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The History of Firestopping

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THE HISTORY OF FIRESTOPPING

This is the first part of a two-part article which will explore the history of firestopping. To set the stage for this article, let's explore the meaning of the word firestopping. Based on the various definitions and requirements of the International Building Code (IBC) and NFPA 101, *The Life Safety Code* (LSC), the application for firestopping relates to the protection of penetrations covered in Section 714 and Chapter 8, respectively. These codes – IBC and LSC - detail the methods of protecting penetrations in or through fire-resistance-rated (FRR) building elements and assemblies. Typical penetrating items include electrical conduit, cables and outlet boxes, plumbing pipes, devices such as recessed washer supply and drain boxes, and mechanical services such as air ducts not required to be protected with dampers.

The industries supplying and installing the firestopping products have expanded the scope of the word firestopping to include the protection of other breaches within fire-resistance-rated construction, including the protection of joints and voids covered in Section 715 and Chapter 8 of the IBC and the LSC, respectively. Examples of joints and voids which are protected with firestopping include fire-resistant joint systems installed in or between fire-resistance-rated assemblies, and perimeter fire containment systems installed between the edge of a FRR floor and a non-FRR curtain wall.

This first part of the article will address the history of firestopping as it relates to the protection of penetrations. The second part of the article will address the history firestopping as it relates to the protection of joints and voids.

Unlike the need to protect door openings, which goes back over a century, the fire protection engineering community was slow to pick up on the need to protect penetrations. The first firestopping was done for the marine industry in the 1960s. These systems were both crude and robust by today's standards. Typically, steel sleeves were mechanically secured or welded to bulkheads and steel decks, pipes or cables were passed through the sleeve, and the ends of sleeves were plugged as shown in ***ILL. 1***. Not long thereafter, the nuclear power industry also began firestopping using various proprietary methods.

ILL 1. Marine Bulkhead Firestop System. Abesco Fire Image

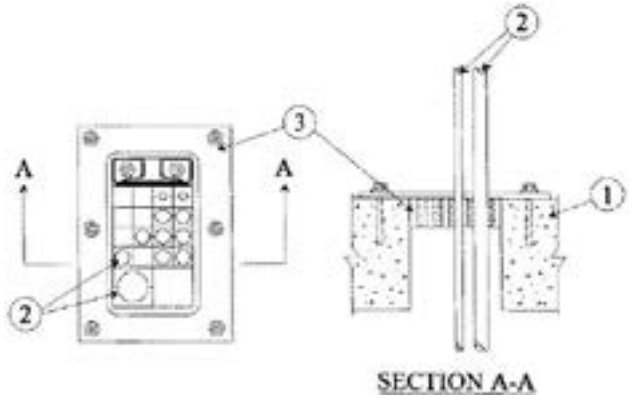
The first published code requirements relating to firestopping which were identified were contained in the 1973 Standard Building Code (SBC) published by the Southern Building Code Congress International. The SBC required

> *"All openings around exposed pipes or power shafting shall be filled with approved non-combustible material, or shall be closed off by close-fitting metal caps at the ceiling and floor line, and on each side of a wall or partition."*

Although primitive by today's standards, the SBC did recognize the need to protect penetrations.

The Brown's Ferry Nuclear Plant fire on March 22, 1975 became the defining moment in the development of the firestopping requirements we know today. The temporary firestopping used by this facility, consisting of a foamed plastic covered with a fire-retardant coating, was a contributing factor to a near nuclear disaster. It was obvious from this fire that the fire protection community needed to develop a science-based test procedure and code requirements for protecting penetrations of FFR construction.

Shortly after the Brown's Ferry fire, Underwriters Laboratories (UL), in conjunction with several manufacturers, began developing a new test procedure at UL's Northbrook, IL test facility. The intent was to develop a test methodology which complimented the test standards for the fire-resistive performance of the basic barriers, ASTM E119, NFPA 251 and UL 263, but also accounted for the nuances of penetrations. Adaptations included, among other things, the required furnace size, the differential pressure between the furnace chamber and the lab environment, the method of measuring temperatures on the firestop systems, the use of the hose stream test in lieu of loading horizontal test samples, and the conditions of acceptance.



