Standards Used in Fire-Resistance-Rated & Smoke Resistant Assemblies

Abhishek Chhabra, Thomas Bell-Wright International Consultants
Rich Walke, Consultant to FCIA

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Passive Fire Protection

Containment

Ignition/Spread

Structural

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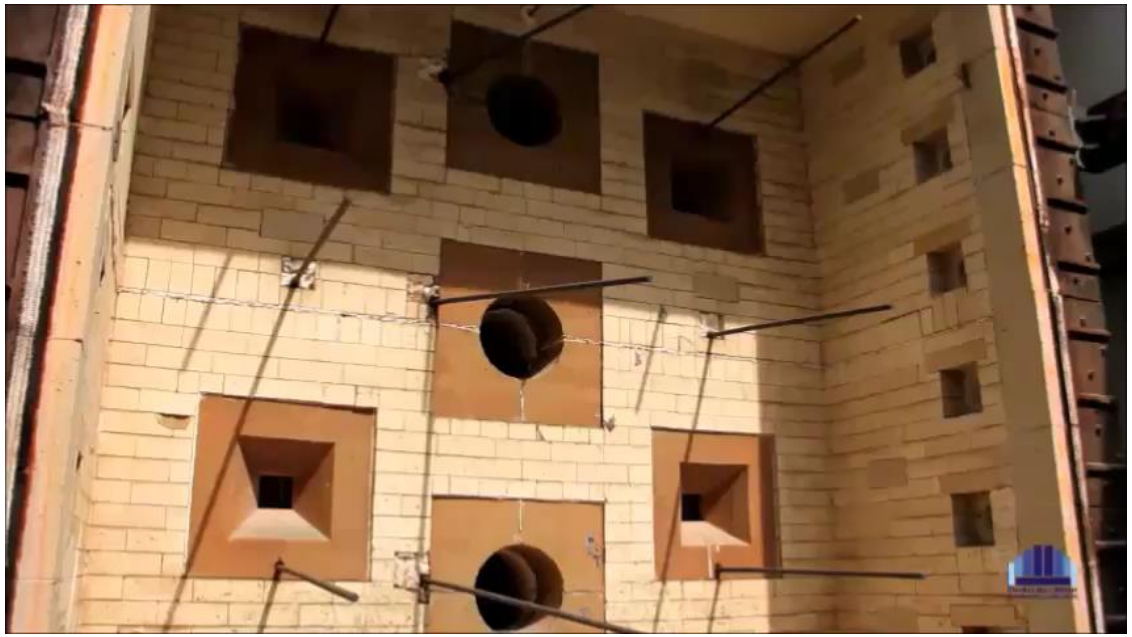
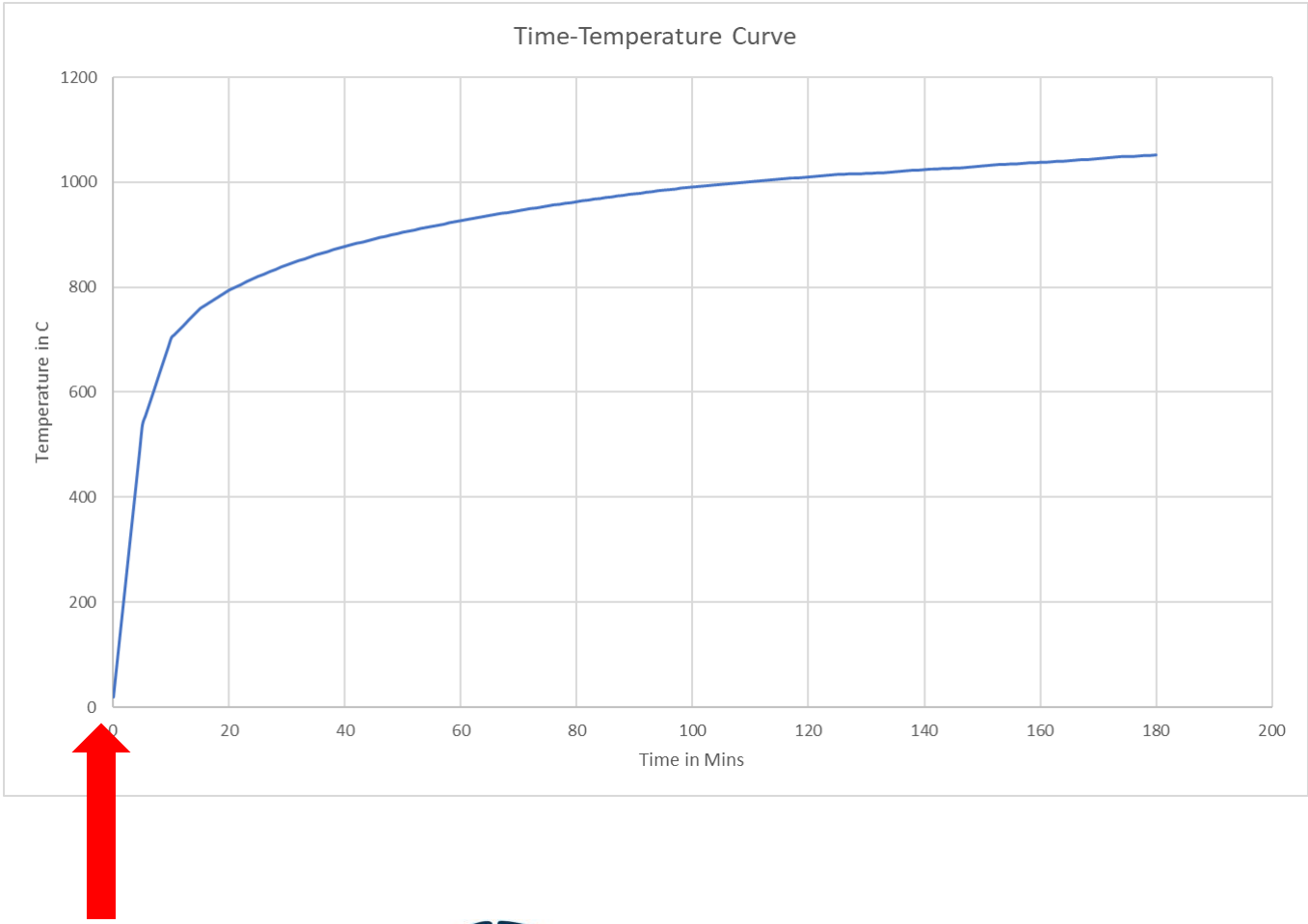
How does fire resistance get verified?





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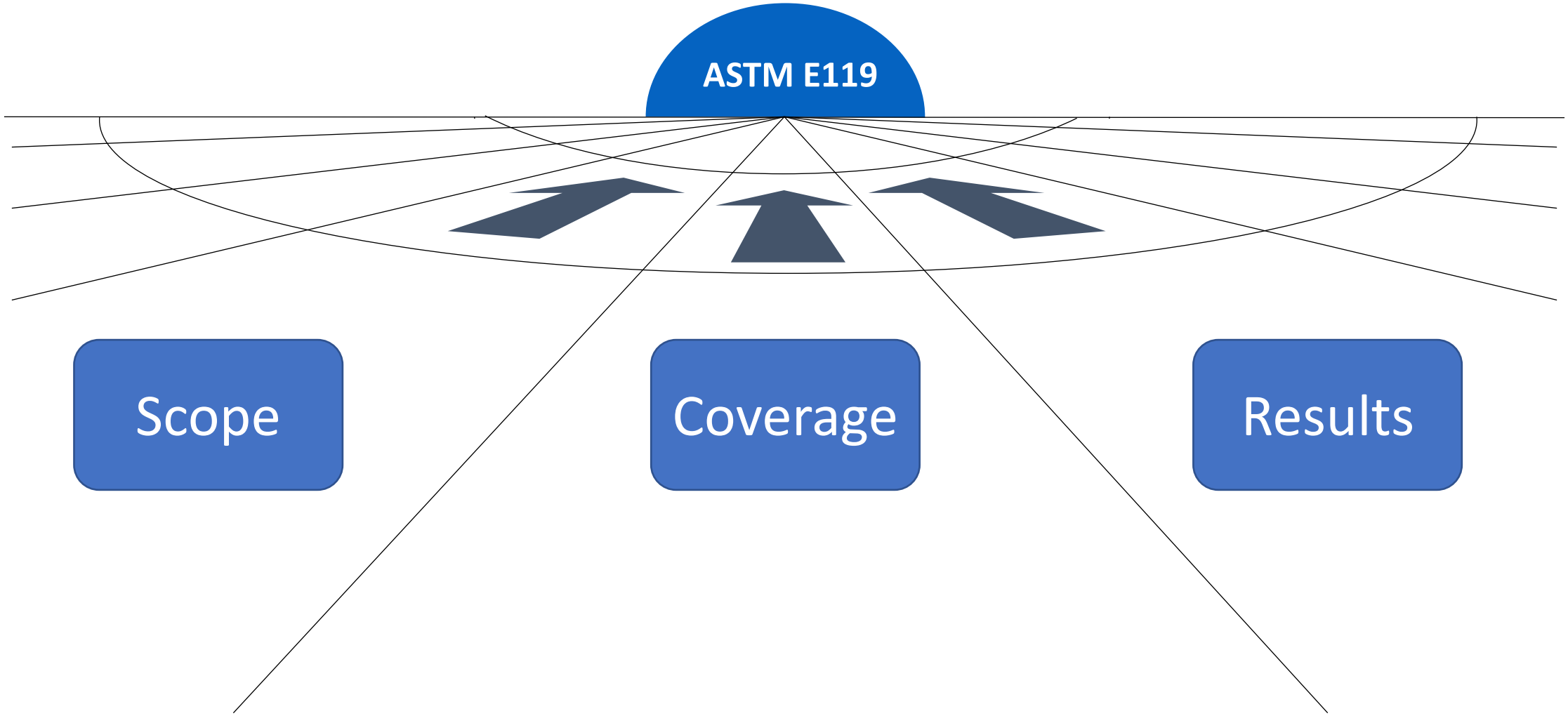

