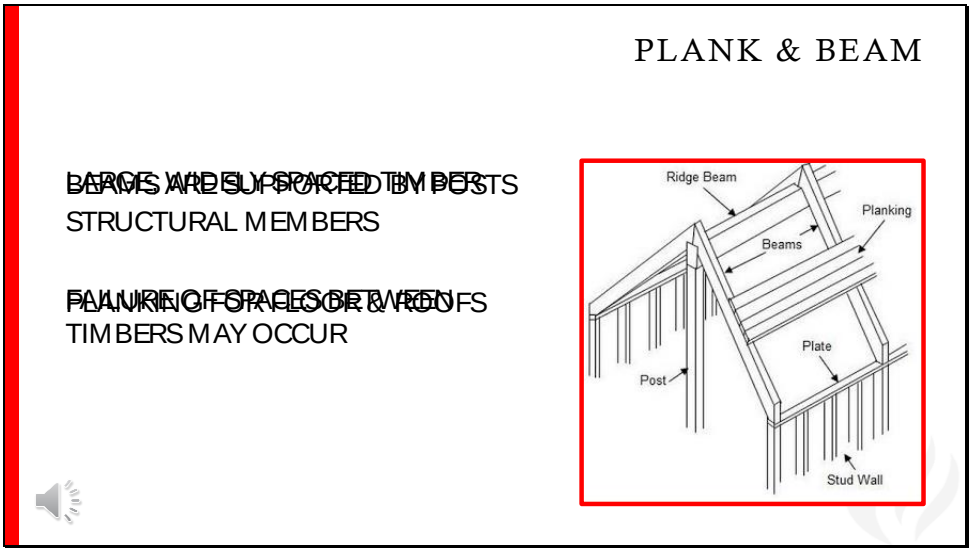
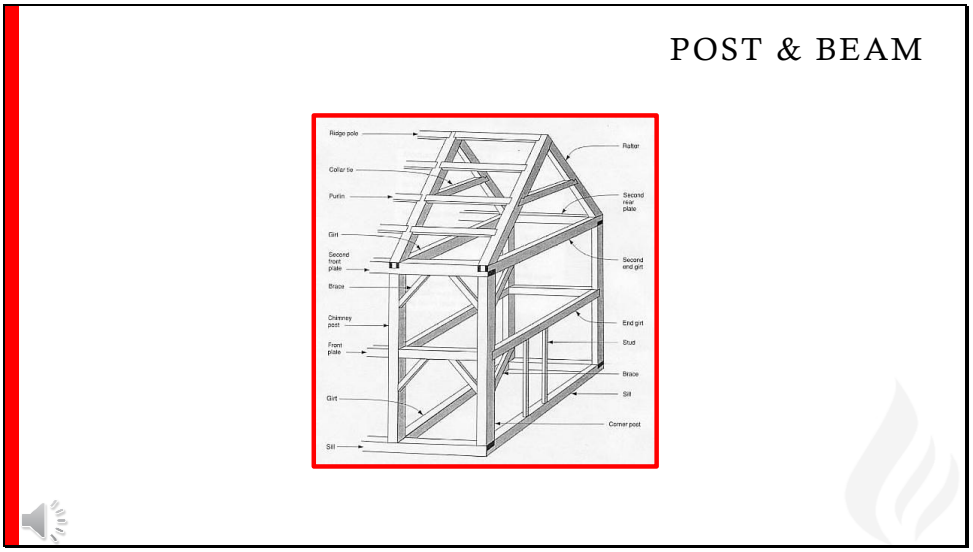


Plank and beam construction uses larger beams that are widely spaced and supported by posts.
The decking for floor and roofs is planking in minimum thickness, in place of plywood sheeting.
Most planking is tongue and groove, which will slow the progression of fire.
Instead of bearing partitions supporting the floor or roof joist or rafter system, the beams are supported by posts.
Generally, there is only a limited amount of concealed spaces to allow a fire to spread.
Failure of the spaces between timbers may occur leaving large frame members still standing.
Interior finishes in these structures often have large areas of exposed, combustible surface that may allow flame spread over its surface resulting in rapid fire development and spread.

Slide 39



Post and Beam construction is similar to Plank and Beam construction in that the structure utilizes larger elements, and the frame included is provided to attach the exterior finish. An example of this type construction is a barn, with the major support coming from the posts and beams, and the frame providing a network for the exterior finish to be applied.

Slide 40

Mobile homes also know as Manufactures Homes, are structures that are transportable in one or more sections.
Mobile homes built after 1970 react similar to conventional housing in a fire. Units built after 1970 use gypsum wallboard on interior walls to reduce the spread of fire.

NFPA 501, Standard on Manufactured Housing and Manufactures Home Construction and Safety Standard (HUD Standard) are the standards these types of homes are built in compliance with.

In Canada a certification label, indicating compliance with Canadian Standards Association (CSA) standards, is the building inspector's assurance that the factory-constructed buildings meet local requirements.

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MOBILE HOMES

OLDER MOBILE HOMES PRE 1970

- **RAPID BURN** THROUGH OF INTERIOR FINISH (PREMATURE COLLAPSE)
- SMALLER ROOMS (FUEL LOAD)
- FASTER FLASHOVER
- METAL ROOF (OVEN EFFECT)

Pre-1970 units typically have metal exteriors and interiors of wood paneling. They experience rapid fires of greater intensity than fires in conventional wood frame construction. The rapid burn-through time of the interior walls and ceiling results in quick involvement of the stud walls and roof supports. The smaller room sizes often have greater fuel load per unit of volume leading to faster flashover. The exterior metal shell results in increased radiation heat feedback after it is exposed to an interior fire. Metal roofing nominally prevents auto vertical ventilation resulting in an oven effect and total fire involvement.

