Firestopping – Past, Present and Future

Topics

I. Past
II. Present
III. Future
Past
Past – The Early Years

• The first firestopping was done for marine applications in the 60’s. These were both very crude and robust by today’s standards. Typically steel sleeves were welded to bulkhead, pipes or cables passed through the sleeve, and ends of sleeves plugged.

• For commercial construction, 1973 Standard Building Code 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.”
  • Relied on the code official determining what was an “approved” material.

• Brown’s Ferry Nuclear Plant Fire – March 22, 1975 – Firestopping, consisting of a foamed plastic covered with FR coating, was a contributing factor to a near nuclear disaster. This fire was pivotable in the development of firestopping as it know it today.

• Shortly after the Brown’s Ferry fire, UL and the codes writers recognized the need for more robust firestopping. The first step in that process was to develop a test method for evaluating the systems.

• UL’s Leon Przybyla and Abdur Abassi began work on developing a test method for firestopping in 1975.
Past – The Early Years

• UL published the first Firestop listing for Nelson Electric in 1976. Listing published under the product category “Wall Opening Protective, Multiple-Cable Devices” (ZCMU) as a product listing. This listing was published as a product listing due to it simplistic nature. This product category was later renamed “Wall and Floor Opening Protective, Multiple-Cable Devices” (ZCMU), “Through-Penetration Firestop Devices” (XHCR) and finally “Firestop Devices (XHJI). Listing based on fire tests conducted using an UL 263 / ASTM E119 time-temperature curve.

• UL published the first Firestop System listing for Semco covering a silicone foam in 1977. Listing published under the product category “Wall and Floor Opening Protective, Multiple-Cable Systems” (ZCOR). This product category was later renamed “Through-Penetration Firestop Systems” (XHEZ). Listing likewise was based on fire tests conducted using an UL 263 / ASTM E119 time-temperature curve.

• By December, 1980, UL had 23 published firestop systems and four firestop device product listings.

• The product category “Wall and Floor Opening Protective, Multiple-Cable Devices” (ZCMU) was renamed “Through-Penetration Firestop Devices” (XHCR) in 1982.
Past – The Early Years

• The product category “Wall and Floor Opening Protective, Multiple-Cable Systems” (ZCOR) was renamed “Through-Penetration Firestop Systems” (XHEZ) in 1982.
• UL began testing firestop devices and system to UL 1479 in 1982.
• These early listings were published in the UL Building Materials Directory.
Past – Development of UL 1479 – Firestop Systems – XHEZ

- UL and the industry began developing a test method to address protection of penetrations in 1975. UL and the codes recognized the need for more robust firestopping.

- Intent was to develop a unique fire test standard which complimented ANSI/UL 263 and ASTM E119, but addressed the unique nature of firestop systems:
  - Sample size
  - Differential pressure
  - Length of penetrating item
  - Temperature measurement / thermocouple pad size
  - F and T Ratings
- UL began using the published UL 1479 standard to test firestop systems in late 1992.

- Simultaneously, the codes began to require tested firestop systems. 1979 UBC required the following:
  - Penetrations. Penetration through walls, floors and ceilings which require protected openings (shall be protected):
    - 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 time-temperatures curve prescribed in U.B.C. Standard No. 43-1 (UL 263 / ASTM E119) for the specific assembly.
    - Openings for steel electrical outlet boxes not exceeding 16 square inches in area, provided the area of such openings does not aggregate more than 100 square inches for any 100 square feet of wall or partition area. Outlet boxes on opposite sides of walls or partitions shall be separated by a horizontal distance of 24 inches.
    - Where walls and partitions are penetrated by outlet boxes of other materials or where larger openings are required, they shall be qualified by tests conducted in accordance with the provisions of Section 4302 (U.B.C. Standard No. 43-1 / UL 263 / ASTM E119).
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.
4304. (e) Penetrations.

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. T Rating waived under certain circumstances.

Exception: 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 U.B.C. Standard No. 43-1 (UL 263 / ASTM E119) time-temperature curve under a min 0.01 in. water column.

Openings in walls for steel electrical outlet boxes not exceeding 16 square inches in area, provided the area of such openings does not aggregate more than 100 square inches for any 100 square feet of wall or partition area. Outlet boxes on opposite sides of walls or partitions shall be separated by a horizontal distance of 24 inches.
Past – Evolutionary Changes to UL 1479 and UL 1479 Listings

The mid to late 80s and early 90s brought about a rapid advancement of the firestop industry.

