FM4411 - Approval Standard For Cavity Walls And Rainscreens

Mark D. Tyrol, P.E.

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FM Global - OVERVIEW

- Largest industrial and commercial insurance company in the world
- $5.7 billion in annual premiums
- $9.7 billion in reserves
- 5,500 employees, 2,000 loss prevention engineers
- 130,000+ insured locations in over 100 countries
- Insure one of every three FORTUNE 1000 companies.
- Invested over $250 million in the Research Campus – a world-renown research and testing laboratory; the Learning Center in Norwood, MA; and the Loss Prevention Training complex located in Singapore.
- Belief that most losses can be prevented.

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FM Approvals - OVERVIEW

- 200+ employees, offices worldwide
- Nationally Recognized Testing Laboratory (NRTL)
- Notified Body (CE) and Member of EOTA
- Solely focused on Approving Products that promote Property Loss Prevention
- Develops and publishes Approval Standards
- 50,000+ products Approved
- Publish on-line in Approval Guide and RoofNav
- We test building materials, fire protection equipment, and electrical equipment.

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Member of the FM Global Group

Approval Standard
for
Cavity Walls and Rainscreens

Class Number 4411

Draft Standard for Review

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Building “met Code”. Everyone got out OK.

What about the property loss, business interruption, not to mention the air, land and water pollution, etc.

Wouldn’t it have been better to prevent the loss?

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Recent fire loss: Ignition occurs in a crawl space between floors and enters cavity wall, spreads within the cavity and leads to roof fire in attic. No sprinklers or smoke detectors are provided in the attic. Building is a complete loss.

A few comments:

1. Buildings of limited height and area sometimes use plywood or OSB as a substrate in the cavity wall. FM would recommend a cavity wall assembly that would not spread fire.

2. That could explain how the fire went up the cavity and got into the unprotected, combustible attic space. Sadly, the code permits these two deficiencies.

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3. When the Fire Dep't. responded that the building met code, it is too bad the reporter was not sharp enough to ask if there is something wrong with the code.

4. This type of fire loss, where the fire spreads in a cavity wall and then gets into the unprotected attic space and destroys a building that is otherwise sprinklered, is way too common.

This loss makes a strong case for the need for testing to the new FM 4411 standard.

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In fact, during a recent 15-year period, FM Global recorded nearly US$154 million in losses due to fires in concealed wall spaces.

Cavity Wall Risk Profile

- The potential fire risk of cavity and rainscreen wall construction lies in the combination of potentially combustible insulation, air / moisture retarders, cladding, and the air gap inside the wall.

- Hot work, welding slag, sparks from grinding, cutting torches, and electrical short circuits are just some of the possible ignition sources.

- Current codes and standards assess fire performance of exterior wall assemblies subjected to external ignition sources.

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- These test methods do not address the potential fire hazard resulting from ignition of combustibles within a cavity wall.
- FM Global created a new fire performance test for cavity walls – FM 4411.
- FM Global recommends the use of FM Approved wall assemblies to their insured customers. “Exceeds Code”.

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Cavity walls and rainscreens are exterior wall constructions typically consisting of two walls separated by a cavity which contains an air gap. For cavity walls, the exterior facade could be made of brick or masonry construction while the interior facade can be made of combustible or noncombustible construction materials. The cavity can contain insulation and air and moisture retarders.

