Challenges with Firestopping and Airflow Containment in Data Centers

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INTRODUCTION AND TOPICS TO ADDRESS

Firestopping is critical to building design, construction, and operation…

However, beyond Firestopping, what impact does airflow have on…

- data center cooling costs and energy efficiency?
- data hall pressurization for proper operation of suppression systems?
- control of dust & whiskers that could damage server equipment?

Can the firestopping method affect a building's performance?

What do owners, designers & contractors need to understand when addressing cable pathways in critical facilities?

EXAMPLE OF AIRFLOW & SMOKE PROPOGATION

Real case: fire in a hospital and smoke propagation:

in less than 2 minutes the hallways in this hospital were full of toxic smoke ...

AGENDA

1. What is firestop and why is it necessary
2. Elements of compartmentation
3. Addressing real life applications
4. Critical needs in data centers
5. Best practices to help improve a building’s performance

LET'S START WITH THE BASICS

What is firestop?

- **Firestop systems** (if installed correctly), help restore the rating of a floor or wall as it is penetrated by objects such as cable bundles and resist the spread of smoke and fire.
- **Firestop** is part of the life safety plan in building structures.
- **Life safety** also includes air ducts with dampers, smoke and fire alarms, wired glass, fire rated doors, sprinkler systems etc.

Why is it necessary?

- To give people more time to safely exit a structure, even if they don't react right away
- Fire and smoke are a major risk to property damage
- Mandated by the Codes: IBC, IFC, NFPA, NEC

MAJORITY OF FIRESTOP APPLICATIONS FALL INTO FOUR CATEGORIES

Through-Penetrations

Interior Joints

Edge of Slab Joints

Membrane Penetrations

WHAT IS THE LEADING KILLER IN FIRES?

Smoke and Toxic Gases

In addition, the biggest threat to damaging communications and server equipment within a building is also smoke and the products of combustion.

FIRE STATISTICS IN THE UNITED STATES

United States 2015 facts
- **1.3 million** fires
- **501,500** structure (building) fires
- **$10.3B** in property damage

A fire department responds to a fire every **23 seconds**

More than **8 out of 10** civilian deaths caused by fire were due to structure (building) fires

Source: NFPA Fire Loss Statistics 2015

WHY CONTAIN SMOKE, TOXIC GASES, AND FIRE?

3/4 of all fire deaths are caused by smoke inhalation.

Source: Hall, Jr. John R. NFPA Fire Analysis & Research, Quincy, MA. “Burns, Toxic Gases, and other Hazards”.

Visibility: 47% of survivors caught in a fire could not see more than 12 feet.

Source: NFPA Fire Protection Handbook, 18th Ed. Table 1-1P. Pg.1-15.

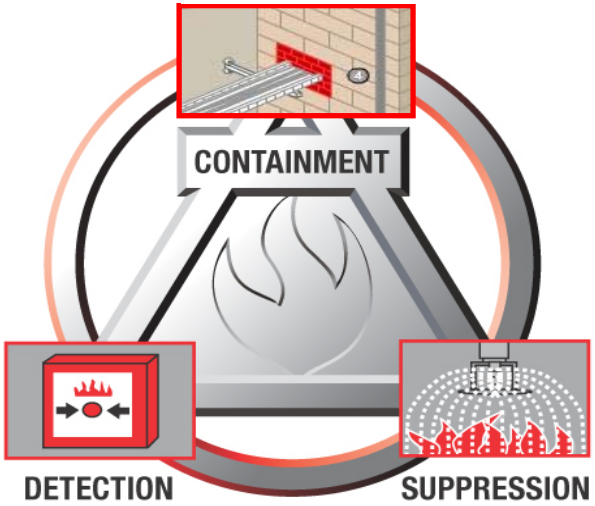
Approximately 57% of people killed in fires are not in the room of the fire’s origin.

Source: NFPA Fire Protection Handbook, 18th Ed. Table 8-1P. Pg. 8-17.

Smoke travels 120-420 feet per minute under fire conditions

Source: Estimate based upon ceiling jet velocity calculations for typical ceiling heights and heat release rates.

WE CAN’T RELY ON ANY SINGLE ACTION TO PROTECT LIVES & PROPERTY



The Balanced Approach to Fire Protection

REALITY OF SOME REACTION TO FIRE ALARMS?

Means of egress are designed for occupants to immediately evacuate upon alarm notification

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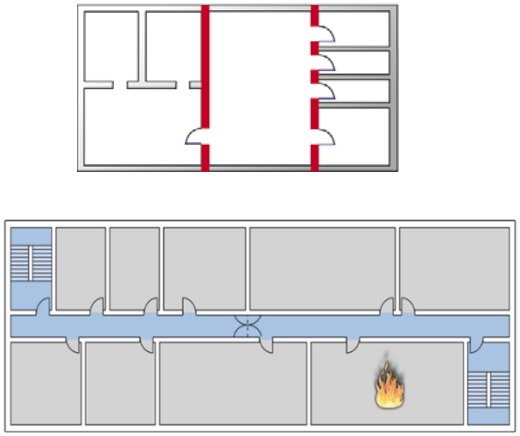
THE ELEMENTS OF COMPARTMENTATION

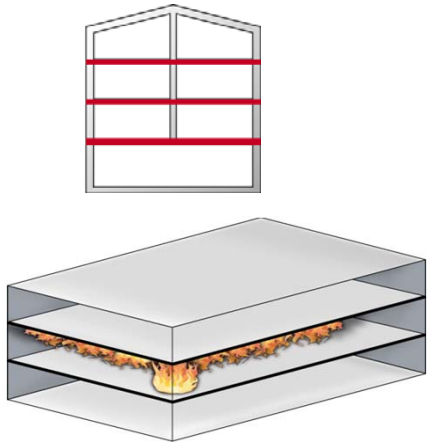
The spread of fire can be restricted by dividing a building into separate compartments with fire-resistive walls and floors increasing the availability of escape routes for occupants.

Compartmentation protects escape routes such as corridors or stairs

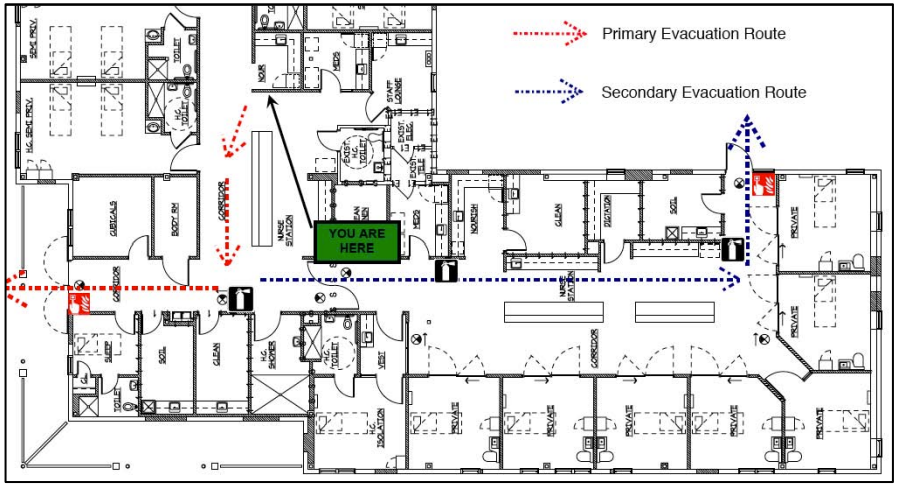
Fire walls



Fire floors



TYPES OF FIRE / SMOKE ASSEMBLIES



- Fire Walls
- Fire Barrier Walls
- Fire Partitions

- Smoke Barriers ?
- Smoke Partitions ?

