



# CHALLENGES TO AIRFLOW CONTAINMENT IN CRITICAL FACILITIES: HEALTHCARE & DATA CENTERS

**Jessica Bello Salguero**  
**Hilti AG**



# Introduction

- What is firestop and why it is especially important when designing cable runs in critical facilities?
- How can firestop affect:
  - Spread of airborne disease in a hospital?
  - Server contamination from dust during cabling changes?
- What do designers need to understand?
- To answer these questions we must first understand some basics...

# Fire Statistics

- **In average, 3,8 million fires occur per year worldwide**

Source: CTIF (International Association of Fire and Rescue Service), Report n. 21 - World Fire Statistics 2016.

- **In average, 45,4 thousand deaths occur per year worldwide due to fires**

Source: CTIF (International Association of Fire and Rescue Service), Report n. 21 - World Fire Statistics 2016.

- **3/4 of fire deaths are caused by smoke**

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

- **57% of fire deaths are not in the room of the fire's origin**

Source: NFPA Fire Protection Handbook, 18th Ed..

- **47% of survivors caught in a fire could not see more than 3,5 meters**

Source: NFPA Fire Protection Handbook, 18th Ed. .



# Why passive fire protection is so important in data centers?

**7908 \$/min**

Most non-home electronic equipment room fires  
(78%) begin with electronic equipment

Sources:

Research published by Ponemon institute in Dec 2013

John R Hall report – Issues Mar 2012

National Fire Protection Association (NFPA) Report

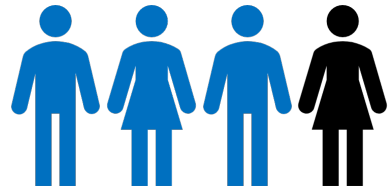
# More recent in July 2018

A nearly-complete data center was on fire for 8 hours.

It was comprised of seven levels, three above and four below ground, where the fire started.

Around 300 workers were on site. 5 men died. 50 people were injured.

# Why Smoke & Fire are key concerns?



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



Approx. **57%** of people killed in fires are not in the room of the fire's origin

47% of survivors caught in a fire **could not see** more than 3.5m

Smoke travels **0.6 - 2.2m per second** under fire conditions

## Sources:

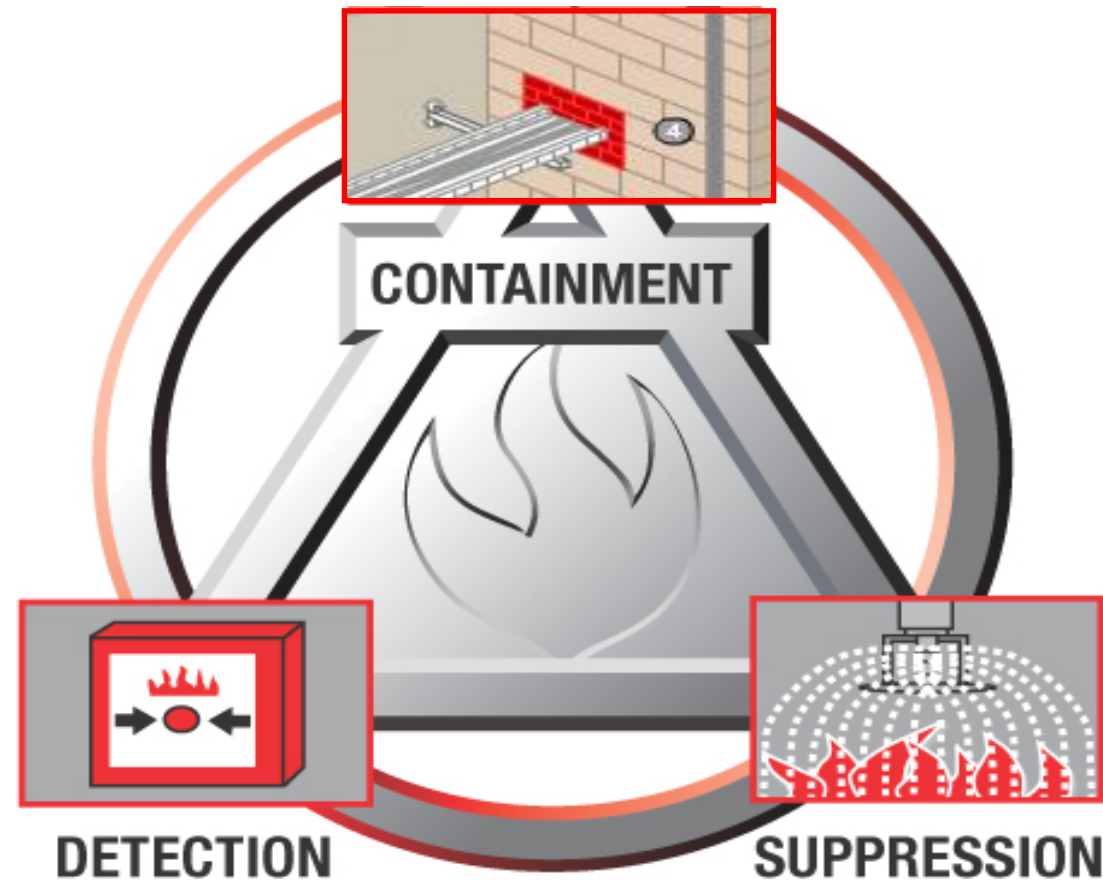
Hall, Jr. John R. NFPA Fire Analysis & Research, Quincy, MA. "Burns, Toxic Gases, and other Hazards".