- Reduced required positive furnace pressure from 0.03 in. water column to 0.01 in. water column in 1985.
- Through-Penetration Firestop Devices (XHCR) product listings were converted into firestop systems in 1991.
- Industry requests UL to consider inclusion of accelerated aging requirements for all firestop materials in UL 1479 in 1992.
  - This request leads to multi-year research on how best to evaluate effects of age on firestopping materials.
  - After much research and discussion, UL 1479 revised to include requirements for accelerated aging for intumescent firestopping materials in August, 2000.
    - Materials exposed to elevated temperature of 158°F for 270 days and high humidity of 97 to 100% and 95°F or 180 days
    - After exposure materials subjected to expansion pressure and expansion factor testing
    - These requirements remain in place today.
Past – Evolutionary Changes to UL 1479 and UL 1479 Listings

- Renumbered all firestop systems from numeric sequence to current numbering system in 1992.
- Used the opportunity to rewrite systems in a standardized format. This was done in part to facilitate electronic searches.

C-AJ-1079

What does this mean?
Past – Evolutionary Changes to UL 1479 and UL 1479 Listings

• L Rating added to UL 1479 in 1993.
  • Developed in response to provisions in the NFPA 101 Life Safety Code requiring penetration in smoke barriers to resist the free passage of smoke and hot gases.
  • Test methodology originated in Germany.
  • Based on what was simultaneously being done for the door industry.
  • L Rating methodology was published in the May 13, 1993 edition of UL 1479.
    • Rating is optional
    • 0.30 in. water column differential pressure
    • Test conducted at ambient and 400°F
    • No acceptance criteria developed – Listings reflected the leakage determine by tests
    • First listing published in 1994 Fire Resistance Directory
Past – Evolutionary Changes to UL 1479 and UL 1479 Listings

- Revised furnace pressure requirements during testing to require 0.01 in. water column of pressure, 12 in. below floor-ceiling assemblies in 1994.

- W Rating added to UL 1479 in 2004.
  - Original intent was to determine ability of system to prevent floor to floor migration of water.
  - Intent later expanded to also address the ability of firestopping materials to continue to perform after exposure to water.

- Three Classes of Exposure:
  - Class 1 – 3 ft water column for 72 hrs
  - Class 2 – 20 ft water column for 10 min
  - Class 3 – 58 ft water column for 10 min

- F and T Ratings determined after fire exposure.
- First listings published in 2005 Fire Resistance Directory. All current listings focus on Class 1 Exposure.
Past – Evolutionary Changes to UL 1479 and UL 1479 Listings

• Added requirements for the testing of membrane-penetrations through wall assemblies in June, 2015.
  • Covers both outlet box penetrations and other membrane-penetrations.
Past – Approved / Qualified Contractor Programs

• Programs that certify a company has the knowledge and quality control procedures to properly install firestopping
  • Min. 2 years in firestop installation business
  • Designated Responsible Individual (DRI) is formally tested by FM or UL at regular intervals
  • Documented and archived record keeping system for all installations
  • Must have an approved Quality Control Manual
    • Firestop Systems and Assemblies
    • Training
Past – Development of UL 2079 – Joint Systems – XHBN

• UL began development of UL 2079, covering **Fire-Resistive Joint Systems**, in 1992
• New standard supported testing on joint systems which was first conducted in 1960 and first published in approximately 1984.
• Intent was to develop a unique fire test standard which complimented ANSI/UL 263 and ASTM E119, but addressed the unique nature of joint systems:
  • Sample size - Permits small-scale testing based on length of sample to maximum width of joint system ratio
  • Differential pressure
  • Temperature measurement / thermocouple pad size
  • Assembly and L Ratings - Unlike firestop system, new standard mandated unexposed surface temperature limitations
• Cyclical movement on joint systems intended for accommodate movement:
  • Class 1 – Thermal
  • Class II – Wind Sway
  • Class III – Seismic
Past – Development of UL 2079 – Joint Systems – XHBN

Past – Evolutionary Changes to UL 2079 and UL 2079 Listings

The mid 90s brought about a rapid acceptance of joint systems, along with modifications of listing requirements.