COMMON TERM ON PROJECT PLANS: “SMOKE WALL”

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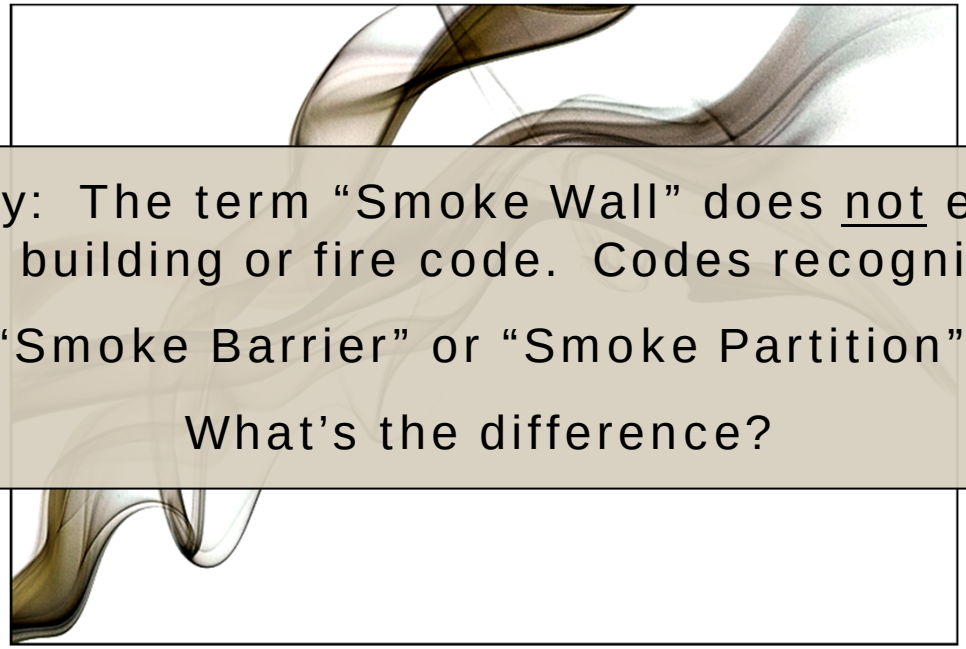


Reality: The term “Smoke Wall” does not exist in any building or fire code. Codes recognize:

“Smoke Barrier” or “Smoke Partition”

What’s the difference?

WHAT IS A SMOKE BARRIER?

Definition: Vertical or horizontal continuous membrane that will restrict movement of smoke

- **Leakage rating** (air leakage) must be less than 5 CFM/SQ.FT. for penetrations or 50 cfm leakage per 100 sq. ft. of wall area
- **Fire rating:** 1-hour

Example: Smoke Barriers divide hospitals into smoke compartments not exceeding 40,000 sq. ft. per IBC 2015.

Lower L-ratings mean less air leakage

WHAT IS A SMOKE PARTITION?

- No fire resistance
- Joints and penetrations “shall be filled with an approved material to limit the free passage of smoke”
- Span floor to floor or Floor to ceiling, if ceiling will limit the transfer of smoke
- Sealed windows
- No louvers in doors
- Doors not required to be self-closing
- Most common use: Corridor walls in sprinklered hospitals

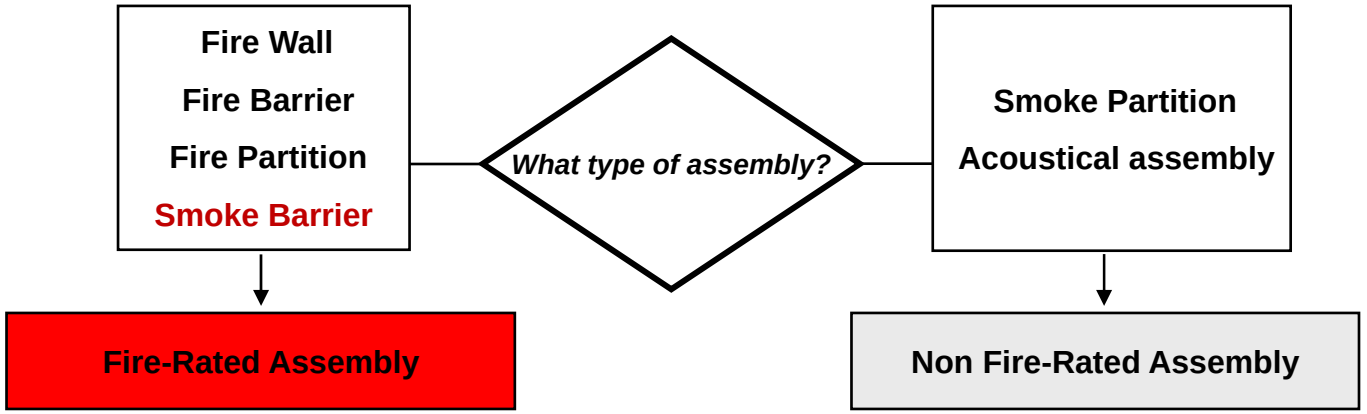
EXAMPLE OF AIRFLOW & SMOKE PROPOGATION

Real case: fire in a hospital and smoke propagation:

in less than 2 minutes the hallways in this hospital were full of toxic smoke ...

Incorrectly sealed penetrations

CRITICAL: CLARIFY THE ASSEMBLY TYPE!



Key Points:

- The term “Smoke Wall” is not referenced in the IBC. Clarify: “Is this a Smoke Barrier or Smoke Partition?”
- “Smoke Barriers” are 1 hour fire-rated assemblies! They require firestop systems and products
- “Smoke Partitions” are non fire-rated and must only resist the passage of smoke.

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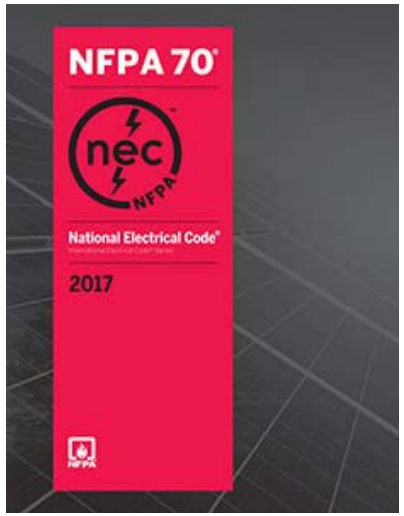
HOW TO ADDRESS THIS APPLICATION?

Cable trays through 2 hour fire-rated concrete wall assembly

FIRESTOP REQUIRED BY ALL CURRENT & LEGACY CODES

ICC
INTERNATIONAL CODE COUNCIL®

NFPA®



FIRESTOP REQUIRED BY ALL CURRENT & LEGACY CODES

ICC
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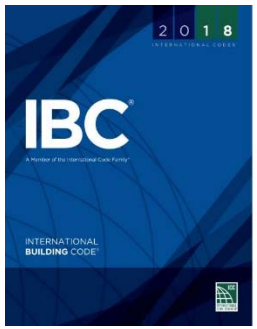
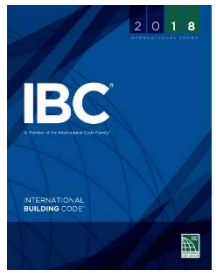
International Building Code (IBC)

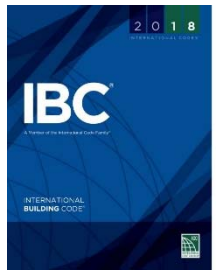


IBC: OCCUPANCY CLASSIFICATIONS



1. Assembly (see Section 303): Groups A-1, A-2, A-3, A-4 and A-5.
2. Business (see Section 304): Group B.
3. Educational (see Section 305): Group E.
4. Factory and Industrial (see Section 306): Groups F-1 and F-2.
5. High Hazard (see Section 307): Groups H-1, H-2, H-3, H-4 and H-5.
6. Institutional (see Section 308): Groups I-1, I-2, I-3 and I-4.
7. Mercantile (see Section 309): Group M.
8. Residential (see Section 310): Groups R-1, R-2, R-3 and R-4.
9. Storage (see Section 311): Groups S-1 and S-2.
10. Utility and Miscellaneous (see Section 312): Group U.

IBC: GROUP B (BUSINESS OCCUPANCY)



Ambulatory care facilities

Animal hospitals, kennels and pounds

Banks

Barber and beauty shops

Car wash

Civic administration

Clinic, outpatient

Dry cleaning and laundries: pick-up and delivery stations and self-service

Educational occupancies for students above the 12th grade

Electronic data processing

Food processing establishments and commercial kitchens not associated with restaurants, cafeterias and similar dining facilities not more than 2,500 square feet (232 m^2) in area.

Laboratories: testing and research

Motor vehicle showrooms

Post offices

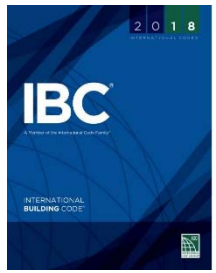
Print shops

Professional services (architects, attorneys, dentists, physicians, engineers, etc.)