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

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

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

# We can't rely on a single action to keep people and assets safe

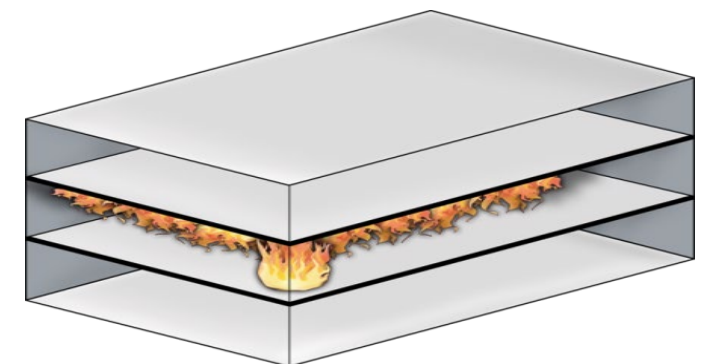
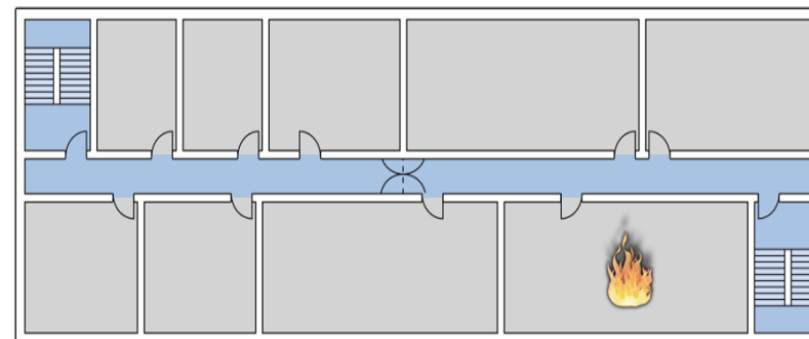
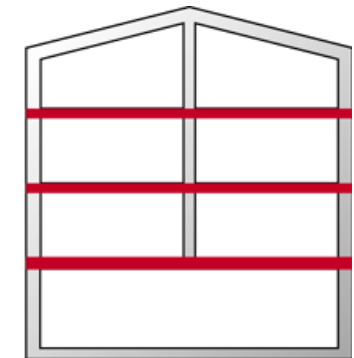
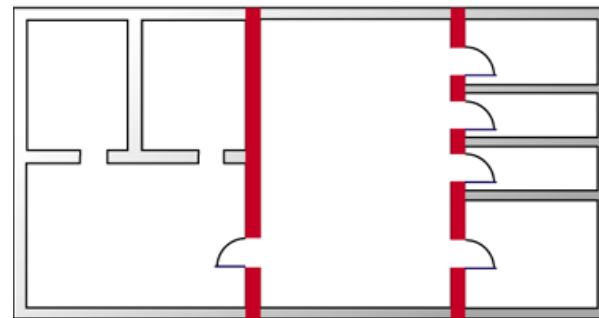


The balanced approach to  
Fire Protection

# 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.

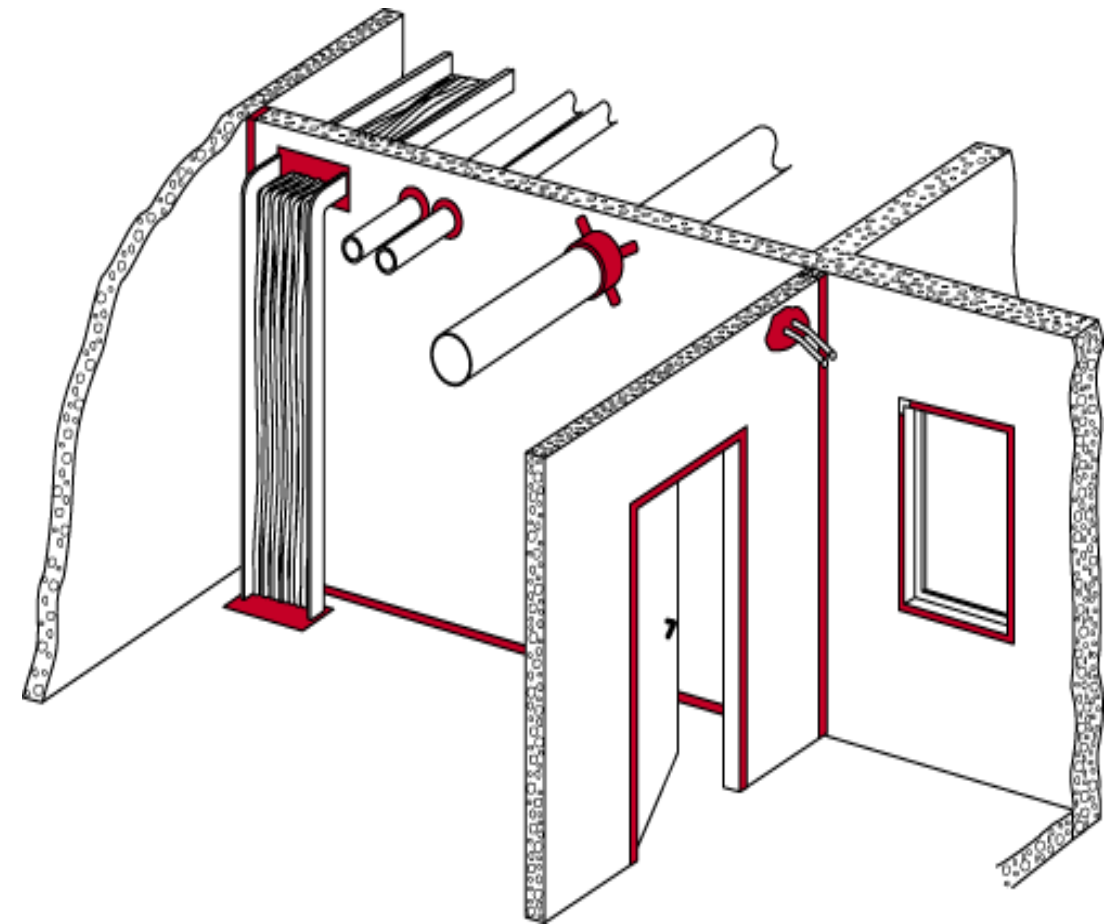
Compartmentation protects **escape routes** such as corridors or stairs.