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MANUFACTURED HOUSING

COMPONENTS

- CHASSIS
- FLOOR
- WALLS
- ROOF

Manufactured homes have four components. They are the chassis, floor system, wall system and the roof system. The interior finish is fire-resistive and will perform similarly to regular residential construction in a fire.

Slide 43

MODULAR/PRE-FAB HOMES

MULTIPLE SECTIONS
BUILT IN FACTORY

PLACED ON A
FOUNDATION

NO AXLES

A modular home is constructed in a factory in sections and placed on a site-built foundation. They are usually built to the same building code standard as conventional site-built dwellings. Modular homes do not have axles and perform like typical wood frame residences in a fire.

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MANUFACTURED WOOD BEAMS

MAJOR COMPONENT IS GLUE

LARGE DIMENSION LAMINATED TIMBERS

ACT LIKE HEAVY TIMBER

INTERIOR USE ONLY

WEATHER MAY DECREASE LOAD-BEARING CAPABILITIES

Manufactured wood beams are often referred to as glulam beams as glue is a major component. Laminated beams are usually large dimension and behave like heavy timbers until the heat of the fire begins to adversely affect the structural stability. If failure occurs, the investigator should document the overall dimensions of the beam as well as the dimensions of the glued pieces.

Laminated beams are like heavy timber because their mass will remain and support loads longer than dimensional lumber and unprotected steel beams.

Laminated beams are designed for interior use only. The effects of weather may decrease the load-bearing capabilities of the beam and this should be considered if the beam has been exposed to water or other similar conditions.

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Lightweight roof trusses are generally used in lightweight commercial construction. These types of roof systems are flat with plywood on top of the trusses to give added strength with a weatherproof membrane over the plywood.
Lightweight roof trusses fail quickly when exposed to heat resulting in early roof collapse.

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LIGHTWEIGHT METAL & WOOD GIRDERS

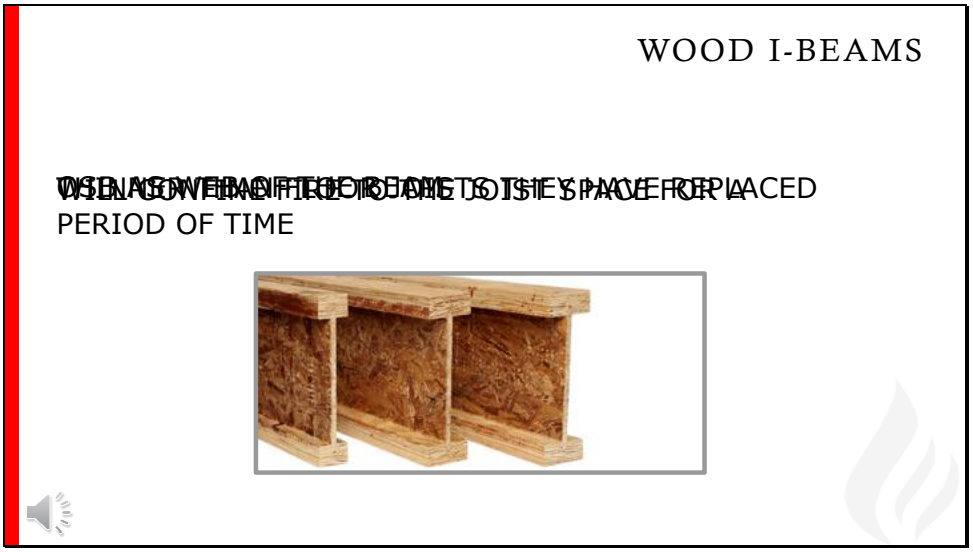
LOW-RISE LIGHT INDUSTRIAL BUILDINGS

COST EFFECTIVE

FAIL RAPDILY IN A FIRE

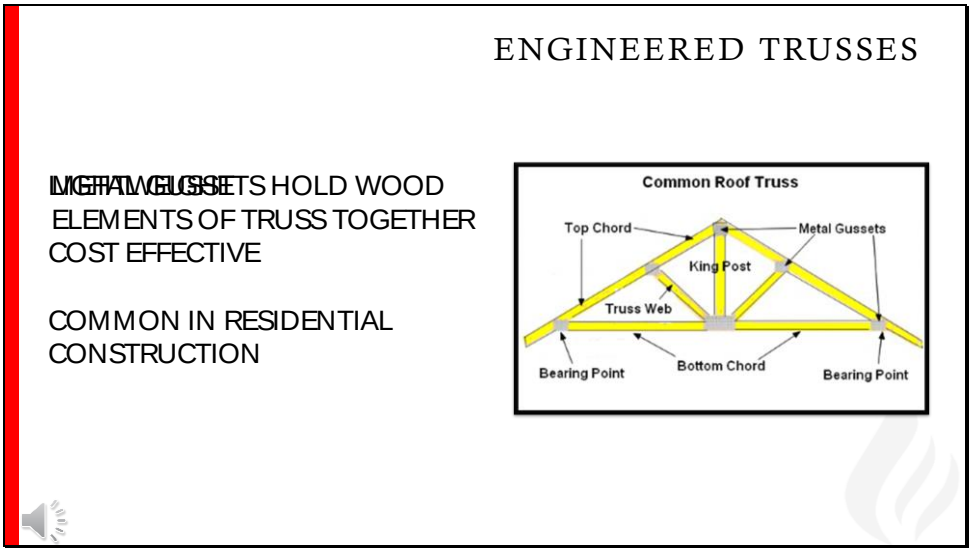
Lightweight wood and metal girders are often used in low-rise light industrial buildings. They are cost effective but can fail rapidly when involved in a fire.