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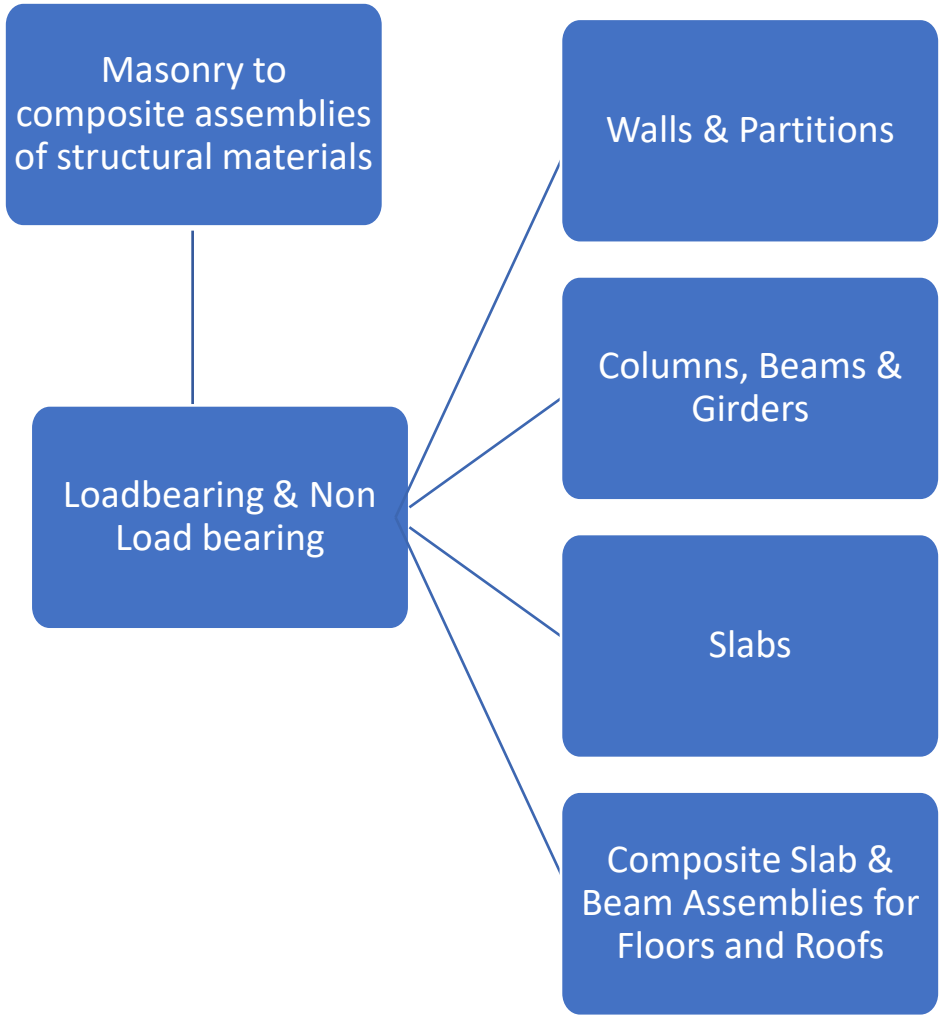
Scope

- Fire Test Response standard for Assemblies and Elements
- Specific Fire-Test conditions
- Response to heat and flame under controlled conditions only
- Results assess one of the many factors



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Coverage

Intended to evaluate the duration in time that these building types

Can contain fire, retain structural integrity (or both)

During a predetermined test exposure

Provides For	Does not Provide for
Walls, Partitions, floor, roof	Performance beyond what is tested
Transmission of Heat	Other hazards like smoke, toxicity, etc.
Transmission of Hot Gasses	‘How much’ (Passage of) smoke, etc.
Measure load (Loadbearing)	Fire behavior of joints
	Flame Spread

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Results

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Test Reference No.:

10.SUMMARY OF RESULTS

The non-loadbearing partition system with a double layer of 12.5mm thick boards used on the unexposed face and a double layer of 12.5mm thick boards the exposed face of the test specimen has been evaluated in accordance with ASTM E119-18c;

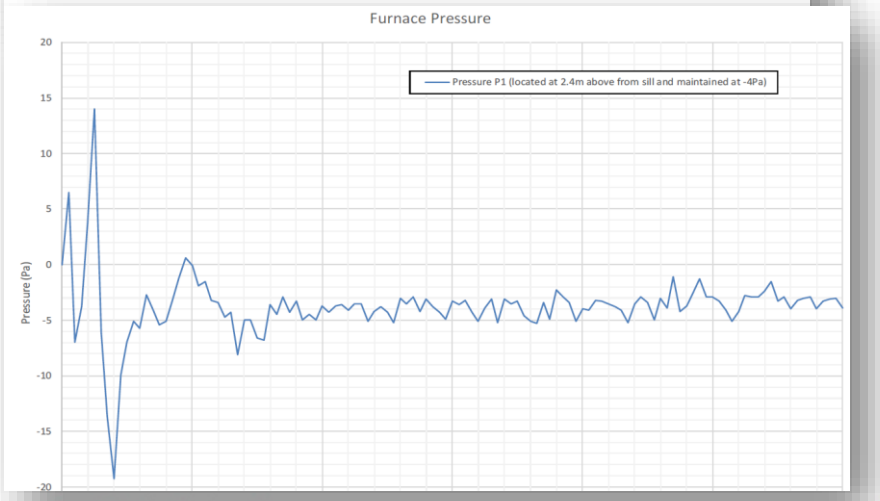
The requirements of the standards were satisfied for:

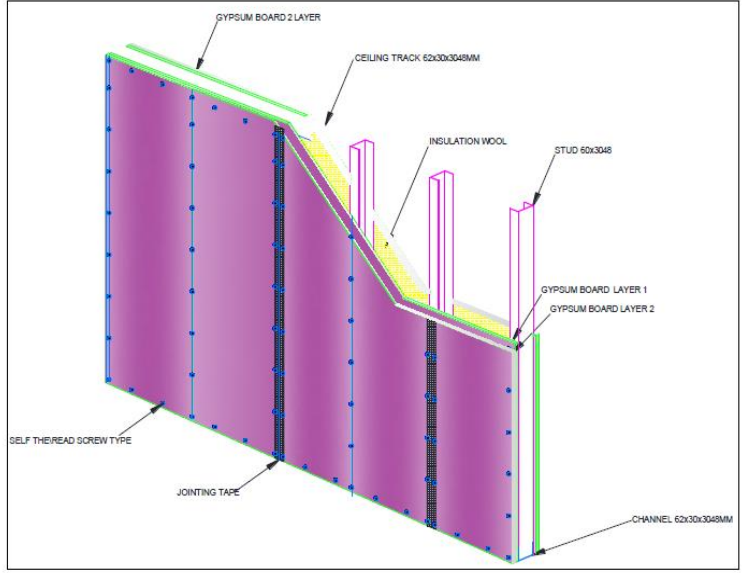
FIRE RESISTANCE RATING
59 MINUTES

***Note**: The test specimen satisfied the criteria of the ASTM E119 fire endurance test for a duration of **60:00 minutes** as agreed with test sponsor, but did not satisfy the criteria of the ASTM E2226 hose stream test. As such, in accordance with section 7.6 of ASTM E119, the maximum rating for a specimen that does not satisfy, the criteria of the hose stream test was **59 minutes**.*

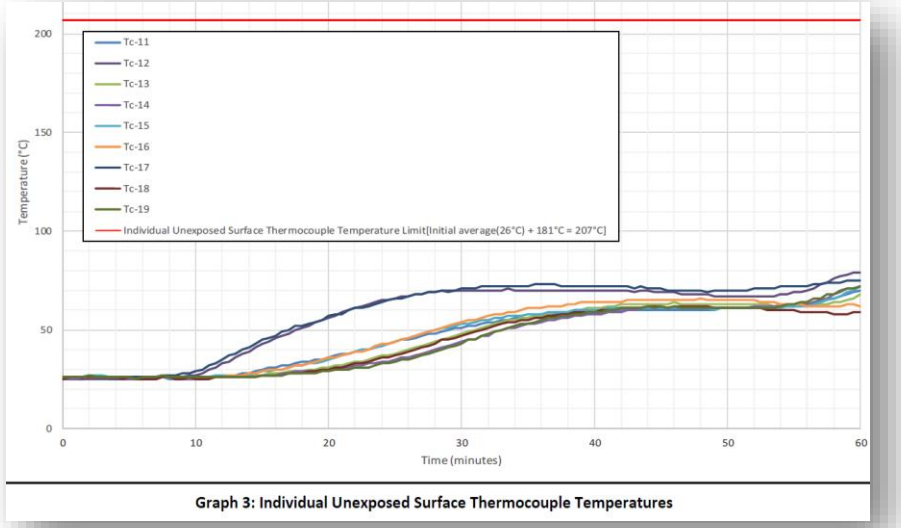
This report and all records of the test to which it relates may be not be retained by TBWIC further than 5 years from the date of testing.

This test report is respectfully submitted by: Thomas Bell-Wright International Consultants





Drawing 7: Overall view of the installation of the specimen.
(Drawing provided by the test sponsor and verified by TBWIC)



Graph 3: Individual Unexposed Surface Thermocouple Temperatures

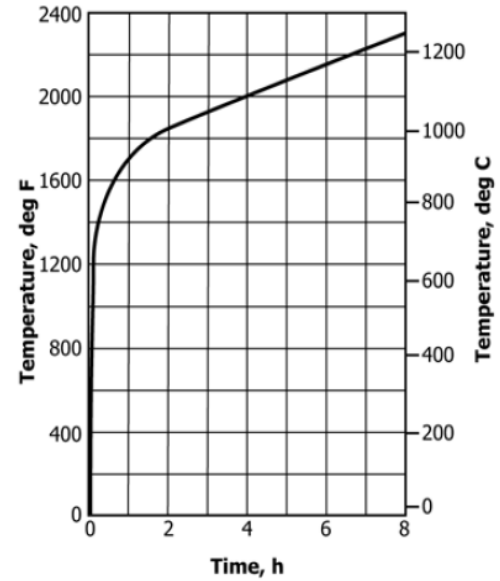


FIG. 1 Time-Temperature Curve

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Maintaining Compartmentalization

Images credit to Etex Building Performance Limited

Intumescence	• To increase in volume upon exposure to heat.
Endothermic reaction	• To absorb heat of the exposing fire and using that to decompose the material.
Ablative reaction	• To resist heat transfer by using the heat of the exposing fire to erode the material.
Insulation	• To resist heat transfer as the result of its low thermal conductivity.