ILL 2. Multiple Cable Transit Firestop Device. UL Image

The first listing to this new test method was published for Nelson Electric in 1976 and covered a multiple cable transit firestop device, as shown in ***ILL 2.*** The device consisted of a steel frame mechanically secured to a wall, and elastomeric plugs sized to fit the specific cables passing through the system. The following year, UL published its first listing of a firestop system using silicone foam. By December, 1980, UL had 23 published firestop systems and four firestop device listings published in its Building Materials Directory. The majority of these early systems were intended to address the needs of the nuclear industry. As time evolved, however, the developing industry recognized the need to protect penetrations in commercial construction.

Simultaneous to the development of the test method and tested and listed systems, the code writers were developing code requirements for penetrations based on the evolving technology. The 1979 Uniform Building Code (UBC), published by the International Conference of Building Officials (ICBO), established the first performance-based requirement for protection penetrations. Keeping in mind UL had not yet published the new test method on firestopping, ICBO used a combination of performance-based requirements and a prescriptive description of the test method to describe their requirements. The UBC required

> *"Walls or partitions, and floors or ceilings, may be penetrated provided penetrations are firestopped using an approved material securely installed and capable of maintaining its integrity when subjected to the time-temperature curve prescribed in UBC Standard No. 43-1 (UL 263 / ASTM E119) for the specific assembly."*

The UBC went on to describe requirements for the installation of outlet boxes and noncombustible pipes. The requirements for noncombustible pipes read

> *"Occasional noncombustible pipes may be installed within or through floors, provided they are protected so as to prevent the movement of hot flames or gases."*

Ultimately, UL and ASTM published standards for fire testing firestop systems between late 1982 and early 1983. The ASTM and UL standards were identified as ASTM E814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops* and UL 1479, *Fire Tests of Through-Penetration Firestops*. Some years later, in 1991, ICBO published their version of the standard, UBC 43-6, *Fire Tests of Through-Penetration Fire Stops*. This standard was later renumbered as UBC 7-5.

With the publication of the test standards and the exponential increase in the number of tested and listed systems, the code writers now had a test method to reference in the code, as well as a reasonable number of tested and listed systems which demonstrated compliance with the code. In the early 1990s, the three legacy codes were all revised to reference the newly published test standards. As an example, the 1991 UBC required

> *"Penetration through walls which require protected openings (doors) and floors shall be protected by a through-penetration firestop system tested to UBC Standard 43-6 (UL 1479 / ASTM E814) having an F and T rating".*

As with today's codes, there were exceptions under which the T Rating was not required.

The 1991 UBC went on to describe an exception to the above requirements for noncombustible penetrating items, which was a refined version of the requirements previously applied to all penetrating items by the 1979 UBC. That exception read

> *"Noncombustible penetrating items not larger than 4 in. diameter or 16 sq in. may penetrate the walls and floor, providing the annular space is filled with a material which will prevent passage of flames and hot gasses sufficient to ignite cotton waste when subjected to a UBC Standard No. 43-1 (UL 263 / ASTM E119) time-temperature curve under a min 0.01 in. water column."*

This exception still exists in a very similar format in the 2021 International Building Code.

The late 1980's and 1990's brought about many evolutionary changes in the two test standards and the certification programs associated with firestop systems. Most of the changes simply refined the test procedure originally developed by UL and are significant only to the test labs; however, several changes were truly significant to the entire industry.

In 1991, UL renumbered its 500 or so published firestop systems using a new alpha-alpha-numeric numbering system. The new numbering system instantly allowed users to identify the attributes of the system based on the numbering system. It also gave UL the opportunity to standardize the language of the systems to facilitate electronic searches. This numbering system is still in place today.

Another significant development which occurred in 1993 was the inclusion of a new optional L (Leakage) Rating in UL 1479. The new L Rating quantifies the (air) leakage through the firestop system under specific pressure and temperature conditions as shown in ***ILL 3***. The new L Rating was added in response to provisions in the NFPA 101 Life Safety Code requiring penetrations through smoke barriers to resist the free passage of smoke and hot gasses. Ultimately, the 2006 IBC and the 2018 LSC were revised to add quantified requirements for leakage through firestop systems in smoke barriers or any other barrier where quantified smoke-resistant properties are desired.