• Renumbered prior joint systems from fire-resistance based numbering system to current system in 1995.
• W Rating added to UL 2079 in 2006.
  • Original intent was to determine ability of system to prevent floor to floor migration of water.
  • Intent later expanded to also address the ability of joint materials to continue to perform after exposure to water.
• Three Classes of Exposure:
  • Class 1 – 3 ft water column for 72 hrs
  • Class 2 – 20 ft water column for 10 min
  • Class 3 – 58 ft water column for 10 min
• F and T Ratings determined after fire exposure.
• Currently there are no listings relating to a W Rating.
Past – Evolutionary Changes to UL 2079 and UL 2079 Listings

• Methodology for evaluating accelerated aging for intumescent materials added to UL 2079 in December, 2014.
  • Methodology mirrors that in UL 1479.
    • Materials exposed to elevated temperature of 158°F for 270 days and high humidity of 97 to 100% and 95°F or 180 days
    • After exposure materials subjected to expansion pressure and expansion pressure testing
  • This testing is optional for materials used in joint systems.

- UL began discussing the development of a test method for Perimeter Fire Containment Systems (i.e. perimeter fire barriers, perimeter firestops) in 1991.
- We struggled with the concept of how to configure the test sample to expose the underside of the perimeter joint to fire.
- Breakthrough came when ICBO-ES published AC108 26-9, covering an intermediate-scale test for flammability of combustible components on the exterior of exterior walls in January, 1996. This method was later published as ICBO Standard 26-9, and later yet as NFPA 285.
- UL and Omega Point simultaneously began development of test method and test equipment for perimeter fire containment systems (i.e. perimeter fire barriers, perimeter firestops) in 1996.
  - Method used the AC108 intermediate-scale furnace, adapted to account for the nuances of perimeter fire containment systems. Methods from the two labs differed in details but were conceptually identical.

• Included cyclical movement on perimeter fire containment systems intended to accommodate movement.
  • Class I – Thermal
  • Class II – Wind Sway
  • Class III – Seismic
• UL developed Integrity and Insulation Ratings, Omega Point developed F and T Ratings.
• First UL Perimeter Fire Containment System published in 1997.
Past – Development of ASTM E2837 – Continuity Head-of-Wall Joint Systems – XHBO

• ASTM began discussing the development of a test method for **Continuity Head-of-Wall Joint Systems** which intersect the bottom of a non-rated floor or roof system in 2006.

• UL conducted research work for the Metal Building Manufacturer’s Association to develop test method.

• Method developed is conceptually similar to that used for UL 2979 Head-of-Wall Joint Systems.

• Included cyclical movement on joint systems intended to accommodate movement.
  • Class I – Thermal
  • Class II – Wind Sway
  • Class III – Seismic

• Test method develops F and T Ratings.


• First UL Continuity Head-of-Wall Joint System published in 2013.

• At the request of FCIA, ASTM began discussing the development of inspection standards for the on-site inspection of firestop systems and joint systems in 2000.

• Standards allowed two parallel paths for inspections:
  • Visual inspections
  • Destructive inspections

  • ASTM E2174 – Installed Firestop Systems
  • ASTM E2393 – Installed Joint Systems and Perimeter Barriers

• Serves as basis for on-site inspections of firestop systems and joint systems.

Legacy Codes

• Three Legacy Codes:
  • Southern Building Code Congress International – Standard Building Code
  • Building Officials & Code Administrators – National Building Code
  • International Conference of Building Officials – Uniform Building Code

• Vickie Lovell, Code Consultant to the International Firestop Council, did an outstanding job modernizing and harmonizing the requirements of the three legacy codes in the mid 90s.

• Three codes included the following provisions relating to the protection of penetrations:
  • Tested as part of a wall or floor-ceiling assembly
  • Tested to UL 1479 / ASTM E814
  • Exception for noncombustible penetrants of limited size through walls and floor-ceiling assemblies, protected with concrete, grout or mortar installed to full thickness of wall or floor-ceiling assembly.