Test Firestop Systems

- Part of the fire-resistance-rated assembly’s
- Separately using the more focused testing methods

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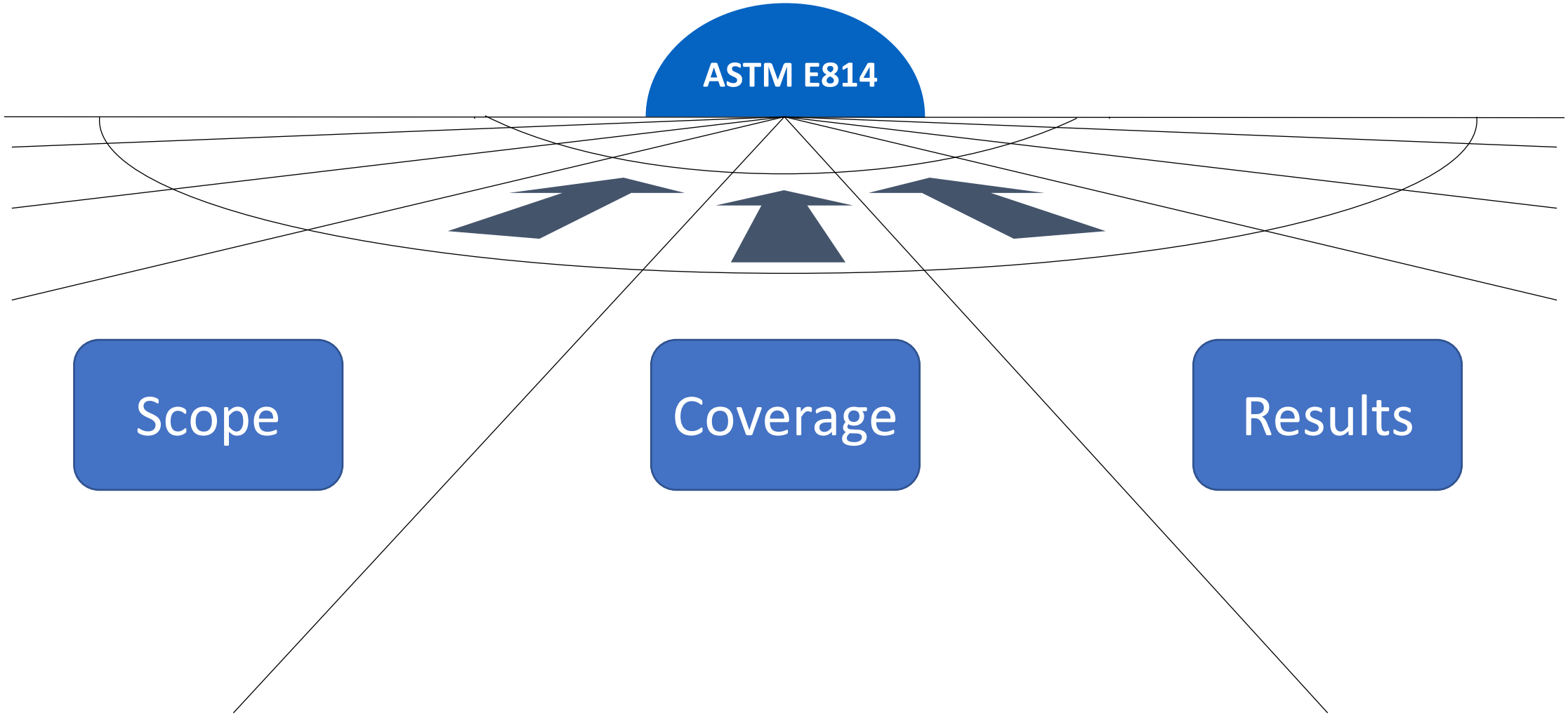

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Scope

Applicable : FS systems intended for use in openings in fire resistance walls & floors that are evaluated as per ASTM E119

Response to heat and flame under controlled conditions only

Firestop (Materials & Devices) are not tested in seclusion, but the firestop system / assembly is tested

Not applicable to membrane penetrations of floor-ceiling, roof-ceiling assemblies or loadbearing walls

Picture 15: The specimen during the hose stream test.

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Coverage

Firestop System

- Combination of Penetrating Item(s), Specific Construction that is penetrated and the materials or devices or both that seal the opening

Membrane penetration (MP)

- A breach in one side of a floor-ceiling, roof-ceiling or wall assembly to accommodate an item installed into or passing through the assembly

Through penetration (TP)

- A opening in both sides of a floor, floor-ceiling or wall assembly to accommodate an item passing through the breach.

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9.2. Fire Test observation

Time (Mins)	Specimen Description
0'00	**Test commences**
1'14	Light smoke through the end of the pipe on the unexposed face.
5'19	Heavy smoke through the end of the pipe on the unexposed face.
11'32	All smoke issuance have been ceased.
20'28	The sealant inside the GS sleeve has started to react and started to bulge away from the furnace.
54'21	Smoke stains on the gypsum supporting partition at the top of the boards.
60'00	Specimen is stable.
90'00	Specimen is stable.
113'29	Smoke stains on the gypsum supporting partition along the vertical studs of the boards.
120'00	**End of Fire Test as agreed with the sponsor.**

9.3. Hose Stream Test observation

Time (Mins)	Specimen Description
0'00	Start of hose stream test
0'09	**Through opening which permitted the water stream beyond the unexposed face.**
0'36	End of Hose Stream Test (the specimen has been subjected to impact, erosion and rapid cooling effects of the hose stream for 36 seconds at 30psi. but failed the hose stream test at 10 seconds as the sealant broke off)
END OF ASTM E814 & ASTM E2226 TEST AS AGREED WITH THE SPONSOR	

F Rating

T Rating

Picture 7 – During the Hose Stream Test the seal had come off

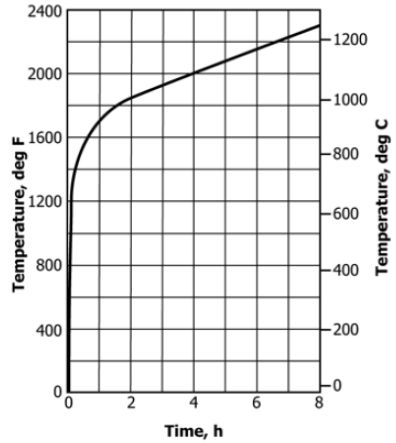
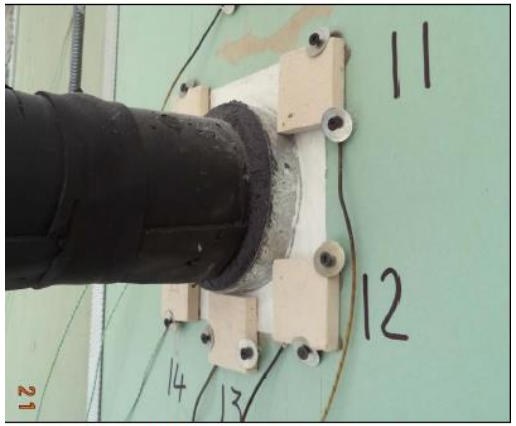


FIG. 1 Time-Temperature Curve



e 3 – Intumescent sealant between the insulation and GS sleeve has started to

ASTM E2307: Standard Test Method for Determining Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Test Apparatus

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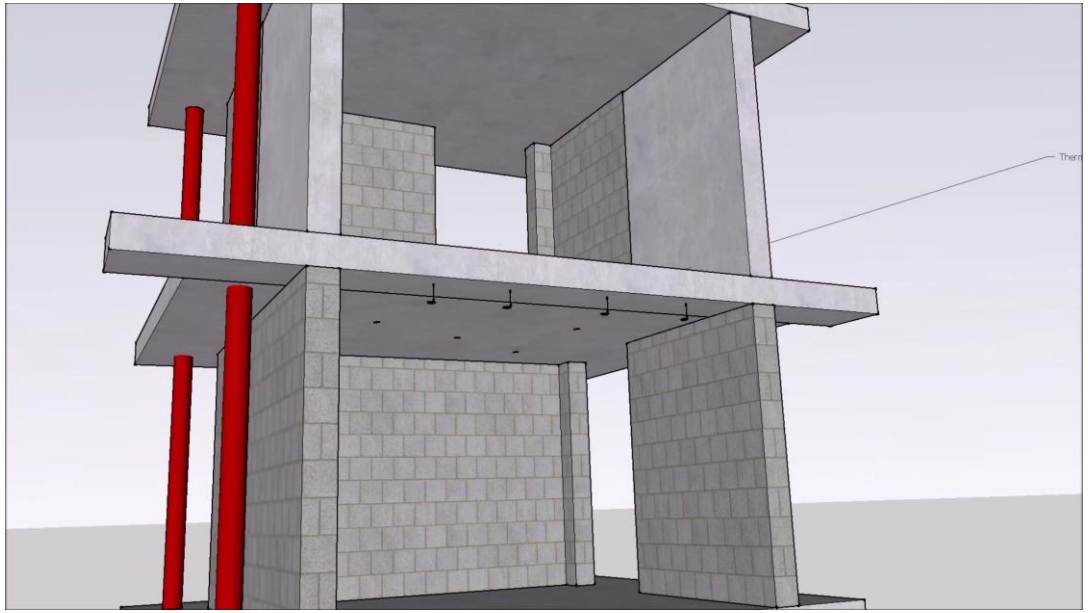
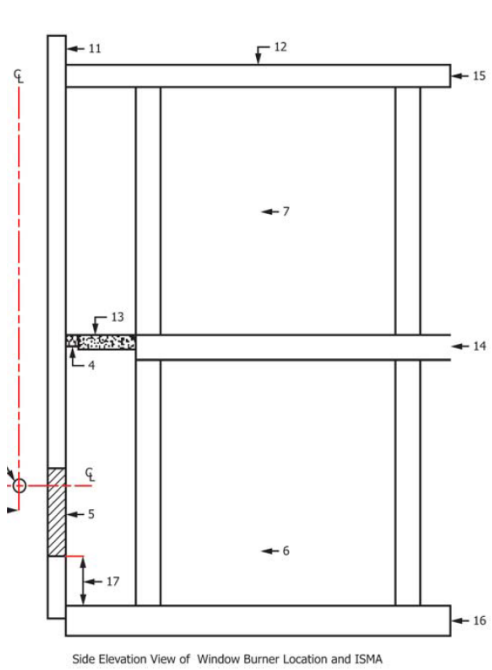
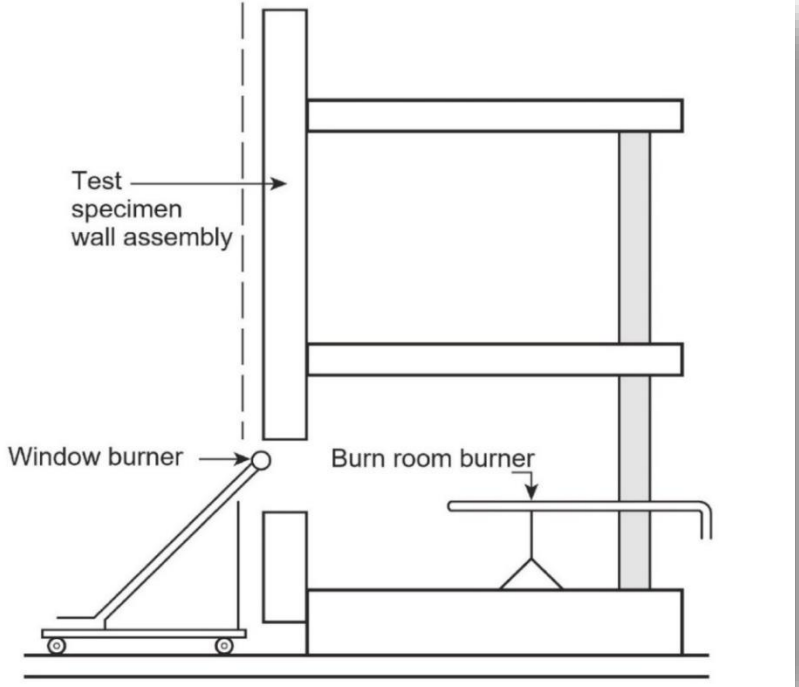