Radio and television stations

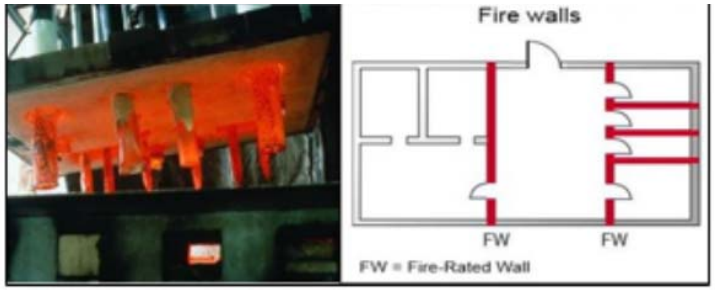
Telephone exchanges

IBC: FIRESTOPPING REQUIREMENT SUMMARY

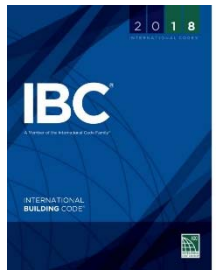


Section 714

- Provides all of the nitty-gritty details required for a code-compliant through-penetration firestop
- Some highlights:
  - 714.4.1.2 Through penetrations shall be protected by an approved penetration firestop system installed as tested in accordance with ASTM E814 or UL1479, with a minimum positive pressure differential of 0.01 inch of water and shall have an F rating of no less than the required fire-resistance rating of the wall penetrated.



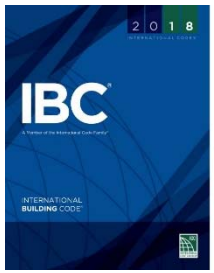
IBC: ASSEMBLY TYPES



- **"Penetrations through (assembly type) shall comply with Section 714*"**
  - 706.9 (Fire Walls)
  - 707.7 (Fire Barriers)
  - 708.7 (Fire Partitions)
  - 709.6 (Smoke Barriers)
  - 712.1.4 (Vertical Openings)
  - 713.8 (Shaft Enclosures)

IBC requires all penetrations through these assemblies to be firestopped with approved methods

IBC: 3RD PARTY FIRESTOP INSPECTION



Special Inspection requirements in accordance with Section 1705.17 for high-rise buildings or in buildings assigned to Risk Category III or IV.

Inspection of installed firestop applications shall be conducted in accordance with:

- **ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops"**
- **ASTM E 2393, "Standard Practice for On-Site Inspection of Installed Fire Resistive Joints and Perimeter Fire Barriers"**

- **Data center "high risk" code classification currently up to AHJ**
- **However, precedence has been set as many owners already enforcing internal auditing or 3rd party inspection**

AFTER OCCUPANCY: BUILDING OPERATIONS

INTERNATIONAL FIRE CODE (IFC)

SECTION 701.5 MAINTAINING PROTECTION

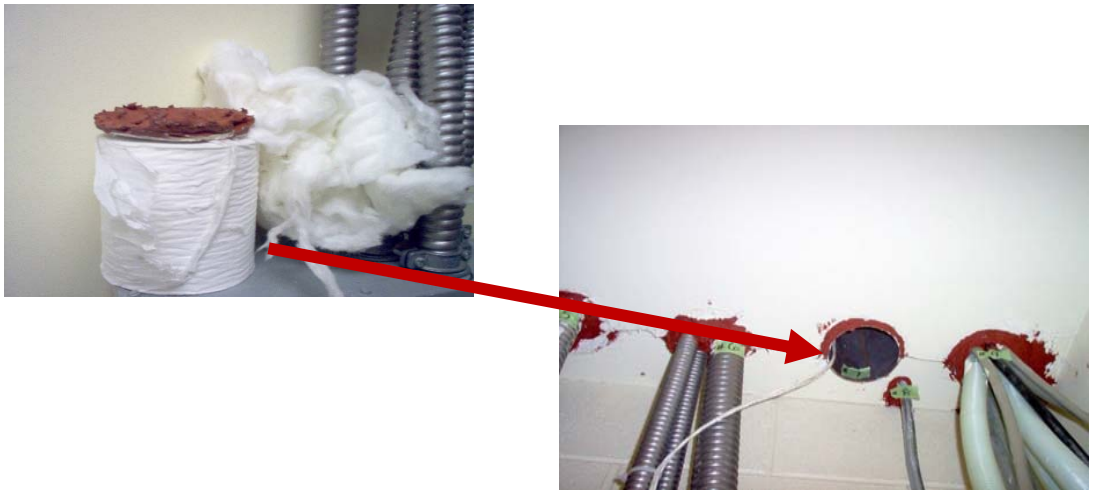
Materials, systems and devices used to repair or protect breaches and openings in fire-resistance-rated construction and construction installed to resist the passage of smoke shall be maintained in accordance with Sections 703 through 707.

SECTION 701.6 OWNER'S RESPONSIBILITY

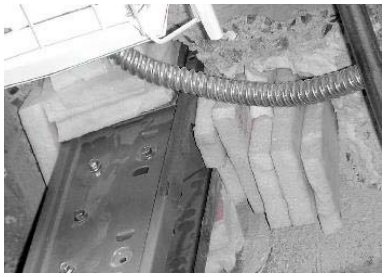
The owner shall maintain an inventory of all required fire-resistance-rated construction, construction installed to resist the passage of smoke and the construction included in Sections 703 through 707. Such construction shall be visually inspected by the owner annually and properly repaired, restored or replaced where damaged, altered, breached or penetrated. Records of inspections and repairs shall be maintained.

IFC requires annual inspection of penetrations through fire-rated assemblies

WHY AN EMPHASIS ON FIRESTOP INSPECTION?



WHY AN EMPHASIS ON FIRESTOP INSPECTION?



CODES & STANDARDS … GLOBAL VIEW

Codes in most countries require firestopping to be designed and installed per a testing standard.

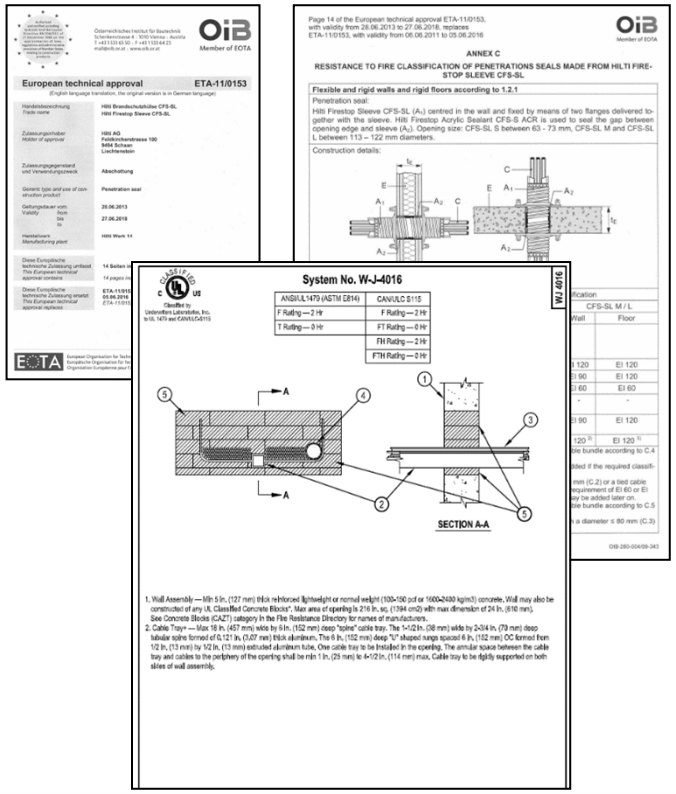
Firestop systems are tested according to international standards such as:

USA: ASTM E 814 / UL 1479

Canada: CAN/ULC S-115

Europe: BS 476, EN 1363, DIN 4102

A successful test yields an approval or firestop listing.