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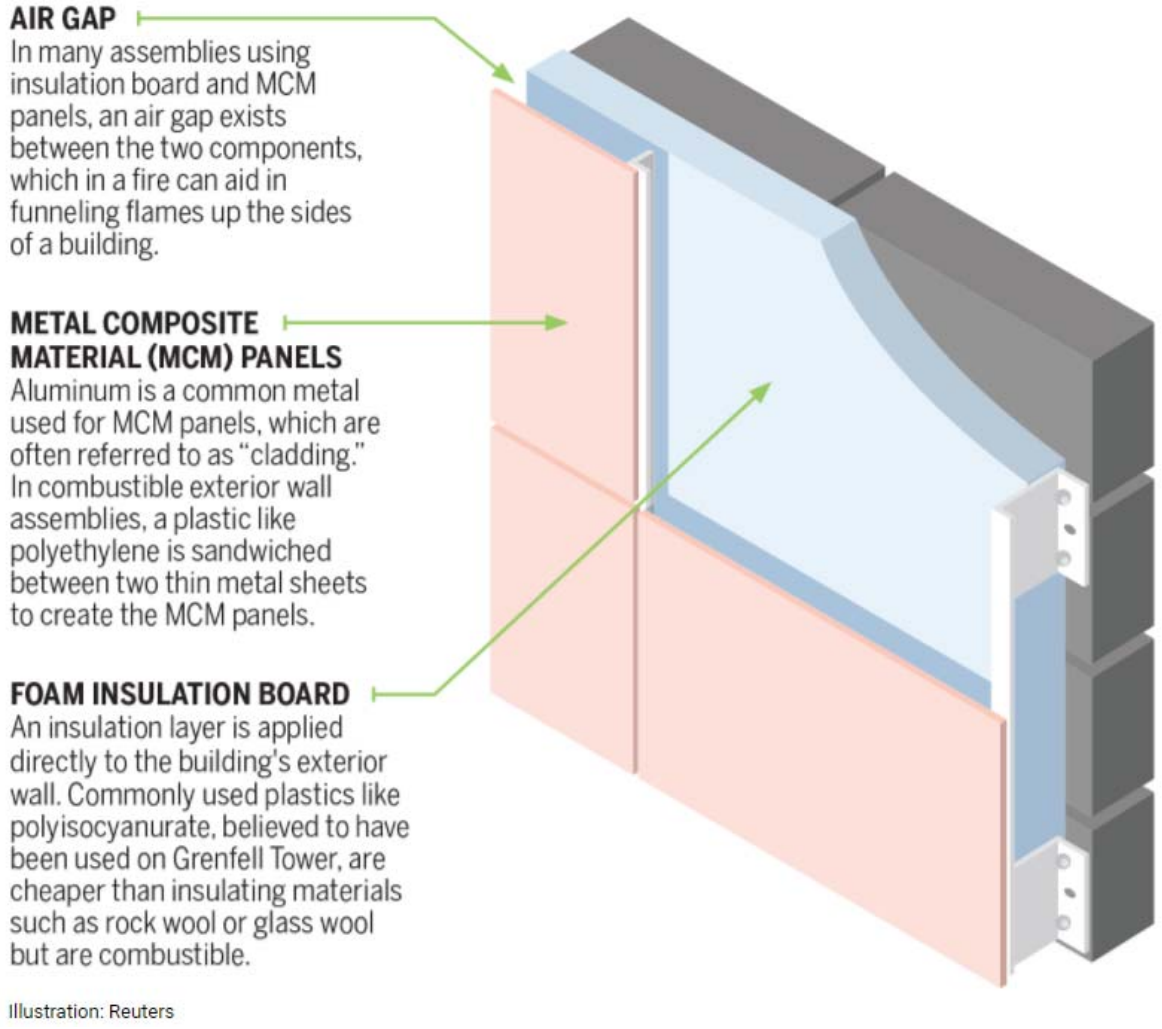
The exterior facade may also be constructed of combustible materials.

Note: FM 4880/4881 is also required.



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4’ x 8’ sample size. FR plywood with glass faced gypsum board.

For brick or masonry exterior façade, combustible sample on 1 side. Other side noncombustible.

For other façade materials, test assembly as built.

Open sides. Bottom and top closed with sheet metal flashing (simulates fire stop).

Not for IEFS or other exterior wall coating systems.

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For 1-2” air gap, test at 2” gap. For >2” up to 4” air gap test at 4” gap.

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Propane sand burner fire. Heat flux to sample surface measured 6” above burner is 40-45 kW/m^2. 15 minutes of fire exposure.

For 2” gap, propane flow rate is 4.2 L/min, chemical heat release rate 5.8 kW.

For 4” gap, propane flow rate is 6.8 L/min, chemical heat release rate 9.5 kW.

These exposure sand burner fires are representative of a potential accidental ignition source within a wall cavity (i.e. welding and cutting torches).

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Test under the FM Global 5-MW calorimeter to measure heat release rate.

Acceptance Criteria: Chemical heat release rate 100 kW (95 BTU/s) and max flame height 6 ft.

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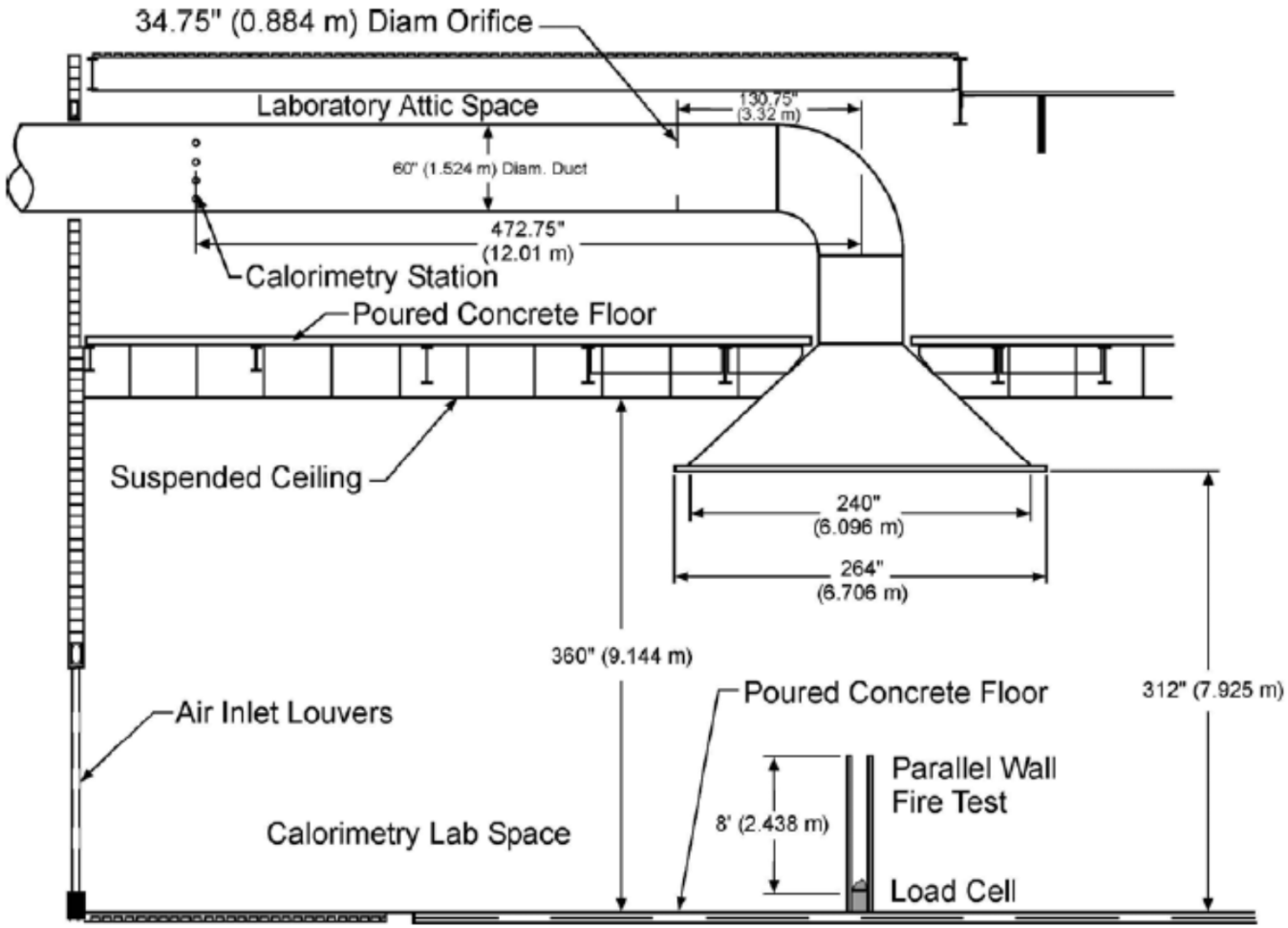