Side Elevation View of Window Burner Location and ISMA



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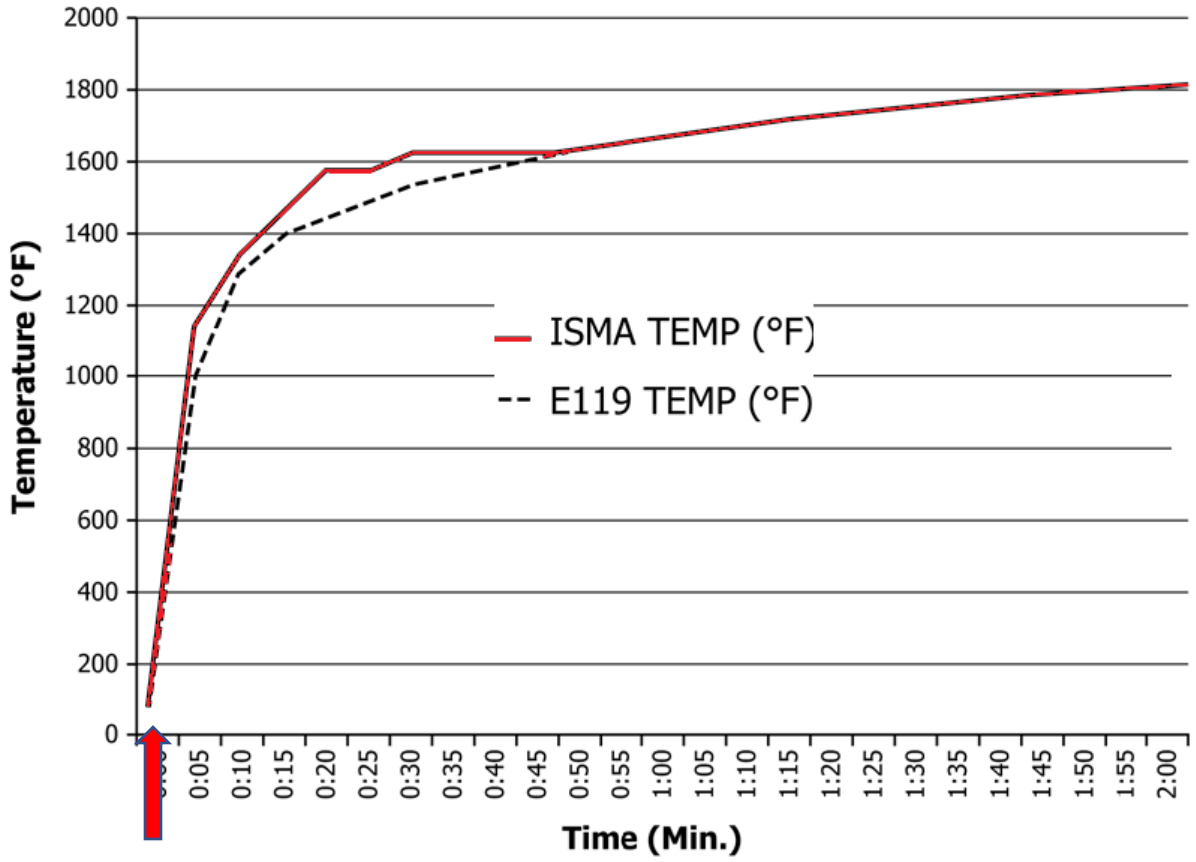

Test each perimeter joint protection with manufactured and field splices. When the technique of the manufactured splice is the same as the field splice, test only one splice.

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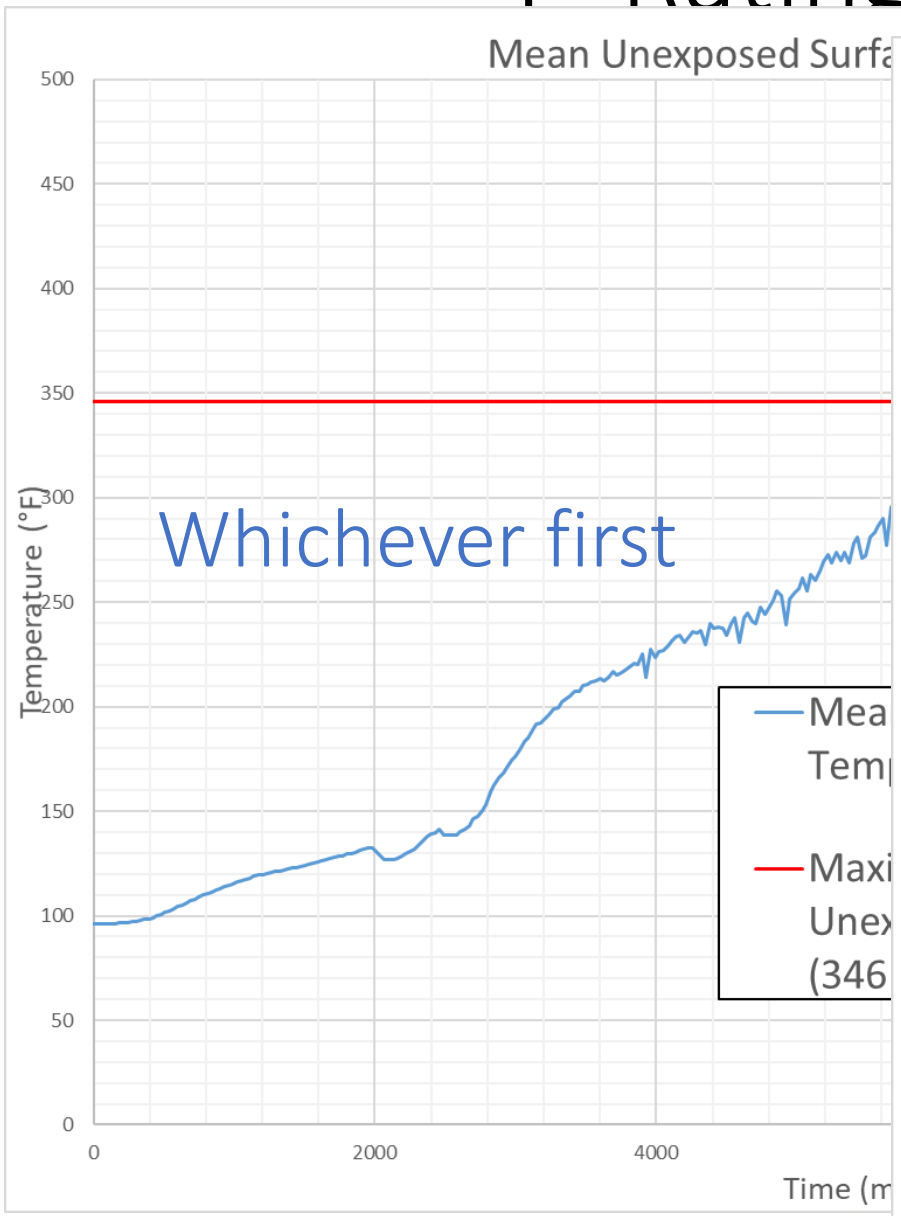
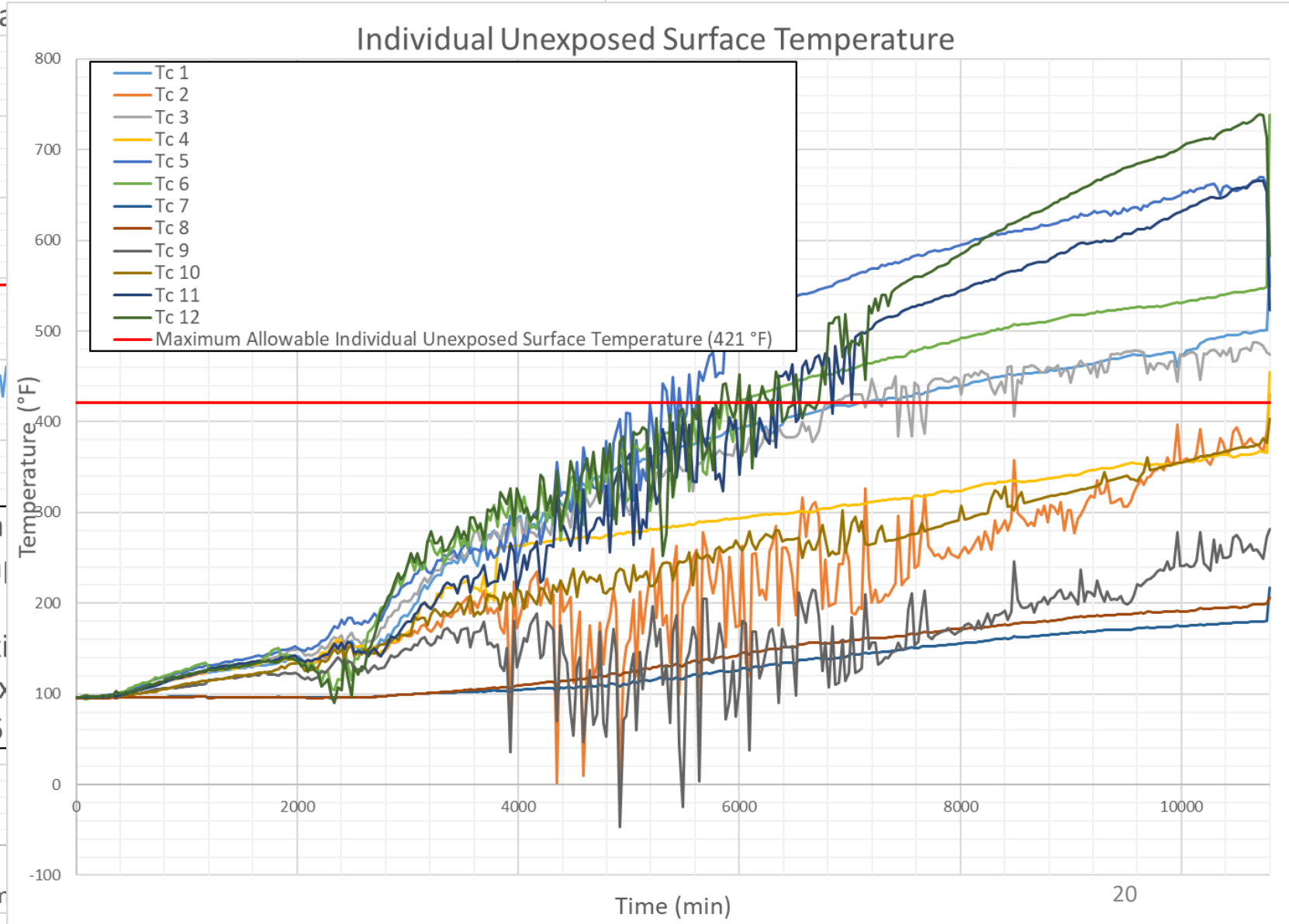
T- Rating – Measured in Time when..