TESTING LABORATORIES & APPROVAL AUTHORITIES

North America: All Test Laboratories are of equal status in regulations (IBC code acceptance)

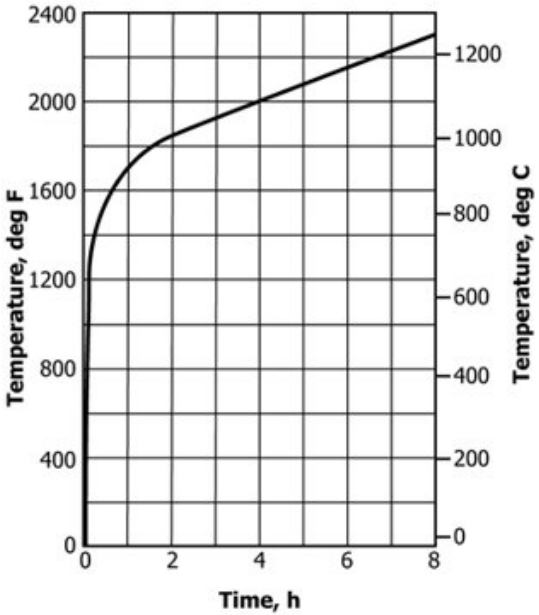
Rest of World: Accepted approvals vary by country

FIRESTOP TESTING PARAMETERS

Rating	Reference Standards	Definition
F rating	ASTM E814, UL 1479, CAN/ULC S115	Time period (expressed in hours) that assembly resists the passage of flames
T rating	ASTM E814, UL 1479	Time by which unexposed (non-fireside) of assembly reaches 325°F (163°C) over ambient temperature
L rating	UL 1479	Air leakage test run at ambient and 400°F (204°C)
W rating	UL 1479	Water leakage testing

- To achieve successful testing in the U.S. the firestop system must also pass the hose stream test

ASTM FIRE TEST TIME / TEMPERATURE CURVE



ASTM E119 time-temperature curve

Temperature at 10 minutes = 1300 °F

Melting Points (approx.):

- Aluminum – 1220 °F[1]
- PVC plastic pipe – 413 °F[2]
- Fiberglas® insulation – 1100 °F[3]

Sources:

1. NFPA Fire Protection Handbook, 18th Ed. Table 4-16A. Pg 4-183.
2. SFPE Handbook of Fire Protection Engineering, 1st Ed. Table 1-12.1. Pg. 1-166.
3. Owens Corning SSL I or II Fiberglas Insulation specification sheet.

STEPS IN FIRE TEST PROCEDURE

1. Assembly is placed on furnace.

2. Assembly is exposed to fire test.

3. Assembly is subjected to hose stream test.

4. Assembly results after hose stream.

AIR LEAKAGE TESTING

L-rating (UL)

- Measures the amount of air leakage through the firestop system in CFM
- Tested at ambient (cold smoke) and at 400°F (hot smoke) temperature.
- Leakage testing is desired in datacenters to protect equipment against smoke damage (fire), zinc whiskers, and for improved energy efficiency

L-rating test chamber

AIR LEAKAGE TESTING

Air Permeability (EN)

- Measures the amount of air leakage through the firestop system in CFM
- Measures air leakage at multiple pressure levels and cable % fill

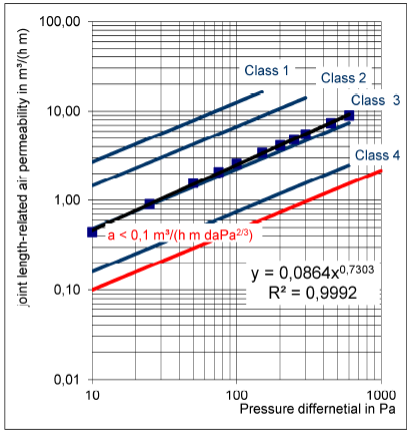


Diagram Joint length-related air permeability pressures

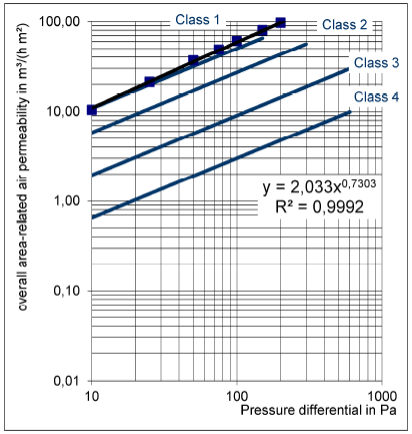
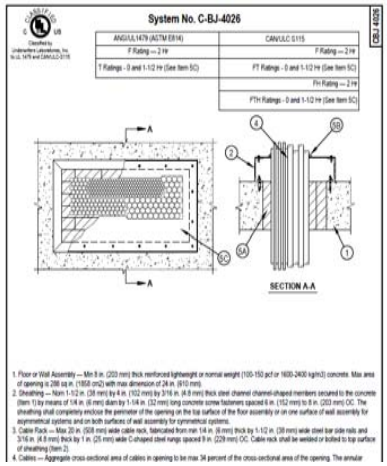


Diagram overall area-related air permeability pressures

WHAT IS THE AVERAGE HOURLY RATING OF A TYPCIAL FIRESTOP PRODUCT?



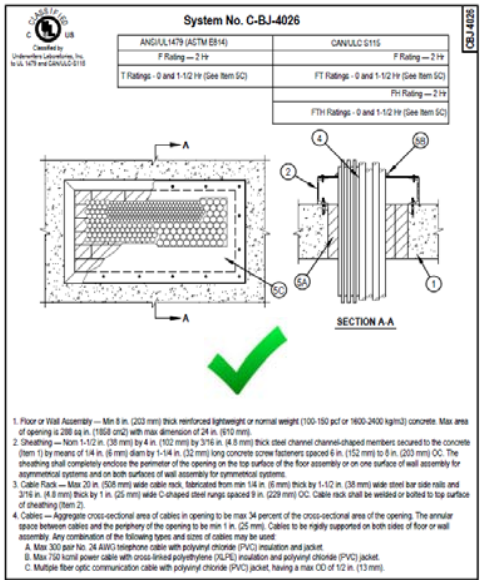
ZERO

Only Firestop <u>systems</u> have ratings!

MULTIPLE PARAMETERS OF A FIRESTOP SYSTEM

Firestop system performance can change completely if altering any parameter

A FIRESTOP SYSTEM IS ISSUED IF ALL ELEMENTS OF THE TEST ARE PASSED



System No. C-BJ-4026

CBJ 4026

ANSI/UL1479 (ASTM E814)	CAN/ULC S115
F Rating — 2 Hr	F Rating — 2 Hr
T Ratings - 0 and 1-1/2 Hr (See Item 5C)	FT Ratings - 0 and 1-1/2 Hr (See Item 5C)
	FH Rating — 2 Hr
	FTH Ratings - 0 and 1-1/2 Hr (See Item 5C)

SECTION A-A

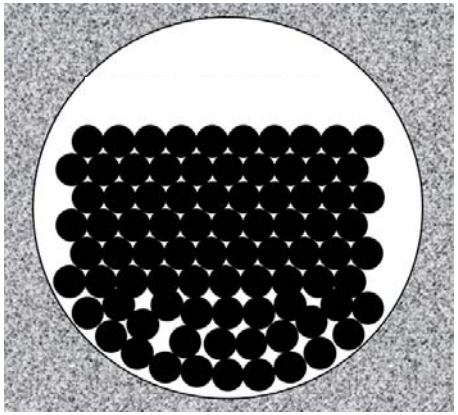
1. Floor or Wall Assembly — Min 8 in. (203 mm) thick reinforced lightweight or normal weight (100-150 pcf or 1600-2400 kg/m3) concrete. Max area of opening is 288 sq in. (1858 cm2) with max dimension of 24 in. (610 mm).
2. Sheathing — Nom 1-1/2 in. (38 mm) by 4 in. (102 mm) by 3/16 in. (4.8 mm) thick steel channel channel-shaped members secured to the concrete (Item 1) by means of 1/4 in. (6 mm) diam by 1-1/4 in. (32 mm) long concrete screw fasteners spaced 6 in. (152 mm) to 8 in. (203 mm) OC. The sheathing shall completely enclose the perimeter of the opening on the top surface of the floor assembly or on one surface of wall assembly for asymmetrical systems and on both surfaces of wall assembly for symmetrical systems.
3. Cable Rack — Max 20 in. (508 mm) wide cable rack, fabricated from min 1/4 in. (6 mm) thick by 1-1/2 in. (38 mm) wide steel bar side rails and 3/16 in. (4.8 mm) thick by 1 in. (25 mm) wide C-shaped steel rungs spaced 9 in. (229 mm) OC. Cable rack shall be welded or bolted to top surface of sheathing (Item 2).
4. Cables — Aggregate cross-sectional area of cables in opening to be max 34 percent of the cross-sectional area of the opening. The annular space between cables and the periphery of the opening to be min 1 in. (25 mm). Cables to be rigidly supported on both sides of floor or wall assembly. Any combination of the following types and sizes of cables may be used:
   A. Max 300 pair No. 24 AWG telephone cable with polyvinyl chloride (PVC) insulation and jacket.
   B. Max 750 kcmil power cable with cross-linked polyethylene (XLPE) insulation and polyvinyl chloride (PVC) jacket.
   C. Multiple fiber optic communication cable with polyvinyl chloride (PVC) jacket, having a max OD of 1/2 in. (13 mm).

