

**Firestop Systems – Through the Building Life Cycle
Design, Installation, Contractor and Installer Qualification, Inspection and Ongoing
Management- a standardized process for an Industry.**

Fire-resistance-rated construction exists in many new and older buildings throughout the US and Canada. Gaps are made at the top of walls to allow for movement and deflection of floors above. Joints are made for expansion in the wall. Penetrations are made as pipes and cables deliver various services to the many parts of the building.

In all cases, the fire resistance rating of the wall must be maintained due to the continuity clauses in code requirements. Both the International Building Code and NFPA Codes mandate ‘continuous fire ratings’ in fire-resistance-rated assemblies.

To maintain continuity where joints, gaps and penetrations exist in fire-resistance-rated construction, there are various methods used to extend the wall to the penetrating item.

The International Building Code, 2009 version, in all sections, Section 706 Fire Walls, section 707 Fire Barriers, Section 709 Fire Partitions, Section 710 Smoke Barriers, all reference Section 713 for Penetrations and Section 714 for Joints. Section 713 allows the following options for Penetrations:

713.3.1 Through Penetrations. Penetrations through fire walls, fire barriers, smoke barrier walls and fire partitions shall comply with section 713.3.1 through 713.3.1.2.

Exception: Where the penetrating items are steel, ferrous, or copper pipes, tubes or conduits, the annular space between the penetrating and the fire resistance rated wall is permitted to be protected as follows:

1. In concrete or masonry walls where the penetrating item is a maximum 6-inch nominal diameter and the area of the opening through the wall does not exceed 144 Square inches, concrete, grout or mortar is permitted where it is installed the full thickness of the wall or the thickness required to maintain the fire-resistance rating; or
2. The material used to fill the annular space shall prevent the passage of flame and hot gasses sufficient to ignite cotton waste when subjected to ASTM E 119 or UL 263 time-temperature fire conditions under a minimum positive pressure differential of 0.01 inch, (2.49Pa) of water at the location of the penetration for the time period equivalent to the fire-resistance-rating of the construction penetrated.

713.3.1.1 Fire-Resistance Rated Assemblies. Penetrations shall be installed as tested in an approved fire-resistance-rated assembly.

713.3.2 Through Penetration Firestop System. Through penetrations shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E 814 or UL 1479, with a minimum positive pressure differential of 0.01

inch (2.49Pa) of water and shall have an F rating of not less than the required fire-resistance rating of the wall penetrated.

To extend the rating of the wall or floor to the penetrating item, Fire Tests ASTM E 814 and UL 1479, are the tests for Through Penetration Firestop Systems. These test standards were developed specifically for through penetrations and cover membrane penetrations as well. Both these tests use similar time temperature curves, and result in fire resistance ratings, (F) to match the assembly penetrated.

There is also Temperature "T" ratings required as well. The T Rating is used to determine how long the penetrating item heats up on the cold side of the assembly, and simulates fire spread without the flame actually passing through the assembly. Instead, the temperature of the penetrating item, when rising 325F above ambient, can cause fire on the non fire side of the assembly, meaning fire spread without flame every moving through the wall or floor.

To maintain continuity of smoke barriers, an additional requirement is needed, the "L" Rating. UL 1479 is currently the only standard that measures the passage of air through the assembly including the penetrating item, at ambient and 400F. Ambient simulates cold smoke, while 400F simulates hot smoke, both measured in cubic feet per minute per square foot of opening area. The lowest rating is <1 CFM/SF, given to several systems that have been tested at various locations to UL 1479.

In 713.4.1.2 Membrane Penetrations, the language is very similar, with the same exceptions as well. Additionally, there are passages that address electrical boxes that do not exceed 16 square inches, nor 100 square inches per 100 square feet of wall area, and the 1/8" max. gap size around the box in ceilings and walls. Also, in 713.4.1.2, section 5 mentions that penetrations around sprinkler piping can be treated with a metal eschutcheon plate.

Ducts must comply with Section 716, and which covers both fire and smoke dampered and non dampered ducts. Fire Dampers are tested to another testing protocol, UL 555 for fire dampers and UL 555S for smoke dampers. Treatment of fire dampers must be to the tested system. There are no generic treatments for fire dampers.