Whichever first



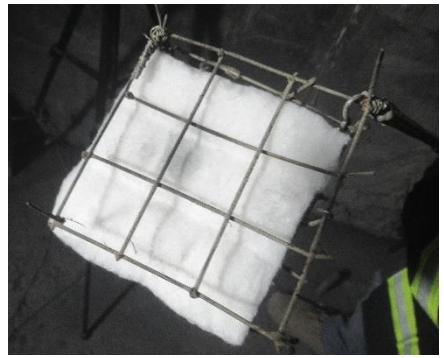
F- Rating – Measured in Time when..

Flame Penetration Through Perimeter Joint protection or around boundaries

Whichever first

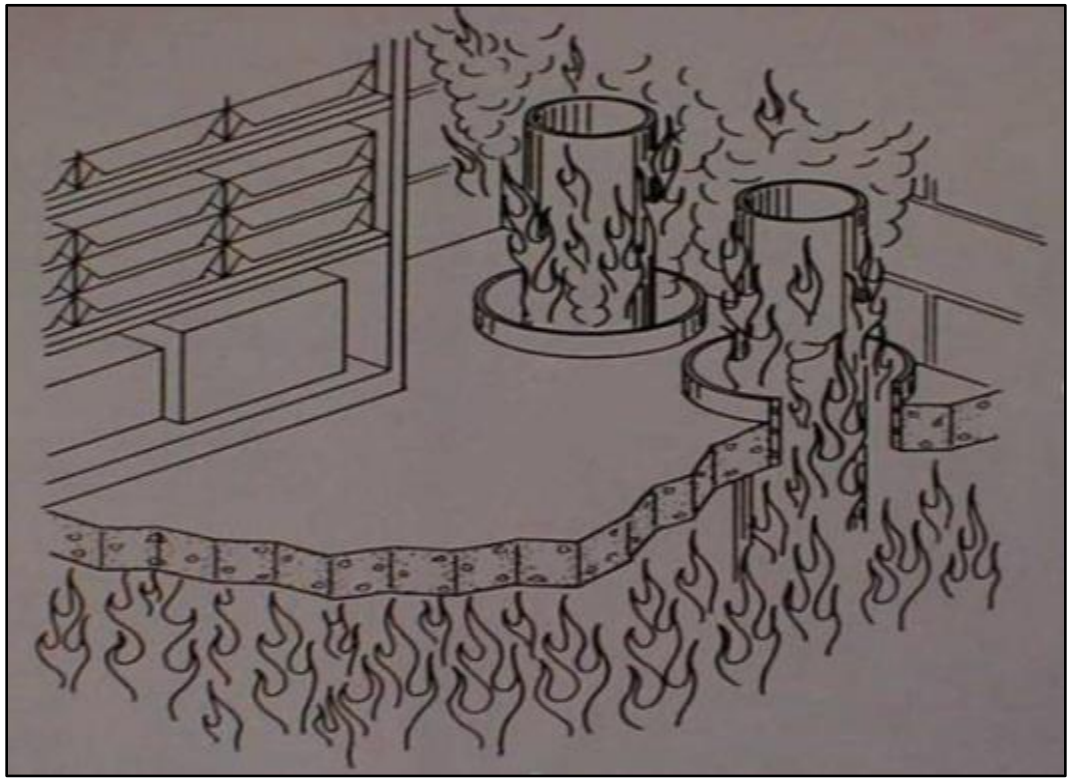
Flames/ hot gasses Cotton Pad

F Rating



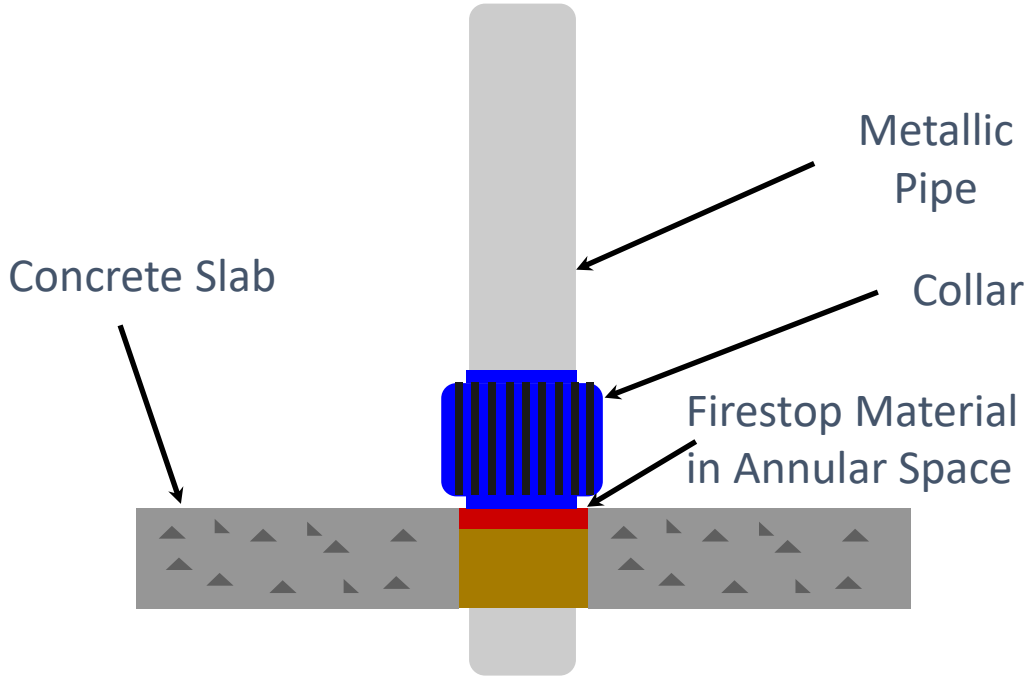
F (Flame) Rating of Firestop Systems

- Passage of Flame
- Hose Stream



T (Temperature) Rating of Firestop Systems

- Passage of Flame
- 325°F (180°C) Temperature Rise
- Hose Stream



L (Leakage) Rating (Optional, Based on UL 1479)

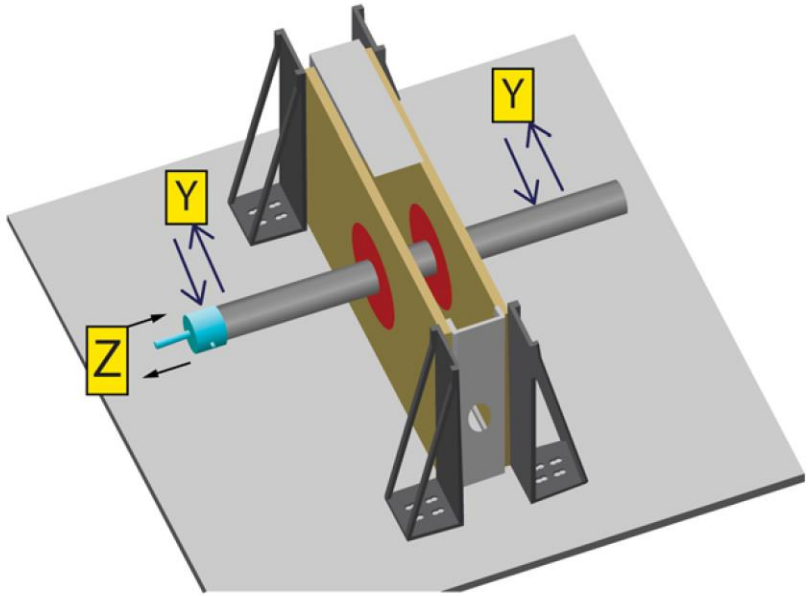
- Air Leakage Rate at Ambient Temperature
- Air Leakage Rate at 400°F (204°C)

W (Water) Rating (Optional, Based on UL 1479)

- Optional program, applicable to incidental water
- 3 Ft. WC (0.91 M WC) Pressure Head / 72 Hr Exposure
- Firestop subjected to water exposure, followed by standard fire and hose stream tests
- Firestop systems assigned a W Rating

M (Movement) Rating (Optional)

- Applicable to movement of penetrating item with respect to the barrier
- Penetrating item move perpendicular and/or in plane of barrier - ASTM E3037
- After movement, fire and hose stream test
- Firestop systems - M Rating
  - Rating within plane based on percentage of the minimum annular space of the field installation
  - Rating perpendicular to barrier based on dimension