Slide 47



Wood I-Beams are constructed with small dimension or engineered lumber, as the top and bottom chord, with Oriented Strand Board or (OSB), or plywood as the web of the beam. These members are generally thinner than the structural members they replace. As a result, burn-through of the web and resulting failure can occur more quickly than is generally predicted with the use of dimensional lumber. This failure can cause early collapse of floor or ceiling assemblies. Breaches in the web for utilities may allow for fire spread through these spaces and result in earlier failure. Unlike wood trusses, wood I-Beams will confine fire to the joist space for a period of time.

Slide 48



Engineered trusses are the framework of light-weight dimensional lumber designed to bridge the space above a room and to provide support for a roof.
Because they are manufactured using lightweight dimensional wood which is pre-assembled, they are cost effective and very common in residential construction.
A typical roof truss, as shown here, fastens the chords, the truss web, and the king post together using metal gusset plates to give the truss its strength.
Gusset plates are stamped sheet fasteners which contain spikes that hold the truss components together. The spikes have very little depth, normally ranging from 3/8 inch or 10 millimeters to ½ inch or 12.7 millimeters. Therefore the spikes do not protrude into the wood very deep but there are many spikes in a small area holding the structural members together.

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ENGINEERED TRUSSES

METAL GUSSET PLATES
READILY CONDUCT HEAT

SEPARATE FROM CHARRED
WOOD MEMBERS

STRUCTURAL COLLAPSE

Metal gusset plates readily conduct heat. Because they are metal, they can expand rapidly when subjected to heat and transfer the heat into the wood creating charring.
The gusset plates can separate from charred wood members resulting in the roof structure collapsing.

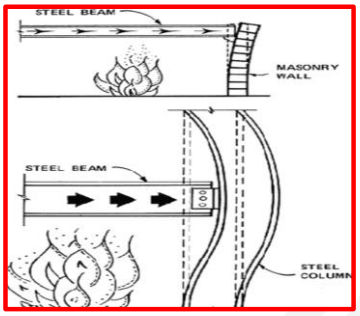
Slide 50

NON-COMBUSTIBLE CONSTRUCTION

BUILDING MATERIALS NON-COMBUSTIBLE

FAILS UNDER LATERAL PRESSURE

EXPANSION OF METAL BEAMS



Non-combustible construction materials such as metal or masonry do not perform well when involved in a fire. Steel beams connecting masonry or concrete block walls expand laterally and may exert longitudinal pressure on a wall causing it to collapse. A steel beam subjected to heat which is connected to a steel column may expand at a faster rate exerting pressure on the column.

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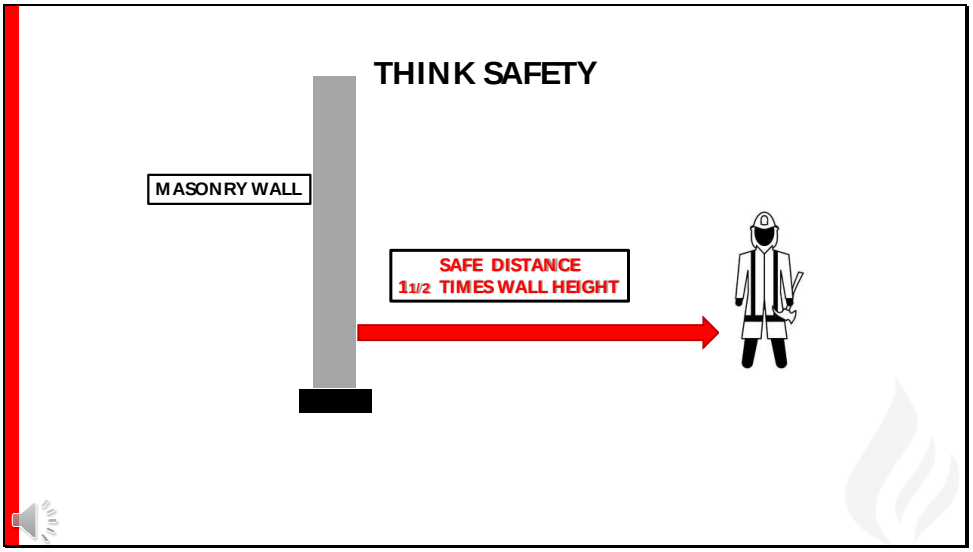

Think Safety! If you are investigating a fire in a building with masonry walls and metal roof components, be aware of the collapse zone. The safe distance is 1 ½ times the height of the wall out and away from the base.
The following pictures clearly show where the collapse zone is.

