Firestopping Through Penetrations

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Specified Technologies Inc. (STI)
Today we will cover...

1. What is firestopping?
2. What do the standards/codes require?
3. Through Penetration Firestop Testing & the different ratings.
5. Through Penetrations. (MEP & Data)
   a. Definition / different types.
   b. Through penetrations vs. Membrane Penetrations.
   c. UL Systems.
   d. Firestop Materials used.
6. Q&A
Key Principles of Fire Protection

1. Early Detection
   - Smoke & Fire Alarms
   - Warning for Egress & Fighting Fire

2. Active Suppression
   - Extinguish Fire (Active)
   - Sprinkler Systems
   - Fire Fighting

3. Passive Fire Protection or Containment
   - Contain Fire to Place of Origin (Passive)
   - Walls, floors, doors, windows, fire dampers, firestop, etc.
The goal of firestopping

Compartmentation

The concept of erecting fire-resistant barriers to divide building space into smaller units that confine fire, hot gases, and smoke to their point of origin.
Compartmentation is Critical

The spread of fire can be restricted by dividing a building into separate compartments with fire rated walls and fire rated floors, increasing the availability of escape routes for occupants.
What is Firestopping?

The process of sealing openings around penetrants or in joints to restore hourly fire resistance ratings.

A barrier with unsealed openings has been compromised
Firestopping:

The process of sealing openings around penetrants or in joints to restore hourly fire resistance ratings.
Why is it so important?

**FLAMMABLE CONTENTS...**
One Box of Paper... 10 Reams...

Equivalent to 3.5 Gallons of Gasoline!
Why is it so important?

**FLAMMABLE CONTENTS...**

The Cable in one foot of 18” x 4” Tray = 150,000 BTUs (1.1 Gal of Gasoline)
This is what you want...
But this is often what you get.
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Why do we firestop?
Because it is a code requirement

IBC – *International Building Code*, Adopted or in use as the code to follow in all 50 states and DC; parts of the IBC reference the following:

NEC – *National Electrical Code (NFPA 70)*

IPB – *International Plumbing Code*

IMC – *International Mechanical Code*

NFPA – *National Fire Protection Association Standards*

* Local AHJ’s may have their own codes/standards
Where do we firestop?

3 main types of firestop systems

1. Penetration
   a. Through-penetrations
   b. Membrane penetrations
2. Joints
3. Perimeter fire containment
Where do we firestop?

IBC (2015 Edition) reference for:

Through-penetrations in fire-resistance-rated walls (Section 714.3.1.2)
Through-penetrations in fire-resistance-rated floors, floor/ceiling assemblies or the ceiling membranes of a roof/ceiling assembly (Section 714.4.1.2)
Fire-resistant joint systems (Section 715.1)
Exterior curtain wall/floor intersection assemblies (section 715:4)
Where do you firestop?

*Smoke Barriers vs. Smoke Partitions*

**SMOKE BARRIERS SECTION 709**

IBC Section 709.3


IBC Section 709.6

Penetrations. Smoke barriers shall comply with Section 714

**SMOKE PARTITIONS SECTION 710**

IBC Section 710.3

Fire-resistance rating. Unless required elsewhere in the code, smoke partitions are NOT required to have a fire resistance rating

IBC Section 710.6

Penetrations. The space around penetrating items shall be filled with an approved material to limit the free passage of smoke
Smoke ‘N’ Sound Acoustical Sprays/Sealants/Devices

Applications:

- Smoke Control - stopping the passage of smoke in smoke partition walls.
- Noise Control - reducing the transmission of sound through wall openings.
- Infectious/Dust Control – reducing the transmission of dust and other airborne particulates.
Where do we firestop?
Check the life safety drawings, or look for...
### IBC referenced test standards

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<td>Joints</td>
<td>E 1966</td>
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<tr>
<td>Curtainwall*</td>
<td>E 2307</td>
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*a.k.a. perimeter fire barrier, safing slot
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Recognized and accredited third-party test facilities

Tests conducted per code-required standards – ASTM and UL

All “nationally recognized test laboratories” are of equal status in regulations (code acceptance)

Each test lab publishes its own listing directory
Firestop Testing
- 1,000°F (538°C) in 5 Minutes
- 1,700°F (927°C) by One Hour
- 1,850°F (1,010°C) by Two Hours
- 1,925°F (1,052°C) by Three Hours
- 2,000°F (1093°C) by Four Hours
Firestop Testing
Result of Firestop Testing
ASTM E-814 / UL 1479

Published systems with ratings:

F Rating - fire resistance in hours
T Rating - temperature rating in minutes or hours
L Rating - air leakage (optional) in cfm/sf
W Rating – water leakage (optional)
What’s a F Rating?

