The Code Corner

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Penetrations

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Those of you involved in contract administration or building inspection have probably seen it hundreds of times--a conduit, pipe, or something as simple as a single wire passing through a fire-resistance-rated wall or floor assembly with little to no consideration of protecting the penetration. An installer, typically the contractor who created the penetration, will apply the common "red putty" around the penetrating item and leave it at that, hoping the inspectors will pass it. A situation such as this, left undiscovered, creates a path of least resistance through an otherwise properly designed and installed fire-resistant assembly, and could potentially lead to tragic results should a fire occur.

Penetrations of fire-resistance-rated assemblies are covered in IBC Section 712, and are categorized into two main types: through-penetrations and membrane penetrations.

Through-Penetrations

A through-penetration is one in which an item passes completely through the fire-resistance-rated assembly. An example of a through-penetration would be an electrical conduit that penetrates a fire barrier on one side of the barrier and exits on the other side of the barrier.

Through-penetrations of fire-resistance-rated walls (fire walls, fire barriers, smoke barriers, and fire partitions) must be protected with a firestop system or device in accordance with ASTM International E 814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*, or Underwriters Laboratories (UL) 1479, *Standard for Fire Tests of Through-Penetration Firestops*. The tested firestop system must have an "F" rating not less than the fire-resistance rating of the wall penetrated. An "F" rating is a measurement of the firestop system's ability to prevent the spread of flame from the exposed side to the unexposed side of the wall.

In horizontal assemblies, firestop systems must have a "T" rating in addition to the "F" rating. The "T" rating is a measurement of the firestop system's ability to resist a rise in temperature on the unexposed side of the penetrating item. Both the "F" and "T" ratings must be at least 1-hour, but not less than the fire-resistance rating of the assembly penetrated.

The requirements for through-penetrations, as those of many other code provisions, have their exceptions. For instance, the IBC permits penetrating pipes of steel, ferrous or copper materials or steel conduits in fire-resistance-rated walls to have the annular space (the gap between the penetrating item and the surrounding wall, floor, or ceiling assembly) filled with grout or mortar in masonry or concrete. This is only limited to penetrating items having a diameter of 6-inches or less, and the opening must have a cross-sectional area not exceeding 144 square inches.

Another exception, applicable to the same materials mentioned above, are those penetrations tested in accordance with ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*. This is the same test required by the IBC for the assemblies being penetrated.

Membrane Penetrations

A membrane penetration is one in which an item penetrates only one face of a fire-resistance-rated assembly. One example of a membrane penetration would be a recessed or semi-recessed fire extinguisher cabinet. Membrane penetrations must comply with the same requirements as those for through penetrations. The main difference is in the type of exceptions permitted by the IBC. It should be noted that there are a few significant differences between the 2003 and 2006 editions of the IBC in this area which are also noted below.

For fire-resistance-rated walls, membrane penetrations have three exceptions:

1. Steel electrical boxes that do not exceed 16 square inches (i.e. a typical 4" x 4" junction box), provided that the sum of such penetrations does not exceed 100 square inches within 100 square feet of wall space. Additionally, electrical boxes on opposite sides of the walls must either be separated by a distance of 24 inches, by a distance not less than the depth of a wall cavity when filled with insulation, by solid fireblocking, by listed putty pads, or by other listed materials and methods.

2. Electrical boxes of any material that have been tested for use in fire-resistance-rated assemblies. The same requirements for separation of boxes on opposite sides apply as stated above, except that wall cavities filled with insulation are not permitted.

3. The annular space of a fire sprinkler is only required to be covered by a metal escutcheon plate.

For horizontal assemblies, the requirements are very similar, but the exceptions vary slightly from those listed above. The first exception in the 2003 IBC permits penetrations of various noncombustible materials provided the area of penetrations doesn't exceed 100 square inches within 100 square feet of ceiling area. The 2006 IBC adds an additional exception that permits electrical boxes of 16 square inches or less as long as the aggregate area is 100 square inches or less within any 100 square feet of ceiling. Both of these exceptions in the 2006 IBC are limited to assemblies having fire-resistance ratings of 2 hours or less.

Other Requirements

In horizontal assemblies having no required fire-resistance ratings, penetrations need to comply with the requirements for shaft assemblies, have penetrating items that are noncombustible and penetrate not more than three stories and are fireblocked with noncombustible materials, or have penetrating items of any material that penetrate not more than two stories and are fireblocked.

In the 2006 IBC, requirements for air leakage were added to the requirements for smoke barriers. For the past 13 years, UL has published in its directories firestop products that have been tested for an "L" rating. The "L" rating is defined as the amount of air permitted to pass through a system measured in cubic feet per minute per square foot of opening. Although the IBC doesn't use the "L" rating terminology, it does establish a minimum of 5 cfm/sf as tested in accordance with UL 1479.

UL has also been working on a "W" rating that tests a firestop system's water resistance. The test was added to UL 1479 in 2004, but has yet to find its way into the model building codes. The test

determines the system's resistance to pooling of water over the firestop system. The intent is to protect lower floors from fire and water damage caused by sprinkler activation or firefighting operations. The "W" rating is optional to manufacturers, so time will only tell if the "W" rating will make any significant impact on penetration protection.

Quality Assurance

The IBC has a requirement for special inspection of sprayed fire-resistant materials, but no requirement exists for penetrations. Even though there is a lack of mandate for inspection in the building code, there are two sources available to owners, architects, specifiers, and building officials that could help reduce the haphazard application of firestop systems frequently encountered in today's construction.

The first source is ASTM E 2174, *Standard Practice for On-Site Inspection of Installed Fire Stops*. As stated in the standard, the purpose is to "establish procedures to inspect fire stops, including methods for field verification and inspection." But inspection is technically a quality control measure rather than a quality assurance measure. The best solution to ensure a proper installation of a firestop system is to make sure it is done correctly the first time.

FM Global, through its Factory Mutual Approvals division, developed FM 4991, *Standard for the Approval of Firestop Contractors*. This standard provides a means for assuring that quality firestopping systems are installed by setting minimum standards for approval of firestop contractors. Since firestop installation is not a licensed contracting specialty, the adoption of this standard by jurisdictions to supplement the minimum requirements of the building code seems unlikely. However, architects and specifiers could utilize this standard to establish minimum requirements for installers in project specifications.

Since the publication of the first *International Building Code* in 2000, controversy has developed regarding the code's frequent use of sprinkler "trade-offs," or the relaxing of certain code requirements because a sprinkler system is installed. At the forefront of this polemic is the reduction of compartmentation, or the use of fire-resistive construction to isolate or limit the spread of fire. It is not the intent of this article to provide an opinion on one side or the other, but to suggest a balanced application of active (i.e. suppression and detection) and passive (i.e. compartmentation, area and height limitations, etc.) systems. Firestopping is a critical part of passive systems and is elemental in providing complete protection.

To comment on this article, suggest other topics, or submit a question regarding codes, contact the author at ron@specsandcodes.com.

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