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This small warehouse is an example of how quickly exterior walls can collapse when the metal roof structural members are subjected to intense heat.
These photos were captured within a one minute time frame. The building went from a smoke showing to collapse in less than one minute.

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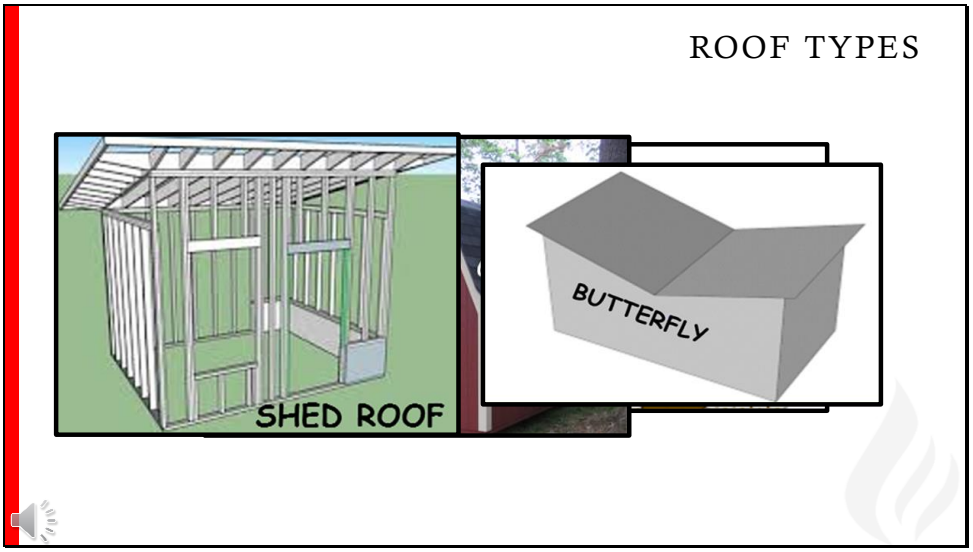
As the fire inside the building developed metal trusses expanded with enough force to cause a masonry wall to collapse.

Slide 54

This aerial view of the building after the fire reveals remnants of the metal roof trusses and the masonry wall that collapsed is outlined in red.

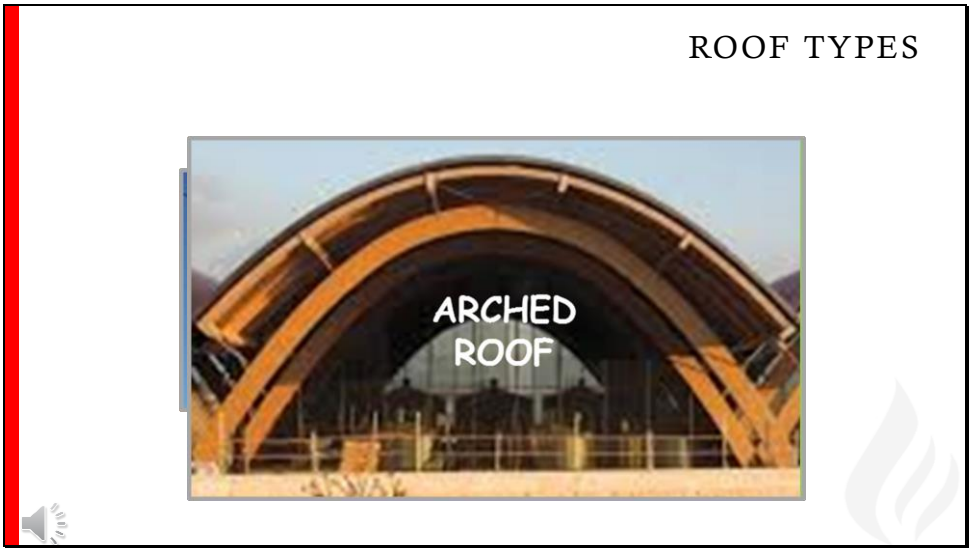
Slide 55



Fire investigators must be able to recognize various types of roof structures and materials because the structural stability could be altered or lost during a fire. Many roof coverings are made from hydrocarbon based products that can burn and flow which can result in burn patterns that are remote from the area of origin.

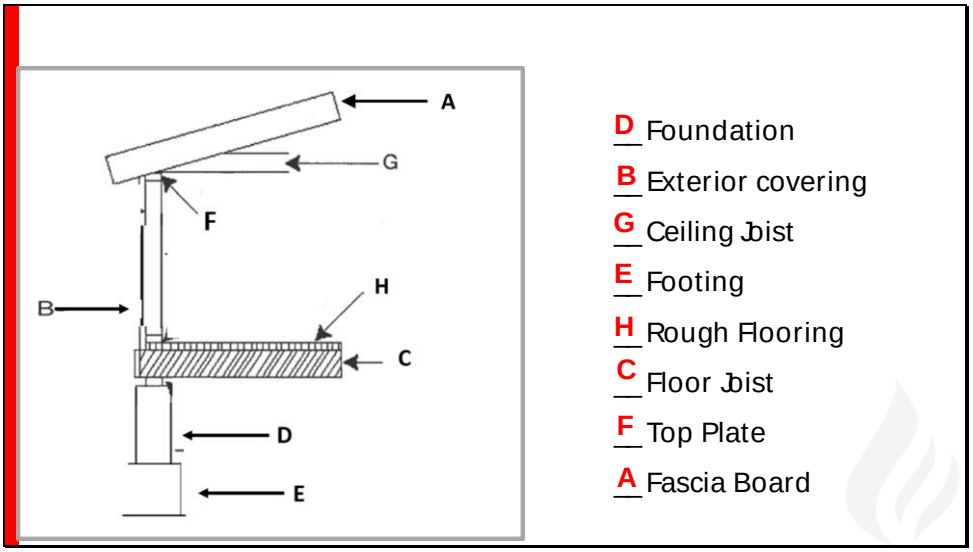
The most common roofs in small residential buildings are the Gable, Pitched, or Sloped roof. These utilize gable ends which can blow out in an explosion.
Shed roofs are one directional flat sloping roofs.
Butterfly roofs are basically 2 shed roofs joined together
Gambrel roofs are usually symmetrical two-sided roofs with two slopes on each side and are often called Barn roofs.
(**pronounced Gam Brell)**