The time period that the through-penetration firestop system limits the spread of fire through the penetration when tested in accordance with ASTM E 814 or UL1479.
What’s a T Rating?

Temperature or Insulation Rating:

The time it takes for a single point on the non-fire side to reach 325ºF (163ºC) over the initial starting temperature (e.g. 400ºF where ambient temperature was 75ºF)
T Rating Example

UL System # C-AJ-1506

F Rating - 2 hr
T Rating - 2 hr

3” thick M.W. pipe insulation 36” above floor

And 12” below floor
T Rating Example
714.4.1.2 Through-penetration firestop system.
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 inch of water (2.49 Pa). The system shall have an F rating / T rating of not less than 1 hour but not less than the required rating of the floor penetrated.

Exceptions:

1. Floor penetrations contained and located within the cavity of a wall above the floor or below the floor do not require a T rating.

2. Floor penetrations by floor drains, tub drains or shower drains contained and located within the concealed space of a horizontal assembly do not require a T rating.

3. Floor penetrations of maximum 4-inch (102 mm) nominal diameter penetrating directly into metal-enclosed electrical power switchgear do not require a T rating.
Exceptions:

Floor penetrations:
1. In stud cavity of a wall
2. Drains in concealed space of horizontal assembly
3. Maximum 4” conduit directly into metal-enclosed switchgear
714.4.4 Penetrations in smoke barriers.

Systems for penetrations in smoke barriers must be tested for air leakage per UL 1479.

L Rating shall not exceed:

1. 5 cfm/sf of opening for each firestop system
2. Total of 50 cfm for any 100 sf of wall or floor area
W Rating

Quantifiably measures resistance of a firestop product to water in buildings

3 feet of head pressure is applied to the seal for 72 hours to determine if the seal is “water-tight”

*Intended to address “washout” during construction*
M Rating - ASTM E3037 (New)

- ASTM E1966 or UL 2079 for the movement capabilities of a joint system.
- ASTM E814 and UL 1479 standards used to test through-penetration firestops, do not include provisions for movement testing. (silicone or pillows were used for firestops expected to experience large degree of movement)
- November 2016 a new ASTM standard was published that can help quantify the movement allowances of through penetrations. This new standard is ASTM E3037, “Standard Test Method for Measuring Relative Movement Capabilities of Through-Penetration Firestop Systems.”
M Rating - ASTM E3037 (New)

• It has been several years since this standard was published, testing laboratories are still in the process of deciding how they will report the data collected during these tests. Any results to date are strictly generated internally by firestop manufacturers.

• Initial testing has shown that firestop devices such as cable pathways or firestop collars perform very well and can accommodate a large range of movement. This is to be expected since these types of products do not involve a curing process with an adhesive bond formed to the penetrant.

• It stands to reason that firestop systems that utilize a sealant will eventually suffer damage during movement since the bond between the firestop and penetrant will be compromised at a critical displacement value.

• However, this is not to say that these types of systems are inherently inferior to firestop devices.

• STI and other firestop manufacturers can point to decades of successful installations that feature firestop sealants without any indication of damage in the face of normal movement cycling.
M Rating - ASTM E3037 (New)

• Collectively these installs have been subjected to water hammer, thermal expansion/contraction, vibrations and deflection due to building loading just to name a few potential causes of movement. Failure in a sealant-based firestop system due to penetrant movement is an outlier and can likely be traced back to an extreme operating environment or a potentially compromised installation process.

• ASTM E3037 testing will soon give interested parties additional information when selecting a firestop system. As an industry we have to be careful we are using this data as a meaningful screening tool, and we must not fall into the trap of simply selecting a firestop that accommodates the greatest degree of movement. There are many other important factors to consider when arriving at the best system for a given application.

• Currently there are still no test per this standard, it is still new and UL did not properly define yet a proper protocol to issue the systems.
Ratings Summary

F Rating - the minimum amount of time an installation has been shown to prevent the propagation of fire. (F = Fire / Flame).

T Rating - amount of time for the surface of a penetrating item on the non-fire side of the assembly to rise to 325°F + ambient temperature. (T = Temperature Rise / Thermal).

L Rating - amount of air (smoke) that can leak (pass) through an assembly, measured in cubic feet per minute. (L = Leakage / Smoke).