What is percent fill?

WHAT IS PERCENT FILL?

Definition: The cross-sectional area of an opening that is occupied by penetrating items, typically cables. Percent fill is specific to each firestop system.

What is the actual percent fill?



Visually, the opening appears to be 2/3 full

4” circular opening

85 cables, ¼” diameter

Let’s calculate actual percent fill…

WHAT IS PERCENT FILL?

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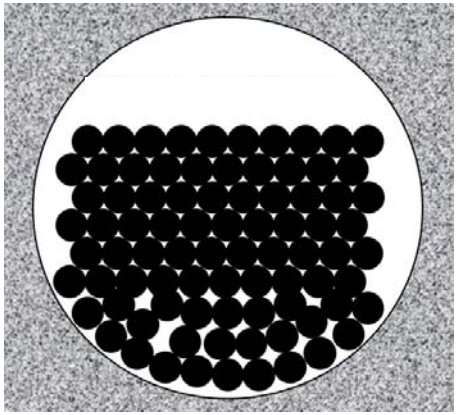
What is the actual percent fill?



Answer:

$(A_o)=3.14 \times (2^2)=12.56\ in^2$

$(A_c)=[3.14 \times (.125^2)] \times 85 = 4.17\ in^2$

$(\%_f)=(4.17/12.56) \times 100 = 33.2\%$

Actual % fill

Actual % fill rates are typically half of what they visually appear

PERCENT FILL HAS AN IMPACT ON FUTURE CAPACITY

Consider

Many firestop solutions limits cable fill to ~ 25% of opening

Challenge

How do you ensure this is not exceeded during actual use?

Solution

When designing networks, consider a firestop system's percent fill and plan for future MAC work

Design tip: Specify firestop pathway solutions allowing up to 100% visual fill

HOW TO ADDRESS THIS APPLICATION?

Cable trays through 2 hour fire-rated concrete wall assembly

HOW TO ADDRESS THIS APPLICATION?

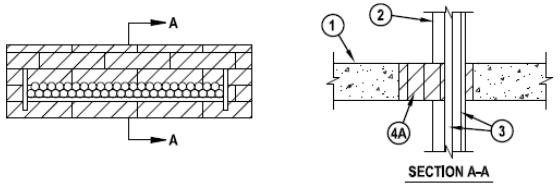
CLASSIFIED C UL US

Classified by Underwriters Laboratories, Inc. to UL 1479 and CAN/ULC-S115

System No. C-AJ-4035

ANSI/UL1479 (ASTM E814)	CAN/ULC S115
F Rating — 3 Hr	F Rating — 3 Hr
T Rating — 0 Hr	FT Rating — 0 Hr
	FH Rating — 3 Hr
	FTH Rating — 0 Hr

CAJ 4035



SECTION A-A

1. Floor or Wall Assembly — Min 4-1/2 in. (114 mm) thick reinforced lightweight or normal weight (100-150 pcf or 1600-2400 kg/m3) concrete. Wall may also be constructed of any UL Classified Concrete Blocks*. Max area of opening is 270 sq in (1742 cm2) with max dimension of 30 in. (762 mm).

See Concrete Blocks (CAZT) category in the Fire Resistance Directory for names of manufacturers.

2. Cable Tray* — Max 24 in. (610 mm) wide by max 4 in. (102 mm) deep open-ladder or solid-back cable tray with channel-shaped side rails formed of 0.10 in. (2.54 mm) thick aluminum or 0.060 in. (1.52 mm) thick galv steel and with 1-1/2 in. (38 mm) wide by 1 in. (25 mm) channel shape rungs spaced 9 in. (229 mm) OC or a 0.029 in. (0.74 mm) thick steel solid back, respectively. The annular space between the cable tray and the perphery of the opening shall be min 1 in. (25 mm) to max 4 in. (102 mm). Cable tray to be rigidly supported on both sides of floor or wall assembly.

3. Cables — Aggregate cross-sectional area of cables in cable tray to be max 40 percent of the cross-sectional area of the cable tray. Any combination of the following types and sizes of copper conductor or fiber optic cables may be used:

A. 1/C, 500 kcmil with thermoplastic insulation and PVC jacket.
B. 300 pair — No. 24 AWG cable with PVC insulation and jacket.
C. 24 fiberoptic cable with PVC subunit and jacket.
D. Three 1/C No. 12 AWG wire, insulated with polyvinyl chloride, in a nominal 3/4 in. (19 mm) flexible metal conduit.

4. Firestop System — The firestop system shall consist of the following:

A. Fill, Void or Cavity Material* — Fire blocks installed with the long dimension placed horizontally within the opening, flush with bottom of floor assembly or centered within wall opening. In concrete block walls, fire block to fill entire thickness of wall opening unless wall is solid filled. Blocks to be firmly packed and completely fill the entire width and height of opening. Either one or a combination of the block specified below may be used.

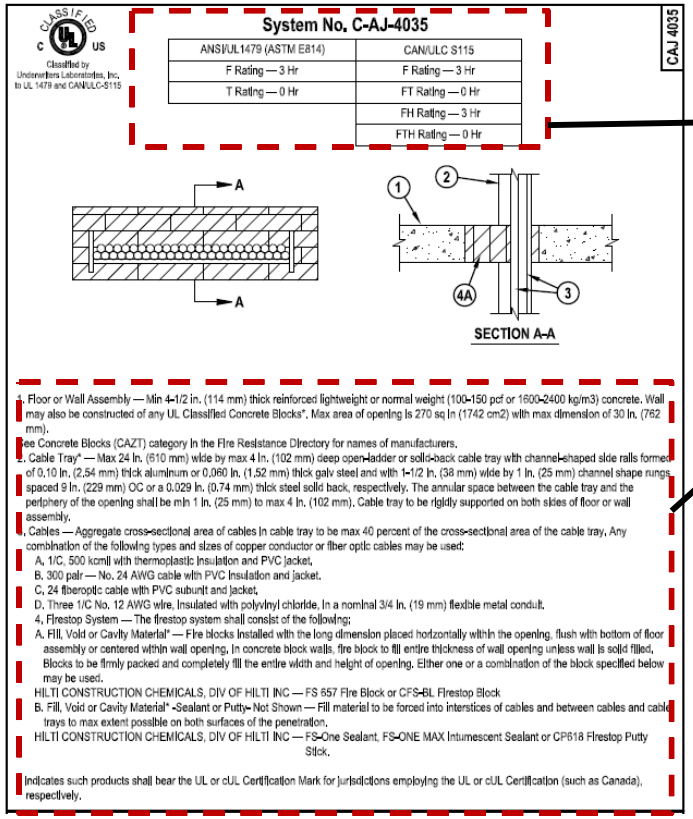
HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — FS 657 Fire Block or CFS-BL Firestop Block

B. Fill, Void or Cavity Material* -Sealant or Putty- Not Shown — Fill material to be forced into interstices of cables and between cables and cable trays to max extent possible on both surfaces of the penetration.

HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — FS-One Sealant, FS-ONE MAX Intumescent Sealant or CP618 Firestop Putty Stick.

*Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.

HOW TO ADDRESS THIS APPLICATION?



CLASSIFIED C UL US
Classified by Underwriters Laboratories, Inc. to UL 1479 and CAN/ULC-S115

System No. C-AJ-4035

ANSI/UL1479 (ASTM E814)	CAN/ULC S115
F Rating — 3 Hr	F Rating — 3 Hr
T Rating — 0 Hr	FT Rating — 0 Hr
	FH Rating — 3 Hr
	FTH Rating — 0 Hr

CAJ 4035

SECTION A-A

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- System Number, Code Standards
- F-Rating: up to 3 hours
- Concrete Floor or Wall
- Allowable cable type, size
- Allowable opening size
- Allowable percent fill
- Preformed, reusable Firestop product

We learned about firestop systems …
Let’s put our knowledge to the test

How would you address the following application?