Slide 56



A Monitor roof is a raised structure running along the ridge of a double-pitched roof, with its own roof running parallel with the main roof.
A saw-tooth roof is a roof comprising a series of ridges with dual pitches either side. The steeper surfaces are glazed and face away from the sun to shield workers and machinery from direct sunlight but allows natural light into the building.
A Mansard roof is another form of Gambrel that has four sloping sides, each of which becomes steeper halfway down.
A Hip Roof has all sides sloping downwards to the walls, and has no gables or other vertical sides to the roof.
Traditional arched roofs were made of stone but are used in modern architecture to provide a unique style. They can be self supporting.

Slide 57



Take a moment and see if you can identify which letter goes with the construction component starting with Foundation.

Did you get them right?

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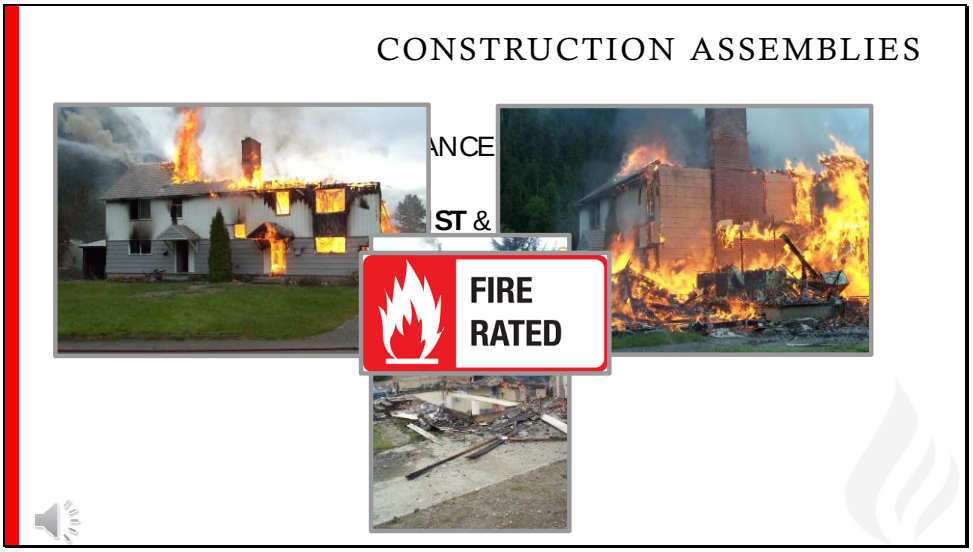
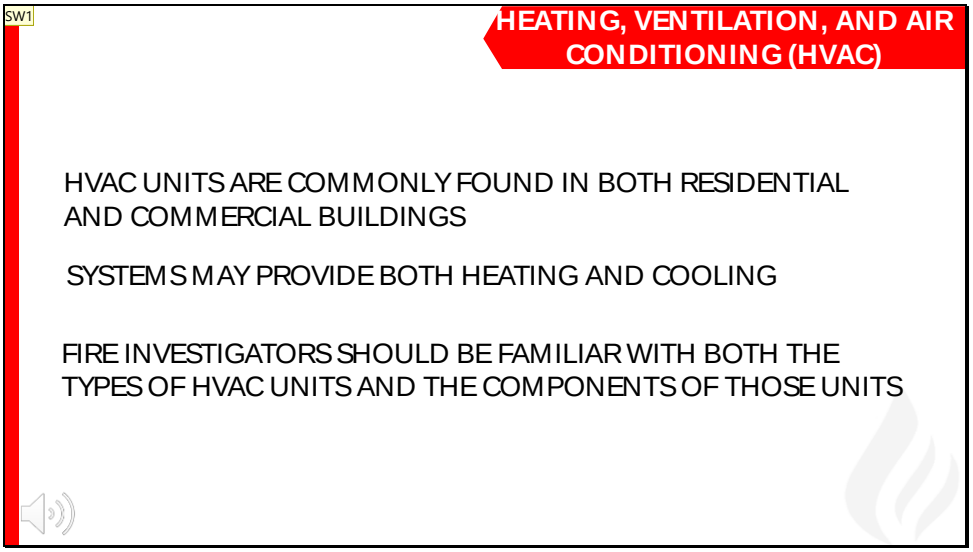


Construction assemblies all have some inherent fire resistance as required in building codes. They are designed to resist and confine a fire.
Fire-rated assemblies are components that have been tested under specific procedures established for hourly fire ratings. Fire resistance ratings may refer to the ability of a structural system to support a load during a fire or to prevent the spread of a fire. Fire resistance ratings are determined on the basis of a specific test and will not necessarily indicate how long a system will perform in an actual fire.