Through- and Membrane-Penetration Firestop Systems

Establishing an L Rating

L (Air Leakage) Ratings

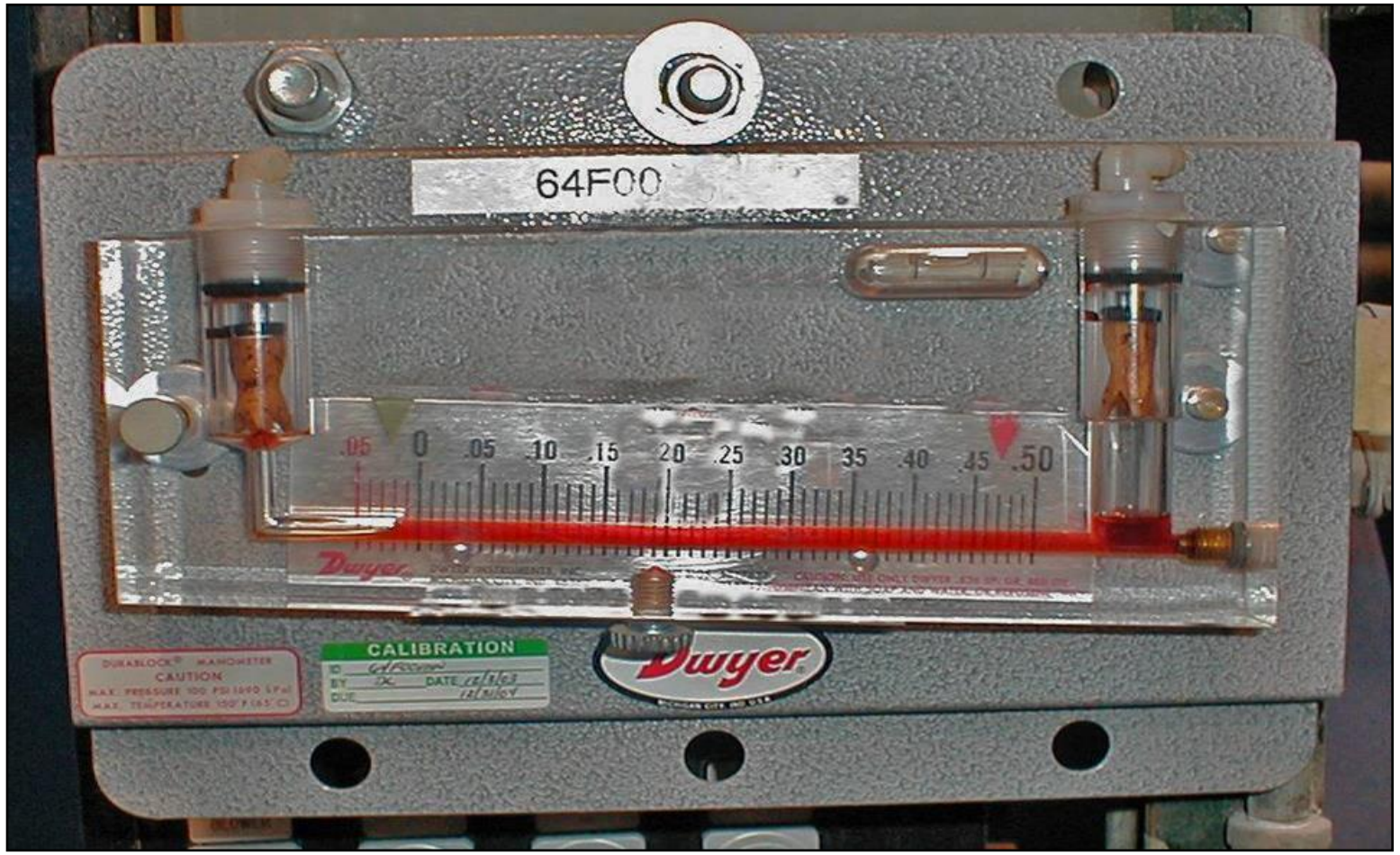
- Optional L Rating methodology added to UL 1479 in 1993
- Leakage determined at 0.3 in. WC (74.7 Pa)
- Tested at Ambient and 400°F (204°C)
- Results published in either CFM (m^3/s) or CFM per sq ft (m^3/s per m^2)

L (Air Leakage) Ratings

L (Air Leakage) Ratings

L (Air Leakage) Ratings

L (Air Leakage) Ratings



Test Procedure

- Incidental chamber leakage determined using blank slab
- Air leakage of test sample determined at ambient temperature
- Air leakage of test sample determine at 400°F (204°C)
- Incidental chamber leakage rechecked after cooling
- Firestop system assigned L Rating at ambient and 400°F (204°C), by subtracting incidental chamber leakage from test sample leakage
- L Ratings of firestop systems published along with F and T Ratings

Fire-Resistant Joint Systems

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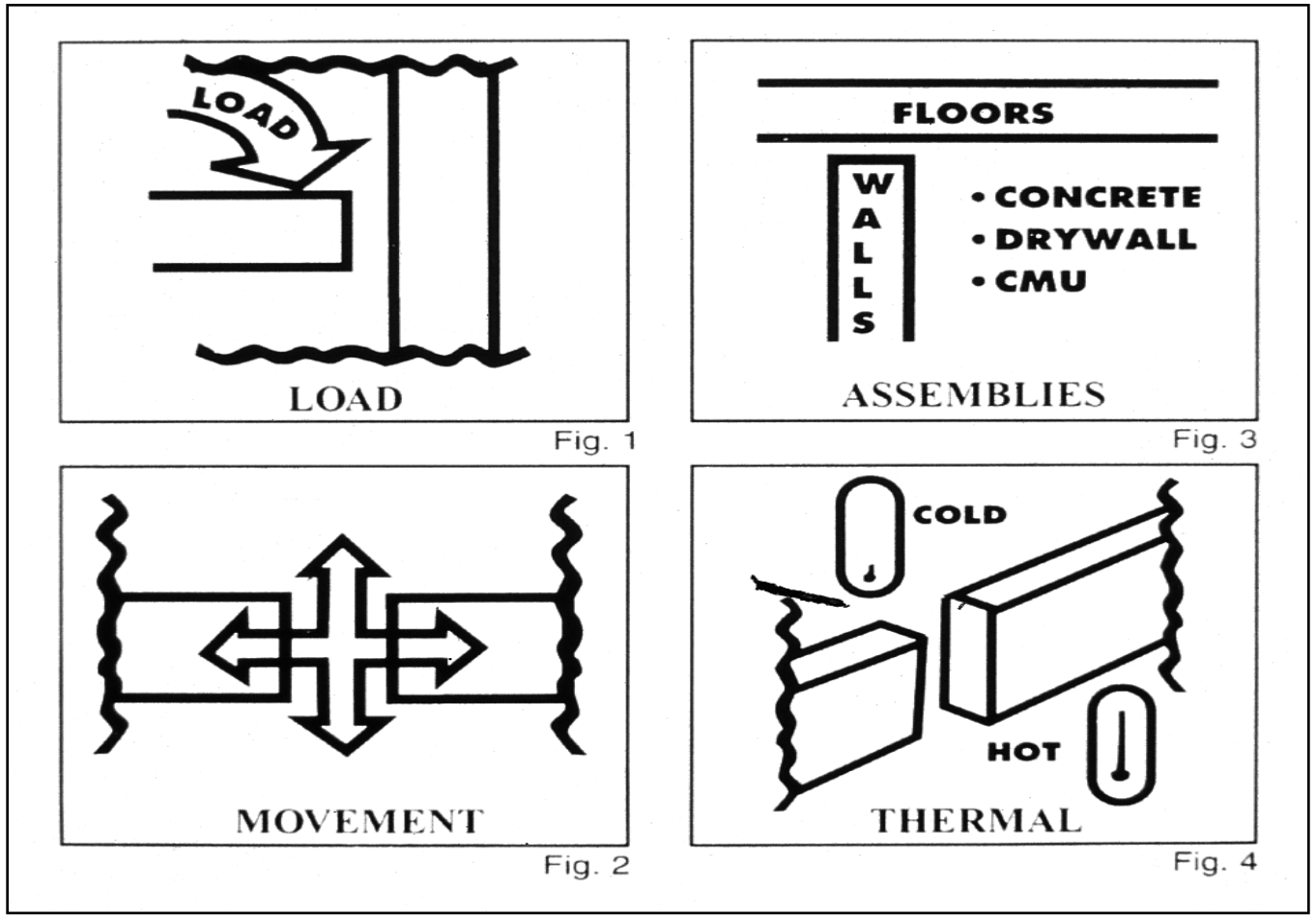
Forces Which Induce Movement



- Thermal
- Wind Sway
- Seismic
- Load

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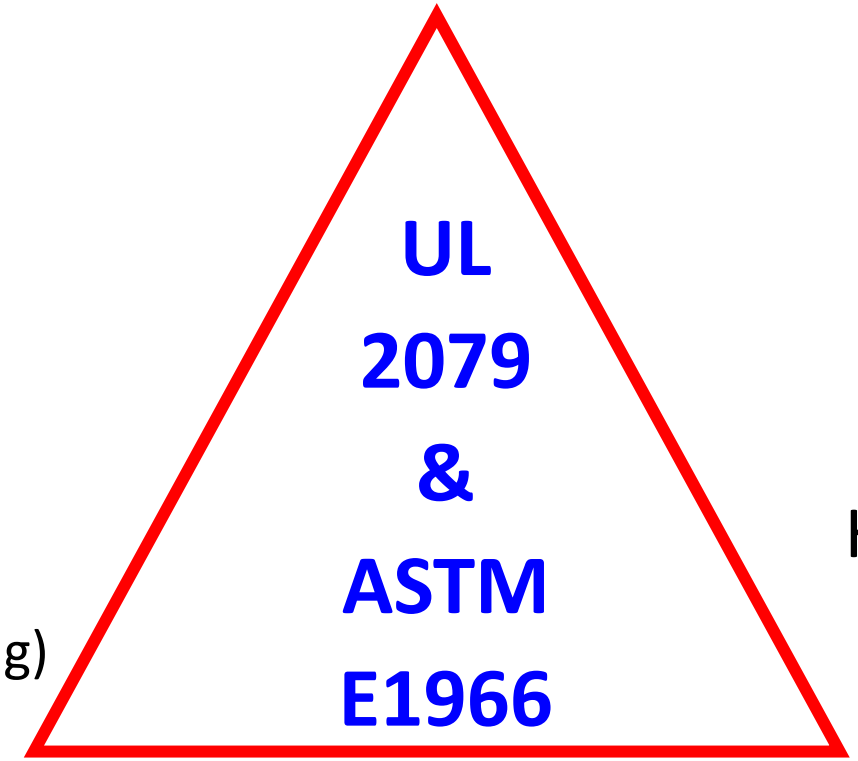
Test Standards / Components

CYCLE TEST

(Movement)



Fire Test

(Hourly Rating)

Hose Stream Test

(Impact,

Temperature, Shock)

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UL 2079 / ASTM E1966 - Test Standards For Building Joint Systems

Assembly Rating

- Evaluates both passage of fire and temperature on the non-fireside (i.e. F and T Ratings)
- Hose stream is only required for head-of-wall and wall-to-wall joints

L Rating (New in 2006 Code)

- The amount of air leakage through the joint system at ambient and 400°F (204°C). IBC requires an L rating of 5 cfm / lineal ft or less.