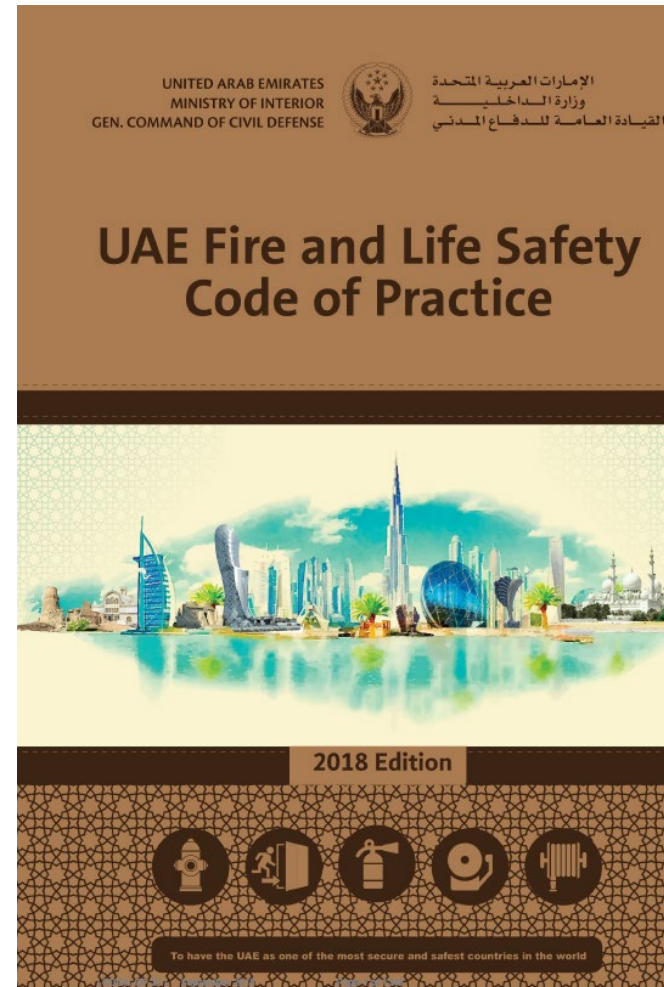
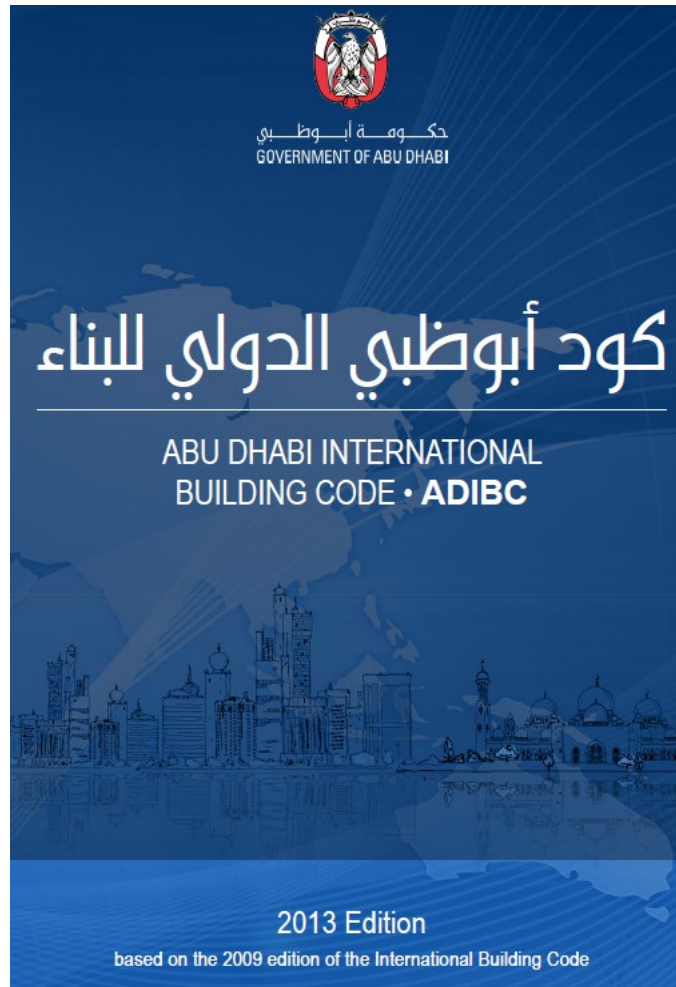


# What is Firestop?

- **Firestop systems** (if installed correctly), help **restore the integrity** of a floor or wall as it is penetrated by an object or joint and resist the spread of smoke and fire.
- **Firestop** is part of the **life safety plan** in building structures.



# Firestop required by codes and building regulations



# Firestop required by codes and building regulations

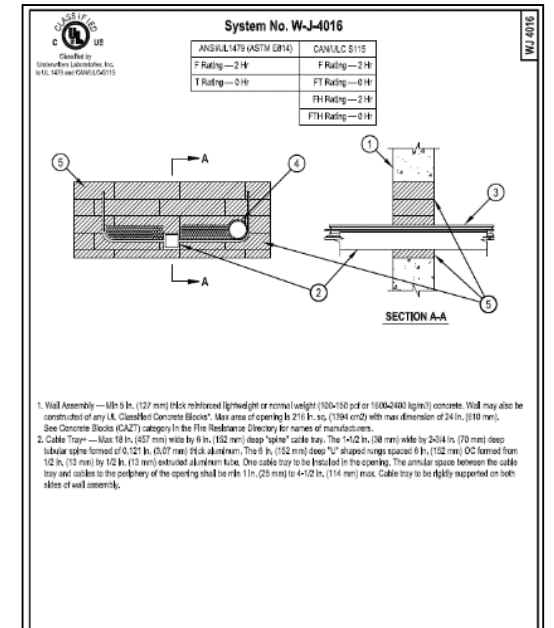
- Codes in most countries require firestop products to be tested, designed and installed per a **testing standard**.

- Firestop systems are tested acc. to international standards such as:

**Europe: EN 1363**

**USA: ASTM E 814 / UL 1479**

- A successful test yields an **approval** or firestop listing.



**European technical approval** **ETA-11/0153**  
(English language translation, the original version is in German language)

Handelsbezeichnung / Trade name: **HHI Brandschutzsleeve CFS-SL / HHI Firestop Sleeve CFS-SL**

Zulassungsinhaber / Holder of approval: **HHI AG, Feldkircherstrasse 100, 6854 Schaan, Liechtenstein**

Zulassungsgegenstand und Verwendungszweck: **Abschottung**

Generische type and use of construction product: **Penetration seal**

Geltungsdauer vom / Validity from: **28.06.2013**

to: **27.06.2018**

Herstellerwerk / Manufacturing plant: **HHI Werk 14**

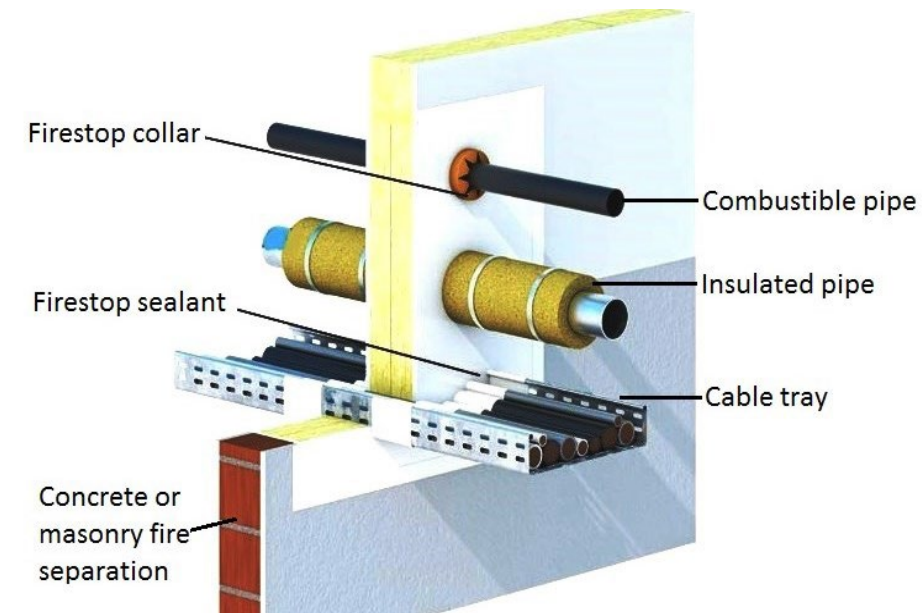
Diese Europäische technische Zulassung umfasst / This European technical approval contains: **14 Seiten inklusive 3 Anhängen / 14 pages including 3 Annexes**