ILL 3. Horizontal Air Leakage Test. © 2020 UL LLC. Reprinted with permission.

The next significant development with the standards was the inclusion of requirements for environmental exposure testing of intumescent firestopping materials in UL 1479 in August of 2000. The requirements call for subjecting separate samples of the firestopping materials to an elevated temperature of 158°F for 270 days and high humidity of 97-100% and 95°F for 180 days. After exposure, the materials are subjected to expansion pressure and expansion factor testing.

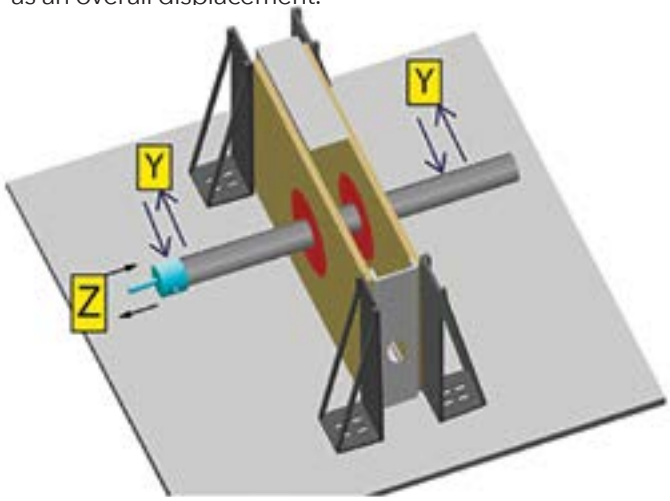
ILL 4. Water Leakage Test Vessel. UL Image

In 2005, UL was asked to consider the addition of a new optional W (Water) Rating in UL 1479. The intent of the W Rating is to demonstrate if the firestop system has the ability to prevent the passage of water and maintain its fire performance after exposure to the water. For a Class 1 rating, which is typically applied to commercial construction, the firestop system is subject to a 3 ft. water column for 72 hours as shown in ***ILL 4***. During this time, the firestop system cannot permit any leakage of water. After the system is dried, it is subjected to the standard fire exposure and hose stream tests of UL 1479 where the F and T Ratings are established.

During the early development of ASTM E814 and UL 1479, the focus was on through-penetrations. The generally held consensus was that a membrane-penetration could be protected using one-half of a through-penetration. While true in some cases, it certainly is not true in all cases. For example, this is not true for systems which use a sleeve. As such, both ASTM and UL updated their standards to incorporate specific methodology for testing membrane-penetrations in vertical assemblies in 2009 and 2015, respectively. ASTM E814 includes the methodology for testing typical pipe penetrations, whereas UL 1479 includes the methodology for both pipe penetrations and outlet box penetrations.

The last significant development relating to the protection of penetrations came with the introduction of a new optional M (Movement) Rating. The M Rating relates to the ability of the firestop system to accommodate relative movement of the penetrating item with respect to the barrier penetrated. The methodology for moving the penetrating item has been incorporated into a new

ASTM Standard, ASTM E3037, *Standard Method for Measuring Relative Movement Capabilities of Through-Penetration Firestop Systems*. This standard addresses movement in the direction parallel to the supporting construction (Y dimension) and movement perpendicular to the supporting construction (Z dimension) as shown in ***ILL 5***. The movement in the Y dimension is expressed as a percentage of the minimum annular space of the field installation. The movement in the Z dimension is expressed as an overall displacement.



ILL 5. Penetrant Movement Directions. ASTM Image

As Part I of this article documents, although the firestopping industry is relatively young in comparison to the other aspects of fire-resistive construction, it has developed rapidly over the last 40+ years thanks to the efforts of the manufacturers, industry trade associations, testing labs, code writers, contractors, designers, and code officials. From 1980 until today, the number of tested and listed systems has expanded from approximately 25 to well over 7000, giving designers and contractors many options for meeting their firestopping needs.

Part II of this article will address the history of the methods of protecting joints and voids, as required by Section 715 of the IBC and Chapter 8 of the LSC.

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