APRIL NEWSLETTER- STRUCTURAL FIRE SPREAD

Most fires start in the contents of a building. For example, a smoldering cigarette starts a fire in a stuffed chair or mattress. But if the flames are not quickly extinguished while in the content phase; they will extend to, and throughout the structure. It spreads throughout concealed spaces, pokes through walls, common roof or attic spaces. Sometimes even along the outside of the building. Extinguishing a structure fire is much more complex than quenching a content fire. The concealed flames must be located and cut off, in addition to extinguishing the original content fire. To do this effectively fire officers must know the various ways a fire can spread throughout a structure. We study our local building codes and construction techniques. But at the scene of a fire, we cannot expect to know every construction detail of a building. However, we should know the basic construction types in our community, and we should be able to associate the burning building with one of the basic construction types. If we can do this, we can determine approximately how a fire may spread.

Five types of construction and Fire Spread

There are five basic groups of building construction used throughout the United States. We should know them. Each one has a fire-resistive weakness, which results in a reoccurring fire spread throughout its structure. By knowing how a fire can spread, it helps us extinguish the fire quickly and most importantly, it protects firefighters from becoming trapped by fire, killed or injured. All buildings in America can be associated with one of five basic types of construction, identified by Roman numerals in building codes and by engineering schools throughout the nation: fire-resistive (type I), non-combustible (type II), ordinary (type III), heavy-timber (type IV) and wood-frame (type V). All buildings are not created equal. Some building construction types burn much more readily than others do. When we size-up a building's fire hazard, we must look at both its contents and its construction. Both the materials stored inside a building and the material the structure was built with add fuel to a fire. However, when the building is vacant or the contents are non-combustible, then the structure presents the main fire hazard. The five basic construction types are arranged in a scale based on the amount of combustible material used in their construction. For example, a type I fire-resistive building has the least amount of combustible material in its structure; a type V wood-frame building has the most. In addition to the relative combustibility of the five types of construction, fire officers should know specific fire spread problems inherent in each type. These recurring fire spread hazards increase our firefighting problems. The following are recurring problems which allow a fire to grow in each one of the five basic types of building construction:

COMBUSTIBILITY OF STRUCTURES

CONSTRUCTION TYPE------------------------------RELATIVE FUEL LOAD SCALE

Type I (fire-resistive)	Least combustible
Type II (non-combustible)	
Type III (ordinary)	
Type IV (heavy timber)	
Type V (wood frame)	Most combustible

Fire-resistive construction (type I) was originally designed to contain fire inside the building to one floor. This concrete and steel structure, called fire-resistive when first built at the turn of the century, was supposed to confine a fire by its construction. Today, that is no longer true. Fire does spread several floors in a modem fire-resistive building, despite its steel and concrete structure. Two avenues by which fire and smoke can spread throughout a fire-resistive building are by central air conditioning ducts and by auto-exposure, a term used by the fire service to describe flames extending vertically from window to window. Central air conditioning systems are used in fire-resistive buildings occupied as high rise office buildings and hotels. These systems may serve the entire building with cool air in the summer and heat in the winter. A system of ducts acts as a network to supply this conditioned air. These ducts, unfortunately, allow fire and smoke to spread throughout a so-called fire-resistive, type I constructed building. Fire or smoke in a room near fresh air intake or return air duct will be sucked into the air conditioning system and be pumped throughout the structure. Air ducts of a central air conditioning system penetrate every fire barrier in the type I building. Ducts pierce the walls, floors, partitions, and ceilings. One such fire in a Nevada hotel resulted in the deaths of 85 people because the central air conditioning system pumped deadly smoke throughout the burning building. There was no smoke detector inside the air conditioning system designed to shut down the system when a fire occurred. So, the first action taken by a fire officer in command of a fire

inside a fire-resistive building should be to order the air system shut down. Auto-exposure, the vertical spread of

flames from windows below to windows above, is another way fire spreads throughout a type I building. Flames erupting out of a heat-shattered window can melt and break the glass window directly above. Once the window above is broken and falls away, flames can enter and ignite ceiling tile, curtains or furnishings. Even if the windows do not melt or break from heat, a small-concealed space between the exterior wall and the end of the floor slab can allow vertical spread of fire and smoke from floor to floor above and near a window. To combat fire spread by auto-exposure, the officer in command should order an aerial master stream into operation. A water stream can slow down auto-exposure fire if it is within the reach of the aerial ladder. A water stream directed against the spandrel wall the exterior wall between the top of one window opening and the bottom of the window above can slow down fire spread. An aerial stream should not be directed into the flaming window if firefighters are inside. The stream should be directed against the exterior spandrel wall. A 100-foot aerial ladder may be effective extinguishing a fire deep inside a burning floor up to 100 feet from street level. Depending on the height of each floor in the building, this fire extinguishing ability may be the I0th floor if the height of each floor is 12 feet; or the 12th floor if each level is 10 feet; or up to the 15th floor if each level is eight feet. (Note: Commercial building floors are 10 or 12 feet from floor to ceiling in height and residence building floors 8' heights.) An aerial ladder master stream may stop vertical fire spread from auto-exposure at much higher levels. The stream does not have to penetrate the floor interior; it simply must reach the spandrel wall and spray the exterior surface of the building. An aerial stream nozzle I00 feet above ground level directed at a 75-degree angle could reach to the 15th floor of a modem high-rise fire-resistive building.