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Test Method for Fire Spread within Cavity Wall Constructions

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Test Method for Fire Spread within Cavity Wall Constructions

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To develop test and acceptance criteria, 11 samples tested under 5-MW calorimeter to measure heat release rate.

Table 1. Summary of cavity wall test parameters and results.

Test #	Insulation Type	Test Duration (min)	Cavity /Sand Burner Width (mm)	Sand Burner Fire Exposure (kW)	Peak Chemical Heat Release Rate† (kW)	Maximum Flame Height (m)	Height of Char (m)
1	Rigid extruded polystyrene	15	51	5.8	835	> 2.4	2.4
2		15	51	5.8	1020	> 2.4	2.4
3		15	51	5.8	1100	> 2.4	2.4
4		15	102	9.5	1270	> 2.4	2.4
5		15	102	9.5	1630	> 2.4	2.4
6		15	102	9.5	1460	> 2.4	2.4
7	Sprayed polyurethane foam	20	51	5.8	<100	1.8	1.8
8		20	102	9.5	<100	1.2	1.2
9		20	102	9.5	<100	1.1	0.9
10		15	102	15	<100	2.3	2.1
11		30	102	15	<100	2.1	1.8

† The lowest chemical heat release rate which the 5-MW calorimeter is capable of accurately measuring is 100 kW [29]

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Table 1. Summary of cavity wall test parameters and results.

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Per ASTM E84, FSI = 5

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Wider gap, higher exposure = Higher HRR.

Test provides repeatable results.

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Tests #1-6 – All had flame height greater than 8’.

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Tests #1-6 – All had charring the full 8’ length.

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Extended test time, all fire spread occurred within 15 min. 15 min is adequate.

Test provides repeatable results.

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Increased Fire Exposure to 15 kW, 5.8 and 9.5 is adequate.

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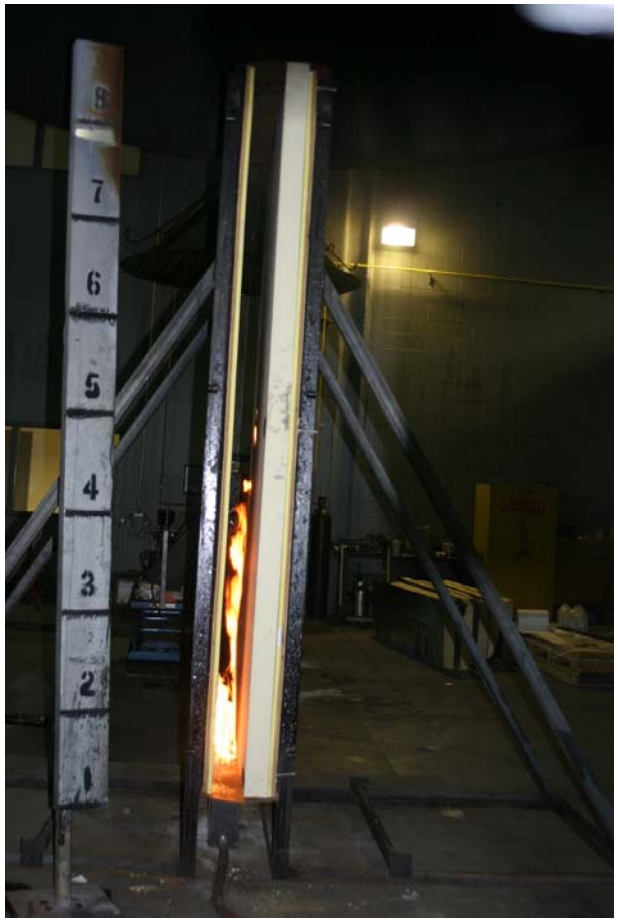
Tests #7-9 – All had flame height less than 6’.