W Rating

- Water Leakage

Continuity Head-of-Wall Joint Systems

Test
Method

Designation: E2837 – 11

Standard Test Method for
Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies[1]

INTRODUCTION

Wall continuity is required by various model codes at *joint openings*, which are linear voids, gaps, openings, or other discontinuities between or bounded by a *rated wall assembly* and *nonrated horizontal assemblies*, to ensure that the protected *joint opening* has the same fire resistance rating as the *rated wall assembly*. The *joint opening* at the termination at the top of the *rated wall assembly* below the *nonrated horizontal assembly* must be protected by a *continuity head-of-wall joint system*, which has a fire resistance rating, in order to maintain continuity established by the *rated wall assembly*. This test method is not required when the *rated wall assembly* contacts *nonrated horizontal assemblies* when there is no *joint opening*. Normally such joint openings are denoted as "linear" because the length is normally greater than their width, which is defined by a typical ratio of at least 10:1 as in practice. *Joint openings* are present in buildings as a result of (*1*) Design to accommodate various movements induced by thermal differentials, seismicity, and wind loads and exists as a clearance separation. (*2*) Acceptable dimensional tolerances between two or more building elements, for example, between non-load-bearing walls and roofs. (*3*) Inadequate design, inaccurate assembly, repairs or damage to the building. There are many unique applications for joint systems in buildings. To address this issue, there are different types of *continuity head-of-wall joint systems*. It is not possible to test all fire-resistive joints systems using the same test apparatus or method of test, for example, Test Method E2307 employs the ISMA test apparatus. A *continuity head-of-wall joint system* is a particular type of fire-resistive joint system that provides fire resistance to prevent passage of fire from compartment to compartment within the building at the *joint opening* between a *rated wall assembly* and a *nonrated horizontal assembly*. A *continuity head-of-wall joint system* is a unique building construction detail not addressed by other fire test methods such as Test Method E1966 that tests joint systems installed between two assemblies that are fire-resistance rated.

1. Scope

1.1 This fire-test-response test method measures the performance of a unique fire-resistive joint system called a *continuity head-of-wall joint system*, which is designed to be used between a *rated wall assembly* and a *nonrated horizontal assembly* during a fire-resistance test.

1.2 This fire-test-response standard does not measure the performance of the following:

1.2.1 The *rated wall assembly*, which is already established by other test methods, such as Test Method E119, or

1.2.2 The *nonrated horizontal assembly*, which would be established by other test methods such as Test Method E119.

1.3 This fire-test-response standard is not intended to evaluate the connections between *rated wall assemblies* and *nonrated horizontal assemblies* unless part of the continuity head-of-wall joint system.

[1] This test method is under the jurisdiction of ASTM Committee E06 on Fire Standards and is the direct responsibility of Subcommittee E06.21 on Fire Resistance.

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Continuity Head-of-Wall Joint Systems Cont.

- E2837-11: Standard Test Method for Determining the Fire Resistance of Continuity Head-of-Wall Joint Systems Installed Between Rated Wall Assemblies and Nonrated Horizontal Assemblies
- Scope – Covers rated wall intersecting bottom of non-fire-resistance-rated roof/ceiling or floor/ceiling assembly
- Testing similar to that done for Head-of-Wall Joint Systems per ASTM E1966 and UL 2079

Continuity Head-of-Wall Joint Systems Cont.

- Major differences between ASTM E2837 and UL 2079:
  - No thermocouples on roof or floor
  - As roof/floor may sag in a “real” fire, test protocol does not rigidly support the roof/floor
- Assembly Rating
  - Flame Passage
  - Temperature Rise on the Unexposed Surface of the Joint System
  - Hose Stream

Opening Protectives

- Fire Door Assemblies
  - Fire Door Frames
  - Fire Doors
  - Hardware
  - Glazing within Fire Doors

- Fire Window Assemblies
  - Fire Window Frames
  - Glazing

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Component Approach Used for Fire Door and Fire Window Assemblies

- The UAE Fire and Life Safety Code, the IBC and NFPA 101 prescribe a component approach for testing fire door and fire window assemblies
- By referencing NFPA 80, the codes require fire door and fire window components to be Listed and Labeled
- Individual listed and labeled components are installed together in the field to form the complete opening protective
- Approval of the finished opening protective relies on Listing and Labeling of individual components with the final approval up to the Code Official

Fire Door and Shutter Assemblies

- Code Referenced Standards
  - Side-hinged or pivoted swinging doors shall be tested to UL 10C or NFPA 252 (positive pressure)
  - Tin-clad fire door assemblies shall comply with UL 10A, UL 14B, and UL 14C
  - Other types of doors shall be tested to UL 10B or NFPA 252 (neutral pressure)
- All the above standards establish a “Fire Protection Rating”
- For a Fire-Protection Rating, the fire door assembly must:
  - Prevent passage of flame through the door assembly during the fire exposure
  - Prevent a through projection of water through the door assembly during the hose stream test conducted after the full duration fire exposure

Fire Window Assemblies

- Code Referenced Standards
  - Fire Window assemblies shall be tested to UL 9 or NFPA 257 (positive pressure)
- The above standards establish a “Fire Protection Rating”
- For a Fire-Protection Rating, the fire window must:
  - Prevent passage of flame through the window assembly during the fire exposure
  - Prevent a through projection of water through the window assembly during the hose stream test conducted after the full duration fire exposure

Fire Window Assemblies

- Fire window assemblies are glazed with a fire-protection-rated glazing
- Code limits the maximum size (individual panel size and total cumulative area) and maximum rating of fire window assemblies
- Where required size or rating exceeds code allowance or when a fire window assembly is not permitted, a fire-resistance-rated window assembly may be utilized
- A fire-resistance-rated window assembly meets the same requirements as any other wall assembly (ASTM E119 / UL 263)
- A fire-resistance-rated window utilizes a “non-conductive” frame and fire resistance-rated glazing

Fire-Rated Glazing

Types of Fire-Rated Glazing

- Fire-Protection-Rated Glazing
- Fire-Resistance-Rated Glazing

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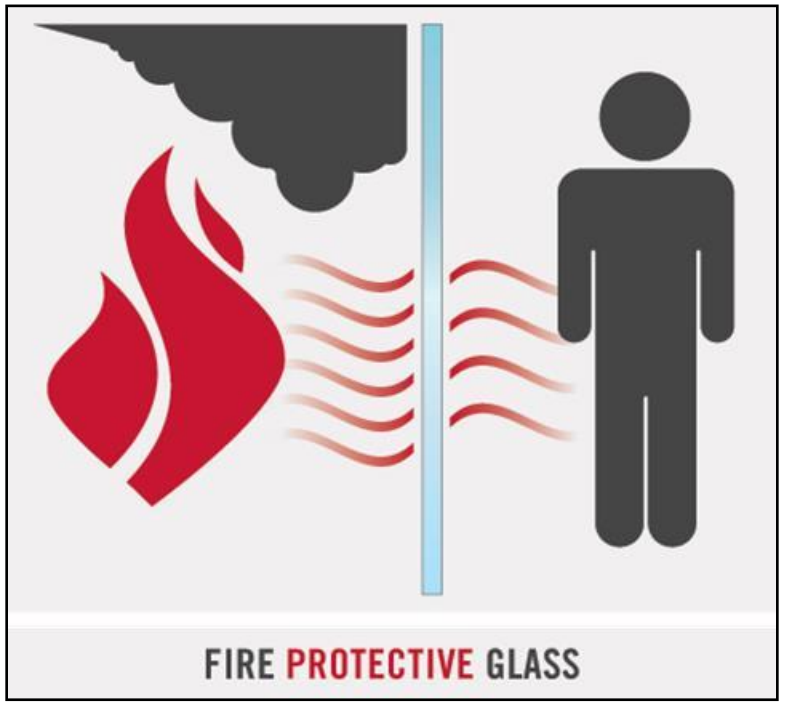
Fire-Protection-Rated Glazing

- Fire-rated, thin glazing
- Traditional fire-rated material for use in fire doors and fire windows
- Allows significant radiant heat from unexposed side

- May or may not be required to meet hose stream requirements depending on application



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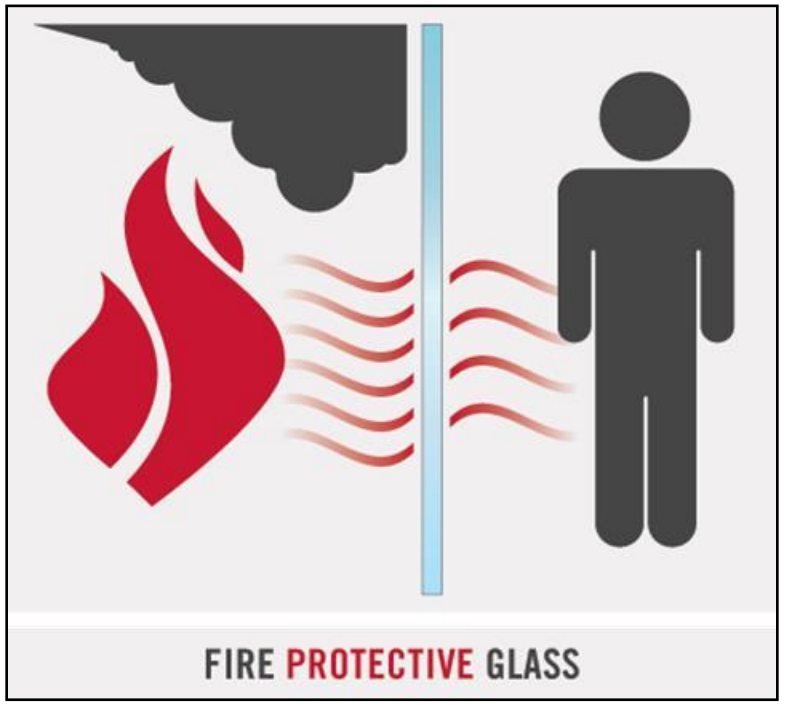
Fire-Protection-Rated Glazing Cont.