Non-combustible (type II) constructed building has a different recurring fire spread problem: fire spreads on the roof deck. A type II building has steel or concrete walls, floors and structural framework; however, the roof covering is combustible, it burns and spreads fire. The roof covering of a type II building can be a layer of asphalt waterproofing, with a combustible felt paper covering. Another layer of asphalt may be mopped over the felt paper. A combustible foam

insulation may be placed on top of the asphalt, and another layer of asphalt mopped over the foam insulation. When a fire occurs inside a type II building, flames rising to the underside of the steel roof deck may conduct heat through the metal and ignite the combustible roof covering above. Conduction is the transfer of heat through a solid. The asphalt, felt paper, and foam insulation may bum and spread fire along the roof covering. After a fire has been extinguished inside a type II building, the officer should go to the roof and examine the roof covering directly above for extension. If necessary, a hoseline should be stretched to the roof for extinguishment. Modern type II and type III buildings have combustible ÒmembraneÓ roof coverings which are more combustible than the asphalt roof covering.

Ordinary constructed (type III) building is also called a brick-and joist structure. It has masonry-bearing walls but the floors, structural framework and roof are made of wood or other combustible material. Ordinary construction has been described by some firefighters as a "lumberyard enclosed by four brick walls." The major recurring fire spread problem of type III construction is concealed spaces and poke-through holes. These small voids, crevices and openings through which smoke and fire can spread are found behind the partition walls, floors and ceilings. Concealed spaces are created by wood studs, floor joists and suspended ceilings. Poke-through holes are created by small openings for utilities. These small openings around pipes and wires allow fire to spread into concealed spaces. Flames can spread vertically several stories or horizontally to adjoining occupancies inside concealed spaces. The largest concealed space is the cockloft. This roof space, above a top floor ceiling and below the roof deck, is large and can sometimes extend over several buildings. A fire in a cockloft or roof space extending over a row of three or four houses or stories can destroy the entire row of structures. Fire spreads inside concealed spaces of a type III building by convection. Convection is the transfer of heat by fluid motion, such as by a liquid or gas. Heated fire gases and flame in a concealed space can travel upwards several floors and break out in a cockloft. When firefighters search for hidden fire, and must open walls and ceilings to find it and extinguish it, they should remember this fact

and try to cut off the rising fire. For example, if you discover fire in a floor, open up the wall above it. If you discover fire in a wall, open up the ceiling. If you discover fire in a ceiling, open up the baseboards on the floor above it. By doing this, convection currents of flame and heat can be cut off and revealed so they can be extinguished.

Heavy-timber (type IV) construction is sometimes called "mill construction" because it was the type of structure used at the turn of the century to house textile mills. These buildings have masonry walls like type III buildings but the interior wood consists of large timbers. The floor and roof are plank boards. In a heavy-timber building a wood column cannot be less than eight inches thick in any dimension and a wood girder cannot be less than six inches thick. One difference between a heavy timber building and ordinary construction is that a heavy-timber building does not have plaster walls and ceilings covering the interior wood framework. The exposed wood timber girders, columns, floor beams and decks, if ignited in a fire, create large radiated heat waves after the windows break during a blaze. If a fire in a heavy-timber building is not extinguished by the initial attack, a tremendous conflagration with flames coming out of the windows will spread fire to adjoining buildings by radiated heat. A fully involved type IV building can create a conflagration. As the fire grows, apparatus will have to be repositioned away from the radiated heat waves. Large water supply sources must be located and master streams set up to protect nearby buildings. A collapse danger zone must be designated to protect against a building collapse. Expect the floors to collapse first and then the walls to push outward falling into the street.

Wood-frame (type V) construction is the most combustible of the five building types. The interior framing and exterior walls may be wood. A wood-frame building is the only one of the five types of construction that have combustible exterior walls. When sizing up a fire in a wood

building, the outside walls must be considered for the fire spread. Flames can spread out a window and then along the outside wood walls (in addition to the interior fire spread). To combat fire in a wood-frame building, an officer must position a hoseline or master stream outside the

structure in addition to the attack line inside the structure. Outside streams must stand by or extinguish exterior siding fire from spreading to adjoining structures.

Lessons learned

Knowledge of building construction can assist a fire officer in his size-up and make the firefighting actions of locating, confining and extinguishing a structure fire more effective.

True or False

1. A modern fire-resistive, type I, constructed building will confine a fire by its construction.

Answer_______

Questions

2. Two avenues by which fire and smoke can spread throughout a fire-resistive building are:

A. HVAC system and auto exposure
B. Exterior siding an auto exposure
C. Cockloft and auto exposure
D. Roof deck and auto exposure

Answer_______

3. The definition of flames spreading from a window below to window above is called:

A. Radiation fire spread

B. Conduction fire spread

C. Auto exposure

D. Adjacent exposure

Answer_______

4. A spandrel wall is defined as:

A. The exterior wall to the side of a window

B. The exterior wall where the opening is located

C. The exterior wall between the top of one window opening and the bottom of the window above

D. None of the above

Answer_______

5. The most common avenue of fire spread in an ordinary constructed building, type III is:

A. The combustible roof deck

B. Concealed Spaces

C. Exterior siding

D. Conduction

Answer: _______

6. The only construction type that can spread fire along the outside combustible exterior surface is:

   A. Type I

   B. Type II

   C. Type III

   D. Type IV

   E. Type V

Answer_______

Answers

1. False; 2. A; 3. C; 4. C; 5. B; 6. E

To use this newsletter for training in firehouse:

1. Read the newsletter.
2. Print out the newsletter. Copy for each firefighter.
3. Use bold print as keywords for a training presentation.
4. Use questions for discussion.
5. Use questions to test firefighters.