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Tests #7-9 – All had charring less than 6’.

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FM 4411 is a fire performance test that evaluates the fire propagation behavior of combustible insulation in a configuration that is representative of the actual installation.

The test utilizes a full scale cavity wall assembly and offers fire performance evaluation of insulation of any thickness.

The ignition source is reliable and repeatable, its heat output has been carefully calibrated to be representative of potential ignition scenarios that may occur within a cavity wall.

While this test is suitable for incorporation into other codes and standards, our focus is on FM Global insureds.

What about other test methods?

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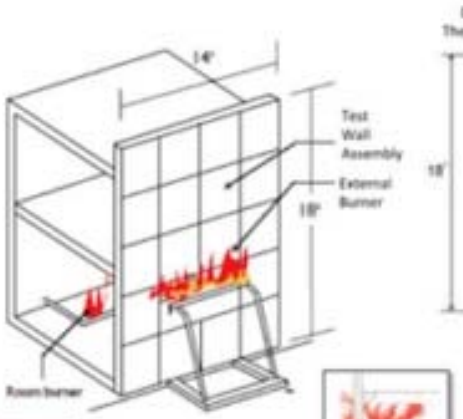
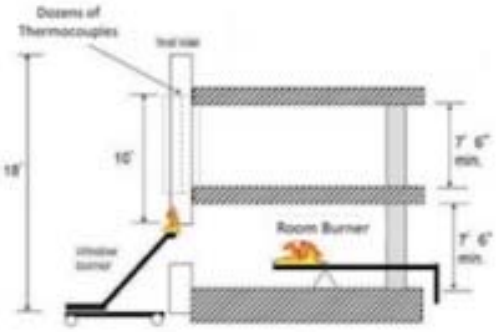
What About NFPA 285?

Conducting an NFPA 285 Test

Test Apparatus and Premise





Simulates two-story fire

- Room burner ignites
- 5 Minutes – Window burner ignites
- Visual monitor of fire spread
- Thermocouples monitor wall temperatures
- 30 Minutes – Burners shut down

https://westcon.wildapricot.org/widget/event-2593010

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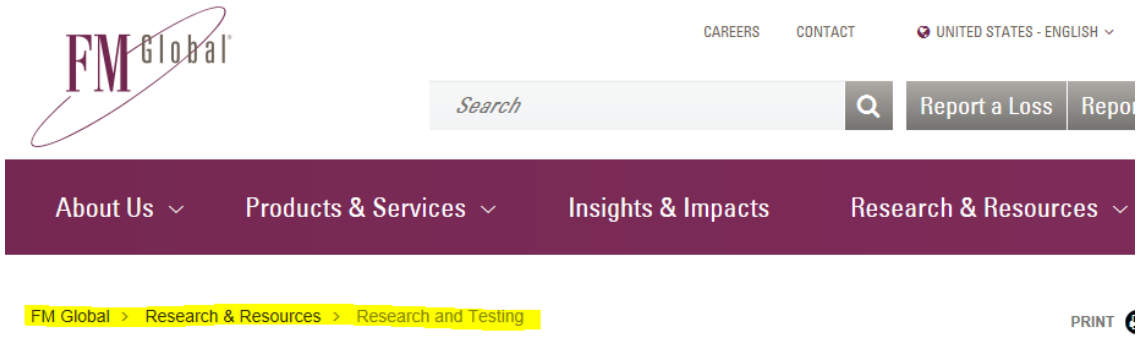

RESEARCH TECHNICAL REPORTS

Understanding a World of Uncertainty

Put science on your side to become resilient in a world that isn't short on surprises.

With FM Global, you recruit a team of scientists, engineers and technicians from 14 countries, holding 50 advanced degrees. You give your company access to research that can't be replicated anywhere but the Research Campus. Within its state-of-the-art labs, scientists simulate hazards like 5-alarm fires or category-5 hurricanes, so you'll better understand their potential effects on your company's facilities.

Since you need to look at property loss from every angle, we go outside the lab, too. A blend of theoretical, computational and experimental methods address tomorrow's risk challenges. Our over a hundred years of experience with businesses in nearly every sector allows us to ground theory in reality. And our collaborations with universities, organizations and industry groups allow us to give you unlimited expertise from which to draw.

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RESEARCH TECHNICAL REPORT

Evaluation of the Fire Performance of Aluminum Composite Material (ACM) Assemblies using ANSI/FM 4880

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Highlights of the Research Technical Report

- Compares the 16’ Parallel Panel Test (referenced in ANSI FM 4880) to NFPA 285.

