Common Firestop Issues in
Wood Framed Commercial Construction

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At the July 24, 2014 Metro KC ICC Fire and Life Safety Training all day seminar, there were multiple questions pertaining to issues with multi-story wood framed construction. This was in part due to the volume of fires that occur in wood framed construction and the risks associated with fire igniting and spreading more rapidly as compared to other types of construction.

As requested at the seminar, we have put together a list of the top 5 issues for the inspection and design community to be aware of in wood framed construction. These are based on current, commonly found issues experienced on projects today.
1) Membrane penetrations in floor / ceiling assemblies.
One of the most common issues with wood framed construction deals with contractors utilizing the buildings interstitial space to carry normal building systems such as plumbing, piping, HVAC, electric service, etc.

Most often these service lines then branch into a unit creating a membrane penetration. These membrane penetrations are then incorrectly treated thereby eliminating the rated barrier functionality.

Fire traverses the interstitial space of wood framed construction quite rapidly. This is compounded by the failure to install the correct firestop system. Installing the appropriate UL system is paramount to stopping the spread of fire in wood framed construction. The graphic to the right shows a post fire investigation where the fire was contained in an interstitial space. Note the damage caused within this space which is indicative of how hot the fire can burn in this unique space.
The selection of an appropriate UL system must include this application as part of the system details. This is ONLY allowed if the floor ceiling system has been tested as such and specifically allows this application. Usage of only part of a complete system is not compliant and leaves the building and occupants at risk as the system would not be expected to maintain the hourly rating if it has not been designed and tested as a complete system.

For example take the following common system detail:
http://multimedia.3m.com/mws/mediawebserver/mwslid=66666 UgxG CuNyXTiNXTymXVEtQ EuuZgVs6EvE6E666666--&fn=FC2369.pdf&fn=-

As you can clearly see from the UL system above, the branch items are to be treated differently than the vertical elements. The treatment varies with the type of penetrant(s), size of penetrant, location, etc. Simply taking a part of this system as an application would be incorrect and expected to fail if used independently from the system as a whole.

In this instance another commonly missed item is that the firestop material is not installed within the 1/2" annular space to a depth of 3/4". Installing the sealant on the surface of the floor does not allow the intumescent sealant to close off the opening in the event of a fire (as there is nothing to push against and the sealant is most likely to move outward instead of inward towards the opening).
2) Use of plastic/pvc/pex instead of metal
Wood framed construction is commonly utilized for cost reasons. As such a typical value engineering option is to switch mechanical and plumbing piping from metallic to non-metallic in order to save additional money. Seldom is consideration given to the increased costs associated with the fire protection required for this non-metallic piping.

Before we discuss the general guidelines, it is critical to note that a simple visual walk inspection can only determine what was done wrong or potential issues. It can never assess what was installed correctly. This can only be done through asking what system was installed and reviewing the parameters of the system.

As general guidelines during inspections, non-metallic piping of 2” and less in diameter will not require collars as a standard installation option. There are instances where collars are required so again be sure to ask for the tested and listed system. The major differences in these small diameter non-metallic installations are the typical requirements of additional material thickness as compared to a metallic system installation (with 1/2" or more being commonplace). A general requirement is that the material be installed in the annular space and not simply on the surface or point of contact, and almost all vertical applications require mineral wool as a part of the system application.

As general guidelines during inspections, non-metallic piping of 3” and more in diameter will require additional protection features such as collars, wrap strips or other additional protective features. Vertical installations will become more intensive in installation requirements as compared to horizontal applications.
See sample system below as example of protection of 1.5" PVC pipe through a concrete floor. Note the mineral wool requirement and 1" of sealant that is required to be installed in the annular space.

3) Equal F and T systems
One of the most commonly missed items is the code requirement for equal F and T ratings in vertical penetrations not within a wall cavity. Common areas are in utility closets for individual units, mechanical rooms, electric rooms and data closets.

In order to effectively compartmentalize a fire, a floor or wall must prevent the passage of smoke and flame and also prevent the temperature on the non-fire side from rising high enough to ignite materials stored on the non-fire side. This means that fire-rated assemblies are required to meet both Fire and Temperature standards.

Through penetrations present a problem in ASTM E119 testing for two reasons. One is that the openings made in the assembly will allow the passage of smoke and flame. The other is that some through penetrating items, such as metallic pipes, conduits, beams, and ducts, both absorb and conduct heat readily. Complicating the matter is that different materials conduct heat differently. As an example a 6 inch diameter copper pipe shows similar temperature rise as a 30 inch diameter steel pipe. Clearly, the thermocouples placed on these types of penetrants would quickly exceed the temperature limitations in ASTM E119. To solve this problem, test standards now require both flame side and non-flame side ratings for vertical through penetrations in open spaces.

Per the IBC 2003 (and all subsequent versions): Section 712.4.1.2 Through-penetration firestop system states that through penetrations shall be protected by an approved through-penetration firestop system installed and tested in accordance with ASTM E814 or UL 1479, with a minimum positive pressure differential of 0.01 in (2.49 Pa) of water. The system shall have and F rating and a T rating of not less than 1 hour but not less than the required rating of the floor penetrated. Exception: Floor penetrations contained and located within the cavity of a wall do not require a T rating.

For example, the previous system would not comply with this rating for a vertical installation in a non-wall cavity application.
4) **Inadequate depth of sealant and installation of sealant**

By far the primary firestop installation failure lies within the everyday installation of firestop sealant. The requirements in the tested and listed systems are MINIMUM requirements for installation. Anything less than the listed amount would be expected to fail. Unfortunately this does not result in a partial protection but most likely a complete failure.