Legacy Codes

- Exception for noncombustible penetrating items protected with materials which prevent ignition of cotton waste when subjected to UL 263 / ASTM E119 time-temperature fire conditions under a min 0.01 in. water column positive pressure
- Electrical box exceptions
- Firestop Systems tested to UL 1479 / ASTM E814 required F Rating on wall penetrations and F and T Ratings on floor penetrations, with exceptions
- Three codes contained provisions relating to the protection of joints:
  - Full-scale testing to UL 263 / ASTM E119
  - Cyclical movement on joint systems intended for accommodate movement.
  - Joint system tested at maximum joint width
  - Positive furnace pressure
  - Mandatory unexposed surface temperature (i.e. T Rating)

Legacy Codes

• Three codes contained provisions relating to the protection of perimeter voids:
  
  • UBC required voids created at intersection of exterior wall and floor slab to be sealed with approved material, securely installed and capable of preventing passage of flames and hot gases sufficient to ignite cotton waste when subjected to UL 263 / ASTM E119 time-temperature fire conditions under a minimum 0.01 in. water column positive pressure.
  
  • The SBC required voids created at intersection of exterior wall and floor slab to be sealed with approved material designed and tested for this purpose.
  
  • The NBC was silent on this protection.
  
  • All three code lacked details on how that material would be tested.
Past – International Building Code

• The three legacy code writers merged in the late 90s into one organization, the International Code Council (ICC). Original intent was NFPA was to be part of ICC. NFPA ultimately decided to maintain their independence.

• The legacy building codes were merged into one model building code, the International Building Code (IBC).

• First edition of the IBC was published in 2000.

• Requirements for the protection of penetrants mirrored the last editions of the three legacy codes.

• Requirements for the protection of joints changed significantly:
  • UL 263 / ASTM E119 was replaced with UL 2079, thereby allowing small-scale testing on the narrower width joints
  • Requirements for the protection of perimeter voids mirrored the 1997 edition of the UBC.
Past – Evolutionary Changes to IBC

• A number of evolutionary changes to the IBC occurred from the 2000 edition to the 2018 edition thanks to the efforts of FCIA and IFC.

• Significant changes were as follows:
  • 2003 IBC – Methods of protecting membrane penetrations by outlet boxes continued to expand.
  • 2006 IBC – Methods of protecting membrane penetrations by outlet boxes continued to expand.
  • 2006 IBC – Requirements were added that penetrations and joints through or in smoke barriers are required to have an L Rating when tested in accordance with UL 1479 and UL 2079, respectively.
  • 2006 IBC – ASTM E2307 was referenced as an optional test method for evaluating the perimeter void.
  • 2009 IBC – Provisions relating to the protection of duct penetrations using firestop systems was clarified.
  • 2009 IBC – Methods of protecting membrane penetrations by outlet boxes continued to expand.
  • 2012 IBC – Requirement added that interior fire-resistance-rated wall assemblies shall be identified as being fire rated through specific marking at specific locations.
Past – Evolutionary Changes to IBC

• 2012 IBC – Methods of protecting membrane penetrations by outlet boxes continued to expand.
• 2012 IBC – ASTM E2307 became the base requirement for testing perimeter voids. An additional provision was added that stated floor to ceiling glass systems need only meet the traditional UL 263 / ASTM E119 time-temperature fire conditions, essentially as required by the 2000 IBC.
• 2012 IBC – Requirements added for special inspections for firestop systems and fire-resistant joint systems in high-rise buildings (occupied floor > 75 ft above FPD access) and Category III and IV buildings, based on the inspections standards ASTM E2174 and E2393, respectively.
• 2015 IBC – Requirement added that void between fire barrier and nonrated roof be filled with an approved material.
• 2015 IBC – Requirement added that void between curtain wall and vertical fire barrier be filled with an approved material.
• 2015 IBC – Methods of protecting membrane penetrations by outlet boxes continued to expand.
Past – Evolutionary Changes to IBC

- 2018 IBC – Provision added that firestop systems and fire-resistant joint systems shall be installed in accordance with the manufacturer’s instructions and the listing criteria.
- 2021 IBC – Rewrote Section 715 covering Fire-Resistant Joint Systems to clarify existing requirements. Changes were primarily editorial.
- 2021 IBC – Requirements for special inspections of firestop systems and joint systems expanded to include R occupancies (Residential) with occupant load greater than 250.
Past – Evolutionary Changes to IFC

• 2019 International Fire Code (IFC) – Rewrote Chapter 7 covering inspection and maintenance of Fire and Smoke Protection Features, including fire-resistance-rated construction and the methods of protecting breaches through that construction.
Present
Present – IBC Requirements

• Your Association has been an active participant in developing a well defined set of requirements relating to the fire safety of commercial buildings.