Non Dampered ducts, however, have the same requirements and limitations as metal pipes listed above in 713.2 through 713.3.3

Regardless of the type of penetrating item, gap or joint, the continuity of the fire resistance or smoke resistant assembly must be maintained. In order to maintain the fire resistance, one of the prescribed methods needs to be used. To use the method, the appropriate fire resistance rated assembly must be selected and installed to the system either tested or described in the code. Systems Selection is a key component to a successful installation, whether with the generic materials described in the code, or a tested and listed firestop system from the Underwriters Laboratories, FM Approvals or Intertek directories.

In Section 714, Fire-Resistant Joint Systems, there is important language that requires that the fire resistance rating of the assembly be maintained.

The void created at the intersection of a floor ceiling assembly and an exterior curtain wall assembly shall be protected in accordance with Section 714.4.

In 714.6, Fire-resistant joint systems in smoke barriers, Fire-resistant joint systems in smoke barriers and joints at the intersection of a horizontal smoke barrier and an exterior Curtainwall, shall be tested in accordance with the requirements of UL 2079 for air leakage. The air leakage rate of the joint shall not exceed 5 cfm per lineal foot of joint at .3 inch of water for both the ambient temperature and elevated temperature tests.

Firestopping is much more than just ‘sealing penetrations’. It is a trade devoted to fire and life safety through extending the fire resistance and smoke resistant assembly properties, with quantified requirements outlined in codes and standards. Regardless of code, the case is clear. Firestopping must be installed to the code described tested and listed system, or prescribed material.

Why is systems selection important?

Whether treating a penetrating item or items, the appropriate firestop system or exception must be selected or applied.

Systems Selection is the key to firestopping appropriately. If treating a smoke barrier, an “L” Rated Firestop System is required. And, the International Building Code 2009 version only allows 100CFM/SF of wall area. Therefore, the cumulative air leakage of penetrations in the 100SF area must be added to assure compliance.

Without proper systems selection and installation to the tolerances noted in the system, a violation of the fire resistance rated assembly occurs, and the wall or floor continuity is compromised.

DIIM – Design, Install, Inspect and Manage Firestopping

The firestopping industry has been evolving quickly since its inception in the building industry in the late 70’s, early 1980’s. There now are real standards for fire Systems selection, then installation to that system and its limitations is imperative to maintaining the continuity of the assembly, and its fire-resistance rating stop installation and inspection quality that are catching on in other compartmentation disciplines.

By looking inside our industry’s complete process from product characteristics through execution and inspection, commissioning, and into the work result, we found a need to create standards not just for testing, but for everything. We saw the need for every step of the way, including installation, inspection and management. Using this holistic view of firestopping *and* effective compartmentation brought new ideas to the construction industry, through firestopping. This section focuses on these programs, and where they might be specified for the benefit of the building owner and manager.

Design - Tested Systems Explosion

From a small 5" x 7", 200 page book with firestop designs suitable for protecting a limited number of situations, to an 8" x 11" 3-volume phone book, systems are available now to firestop many building types with all tested and listed systems straight from the published directories. There are literally 8800+ classified firestop systems, with up to 30 variations of each one, meaning a wide array to cover a multitude of construction conditions. That means specifiers can feel confident there are systems for almost all configurations in buildings. Building owners and managers can use tested and listed systems for just about all the applications their contractors workforce encounters. And where none exists, by any manufacturer, then we consider asking for an Engineering Judgment.

These systems and engineering judgments, plus product data sheets, must be what is seen in submittal packets from contractors on projects, usually specified in 07-84-00, Submittals. FCIA has a sample specification for use at <http://www.fcia.org> , click on specification.

Engineering Judgments

FCIA's Firestop Manual of Practice, 2009 edition, states that classified products used in tested and listed systems provide test proven protection, and should be used first even if it means a change in manufacturer for that situation on a project. Since most specifications call for 'single manufacturer to the greatest extent possible', it allows for more than one manufacturer's products to be used on a project ... within reason ... as is discussed with building owners and managers of the facility. Additionally, there are jurisdictions that may not allow engineering judgments without an engineer's stamp.