W Rating - water resistance of an assembly, tested @ 72 hours with 3’ head of water (pressure). (W = Water).
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<td>Fire tests on building materials and structures. Method for determination of the fire resistance of elements of construction (general principles).</td>
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<th>BS EN13501-1</th>
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<td>Fire resistance tests for service installations - Penetration seals.</td>
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<th>BS EN1366-4: 2006</th>
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<td>Fire resistance tests for service installations - Linear joint seals.</td>
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Different Standards & Certification

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<tr>
<td>ASTM E 84</td>
<td>Test method for Surface Burning Characteristics of Building materials. The test evaluates the spread of flame along the surface of the material. It is not a resistance test.</td>
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<tr>
<td>ASTM E 1966</td>
<td>Test method for Fire-Resistive Joint Systems. This test is used to evaluate the performance of a joint after a cyclic movement test and fire exposure test. UL 2079 - equivalent</td>
</tr>
<tr>
<td>ASTM E 814</td>
<td>Test method for Fire Tests of Through Penetrations Firestops. This test is used to evaluate the performance of a firestop system, following fire exposure a hose stream test is conducted. UL 1479 - equivalent</td>
</tr>
<tr>
<td>BS EN ISO 10140</td>
<td>The laboratory measurement of airborne sound insulation of building elements.</td>
</tr>
<tr>
<td>BS EN 1026: 2000</td>
<td>Air permeability test method.</td>
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<td>BS EN 1027: 2000</td>
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<td>Different Standards &amp; Certification</td>
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<td><strong>CE</strong></td>
<td>CE marking is a declaration by the manufacturer (through verified testing) that the product meets all the appropriate provisions of the relevant legislations implementing certain European Directives.</td>
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<td>ETA - The European Technical Assessment provides information about the construction product to be declared in relation to its essential characteristics.</td>
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<td><strong>UL</strong></td>
<td>UL is an abbreviation for Underwriters Laboratories Inc. which is an independant, not for profit product safety testing and certification organisation.</td>
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<td><strong>FM Approvals</strong></td>
<td>FM Approvals is an international leader in third-party certification and approval of commercial and industrial products.</td>
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<td><strong>Certifire</strong></td>
<td>Certifire is an independant Third Party Certification organisation. The scheme undertakes requirements such as the manufacturing of products under a Third Party Quality Management System, Independant Audit Testing, and a Comprehensive Field of Applications document based on careful chosen test that helps to ensure the products and systems are used within their approval scope.</td>
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The BS476 is the old British standard for fire resistance in construction, in 2008, it was replaced by the EN1366-3. No manufacturer continues to test per the BS476. Both standards are very similar.

UL1479 / ASTM E814 and EN 1366-3 are both used as test standards for firestopping penetrations however they are prescribed in different parts of the world with different code requirements. UL 1479 / ASTM E814 are prescribed in the USA and where countries adopt the US codes and standards. The EN 1366 is prescribed in the EU and in countries that adopt EU standards.

It should be noted that unlike UL 2079 and UL 1479, BS 476: Part 20 does not specifically detail the requirements for testing joint seals or penetration seals. For this reason, in the absence of a published British Standard specifically for this purpose, details from EN 1366-3 and EN 1366-4 have been used.
Main differences between the BS476 part 20 and UL2079 / UL1479 standards

- **Mounting and installation** – No specific instructions for mounting and installation are given in BS 476: Part 20. UL2079 and UL1479 require the seal to be installed in a representative manner of end use.

- **Heating conditions** – Both standards use almost identical specified heating conditions (based upon ISO 834). However the method of measuring the temperature is slightly different. The use of shielded thermocouples in UL 2079 and UL1479 results in a more severe exposure for the seals, due to the need for a greater gas/air mix input to achieve the same measured temperature.

- **Pressure conditions** – The required pressure of BS 476: Part 20 (adopted from EN 1366-4) for the testing joint seals in walls is 10 Pa at mid-height in walls and, 20 Pa 100 mm below the floors. The requirement of UL 2079 and UL1479 is 2.5 Pa at mid-height in walls and 2.5 Pa at 305 mm below the floors.
Main differences between the BS476 part20 and UL2079 / UL1479 standards

• Movement – The BS 476: Part 20 test includes no requirements for movement capability. The UL 2079 test requires that cyclic testing is conducted prior to fire testing if the seal is to be designated as ‘Dynamic’. The UL 2079 test is therefore more stringent in this respect.

• F Rating - Integrity – Both methods require that there is no ignition of a cotton pad, sustained flames or gaps. For all test methods, the F-Rating condition is mandatory.