- Used as Opening Protectives
  - Fire Doors: 20 minutes to 3 hrs
  - Fire Windows: 20 to 90 minutes
    - Area of fire window may not exceed 25% of the area of a fire-resistance-rated wall
  - Size of individual pane shall comply with IBC and NFPA 80, and may not exceed manufacturers tested sizes



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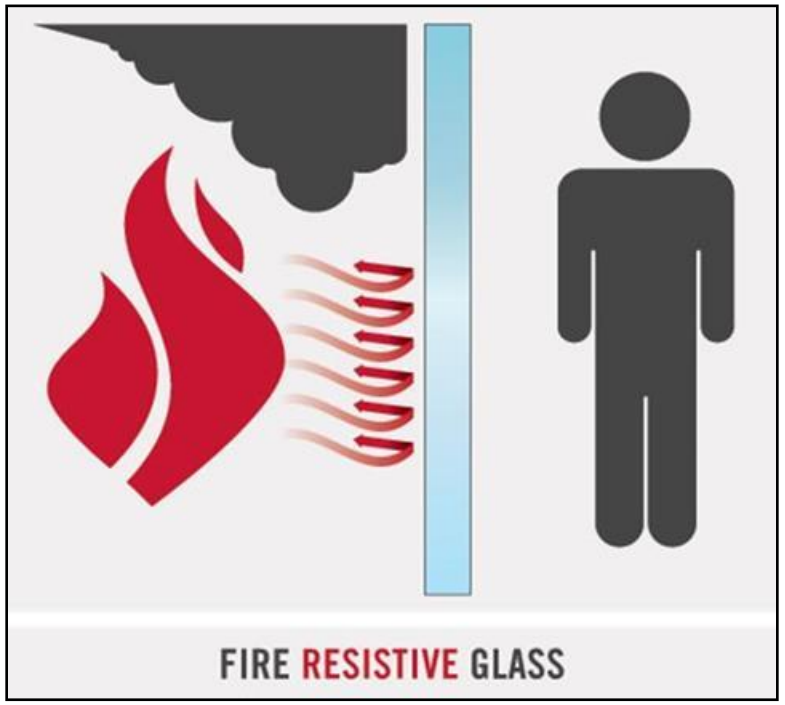
Standards
Fire-Protection-Rated Glazing

- UL 10B (Fire Door Assemblies)
- UL 10C (Fire Door Assemblies)
- NFPA 252 (Fire Door Assemblies)
- UL 9 (Window Assemblies)
- NFPA 257 (Fire Window Assemblies)

Fire-Resistance-Rated Glazing

- "Thick" glazing
- Stops fire **AND** radiant heat
- Classified as a "wall" rather than an opening (window)
- Meets same requirements as a gypsum or CMU wall

- When use in walls, both glass and frame must block passage of heat



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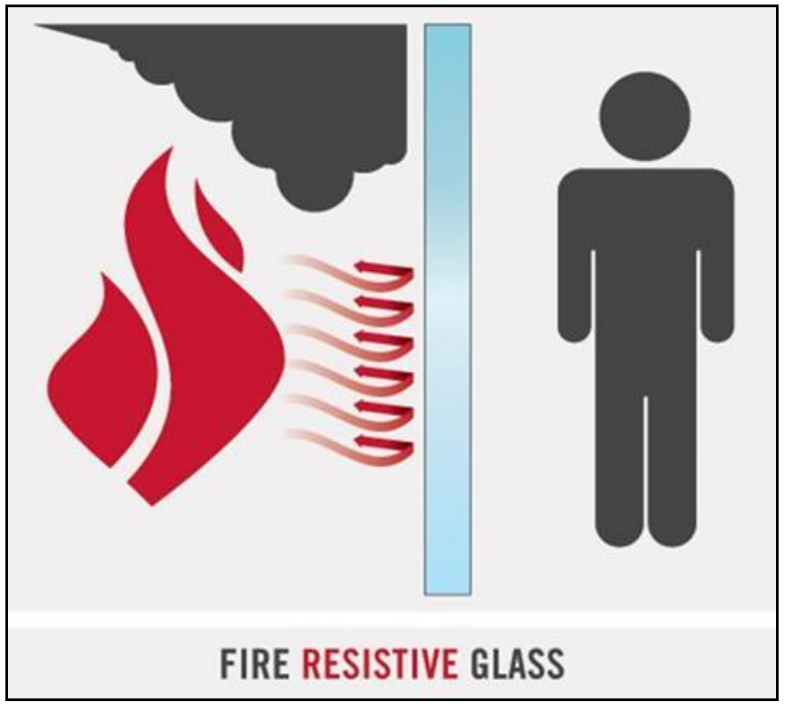
Fire-Resistance-Rated Glazing Cont.

- Used in fire door assemblies when required glazing exceeds size or rating permitted for fire-protection-rated glazing
- Used in window assemblies when required glazing exceeds size or rating permitted for fire-protection-rated glazing in fire windows



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Standards
Fire-Resistance-Rated Glazing

- UL 263
- ASTM E119

Leakage Rated Door Assemblies

- Required for rated corridor walls and smoke barriers
- Tested to UL 1784
- Tested as complete package of components necessary to obtain rating
- Maximum 3 cfm per sq ft (0.01524 m^3/s per m^2) door area at 0.1 in. WC (24.9 Pa) at ambient and 400°F (204°C)

Leakage Rated Door Assembly Under Testing

Ducts and Air Transfer Openings

- Fire Dampers
- Smoke Dampers
- Combination Fire / Smoke Dampers
- Corridor Dampers
- Ceiling Radiation Dampers

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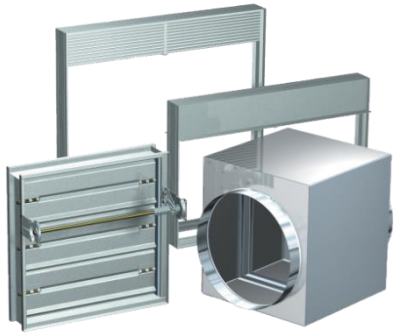
Fire Dampers

- Tested and listed to UL 555
- Rated for minimum 3 hrs when used in barrier rated 3 hrs or greater
- Rated for minimum 1-1/2 hrs when used in barrier rated less than 3 hrs



Fire Dampers Cont.

- UL 555 differentiates between static and dynamic dampers
  - Static – For use in HVAC systems designed to shutdown upon detection of fire or smoke
  - Dynamic – For use in HVAC systems designed to remain operational during a fire situation. All combination fire / smoke dampers are dynamic
- UL 555 describes many tests, including fire exposure test, hose stream test, airflow test, temperature test, duct breakaway test, corrosion protection test, durability tests, dynamic closure test, etc., etc.

Smoke Dampers

- Tested and listed to UL 555S
- Required by code to be rated for Class I or II leakage at a temperature rating of not less than 250°F (121°C)

Smoke Dampers Cont.

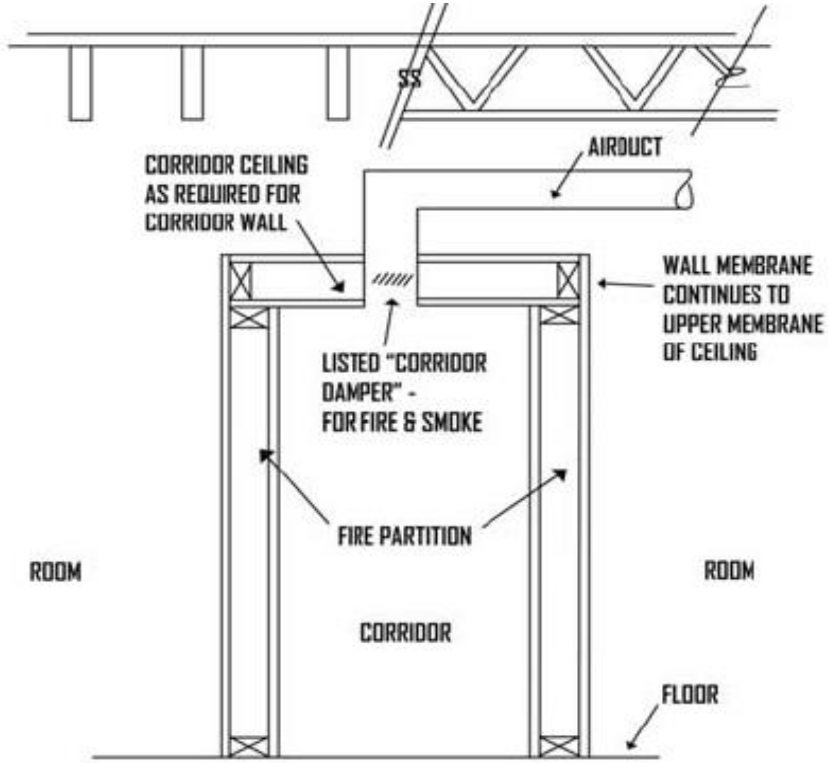
- UL 555S describes many tests, including leakage test, temperature test, pressure test, air velocity tests, duct breakaway test, corrosion protection test, durability tests, etc., etc.

Combination Fire and Smoke Dampers

- Tested and listed to both UL 555 and UL 555S
- Required by code to meet requirements for both a fire damper and a smoke damper

Corridor Dampers

- Section 717 of the IBC
  - Used in ceilings of exit corridors where ceiling is constructed as required for corridor walls per Section 708.4, Exception 3
  - Designed to be installed in horizontal “wall”

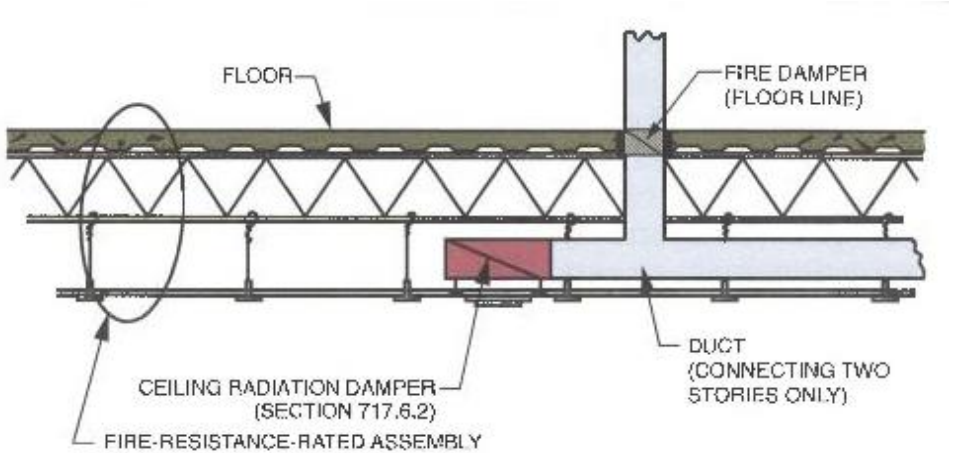


Corridor Dampers Cont.

- Corridor dampers shall be listed and labeled in accordance with UL 555 and UL 555S. Corridor dampers shall also demonstrate acceptable closure under air flow conditions.
  - Shall meet the rating requirements for both fire and smoke dampers
    - 1 hr fire rated
    - Leakage rating shall be Class I or II with a temperature rating of not less than 250°F (121°C)

Ceiling Radiation Dampers

- Used in fire resistive floor-ceiling and roof-ceiling assemblies where duct penetrates membrane ceiling
- Intent is to minimize heat transfer into concealed space



Ceiling Radiation Dampers Cont.

- Ceiling radiation dampers shall be listed and labeled, and tested in accordance with UL 555C or as part of a floor/ceiling or roof/ceiling assembly in accordance with UL 263 or ASTM E119

Ceiling Radiation Dampers Cont.

- UL 555C differentiates between static and dynamic dampers.
  - Static – For use in HVAC systems designed to shutdown upon detection of fire or smoke
  - Dynamic – For use in HVAC systems designed to remain operational during a fire situation
- UL 555C describes many tests, including fire exposure test, airflow test, temperature test, corrosion protection test, durability tests, dynamic closure test, etc., etc.

Answering Questions and Queries

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Please type your questions in the chat window

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Thanks for Attending!!!

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