Diese Europäische technische Zulassung ersetzt / This European technical approval replaces: **ETA-11/0153 mit Geltungsdauer von 06.06.2011 bis 05.06.2016 / ETA-11/0153 with validity from 06.06.2011 to 05.06.2016**

**ETA** European Organization for Technical Approvals / Europäische Organisation für Technische Zulassungen / Organisation Européenne pour l'Agrement Technique

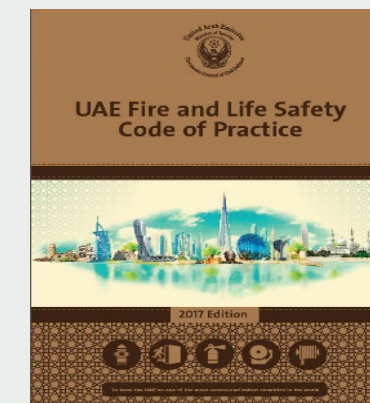
# UAE Fire & Life Safety Code 2018

- Openings in fire rated assemblies where penetrants are passing through a fire-rated construction and where the integrity of the wall and/or floor needs to be maintained.



- **UAE LIFE AND SAFETY CODE OF PRACTICE**

Through-penetration firestop system ratings Shall be as :  
**ASTM E 814, UL 1479, EN 1366-3, FM 4990**



# Official testing laboratories



Intertek (Omega Point) Listings

Warnock Hersey



Warnock Hersey



Underwriters Laboratories Inc.



Factory Mutual Standards Laboratories

- All “Nationally recognized Test Laboratories” are of **equal status** in regulations (code acceptance)
- Each test lab publishes its **own listing directory**

# Official approved systems

The field of application reflects the interplay between the firestop system, consisting of:

1. a fire-rated **wall or floor** assembly,
  2. a **penetrating item** or items passing through an opening in the assembly,
- AND
3. the **materials** designed to help prevent the spread of fire through the openings.

**System No. W-J-3167**

ANSI/UL1479 (ASTM E814)	CANULC S115
F Ratings — 2, 3 and 4 Hr (See Items 1 and 2)	F Ratings — 2, 3 and 4 Hr (See Items 1 and 2)
T Ratings — 0, 1/2, 1-1/2 and 2 Hr (See Items 2 and 3)	FT Ratings — 1/2, 1, 1-1/2, and 2 Hr (See Items 2 and 3)
L Rating At Ambient — See Item 2	FH Ratings — 2, 3, or 4 Hr (See Items 1 and 2)
L Ratings At 400 F — See Item 2	FTH Ratings — 1/2, 1, 1-1/2, and 2 Hr (See Items 2 and 3)

1. Wall Assembly — Min 5 in. (127 mm) thick for 2 hr wall assembly, min 5-5/8 in. (142 mm) thick for 3 hr wall assembly, min 6-1/2 in. (167 mm) thick for 4 hr wall assembly, reinforced lightweight or normal weight (100-150 pcf or 1600-2400 kg/m<sup>3</sup>) concrete. Wall may also be constructed of any UL Classified Concrete Block (CAZT) category in the Fire Resistance Directory for names of manufacturers.

2. Cables — Within the loading area for each firestop device, the cables may represent 0 to 100 percent visual fill. Cables to be tightly bundled within the device and rigidly supported on both sides of wall assembly. Any combination of the following types of cables may be used:

- A. Max 100 pair No. 24 AWG (or smaller) copper conductor telecommunication cable with polyvinyl chloride (PVC) jacketing and insulation.
- B. Max 7/C No. 12 AWG Copper conductor power cable with insulation.
- C. Max 48 No. 14 AWG ground cable.
- D. Max 48 pair No. 22 AWG Cat 5 or Cat 6 computer cables.

3. Firestop Device\* — Firestop device consists of a corrugated steel tube with an inner plastic housing, intumescent material, and fabric smoke seal, flanges and gasketing (not shown). Firestop device to be installed in accordance with the accompanying installation instructions. As an option, the inner fabric seal may remain open except that, to attain the L Rating, the inner fabric seal shall be twisted to completely close off the opening within device. Device slid into wall such that ends project an equal distance from the approximate centerline of the wall assembly. The annular space between the device and the periphery of the opening shall be min 0 in. (point contact). Device provided with flanges that are spun clockwise onto device threads, over gasketing material, butting tightly to both sides of wall. Device flanges are optional except for 3 and 4 hr fire rating, flanges are required. When the device flanges are not used, the T, FT and FTH Ratings for the firestop system are 0 hr. For blank opening (no cables), the T, FT and FTH Ratings for the firestop system are 2, 3 or 4 hr only when the device flanges are used.

HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — CP 653 and CP 653 BA 2" Speed Sleeve, CP 653 and CP 653 BA 4" Speed Sleeve, CFS-SL GA L 2" and 4" Speed Sleeves

The CFS-SL GA L 2" and 4" Speed Sleeves shall only be used in wall thickness of 8 in. (203 mm) or greater.

4. Firestop Sealant — As an alternate to gasket material (see item 3), min 1/2 in. (13 mm) thick firestop sealant material applied within the annulus between firestop device and wall, with smooth surfaces of device and wall, with 1/4 in. (6 mm) bead applied around periphery of device. Sealant is required when device flanges are not used (see item 3).

HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — FS-ONE or FS-ONE MAX Intumescent Sealant, or CP 606 Sealant

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Hilti Firestop Systems

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# What is the average hourly rating of any firestop product?



ZERO

System No. W-J-3167

ANSI/UL 1479 (ASTM E814)	CANULC 5115
F Ratings — 2, 3 and 4 Hr (See Items 1 and 2)	F Ratings — 2, 3 and 4 Hr (See Items 1 and 2)
T Ratings — 0, 1/2, 1-1/2 and 2 Hr (See Items 2 and 3)	FT Ratings — 1/2, 1, 1-1/2, and 2 Hr (See Items 2 and 3)
L Rating At Ambient — See Item 2	FH Ratings — 2, 3, or 4 Hr (See Items 1 and 2)
L Ratings At 400 F — See Item 2	PTH Ratings — 1/2, 1, 1-1/2, and 2 Hr (See Items 2 and 3)

1. Wall Assembly — Min 5 in. (127 mm) thick for 2 hr wall assembly, min 5-5/8 in. (142 mm) thick for 3 hr wall assembly, min 6-1/2 in. (167 mm) thick for 4 hr wall assembly, reinforced lightweight or normal weight (100-150 pcf or 1600-2400 kg/m<sup>3</sup>) concrete. Wall may also be constructed of any UL Classified Concrete Blocks\*. Opening in wall to be max 2-1/2 in. (64 mm) diam for 2" device and max 4-1/2 in. (114 mm) diam for 4" device.  
\* See Concrete Blocks (CAZT) category in the Fire Resistance Directory for names of manufacturers.