HOW WOULD YOU ADDRESS THIS APPLICATION?

Not all firestop applications are tested

ENGINEERING JUDGMENTS

For conditions where a tested system does not exist an Engineering Judgment may be needed

Typical Engineering Judgment conditions:

- Annular space larger/smaller than tested
- Irregular hole shape
- Hole shape different than tested
- More penetrating items in hole than system allows
- Access to one side only
- Structural member penetrations
- Intersections of rated assembly with non-rated assembly

- **Engineering Judgments should only be designed by qualified firestop manufacturer's personnel**
- **Note: Engineering Judgments can be developed in the design phases of projects**

IS THERE A RELATIONSHIP BETWEEN FIRESTOP SELECTION & BUILDING PERFORMANCE?

Beyond Firestopping …

Airflow control through most all wall and floor assemblies is becoming increasingly important in data centers as it can significantly impact:

- Data hall / room pressurization
- Dust control
- Cooling costs

Additional concerns with cabling penetrations:

- Noise transmission
- Seismic events

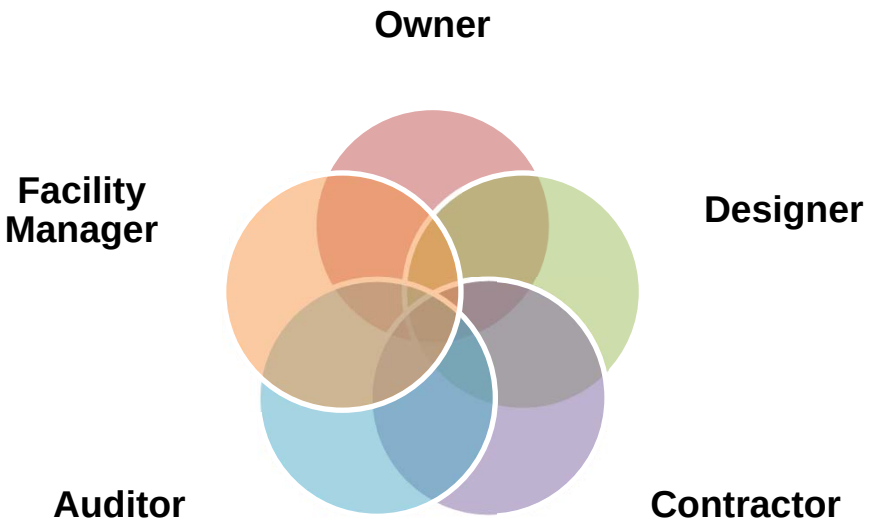
How does firestop system selection impact these design needs?

AGENDA

1. What is firestop and why is it necessary
2. Elements of compartmentation
3. Addressing real life applications
4. Critical needs in data centers
5. Best practices to help improve a building's performance

DATA CENTER STAKEHOLDERS

What keeps them up at night?



DATA CENTER STAKEHOLDER NEEDS & PAIN POINTS

Owners

Specifiers

GC

Facility Mgr / Auditor

Key Pain Points

Risk Mitigation	Airborne particulates	
Construction Costs	Material	Labor (const & design)
Operations	Cooling costs	Uptime / reliability
Future		
Seismic	Earthquake	
Acoustics	General noise nuisance	

Wall & Floor Penetration Impact

- Fire / smoke (continuous)
- Pressure control
- Code compliance.

High priority concern

Limited coverage with traditional technology

Design & installation considerations should factor firestop airflow control solutions to better impact owner pain points

DATA CENTER AIRFLOW LEAKAGE RISKS

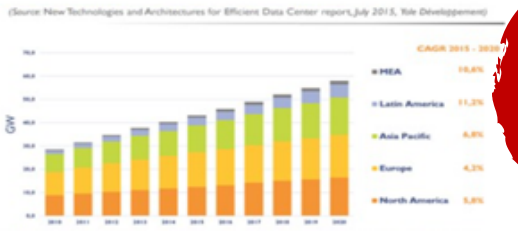
Mission Critical			
Data	**Power**	**Cooling**	**Other**
Data Cabling	Electric Cabling	Piping/Ducts	Fire, Gas Suppression
			Emergency Lighting
			Access & Security Control Cabling

Highest risk

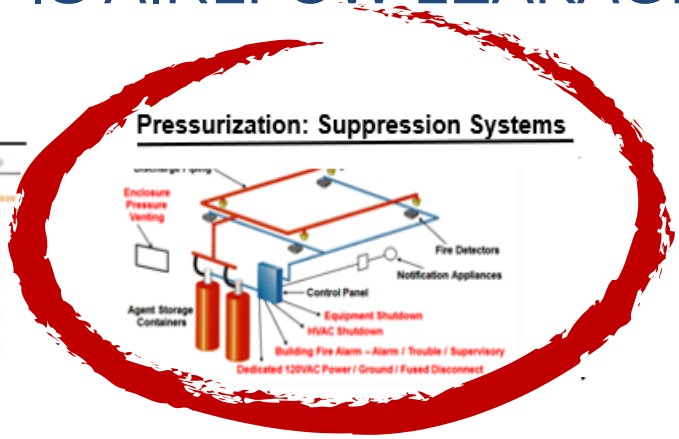
- ✓Creates largest volume of openings through wall and floor assemblies
- ✓Present unique challenge due to continuous cable re-penetration

SUMMARY: WHY IS AIRLFOW LEAKAGE AN ISSUE?

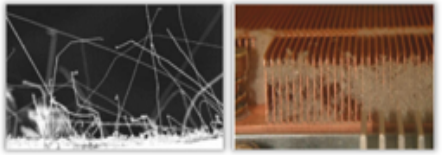
Energy cost: Cooling Equipment



Pressurization: Suppression Systems



Contamination: Whiskers & Dust



Powering and cooling costs for telecom and data center facilities comes at are tremendous

Energy costs for data centers increased 24% from 2010-2014.

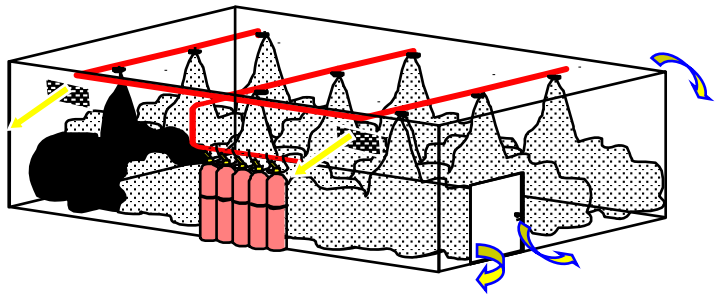
Non water based **suppression systems** require rooms to be able to hold pressure levels up to 300+ pa.

Whiskers may physically detach from metal surfaces and cause electronic system failures

Construction **dust** can cause optical interference or obstruct cooling airflow

Suppression systems have fast trended to be a key concern of operations due these systems high pressure requirement to function properly. Data cables are the significant source of air leakage.

GAS SUPPERSSION SYSTEMS REQUIRE SEALED ROOMS ➔ ESSENTIAL FOR OPENINGS TO HAVE LOW LEAKAGE



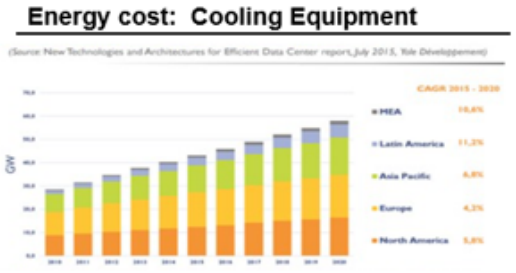
<u>Gas suppression systems</u>:

- Rely on lowering the level of oxygen available to fire
- Depend upon a sealed area in order to prevent oxygen from re-supplying the fire

<u>Needs for penetration seals</u>:

- ✓ **Low leakage ratings**
- ✓ **Pressure resistance**
  - Firestop solutions must remain intact in case of activation of fire suppression systems
  - Standards require yearly review of gas suppression system or yearly documentation that all seals are correctly maintained

SUMMARY: WHY IS AIRLFOW LEAKAGE AN ISSUE?