IFC has produced a video which shows the importance of correctly installing firestop assemblies: [IFC UL Demonstration of Proper vs Improper Firestopping](https://www.youtube.com/watch?v=whK7CCRIuRgm). As the video states "deviation from any of the listed system components severely compromises the overall effectiveness of the firestop." We urge you to view the video and see for yourself the importance of a correct installation versus one that simply looks good.

This depth of sealant must be in place after the required tooling has been performed. Tooling is required for adhesion as otherwise fire and combustion simply pushes the sealant from the opening. Imagine how long caulking in your bathtub would last if you just squirted it into the gap and did not press it into place.

Furthermore a significant percentage (and even majority in many instances) of firestop sealant applications are performed by installing the material on top of the substrate instead of within the annular space as required for the system to actually perform. It is this installation within the annular space the 1) holds the material in place as fire and combustion is pushing outward and 2) allows the intumescing material to push off the substrate to fill the opening as combustible materials such as plastic pipe, data cables, insulation and jacketing all burn away. Installation on the surface of the substrate does not allow this to happen and this is the reason EVERY firestop system will call out a minimum/maximum annular spaces, if point of contact is allowed, and what must be done differently if point of contact is allowed. All too often the opening is not cut to allow for the minimum annular space or the drywall contractor has mudded up to the penetrant creating a point of contact situation where it is not allowed.
1. Wall Assembly — The fire-rated gypsum wallboard/stud wall assembly shall be constructed of the materials and in the manner specified in the Individual U300 or U400 Series Wall and Partition Designs in the UL Fire Resistance Directory and shall include the following construction features:
   A. Studs — Wall framing may consist of either wood studs or steel channel studs. Wood studs to consist of nom 2 by 4 in. lumber spaced 16 in. OC. Steel studs to be min 2-1/2 in. wide and spaced max 24 in. OC.
   B. Gypsum Board* — 9/16 in. thick, 4 ft wide with square or bevelled edges. The gypsum wallboard type, thickness, number of layers, fastener type and sheet orientation shall be as specified in the Individual Wall and Partition Design. Max diam of opening is 4-3/8 in.
   The hourly fire ratings of the firestop system are equal to the hourly fire rating of the wall assembly in which it is installed.

2. Through-Penetrants — One nonmetallic pipe installed within the firestop system. Pipe to be rigidly supported on both sides of floor or wall assembly. The space between pipe and periphery of opening shall be min 3/4 in. to max 1-1/4 in. Pipe to be rigidly supported on both sides of the floor or wall assembly. The following types and sizes of nonmetallic pipes may be used:
   A. Polyvinyl Chloride (PVC) Pipe — Nom 2 in. diam (or smaller) Schedule 40 PVC pipe for use in closed (process or supply) piping systems.
   B. Chlorinated Polyvinyl Chloride (CPVC) Pipe — Nom 2 in. diam (or smaller) SDR17 CPVC pipe for use in closed (process or supply) piping systems.

3. FIU, Void or Cavity Material* — Sealant — Installed to completely fill the annular space between the pipes and gypsum wallboard on both sides of wall.

HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — FS-One Sealant

* Bearing the UL Classification Mark

5) Joints and fire walls/barriers

Fire walls are designed to remain free standing and provide fire protection even in the event of an adjacent structure collapse. The standard fire wall is designed to contain a fire within the area of origin, even after other firefighting efforts, such as sprinklers, have failed. Fire walls often have fire resistance ratings of 3-4 hours with limited openings.

Fire barriers typically have lower fire-resistance ratings than fire walls and can also be horizontal members such in the case of a floor/ceiling or roof/ceiling assembly. Fire barriers are typically used to subdivide floors and can be attached to or supported by structural members. Fire barriers are usually non-load-bearing walls that extend from floor-to-floor or floor to roof. Fire barriers often have fire resistance ratings of 1-3 hours with protected openings.

Fire partitions typically have lower fire resistance ratings than fire barriers and typically extend from floor to ceiling. Fire partitions often have fire resistance ratings of at least 30 minutes with protected openings.

Continuity of fire barriers at places like stairwells, elevator shafts and fire walls are often misunderstood and overlooked. As referenced earlier, the floor / ceiling assembly is often used as a chase for a variety of mechanical, electrical and plumbing materials. Due to the installation of these items prior to any sheetrock or wall finishes, the continuity of the fire assembly has typically been breached at these locations. If it is not addressed at the time of an in-wall inspection, it will simply be covered up and never considered an issue. The same concern applies to stairwells that are classified as an exit access stairway (IBC 1009.3). In these locations only penetrating items that are necessary for the function of the stairway are allowed (IBC 1009.3.1.5.1 Prohibited Openings).
In Summary
Wood framed construction presents unique and additional risks when used as a building method. Special attention should be given to the containment and firestop systems as this is absolutely critical for preventing the spread of fire and protection of the occupants and fire fighters.

Most often you can tell if a building has been treated correctly post-fire simply from whether a single compartment has burned or whether multiple compartments have burned. Firefighters are typically on scene prior to the hourly rating being met at which the point the fire can be contained or has spread beyond the original compartment due to containment failure.

Which would you rather have in the event of a fire?

Remember from class, you can only tell with a visual inspection when something is done wrong. In order to determine if it is done right you MUST have the system. Ask for it!