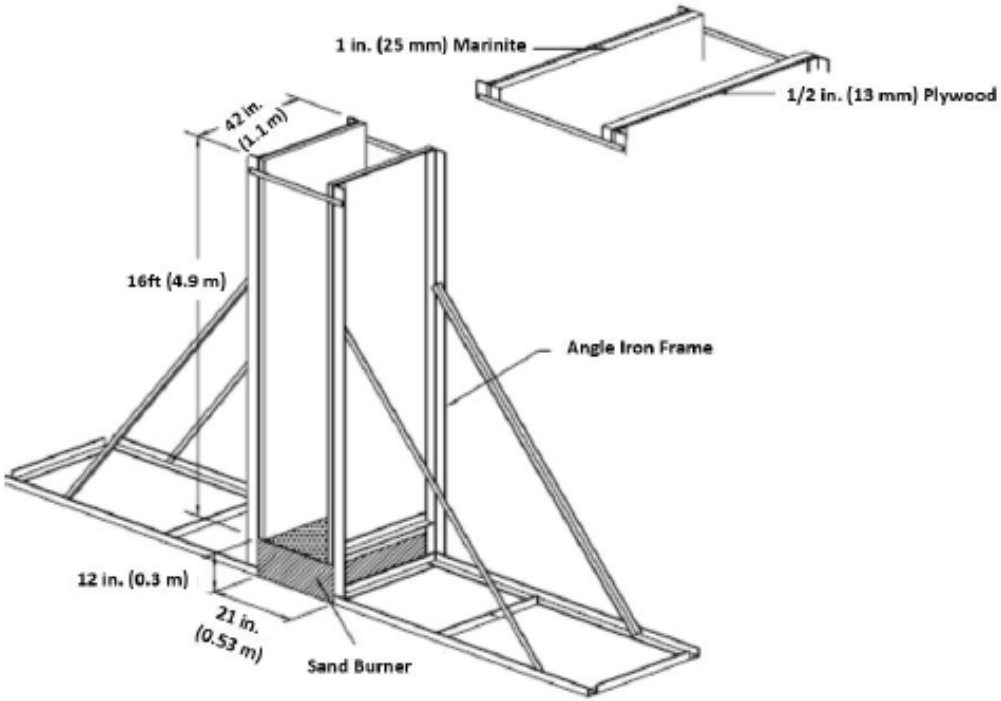

Figure D.1 – 16ft (4.9 m) parallel panel test structure

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Summary of Research Technical Report

NFPA 285 is not a cavity wall test.

NFPA 285 provides a method of assessing the flammability characteristics of exterior wall assemblies.

The Standard addresses fire exposures from interior fires that reach flashover, break exterior windows, and expose the building façade.

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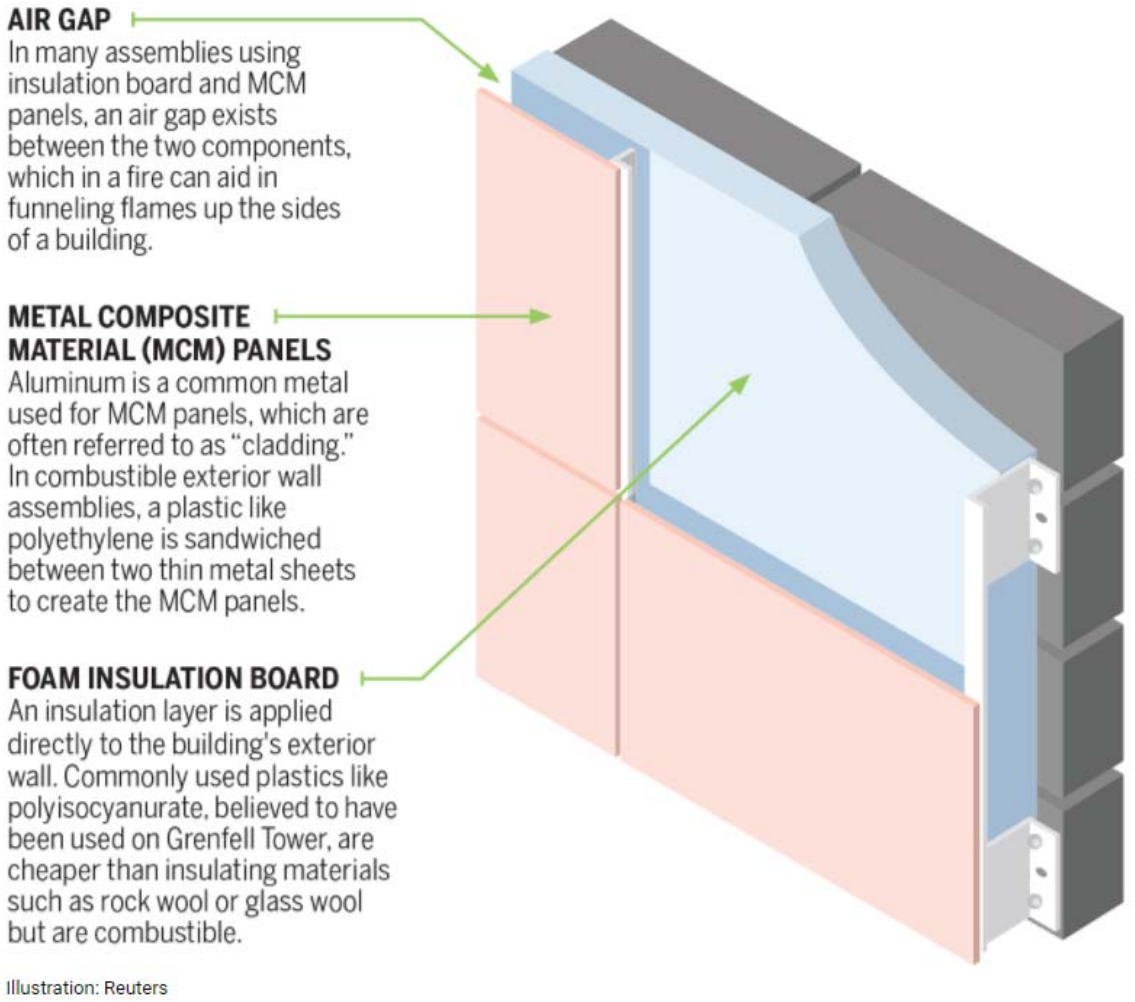
However, these test methods do not address the potential fire hazard resulting from ignition of combustible insulation within the wall cavity.