• T-rating - Insulation – Both methods require that no temperature rise is recorded in excess of 180°C.
  • For UL1479 / ASTM E814, T rating is an optional test, it is required in the US codes for penetrations through fire resistance rated floor assemblies. It is not prescribed for wall assemblies.
  • For the BS and EN, the T-Rating shall be equal to the F-Rating. Depending the European countries it can be EI60, EI90 or EI120
Main differences between the BS476 part 20 and UL2079 / UL1479 standards

• L and W Ratings - Unlike EN 1366 or BS 476, the UL 1479 standard includes two test protocols (conducted at the option of the test sponsor) for evaluating air leakage (L Rating) and short-term water resistance (W Rating). The L Rating is used as an indication of smoke resistance. (Very Important)

• Hose stream – BS 476: Part 20 has no hose stream requirement. However, UL 2079 and UL1479 require that the specimen be subjected to a high-pressure fire hose stream test directly after the fire test, without the formation of any gaps that would allow the projection of water. The purpose is to ensure that the integrity of the system is kept and to ensure the reliability of the firestop system. It is considered that the addition of the post fire test hose stream required by UL2079 and UL1479, which being of a magnitude of pressure, tens of thousands of times greater than the difference in furnace pressure, would be expected to exploit any such weaknesses in the seal and project water and thus result in failure. For this reason, ASTM firestop systems usually use more firestop material to ensure this hose stream test at the end of the fire exposure.
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6. Q&A
MEP Penetrations

- Mechanical
- Electrical
- Plumbing
Data Communications

• High Traffic Openings
Different Types of Penetrations

- Metallic Penetrants
  - Steel, iron, copper, conduit, etc.
- Plastic Penetrants
  - PVC, cPVC, PPR, HDPE, etc.
- Cables
- Cable Tray
- Busway
- Ducts
Penetration Firestopping (XHEZ) as defined by UL

Firestop systems, which are specific constructions consisting of a **wall or floor assembly**, a **penetrating item** passing through an opening in the wall or floor assembly, and the **materials** designed to prevent the spread of fire through the openings.
Through penetrations vs. Membrane penetrations

**Noncombustible Penetrant**
Membrane penetration unaffected by the side of assembly exposed to fire.

**Combustible Penetrant**
Membrane penetration may be affected by the side of assembly exposed to fire due to the possibility of intumescent not activating.
Firestopping is a system

Firestopping is not just one item; rather, it is a **SYSTEM** consisting of:

- **sealing method used to:**
  - seal the opening
  - protect the penetrants

- **penetrant or penetrants** (if any)

- **fire-rated barrier** being penetrated
MEP Penetration UL Systems

Identifying System Variables

Four Variables:
1. Assembly Type & Rating
2. Hole Size/Annular Space
3. Penetrant Type
4. Firestop Material
Verify all system details

- Type of barrier & its hourly rating
- Type of penetrant(s)
- Maximum hole size
- Maximum penetrant size
- Annular space: minimum AND maximum
- Special considerations:
  - Sleeve?
  - Coupling?
  - Angle of penetrant?
Determining Annular Space

Assume a 4” O/D pipe in all openings.

1, 2, 3 = 8” holes  
4 = 4” hole  
5 = 6” hole
Determining Annular Space

For round openings, measure to the widest and narrowest distance between the penetrant and the edge of the opening.

When you have a square or rectangular openings, measure only to points perpendicular to the penetrant, **NOT** to diagonal points.
Always start with a system

Every application has its own system which calls out:

- Hourly Fire Rating
- Type of Barrier
- Type of Penetrant
- Min/Max Annular Space*
- Firestop Materials

FCIA
Firestop Contractors International Association
Following a UL® System Approach

Reading a UL System: Penetration Firestop Systems

W-L-1222

Floor, Wall or Combination
The First Grouping Means:

Penetration Firestop Systems

First Alpha Character – signifies what is being penetrated

F = Floors
W = Walls
C = Walls and Floors

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STI

Specified Technologies Inc.
Reading a UL System: Penetration Firestop Systems

W-L-1222

Construction type of wall or floor
The Second Grouping Means:

Penetration Firestop Systems
Following Alpha Character(s) – wall or floor construction type

A = Concrete floors ≤ 5 inch thick
B = Concrete floors > 5 inch thick
C = Framed floors
D = Steel decks in marine vessels
E-I = Reserved for future use
J = Concrete or masonry walls ≤ 8 inch thick
K = Concrete or masonry walls > 8 inch thick
L = Framed walls
Following a UL® System Approach