• Programs now in place include:
  • A well defined set of code requirements
  • A well defined set of test standards which compliment the code requirements
  • Two qualified/approved contractor programs
  • Inspection standards for firestop systems and fire-resistant joint systems
  • Special inspection requirements for key types of buildings
  • Criteria for evaluating competency of special inspectors
  • Establishment of Master Audit Certificate of Compliance (MACC) Program

You should be very proud of the accomplishments of your Association.
Future
Future

What tools can we create?
What standards can we created?
What certifications can we publish?
What education can we provide?
What qualifications can we offer?
Future – UL Fire Resistance Directory – Product iQ

What should the directory look like?
What information is needed?
What should be changed?
Should there be additional parts of the directory? (e.g. commentary)
How can the information be more digital?
## Future – Firestop Movement

<table>
<thead>
<tr>
<th>Movement Direction</th>
<th>Penetrant Item</th>
<th>Penetrant Diameter</th>
<th>Annular Space</th>
<th>Movement</th>
<th>Sealant Depth</th>
<th>L Rating with Movement</th>
<th>W Rating with Movement</th>
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</thead>
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<tr>
<td>Y</td>
<td>2A</td>
<td>Minimum 1 in.</td>
<td>0.125-1 in.</td>
<td>25%</td>
<td>1/2 in.</td>
<td>X cfm</td>
<td>X</td>
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<tr>
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<td>Minimum 1 in.</td>
<td>&gt;1 in.</td>
<td>5%</td>
<td>1/2 in.</td>
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<td>0.25 in.</td>
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<td>Minimum 1 in.</td>
<td>0.25 in.</td>
<td>1/2 in.</td>
<td></td>
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</tr>
</tbody>
</table>
Future – UL Standards Technical Panel (STP)

How will FCIA members educate the STP?

Will there be research presented on contractor related matters?

- Field conditions and install.
- Field preparations.
- Install sequencing.

Will a day in the life of an FCIA member be brought to the STP and captured in a standard?

Get involved.
Future – UL Certifications

What should the designs look like?

What information is needed?

What should be changed?

Is the alpha-numeric system poised for the future?

System No. W-L-6018
January 08, 2010

F Ratings — 1 and 2 Hr (See Item 1)
T Rating — 1 Hr
Future – Hydrocarbon and Jet Fire Exposures

Other parts of the world focus on hydrocarbon fire exposures.

- Industrial facilities.
- Petrochemical environments.
- Nuclear facilities.
- Offshore platforms.
- Tunnel applications.

Jet fire systems (ISO 22899-1)
Future – New Regions

Where should we focus firestopping resources?

- Middle East?
- South America?
- Asia?
- Mars?
Future – Cross Laminated Timber

How do we accommodate CLT?

• Codes?
• Standards?
• Designs?
• Follow Up Services?
Future – Industry Education

How do we continue to reach and educate the industry?

• UL resources:
  • Newsletters.
  • Webinars.
  • Industry meetings.
• What else?
Future – Archaic Construction
Future – Sleeved Penetrants
Future – CAN/ULC S115

Now includes Perimeter Fire Barrier Containment Systems in accordance with ASTM E2307.

What else can we do to evolve?
Future – Horizontal membrane penetrations.

Wood Subfloor

Wood Joist

Penetrant

Gypsum Ceiling

Firestop System
Future – Patching and Repair Guidelines

Efforts have been initiated.
Future – Interior Rated Wall to Non-rated Exterior Wall

- Not part of any test standard.
- What standard should it be part of?
  - Existing?
  - New?
- What should the testing consist of?
  - Fire from inside and outside (like ASTM E2307)?
  - Fire from one side of interior wall to the other side of the interior wall?
  - Other?
Future – The possibilities are endless.

Qualified contractor requirements in the building code.

3D printing firestops?

RF ID sensors for field labeling?

Micro and macro thinking.
Future – Happy Anniversary FCIA!

20th year anniversary gift, UL China.
Future – What do we want it to be?

The future looks promising.

It is up to all of us to keep it that way.

Plenty of work to do.

The FCIA contribution will continue to breed change.

Keep bringing your expertise to the standards and certification industry.

20 years of great history and track record. Infinite more years to come.

The future depends on our investments now.
Thank you FCIA.