2. Cables — Within the loading area for each firestop device, the cables may represent 0 to 100 percent visual fill. Cables to be tightly bunched within the device and tightly supported on both sides of wall assembly. Any combination of the following types of cables may be used:  
A. Max 100 pair No. 24 AWG (or smaller) copper conductor telecommunication cable with polyvinyl chloride (PVC) jacketing and insulation.  
B. Max 7/0 No. 12 AWG copper conductor control cable with PVC or XLPE jacket and insulation.  
C. Max 4/0 AWG Type RHH ground cable.  
D. Max 4 pr No. 22 AWG Cat 5 or Cat 6 computer cables.

3. Firestop Device — Firestop device consists of a corrugated steel tube with an inner plastic housing, intumescent material rings, twisted inner fabric smoke seal, flanges and gasketing material (not shown). Firestop device to be installed in accordance with the accompanying installation instructions. As an option, the inner fabric seal may remain open except that, to obtain the L Rating, the inner fabric seal shall be twisted to completely close off the opening within device. Device slid into wall such that ends project an equal distance from the approximate centerline of the wall assembly. The annular space between the device and the periphery of the opening shall be min 0 in. (point contact). Device provided with flanges that are spun clockwise onto device threads, over gasketing material, butting tightly to both sides of wall. Device flanges are optional except for 3 and 4 hr fire ratings, flanges are required. When the device flanges are not used, the T, FT and PTH Ratings for the firestop system are 0 hr. For blank opening (no cables), the T, FT and PTH Ratings for the firestop system are 2, 3 or 4 hr only when the device flanges are used. HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — CP 653 and CP 653 BA 2" Speed Sleeve, CP 653 and CP 653 BA 4" Speed Sleeve, CFS-SL GA L 2" and 4" Speed Sleeves shall only be used in wall thickness of 8 in. (203 mm) or greater.

4. Fill, Void or Cavity Material - Sealant — As an alternate to gasket material (see item 3), min 1/2 in. (13 mm) thickness of fill material applied within the annulus between firestop device and wall, flush with both surfaces of wall, and an additional 1/4 in. (6 mm) bead applied around periphery of device. Sealant is required when device flanges are not used (see item 3).  
HILTI CONSTRUCTION CHEMICALS, DIV OF HILTI INC — FS-ONE or FS-ONE MAX Intumescent Sealant, or CP 606 Sealant

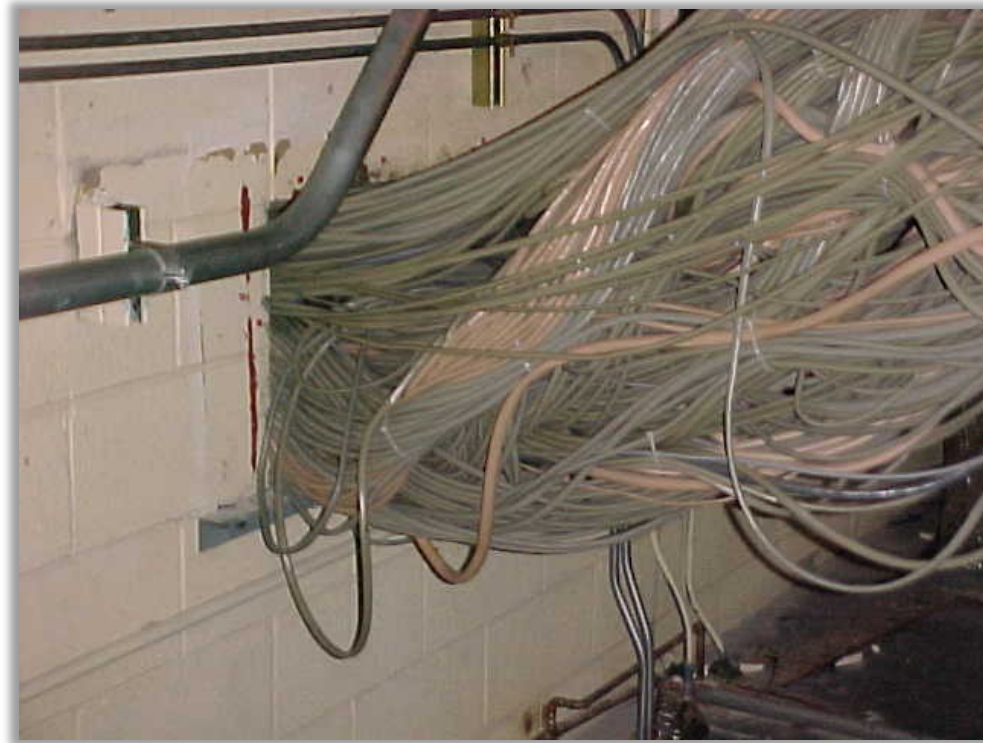
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Only Firestop Systems have ratings!

# How do you address this application?



Not all firestop applications are tested  
What if the site condition deviates from tested design?

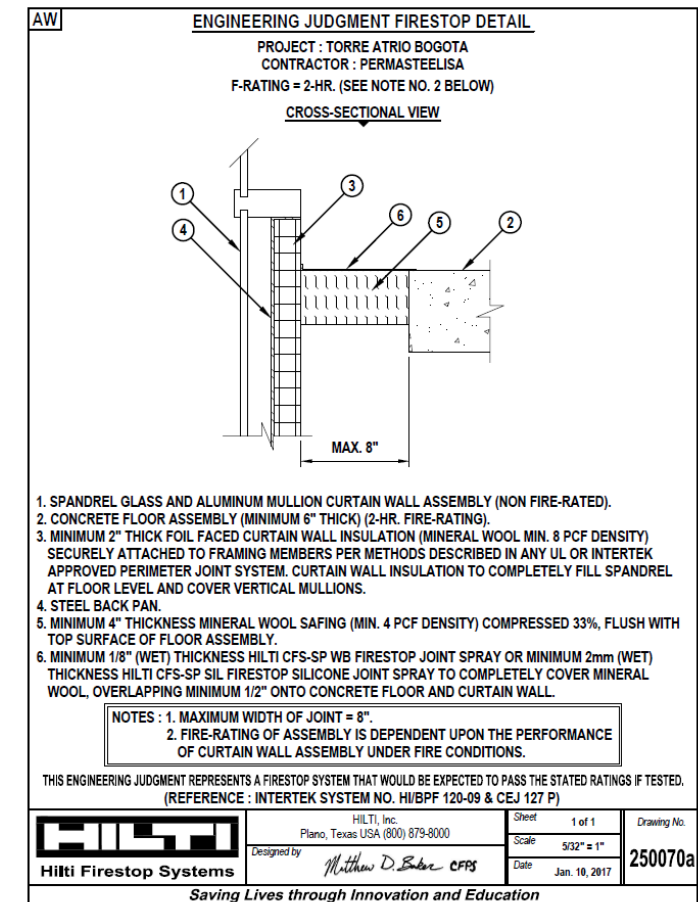


# In absence of tested system, engineering judgements should be used




- Based upon **interpolations of previously tested** firestop systems (referenced on the form)
- Limited only to the specific conditions upon which it was rendered.
- Site specific; **Not transferrable**
- If no related testing data available, the EJ is unlikely.