Install – Contractor Quality ‘Management Systems’ Programs take off, and a workforce develops

The next discussion falls into the category of Management Systems and 'Quality Assurance'. Usually, quality assurance means the manufacturers' products. In this case, to provide a proactive construction process installation protocol program, FCIA worked with FM Approvals to create a standard for the management system process in the construction subcontracting industry...FM 4991 - Standard for the Approval of Firestop Contractors...as well as Underwriters Laboratories, Inc. for the UL Qualified Firestop Contractor Program.

FM 4991. FM 4991, listed in specifications through reference in master specifications such as MasterSpec and SpecLink, is a management system process subjected to an audit program by FM Approvals. To attain approval, the contractor firm must first have a "DRI", Designated Responsible Individual that manages the firestopping installation process. The DRI passes an industry firestop test based on the FCIA Firestop Manual of Practice (MOP), classified systems selection (UL and other directories) and the FM 4991 Standard. The DRI manages the firestop contracting firm's processes, policies and procedures to result in installed firestop systems that meet the tested and listed system

published in the testing directories or engineering judgment / equivalent fire resistance rated assemblies.

During the FM 4991 Approval contractor audit, FM auditors visit the firm, audit the firm's management system based on procedures in the company management system manual and project files. Then, the auditor visually checks the installed firestop systems in the field to verify the office paperwork's validity. This is not an inspection, but an observation by FM's personnel. Follow up audits are done yearly by FM, with the same jobsite audit by FM personnel.

UL Firestop Contractor Qualification Program

UL announced the new Firestop Contractor Qualification Program at the FCIA Firestop Industry Conference, November 2005. In 2006, UL held DRI testing with its own examination administered by UL Personnel. Testing currently takes place at FCIA Conferences and at UL Locations several times yearly. The UL program also has an audit of the contractor's Quality Management System. The new UL Program affirms that the sub-contractor quality process is gathering momentum.

Both the FM 4991 and UL Programs offer audit inspections of the firestop contractors' quality processes, with field verification during an office and field audit.

With these two programs, Specialty Firestop Contractors now have a way to separate themselves from others who have not embraced the quality process. And, it gives the architect a generic way to specify a characteristic that may result in contractors being hired who have an independent, audit tested management system for firestopping...and understand the industry protocol for getting this technical service done right.

Contractor Management System (Quality) Manuals

For a contractor firm to write a quality manual, it must review its processes, procedures and people. The firm's organization processes are reviewed from the time the estimate takes place to project award, communication to the field, then installation and inspection of the work. Contractor Quality Manuals are written to reflect the firms' procedures. These are the Specialty Firestop Contractor firms' competitive tools used to operate their companies.

How the firm selects classified firestop systems, communicates them to the jobsite, and then assures that firestopping is installed to the classified firestop systems and engineering judgments is their private competitive information. Cost, it's under \$3500/year for a contractor after the initial \$7000+ investment.

Workforce

Every trade has it's technical issues to be mastered by the workforce. Some of the 'systems selection' on projects, is performed by the 'office'. However, the installer must understand how to analyze the systems, to get the classified firestop materials installed to the tested and listed system, exactly. It cannot be 'just about there', the system must be installed to the exacting specifications of the tested and listed system. Any variance

means the system may not work when called upon by fire. Therefore, the installer must have a 'zero tolerance' attitude for firestopping installation accuracy. What does it take to become qualified to install firestopping? That's what the industry currently is discussing.

However, in the State of Washington, there is an operating four year apprenticeship program. The trip to 'journeyworker status' for a firestop/containment worker, covers all aspects of firestopping, in a 4 year course with classroom and hands on experience. FCIA's Apprenticeship Committee is working on a four year 'Firestop/Containment Worker' education program to bring the workforce to Journeyworker status, and supply specialty firestop contractors with a trained workforce.

Inspection - ASTM E 2174-01 is born...ASTM E2393 Evolves for "Field Quality Control"

The ASTM E 2174 "Standard for On-Site Inspection of Installed Fire Stops" inspection program was founded from the "Quality Process Approach". It's designed to be part of the protocol needed for zero tolerance Firestop Systems Installation including proper design, installation and inspection.