These pictures are a test fire set in a duplex. The fire was set in the right hand half of the building. The fire was allowed to burn unchecked and the masonry fire separation that divided the building in half prevented the fire from spreading to the second half for a long period of time. As the fire separation did not parapet the roof the fire spread across the roof and into the other half of the duplex.

Slide 59

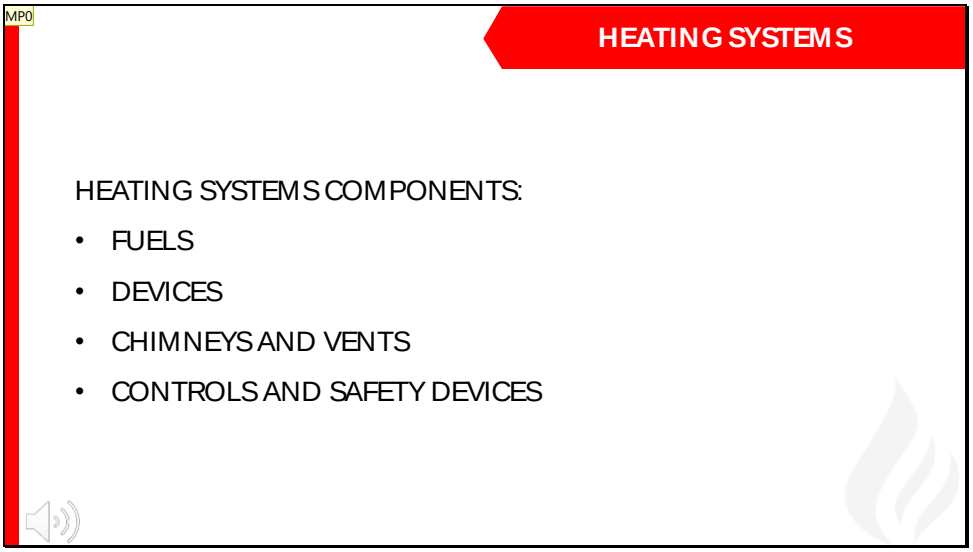


Heating, Ventilation and Air Conditioning or HVAC units can be found in both residential and commercial buildings.

These systems can be used to heat, cool and move air through buildings and can be a stand alone unit or a combined heating/cooling unit.

It is important for the fire investigator to be familiar with the types of HVAC Units as well as the components of those units to better understand their possible role in a fire incident.

Slide 60



Heating system components consist of:

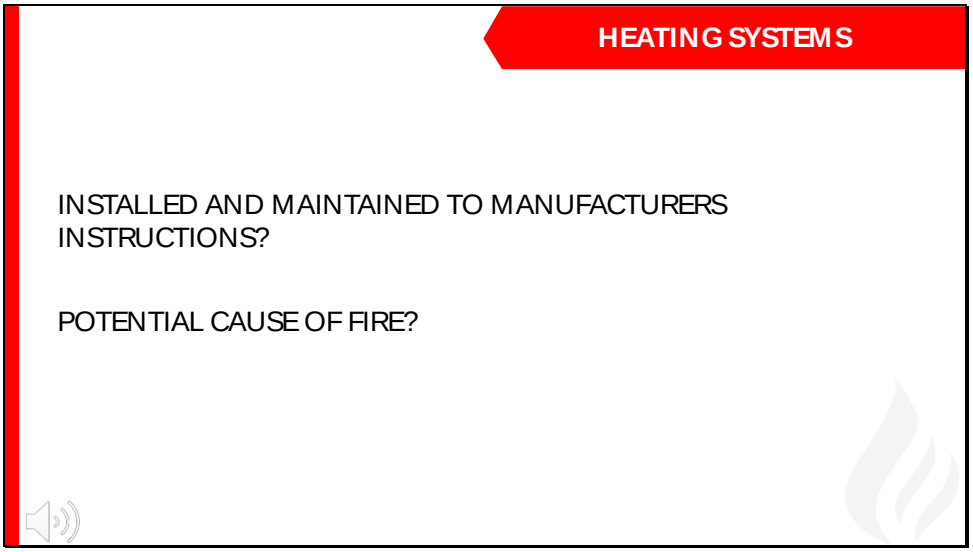
Fuels, which include, natural gas, propane gas, fuel oil, wood coal or other unique types of fuel. Electric systems do not use fuels to generate heat.

Devices which produce heat include, furnaces, boilers, radiant or convective heaters, stoves (wood, wood pellets or coal), fireplaces and electric heating units.

Chimneys and vents are used to exhaust heat producing devices to the outside of a building. Electric heating units do not require chimneys or vents.

Controls such a thermostats will start or stop a burner in response to required demand. Safety devices include such features as pressure switches, high-temperature limits, door switches, flame sensors and flame rollout detectors.