## Typical Engineering Judgment Conditions:

- Annular space larger/smaller than tested
- Irregular hole shape
- Hole shape different than tested...



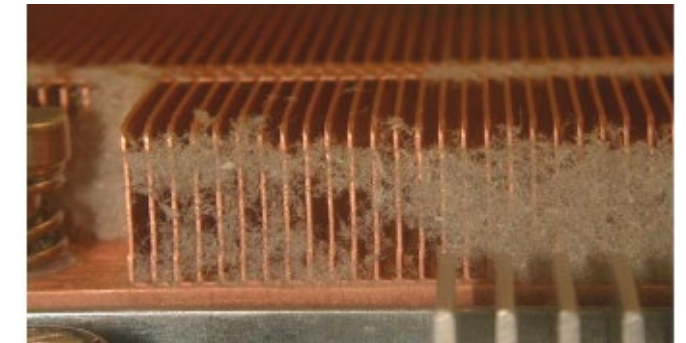
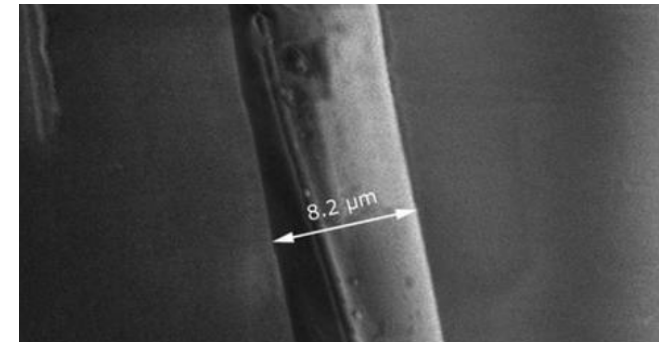
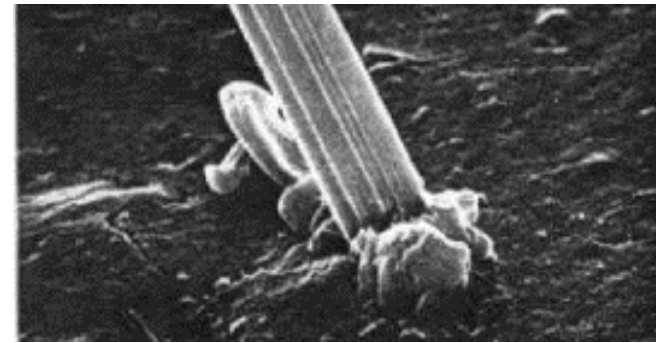
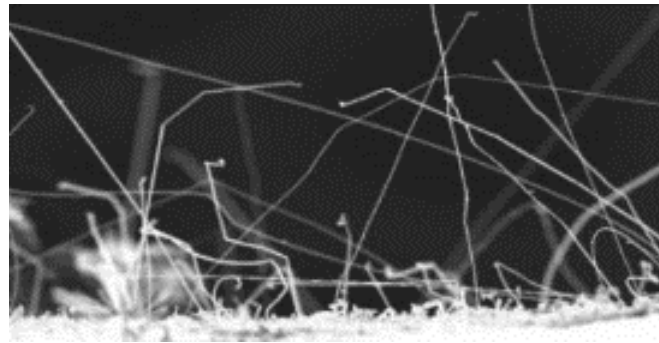
# Airflow mitigation

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**

# Non-conductive particulates pose a risk to efficient and reliable facility operations



**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:

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

**“The key to keeping airborne contaminants out of the data center is to avoid bringing them in<sup>1</sup>”**

**“Particulate contamination can increase a data center’s power demand by 2% or more<sup>1</sup>”**

Source: „The Threat of Data Centre Contamination” on [datacenterknowledge.com](http://datacenterknowledge.com)

# ASHRAE recommends Data centers meet ISO clean room class 8 standard

## ASHRAE TC 9.9—2011

### Gaseous and Particulate Contamination Guidelines for Data Centers

ASHRAE developed a technical guideline for modern data center facilities. Sources of particulate and gaseous contamination should be monitored and controlled at all times.

TC 9.9 re Class 8 or made to f the maxim The gase severity le

For data centers without economizers, the ISO class 8 cleanliness level may be achieved simply by specifying with MERV 8 filters for air recirculated inside the data center, and MERV 11 or MERV 13 filters for air entering a data center.

For data centers utilizing free air cooling or air-side economizers, the choice of filters to achieve ISO class 8 level of cleanliness depends on the specific conditions present at that data center.



Table 3.3 ISO Standard 14644-1: Selected Airborne Particulate Cleanliness Classes for Cleanrooms and Clear Areas

ISO Class	Maximum Number of Particles in Air (Particles in Each Cubic Metre Equal to or Greater than the Specified Size)					
	Particle Size					
	> 0.1 µm	> 0.2 µm	> 0.3 µm	> 0.5 µm	> 1 µm	> 5 µm

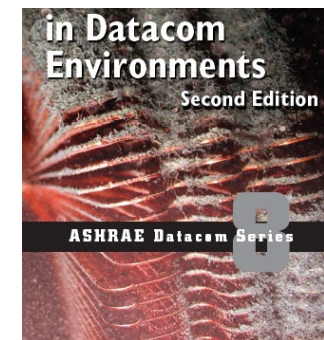
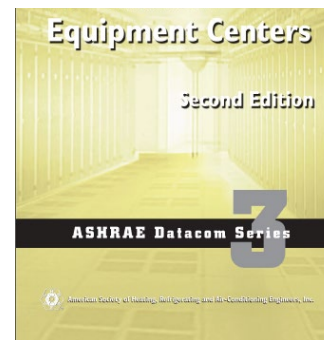
**“Construction materials and processes have a huge impact on the quantity of contaminants that may be present in the environment.”<sup>1</sup>**