FM Approval Standard 4880

The exterior facade may also be constructed of combustible materials.

Note: FM 4880/4881 is also required.



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Summary of Research Technical Report

16’ Parallel Panel Test (referenced in ANSI FM 4880)

- Different than FM 4411 Cavity Wall Test
- Simulates a realistic fire scenario and is representative of both exterior fires in corner situations and post-flashover fires from the building interior.
- Imparts heat fluxes in the order of 100 kW/m² to the walls, necessary to reveal vulnerabilities of system.
- Improved, repeatable, cost-effective fire test method.

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Summary of Research Technical Report

16’ Parallel Panel Test (referenced in ANSI FM 4880)

- Peak heat flux is higher (100 kW/m²) and more realistic than NFPA 285 (10-40 kW/m²), which reaches max heat flux during last 5 minutes and is not representative of a realistic fire hazard.

- NFPA 285 simulates a post-flashover fire existing from a window.

- FM 16’ Parallel Panel Test simulates both a post-flashover fire existing from a window and a realistic external fire.

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Summary of Research Technical Report

16’ Parallel Panel Test (referenced in ANSI FM 4880)

- FM 16’ Parallel Panel Test uses a similar heat flux and is well correlated to large scale 25 ft and 50 ft corner tests.
- Burner size and propane flow are less with FM 16’ Parallel Panel Test than NFPA 285. But peak heat flux is much higher.
- Less expensive to run and faster to set up. Test duration is 15 minutes vs. 30 minutes for NFPA 285.
- Two assemblies that passed NFPA 285 decisively failed the 16’ Parallel Panel Test (flames higher than 25’ in 4 minutes).

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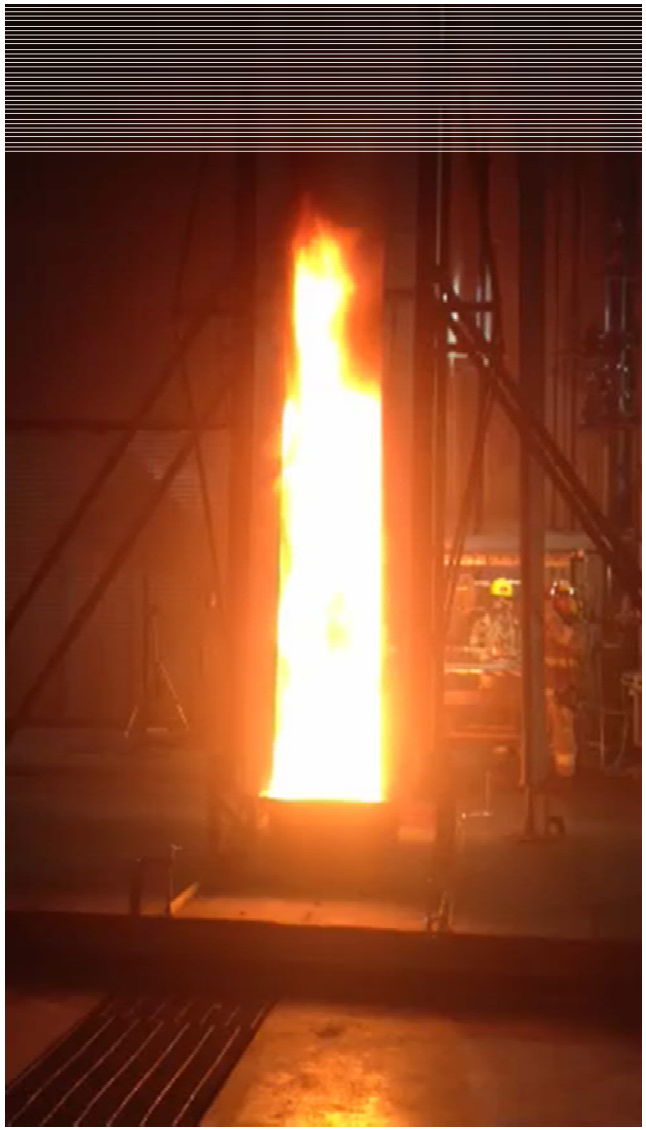
16’ Parallel
Panel Test



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Summary of Research Technical Report

16’ Parallel Panel Test (referenced in ANSI FM 4880)

Requirement:

- For no height restriction, the maximum gross chemical heat release rate (PCHRR) during a 16 ft (4.9 m) High Parallel Panel fire test with a propane gas ignition source of 360 kW shall be less than, or equal to, 830 kW.