Firestop Manufacturers test their products, manufactured to strict tolerances, and publish systems suitable for use as Firestops in the Underwriters Laboratories, (UL & UL Canada), Omega Point Laboratories, (OPL), Warnock Hersey International, (WHI) and Factory Mutual Approvals (FM) Directories in North America. Firestop Contractors select and install systems with some inspection to verify their own work quality. Inspection Agencies who specialize in firestopping have emerged to provide third party verification of installed systems.

ASTM E2174-04 Standard Practice for On-Site Inspection of Installed Fire Stops covers penetrations while ASTM E2393-04, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers covers the standard for inspection of joint systems for walltops, expansion and construction joints, plus perimeter fire protection are the standards for inspection. These standards provide that either visual observation take place 10% of the time, or destructive evaluation is performed, 2% of the time.

Effective quality programs have a procedure for the production process, and in Firestopping it's the use of FM 4991 Approved and / or UL Qualified Firestop Contractors. Contractor sampling by their own crews to an amount that verifies the management system is working exists at contractor firms to be sure the process works. ASTM E2174 / E2393 provide the independent 3rd party check and balance that samples the production process for Firestop installation consistency, to a very specified manner.

Even though it's has not been code required, it's specified, and building owners, general contractors and design build firms want it so there's no surprises during building commissioning process.

It's important enough that International Accreditation Services has launched an Accreditation Criteria for Firestop Inspection Agencies, IAS AC 291, which is like the FM 4991 and UL Contractor Programs. IAS AC 291 has a qualification for the inspector that assures the person understands tested and listed firestop systems and the analysis required as well.

Plus, the 2012 International Building Code will include these two standards in Chapter 17, Special Inspections. The specification of these standards best fits in 'Field Quality Control' areas. ASSE is also working on a qualification of firestop inspectors as well.

Management of Firestopping – The Building Life Cycle

Once installed, firestop systems may need minor management over the life cycle of the building *if trades are controlled as they approach fire resistance rated construction.*

As building services change, there are new penetrations through fire resistance rated compartmentation that needs to be repaired to keep integrity of the compartment intact.

As to the Management of these barriers, the International Fire Code makes it clear that all types of fire protection and resistance need to be managed. Section 703.1 clearly states that building owners shall maintain and visually inspect fire-resistance-rated construction annually, and repairs shall be made to keep systems working in buildings. It is there to provide occupants the fire and life safety intended by fire and smoke protection features in buildings.

The International Fire Code, Section 703.1 was added by the National Association of State Fire Marshals.

703.1 Maintenance. The required *fire-resistance rating* of fire-resistance-rated construction (including walls, firestops, shaft enclosures, partitions, *smoke barriers*, floors, fire-resistive coatings and sprayed fire-resistant materials applied to structural members and fire-resistant joint systems) shall be maintained. Such elements shall be visually inspected by the *owner* annually and properly repaired, restored or replaced when damaged, altered, breached or penetrated. Where concealed, such elements shall not be required to be visually inspected by the *owner* unless the concealed space is accessible by the removal or movement of a panel, access door, ceiling tile or similar movable entry to the space. Openings made therein for the passage of pipes, electrical conduit, wires, ducts, air transfer openings and holes made for any reason shall be protected with *approved* methods capable of resisting the passage of smoke and fire. Openings through fire-resistance-rated assemblies shall be protected by self- or automatic-closing doors of *approved* construction meeting the fire protection requirements for the assembly.

Firestopping is a trade – The workforce

Firestopping is a very technical activity for the workforce, and the office. A successful journeyworker needs to understand 'why' systems are installed to zero tolerance protocol, and not just material slinging with a caulk gun. When workers understand their role in fire and life safety through following the classified firestop system to every detail, they get it...and are worthy Firestop / Containment Workers.

Currently in 2010, a State Apprenticeship Council exists in the State of Washington, with other states looking to get a formal apprenticeship program up and running...and the US Department of Labor looking at declaring the trade as well.

A 2 hour training course doesn't create an effective Firestop / Containment Worker. The workforce needs to understand the fire resistance rated assemblies, penetrating items, joints, gaps, and interaction between them to be productive and accurate at the same time. There's a lot to firestopping and effective compartmentation, and firestopping can be very complicated.

Trends in our industry will continue to be toward education of those who design, install, inspect and maintain our trade through several methods for better fire and life safety in buildings.

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