29  
293  
2930

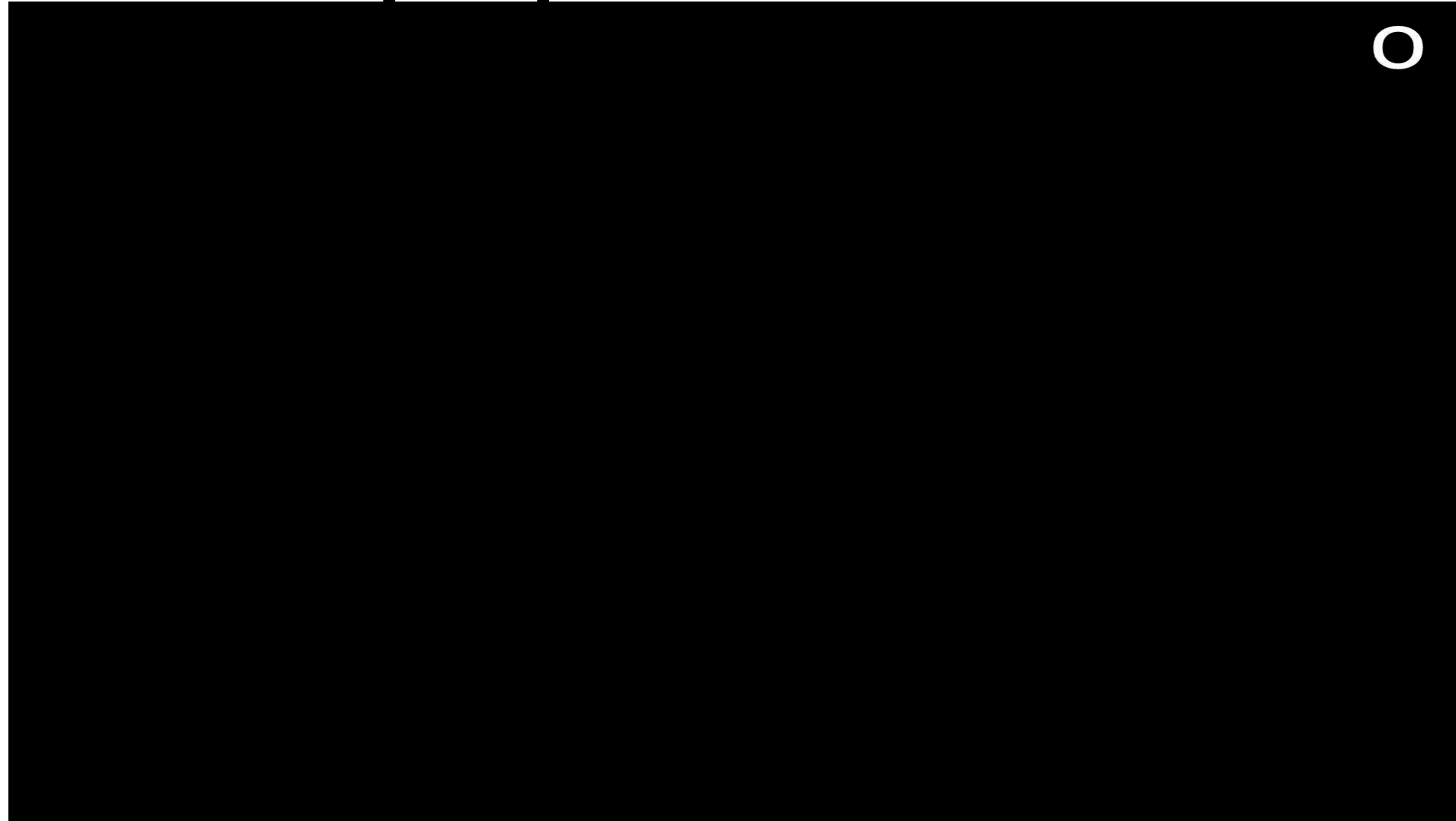
Class 8	3,520,000	832,000	29,300
Class 9		8,320,000	293,000

Note: Uncertainties related to the measurement process require that data with no more than three significant figures be used in determining the classification level.  
Source: ISO Standard 14644-1 (ISO 1999).

Datacom equipment centers must be kept clean to meet the cleanliness requirements of ISO Class 8 (Ortiz 2006). Class 8 allows 3,520,000 million particles 0.5 µm or larger per cubic metre. Class limits must be met with the strictness of the 95% upper confidence limit. Chapter 4 of this book discusses particulate contamination monitoring and analysis.



# Cable repenetrations (MAC's) increase risks to people and assets



# Pre-engineered firestop solutions eliminate the risk of human error and ease maintenance

## New construction



- Traditional systems are also the most often **incorrectly installed**
- **Inspection failures** are common yet don't catch all incorrect installations

## Renovation



- When re-penetrating, there is lack of coordination resulting in **wide-open penetrations**
- Higher risks to fire protection –people and assets-
- Increase **energy costs**

## Solution



- Cable pathway devices **reduce risk**
- Correct firestop, built in
- Easy to **repenetrate**, accommodates future cables → cost-effective maintenance

# Solutions should fit application and project needs

## Performance Requirements

✓ Minimum Code compliance for firestop system rating

- ✓ Ensure life safety and property loss prevention
- ✓ Correct installation
- ✓ Re-penetrability (MAC work)
- ✓ Ease of inspection
- ✓ Prevent airborne disease transmission
- ✓ Prevent dust contamination
- ✓ Room pressurization
- ✓ Reduce cooling and heating costs

## Solution

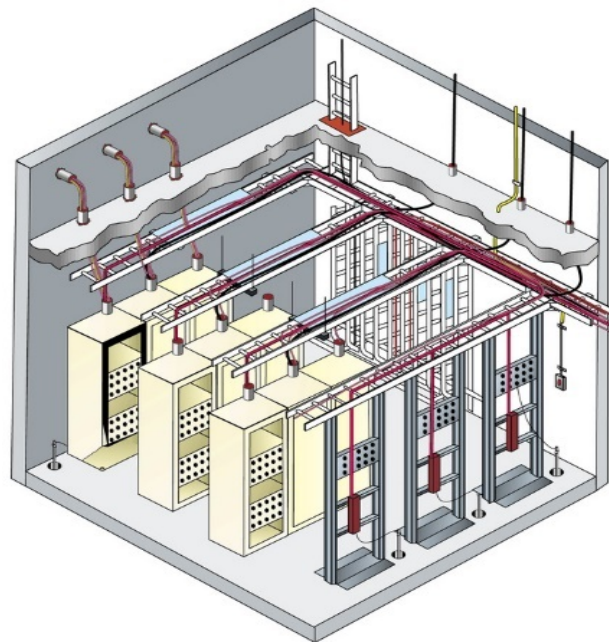
Traditional Firestop System  
(generates dust and greater potential to human error)

**Pre-formed firestop solutions**  
(fiber-free for easy cable changes)



# Clearly convey your design intent

- Mandate cable pathway devices in [Master specs](#)
- [Draw](#) cable pathways devices on Datacom or Telecom details