- For a maximum height of 50 ft (15.2 m) for combustible walls with a noncombustible ceiling, the maximum gross chemical heat release rate (PCHRR) during a 16 ft (4.9 m) High Parallel Panel fire test with a propane gas ignition source of 360 kW shall be less than, or equal to, 1100 kW.

FM 16’ Parallel Panel Test uses a similar heat flux and is well correlated to large scale 25 ft and 50 ft corner tests.

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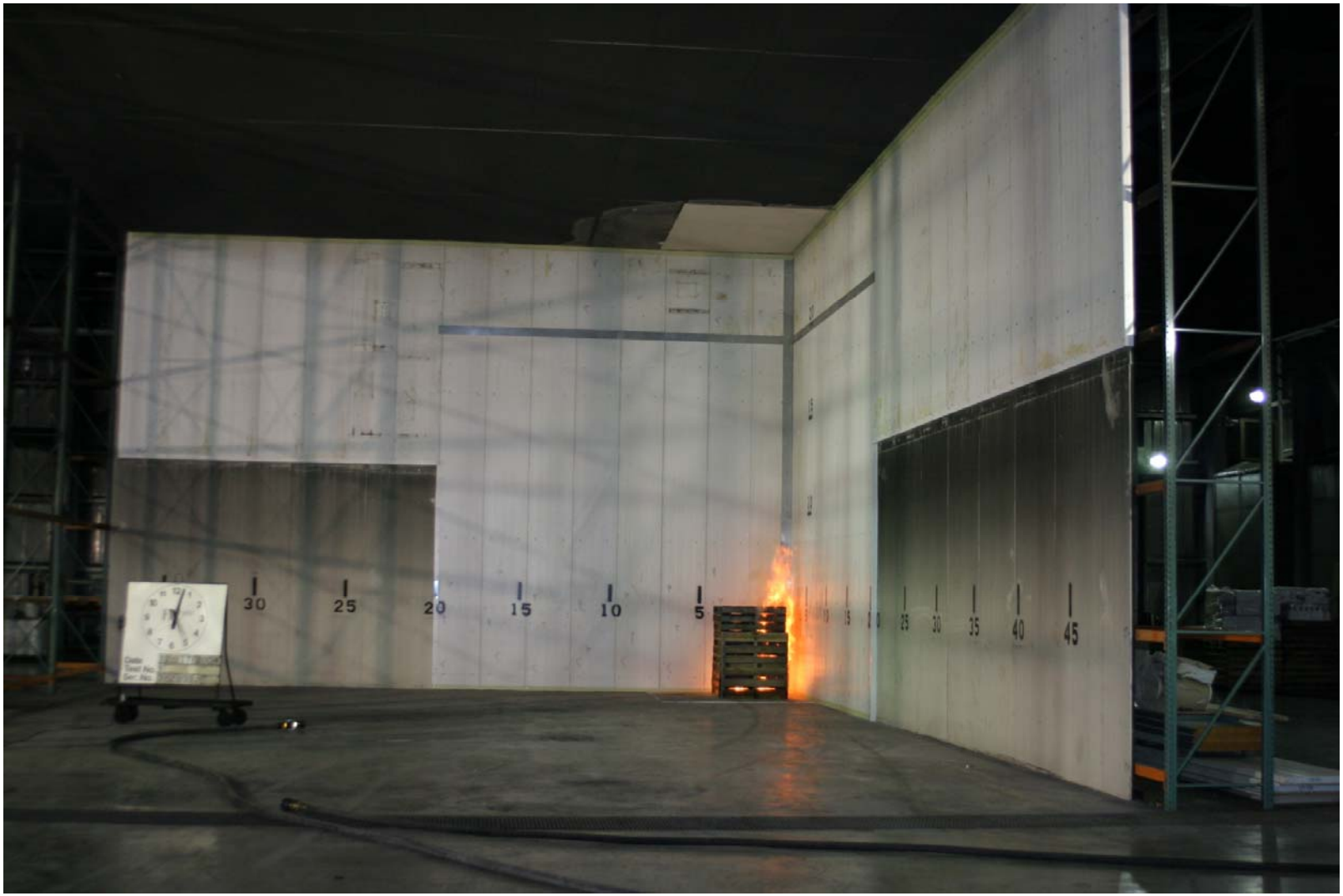
FM Approvals 25 ft (7.6 m) High Corner Test



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FM Approvals 25 ft (7.6 m) High Corner Test

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FM Approvals 50 ft (15.2 m) High Corner Test

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FM Approvals 50 ft (15.2 m) High Corner Test