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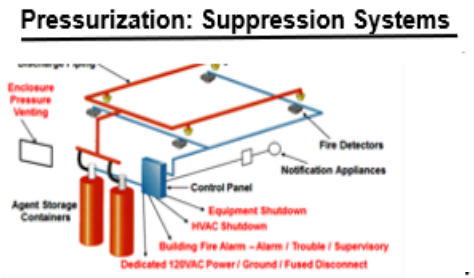
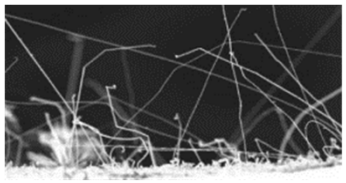


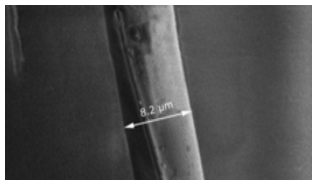
Non water based **suppression systems** require rooms to be able to hold pressure levels up to 300+ pa.

Whiskers may physically detach from metal surfaces and cause electronic system failures

Construction **dust** can cause optical interference or obstruct cooling airflow

AIRBORNE PARTICLES POSE A RISK IN DATA CENTERS





Conductive particles:

- A main cause of conductive dust is zinc whiskers which "grow" on ferrous (steel) surfaces, especially those that have been coated with tin, zinc or cadmium to help protect them from corrosion

Risk:

- Whiskers may physically detach from their surfaces and enter a data center's airflow causing electronic system failures and short circuits

Non-conductive particulates

- Contamination from construction activities such as cement and drywall dust, or paper and cardboard fibers can cause problems such as optical interference or obstruct cooling airflow, resulting in:

Risk:

- lower thermal efficiency and increased cooling costs
- overheating and equipment failure
- shortened equipment life span
- server failures causing enterprise disruption

"Particulate contamination can increase a data center's power demand by 2% or more[1]"

HEALTH, SAFETY, ENVIRONMENTAL (HSE) COMPLIANCE

Leadership in Energy & Environmental Design (LEED V4)

Cradle to Cradle

Living Building Challenge (LBC) Red List

Environmental Protection Agency (EPA) 40CFR Part 59
National Volatile Organic Compound Emission Standards

South Coast Air Quality Mgmt District (SCAQMD)

HSE regulations are increasing and influencing firestop product selection

MOVEMENT & SEISMIC CONSIDERATION

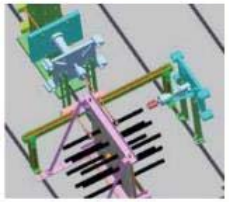
Influence of seismic actions on mechanical performance, smoke and fire ratings

Damage	Smoke	Fire	Overall performance*
■■■	■■■	■■■	■■■

Rating criteria	Damage	Smoke	Fire ratings
■■■	Excellent mechanical performance under seismic conditions	Excellent smoke tightness	Excellent fire performance
■■	Good mechanical performance under seismic conditions	Good smoke tightness	Good fire tightness
■	Poor mechanical performance under seismic conditions	Poor smoke tightness	Poor fire tightness
□	Very poor mechanical performance under seismic conditions	Very poor smoke tightness	Very poor fire tightness

* for an entire evaluation of post-earthquake risks an additional consideration of inherent product properties and installation reliability factors are necessary and therefore might lead to a degradation or upgrading.

* Federal Emergency Management Agency:
Code for interim testing protocol for determining the seismic performance characteristics of structural and non-structural components



Test apparatus seismic testing

Firestop Sleeve test details

Fire test after seismic impacts

Inquire with consultants regarding relevant movement testing in regards to cable penetrations

AGENDA

1. What is firestop and why is it necessary
2. Elements of compartmentation
3. Addressing real life applications
4. Critical needs in data centers
5. Best practices to help improve a building’s performance

SOLUTIONS: TRADITONAL FIRESTOP METHODS

Walls

Floors

Sprays, Caulks, Sealants

Advantages

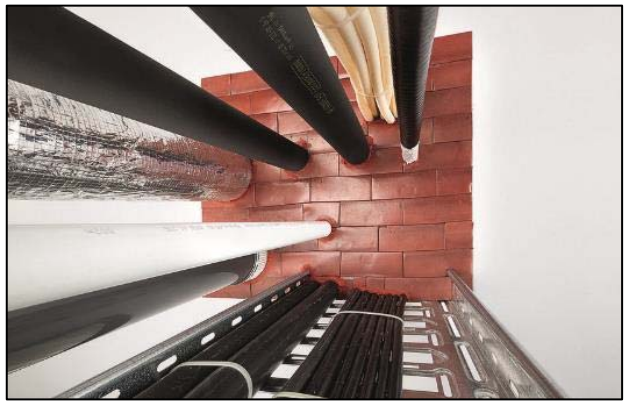
- Economical
- Versatile, covers multiple applications
- Multiple listings available

Disadvantages

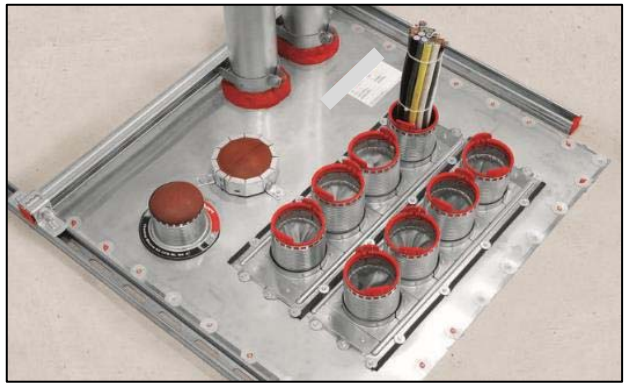
- Non re-penetrable
- Correct installation varies by installer
- Low productivity
- Messy installation
- Wash-off, shrinkage issues
- Inspection concerns

SOLUTIONS: "PRE-FORMED" FIRESTOP METHODS

Walls



Floors



Pre-formed Devices

Advantages

- Re-penetrable
- Reliable, fast installation
- Enhanced air flow performance vs. traditional methods*
- Pre-cured, always the right amount of product
- Easier to design - BIM
- Inspection advantages – no destructive testing per IBC 2012

Disadvantages

- Higher product cost <u>but usually lower total installed cost</u>

* Always refer to listed system

INITIAL DESIGN CONSIDERATIONS

Performance Requirements

- ✓ Minimum Code compliance for firestop system rating

- ✓ Limit airflow leakage
- ✓ Room pressurization
- ✓ Limit dust spread and whiskers
- ✓ Correct installation improvement
- ✓ Enhance life safety and property loss prevention
- ✓ Ease of inspection
- ✓ Re-penetrability (MAC work)
- ✓ Labor cost savings

Solution

Traditional Firestop System

(no air leakage performance required)

Pre-formed Firestop System

(with airflow control testing)

AIR LEAKAGE TESTING … IS THERE A DIFFERENCE?

Air Permeability (EN)

- Measures the amount of air leakage through the firestop system in CFM
- Measures air leakage at multiple pressure levels and cable % fill