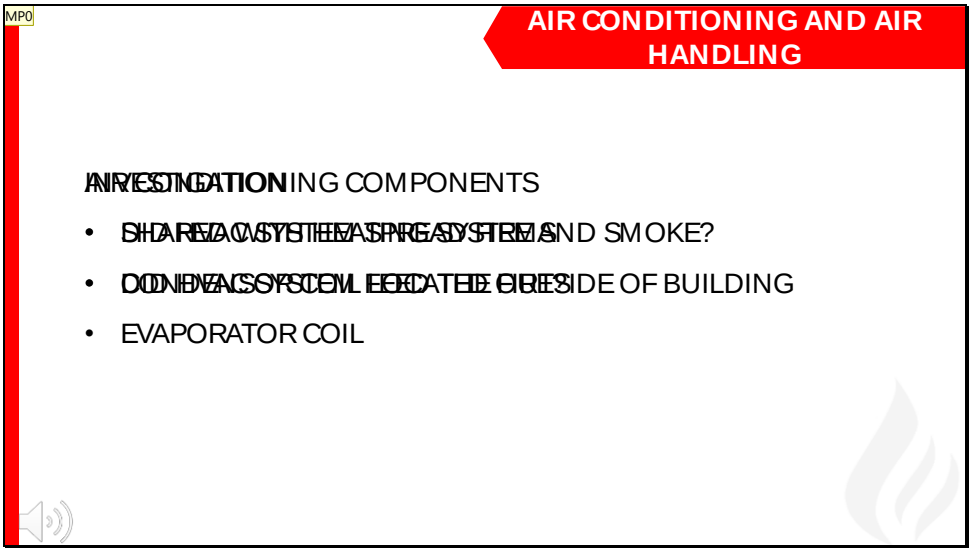
Slide 61



Local codes and standards will address the installation of heating devices and their fuel systems but the fire investigator may have to refer to the manufacturers instructions for information on installation, maintenance and use of the system.

If a heating system is located in the area of origin it must be determined if the system was the cause of the fire or if it can be ruled out as the competent heat source. Scenarios to examine include whether the heating appliance was operating at normal temperatures but too close to a fuel source, whether a failure or fault caused the device to exceed normal temperature, or whether the device was installed or used in a manner outside of the uses intended by the manufacturer and applicable codes.

Slide 62

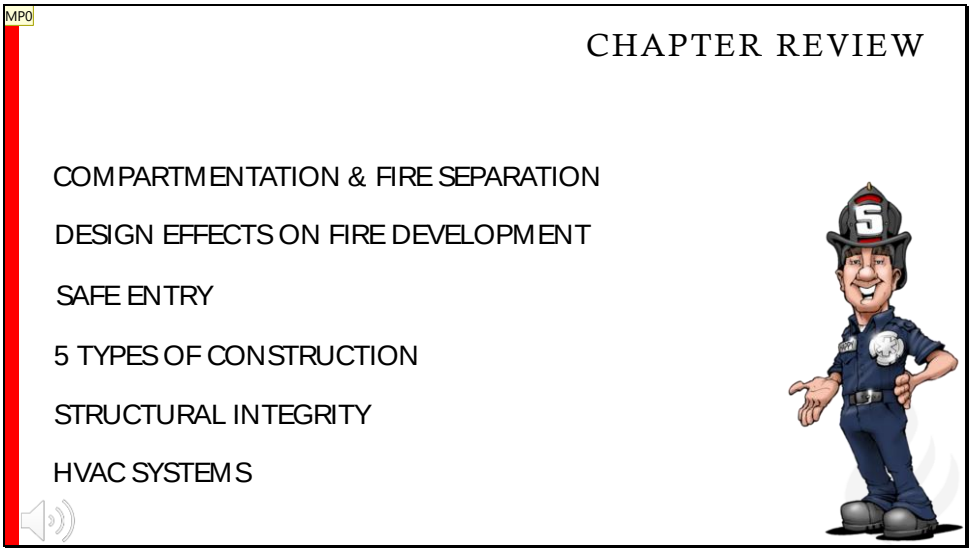


Components of an air conditioning system are typically shared with the heating system.

A condenser coil removes heat from the refrigerant and an evaporator coil uses the cooled refrigerant to cool the air to the building.

It is important for the fire investigator to determine if the HVAC system was operating at the time of the fire and if so did the system help spread the fire and smoke or fedd the fire with fresh oxygen? These factors may impact the fire patterns found.

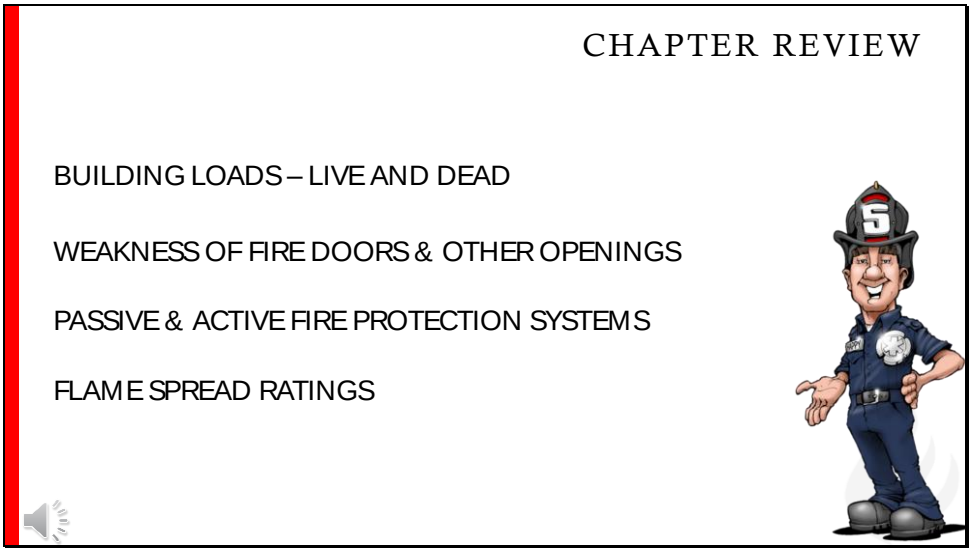
Slide 63



In this chapter we discussed:

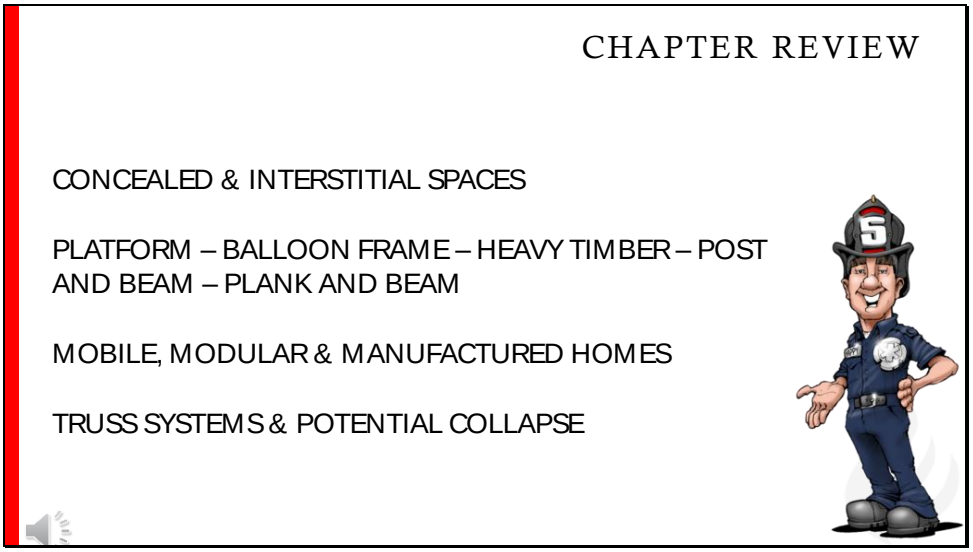
- Compartmentation and fire separations.
- Design and construction effects on fire development
- The fire scene should never be entered until it is safe to do so.
- The five major types of construction with Type one being the most fire resistive.
- Structural integrity and potential for building collapse
- **We also provided a brief overview of HVAC systems that may be present.**

Slide 64



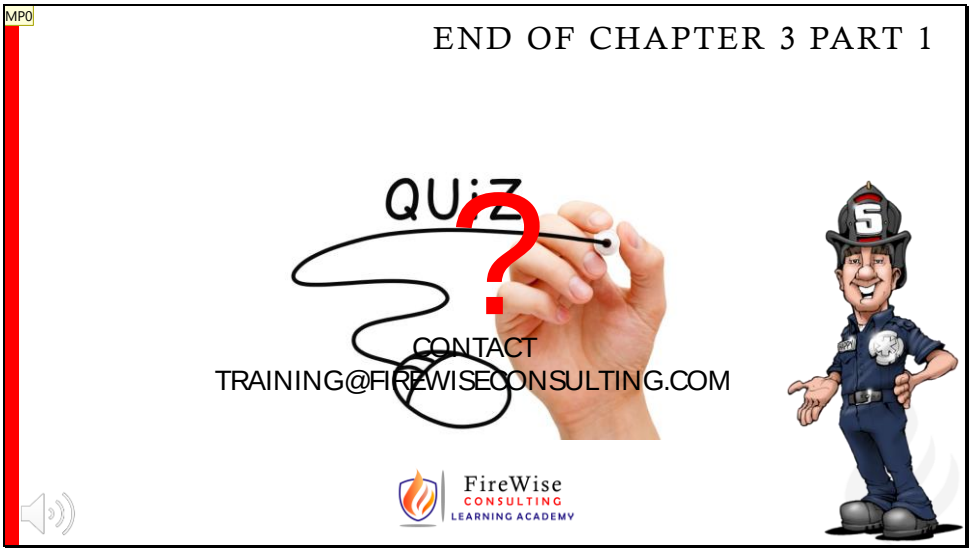
- Live and Dead loads that may affect the building. A live load is temporary while a dead load is always there.
- That fire doors and other openings are the weakest points in fire separations.
- Passive and Active Fire Protection Systems - Passive systems are design features of the building while Active systems require movement such as using a portable fire extinguisher or operating a standpipe and hose system.
- Flame spread ratings which may impact the speed and spread of the fire.

Slide 65



- Concealed and interstitial spaces that may create access problems for firefighters resulting in additional burn time.
- Platform, Balloon Frame, Heavy Timber, Post and Beam and Plank and Beam construction methods
- We discussed Mobile, Modular and Manufactured homes and the fact that since the mid 70's construction standards have improved and
- Truss systems and the potential for collapse.

Slide 66



That's the end of **Part 1 of Chapter 3 Building Construction and Systems**. You are now ready to move on to **Part 2 of Chapter 3** which deals with Fire Protection Systems but please complete the quiz for **Chapter 3 Part 1** first.

If you have any questions now is a good time to contact your teacher.