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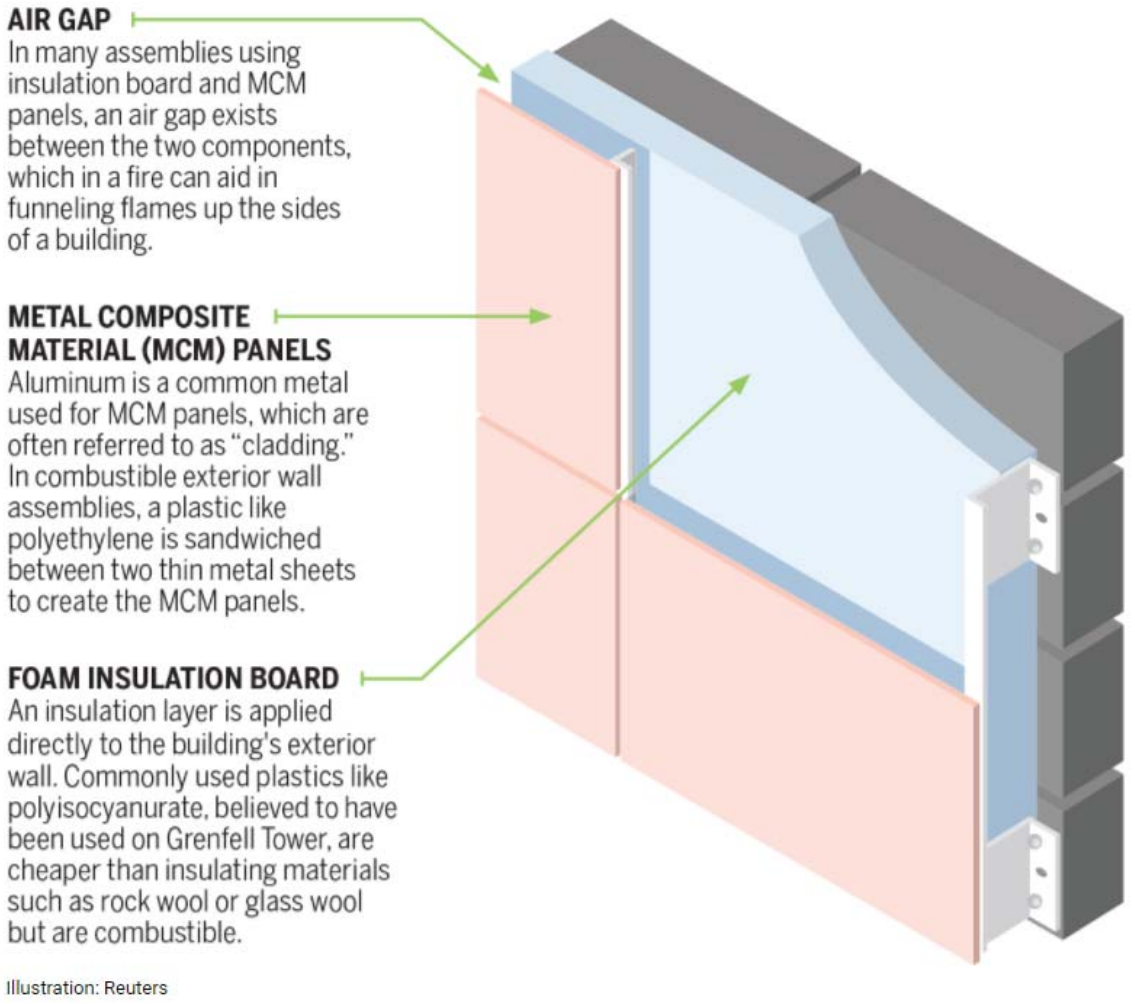
FM Approval Standard 4881

The exterior facade may also be constructed of combustible materials.

Note: FM 4880/4881 is also required.



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Loading Sequence	*Loading Direction*	*Air Pressure Cycles*	*No. of Air Pressure Cycles*	*Outward Pressure Values Multiplied by a Ratio of -1.4*	*Outward Pressure Values Multiplied by a Ratio of -2.0*
1	Inward	$0.2P^{Inward} - 0.5P^{Inward}$	3500	NA	NA
2	Inward	$0.0P^{Inward} - 0.6P^{Inward}$	300	NA	NA
3	Inward	$0.5P^{Inward} - 0.8P^{Inward}$	600	NA	NA
4	Inward	$0.3P^{Inward} - 1.0P^{Inward}$	100	NA	NA
5	Outward	$0.3P^{Outward} - 1.0P^{Outward}$	50	-0.4P/-1.4P	-0.6P/-2.0P
6	Outward	$0.5P^{Outward} - 0.8P^{Outward}$	1050	-0.7P/-1.1P	-1.0P/-1.6P
7	Outward	$0.0P^{Outward} - 0.6P^{Outward}$	50	0.0P/-0.8P	0.0P/-1.2P
8	Outward	$0.2P^{Outward} - 0.5P^{Outward}$	3350	-0.3P/-0.7P	-0.4P/-1.0P

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FM Approval Standard 4411

IN SUMMARY,

- Current codes and standards assess fire performance of exterior wall assemblies subjected to external ignition sources.
- These test methods do not address the potential fire hazard resulting from ignition of combustibles within a cavity wall.
- FM Global created a new fire performance test for cavity walls – FM 4411.

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QUESTIONS?

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