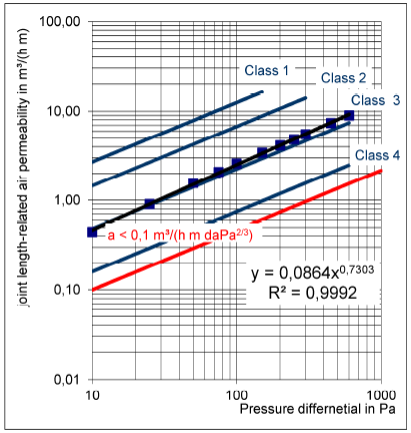


Diagram Joint length-related air permeability
pressures

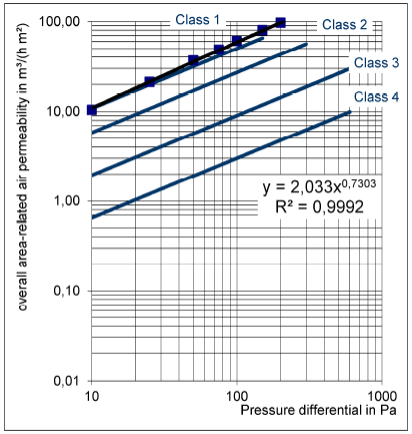
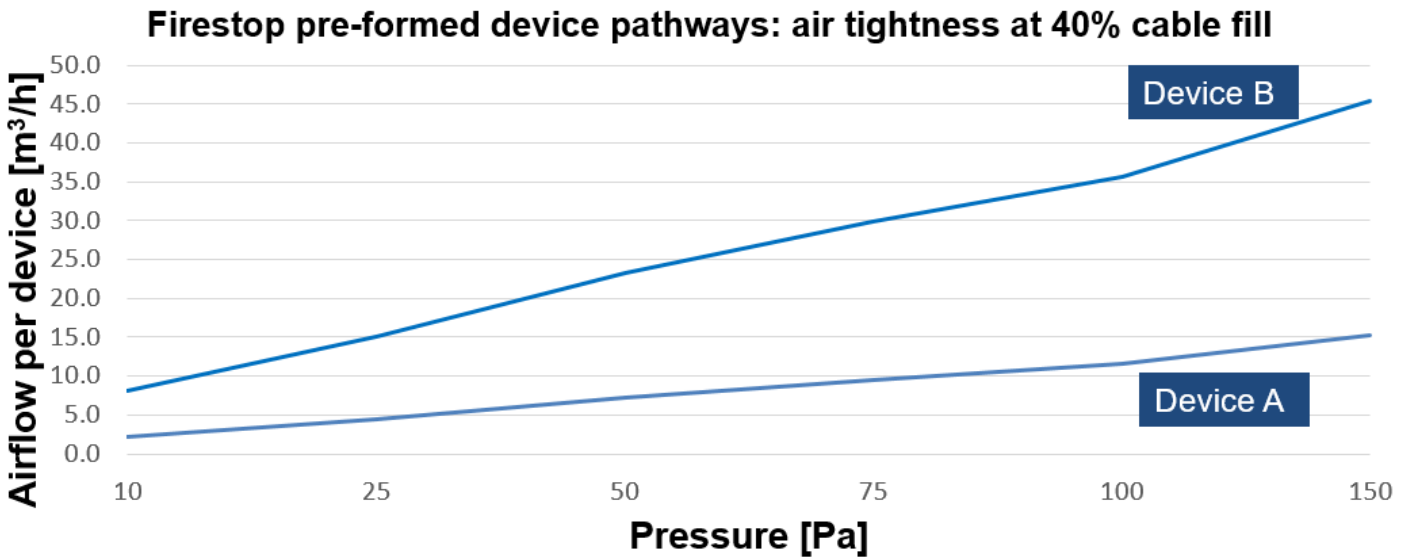


Diagram overall area-related air permeability
pressures

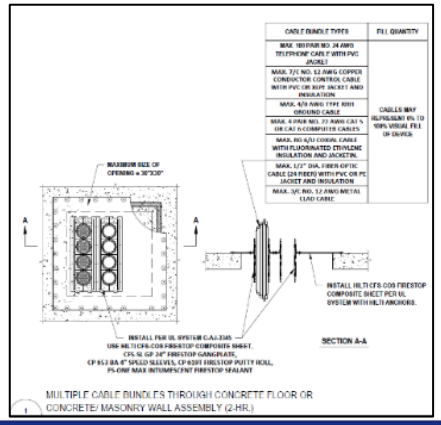
COMPARE FIRESTOP & AIRLFOW SOLUTIONS

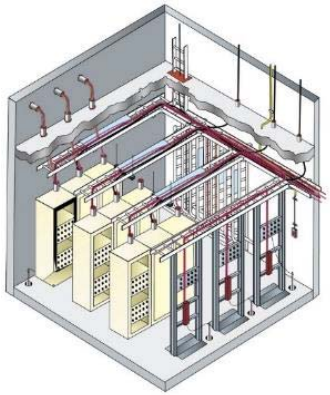


Testing compared 4" Firestop cable devices with 40% cable fill (57x CAT 6 cables); both devices installed acc. to manufacturer IFU
Leakage measured @ 21 °C ; 52 - 57% RH and tested according to EN 1026
Airflow in [m³/h] measured for over- and underpressure, chart displays average values

CLEARLY CONVEY DESIGN INTENT

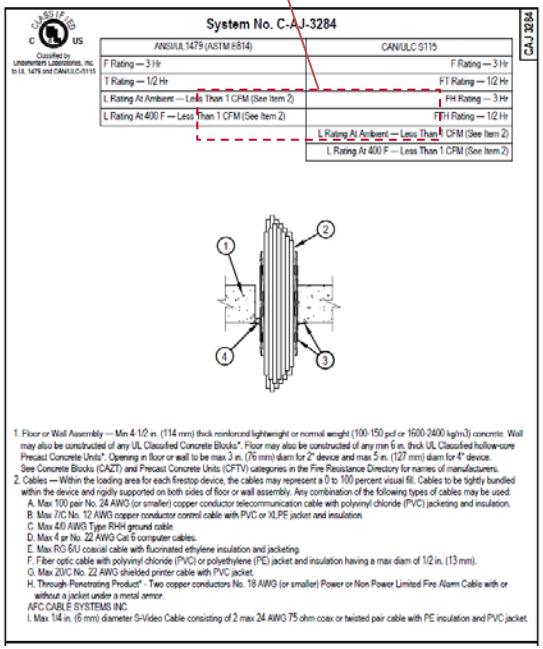
- **Detail firestop / airflow resistant cable pathway solutions on Datacom or Telecom plans**
- **Include in Division 26 & 27 specs**
- **BIM / Revit design**





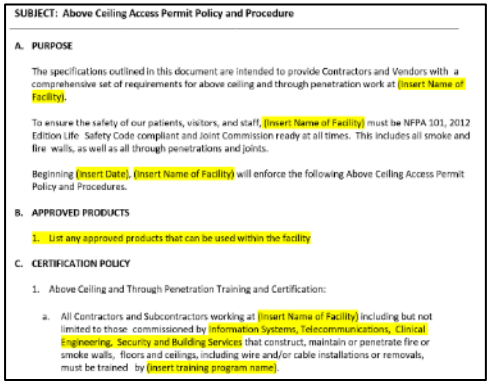
L Rating At Ambient — Less Than 1 CFM (See Item 2)

L Rating At 400 F — Less Than 1 CFM (See Item 2)



PROCEDURE / PERMIT PROGRAMS (OPERATIONS)

Implementing a firestop cabling pathway procedure or “permit program” for ongoing operation of each data center facility is critical



SUBJECT: Above Ceiling Access Permit Policy and Procedure

A. PURPOSE

The specifications outlined in this document are intended to provide Contractors and Vendors with a comprehensive set of requirements for above ceiling and through penetration work at (Insert Name of Facility).

To ensure the safety of our patients, visitors, and staff, (Insert Name of Facility) must be NFPA 101, 2012 Edition Life Safety Code compliant and Joint Commission ready at all times. This includes all smoke and fire walls, as well as all through penetrations and joints.

Beginning (Insert Date), (Insert Name of Facility) will enforce the following Above Ceiling Access Permit Policy and Procedures.

B. APPROVED PRODUCTS

1. List any approved products that can be used within the facility

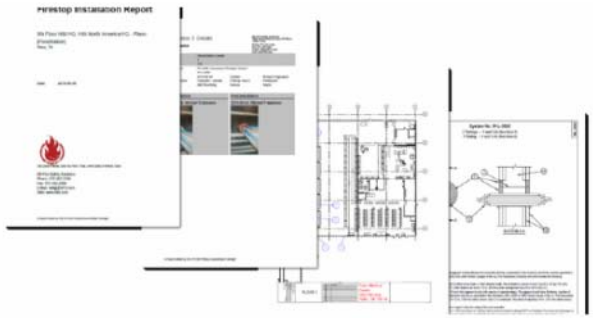
C. CERTIFICATION POLICY

1. Above Ceiling and Through Penetration Training and Certification:

   a. All Contractors and Subcontractors working at (Insert Name of Facility) including but not limited to those commissioned by Information Systems, Telecommunications, Clinical Engineering, Security and Building Services that construct, maintain or penetrate fire or smoke walls, floors and ceilings, including wire and/or cable installations or removals, must be trained by (insert training program name).

Installer training procedures

Electronic documentation



SUMMARY OF KEY LEARNINGS

- Elements of firestop, compartmentation, and airflow containment
- Code and test standard requirements for barrier management
- Tested systems and engineering judgments
- Impact of firestop systems in building performance … airflow control
- Key owner design considerations
- Best design practices

THANK YOU

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