**CLASSIFIED**  
C US  
Classified by  
Underwriters Laboratories, Inc.  
to UL 1479 and CANULC-S115

**System No. C-AJ-3284**

ANSI/UL1479 (ASTM E814)	CANULC S115
F Rating — 3 Hr	F Rating — 3 Hr
T Rating — 1/2 Hr	FT Rating — 1/2 Hr
L Rating At Ambient — Less Than 1 CFM (See Item 2)	FH Rating — 3 Hr
L Rating At 400 F — Less Than 1 CFM (See Item 2)	FTH Rating — 1/2 Hr
	L Rating At Ambient — Less Than 1 CFM (See Item 2)
	L Rating At 400 F — Less Than 1 CFM (See Item 2)

CAJ 3284

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/m<sup>3</sup>) concrete. Wall may also be constructed of any UL Classified Concrete Blocks\*. Floor may also be constructed of any min 6 in. thick UL Classified hollow-core Precast Concrete Units\*. Opening in floor or wall to be max 3 in. (76 mm) diam for 2" device and max 5 in. (127 mm) diam for 4" device. See Concrete Blocks (CAZT) and Precast Concrete Units (CFTV) categories in the Fire Resistance Directory for names of manufacturers.

2. Cables — Within the loading area for each firestop device, the cables may represent a 0 to 100 percent visual fill. Cables to be tightly bundled within the device and rigidly supported on both sides of floor or wall assembly. Any combination of the following types of cables may be used:

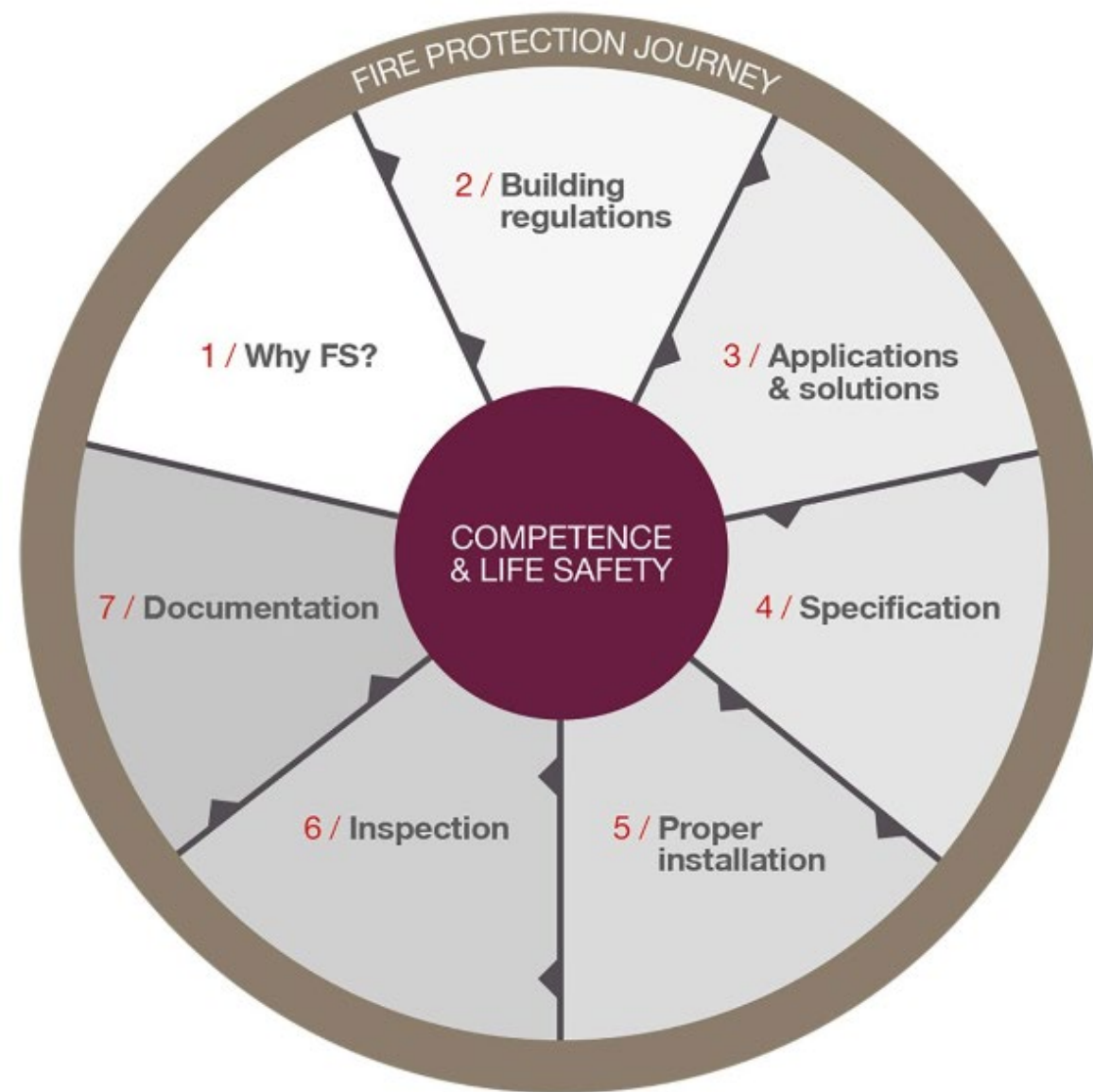
- A. Max 100 pair No. 24 AWG (or smaller) copper conductor telecommunication cable with polyvinyl chloride (PVC) jacketing and insulation.
- B. Max 7/C No. 12 AWG copper conductor control cable with PVC or XLPE jacket and insulation.
- C. Max 4/0 AWG Type RHH ground cable.
- D. Max 4 pr No. 22 AWG Cat 6 computer cables.
- E. Max RG 6/U coaxial cable with fluorinated ethylene insulation and jacketing.
- F. Fiber optic cable with polyvinyl chloride (PVC) or polyethylene (PE) jacket and insulation having a max diam of 1/2 in. (13 mm).
- G. Max 20/C No. 22 AWG shielded printer cable with PVC jacket.
- H. Through-Penetrating Product\* - Two copper conductors No. 18 AWG (or smaller) Power or Non Power Limited Fire Alarm Cable with or without a jacket under a metal armor.

AFC CABLE SYSTEMS INC

I. Max 1/4 in. (6 mm) diameter S-Video Cable consisting of 2 max 24 AWG 75 ohm coax or twisted pair cable with PE insulation and PVC jacket.



# The firestop journey



# 3 things to remember

1. **Fire & Smoke** are devastating occurrence that happen more often than we think
2. Designers should consider maintenance and **future cable capacity**
3. Reach out to us for **support!**

# Thank you

Jessica Bello Salguero  
Global Product Manager  
Hilti AG

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