Reading a UL System: Penetration Firestop Systems

W-L-1222

Penetrant type
The Third Grouping Means:

Penetration Firestop Systems

**Numeric Component** – first digit identifies the type of penetrant, next three are sequential system numbering

- 0000-0999 = No Penetrant
- 1000-1999 = Metallic pipe, conduit or tubing
- 2000-2999 = Plastic pipe, conduit or tubing
- 3000-3999 = Electrical cables
- 4000-4999 = Cable trays with electrical cables
- 5000-5999 = Insulated pipes
- 6000-6999 = Bus ducts
- 7000-7999 = HVAC ducts
- 8000-8999 = Mixed multiple penetrations
- 9000-9999 = Reserved for future use
Following a UL® System Approach

Reading a UL System:
Penetration Firestop Systems

**W-L-1222**

Following numbers – *individual system number*:

- sequential counter, each time a test is passed the next number is assigned to that system
- every system number is unique to a specific manufacturer
MEP penetration firestop materials

- Sealants
- Collars & Wrap Strip
- Putty Pads & Box Inserts
- Pillows
- Mortar
- Composite Board
- Cast-in Devices
Sealants

• Start with a system
• Verify all system details
• Clean the substrates
• Use backing if required
• Install sealant to correct depth
• Tool sealant as needed
Are intumescent materials necessary?

As combustible penetrants soften with heat, intumescent firestop materials will:

• Collapse the penetrant as it burns
• Stop fire from spreading
• Form a tough smoke seal
• Reduce the transmission of heat
Are intumescent materials necessary?

YES!

Charred Pipe

Hot-Side View

Knot formed from Collapsing pipe

Cold-Side View
Installing Collars

Firestopping Plastic Pipes

- Firestop Caulk
- Firestop Collar

PVC Pipe
Electrical Box Firestop

INSTALL WHEN...
1) Boxes greater than 16 square inches (i.e. 4” x 4”)
2) Horizontal separation between boxes on opposite sides of the wall ≤24”
3) Where total area of boxes is >100 square inches per 100 square feet.
Large openings, multiple penetrant installations
Pillows

- Install lengthwise through opening
- Compress approximately 30%
- Fill small gaps with putty or sealant
- Wire mesh may be required
- Never remove the bag!
Mortar

- Mix per instructions
- Stiffer to trowel (walls)
- Looser to self level (floors)
- Non-porous forms
- Forms must be removed!
Composite Sheet

- Cut out openings for penetrants
- Apply bead of firestop sealant around periphery
- Overlap sheet 2” beyond periphery
- Secure with 1 ¼” screws and 1” washers every 6”

Install putty around penetrating items
Cast-in Place Devices

- Saves money by eliminating core drilling
- Saves time, no firestopping step required
- Provides pre-installed fire and smoke sealing
- Provides added protection against transient water
- Pipes can be installed from top or bottom
Data Communications
• High Traffic Openings
Always start with a system
Data Communications UL Systems

Identifying System Variables

**Four Variables:**

1. Assembly Type & Rating
2. Hole Size/Annular Space
3. Cable Type / Fill %
4. Firestop Device or Material
Verify all system details

• Type of barrier & its hourly rating
• Type of penetrant(s)
• Maximum hole size
• Annular space: minimum AND maximum
• Maximum cross-sectional cable fill %
• Special considerations:
  • Sleeve?
    • Extended or Flush?
  • Angle of penetrant?
Data communications firestop materials

- Sealants
- Putty
- Pillows
- Retrofit Devices
- Cable Devices
Traditional: Cables and sleeve with putty
Life-cycle of a typical sleeve

Over time sleeves become overfilled
Installing EZ-Path Retrofit Device
Major Issues & Examples

Challenge:

How do we get from here...
Major Issues & Examples

...to manageable compliance?
Cable Management

EZ-Path Fire-Rated Pathway

• Internal self-sealing mechanism
• Automatically adjusts to the cable load
• Maintenance-Free
• Manage cable moves, adds & changes
• UL’s Evaluation Report
  • 100% code compliant / 100% of the time
Fire-Rated Cable Grommet

- For single or dual cable penetrations in fire-rated drywall
- Two-piece snap-together firestop device
- Cables up to 0.500” dia.
- Membrane or through penetrations
Smoke & Acoustical Pathway

Proven smoke & sound resistance where frequent cable changes are anticipated

FCIA
Firestop Contractors International Association

STI
Specified Technologies Inc.
Thank you

Fouad Hajj
Regional Manager (GCC & South Asia)
Specified Technologies Inc. (STI)