



**PRIEST & ASSOCIATES  
CONSULTING, LLC**

## ENGINEERING EVALUATION

Engineering Extensions based on NFPA 285 Testing

IFTI DC315 (16 mil WFT) with Top Coat Paint (8 mils WFT Sherwin Williams

Sher-Cryl) on SealTite Pro Closed Cell (Winter) with Aluminum Cladding

Project No. 10847, Revision 1

Prepared for:

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*Abstract*

*An NFPA 285 test report has been submitted to determine Engineering Extensions on several aspects of wall designs. These include base walls, cavity insulation, exterior sheathing, water resistive barrier (WRB), exterior insulation, air gaps, and claddings. We have determined that Engineering Extensions on various components of the tested wall designs can meet the criteria of NFPA 285 with specific limitations.*

The conclusions reached by this evaluation are true and correct, within the bounds of sound engineering practice. All reasoning for our decisions is contained within this document.

Submitted by,



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## INTRODUCTION

An NFPA 285 test was conducted on a specific configuration of wall system design. The design incorporated many variables including the SPF insulated base wall, exterior sheathing, SPF exterior insulation, coating(s) over the insulation, air gap and aluminum cladding.

The purpose of this evaluation is to determine Engineering Extensions for the components that can meet the requirements of NFPA 285.

From the wall system tested, an analysis is conducted on the components tested. This will form a base wall system from which replacement components can be interchanged. Additionally, several 3<sup>rd</sup> party approved competing wall systems incorporate similar features to the tested wall system. Some of the Engineering Extensions of those systems will also be examined in this evaluation as alternate choices for components.

## REFERENCE DOCUMENTS

- 1) *UL Test Report R40016-4789167855 – NFPA 285 Test IFTI w/ Carlisle SealTite Pro Closed Cell (Winter)*
- 2) *NFPA 285-19 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-loadbearing Wall Assemblies Containing Combustible Components*
- 3) *3<sup>rd</sup> Party NFPA 285 Approvals*
  - a. *DrJ Engineering TERs 1306-03, 1402-01, 1309-03 and 1601-06 NFPA 285 Assemblies*
  - b. *ICC-ES ESR 1659 NFPA 285 Assemblies*

## EVALUATION METHOD

### NFPA 285 Criteria

The NFPA 285 fire test (Ref. 2) is designed to test the flame spread properties of exterior walls containing combustible components. Two noncombustible rooms are stacked to simulate two stories of a multi-story building. The wall assembly is then attached to the exterior face of the rooms. A typical test wall measures 14 ft x 18 ft with a 30 in. x 78 in. window opening placed on the bottom floor.

Two burners are ignited to produce a specific time-temperature profile in the room and on the exterior face of the wall.

Thermocouples are placed at strategic locations to monitor temperature as an indicator of flame spread.

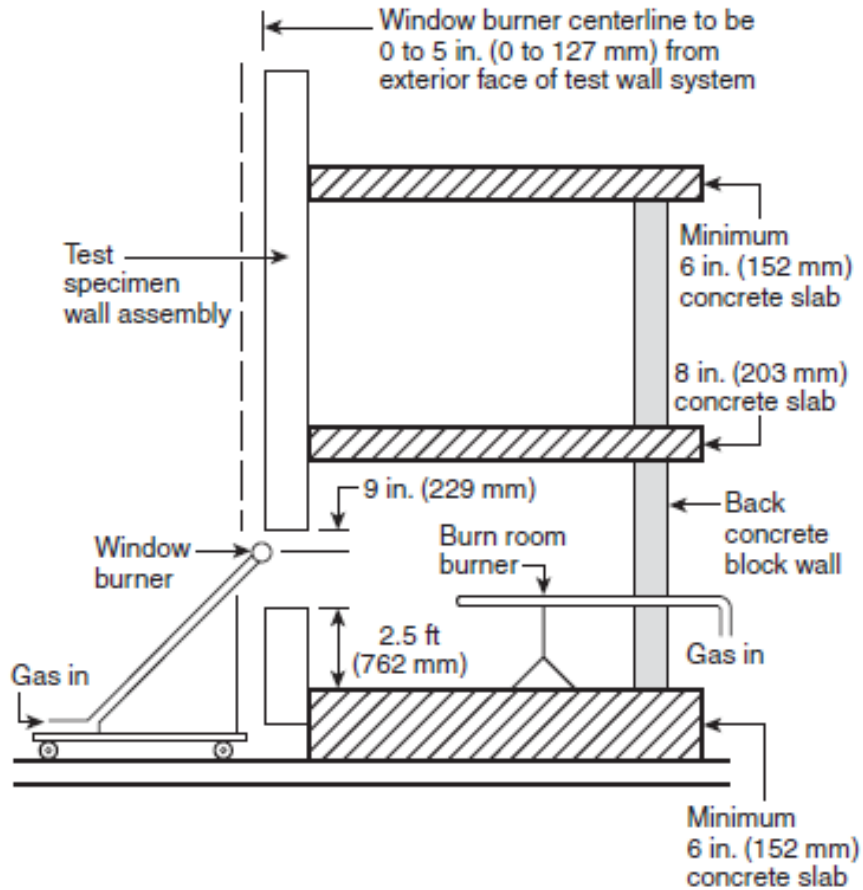
In the depictions below, Thermocouples 1 - 10, and 20 - 27 are not used for compliance purposes. The remainders are used to monitor flame spread.

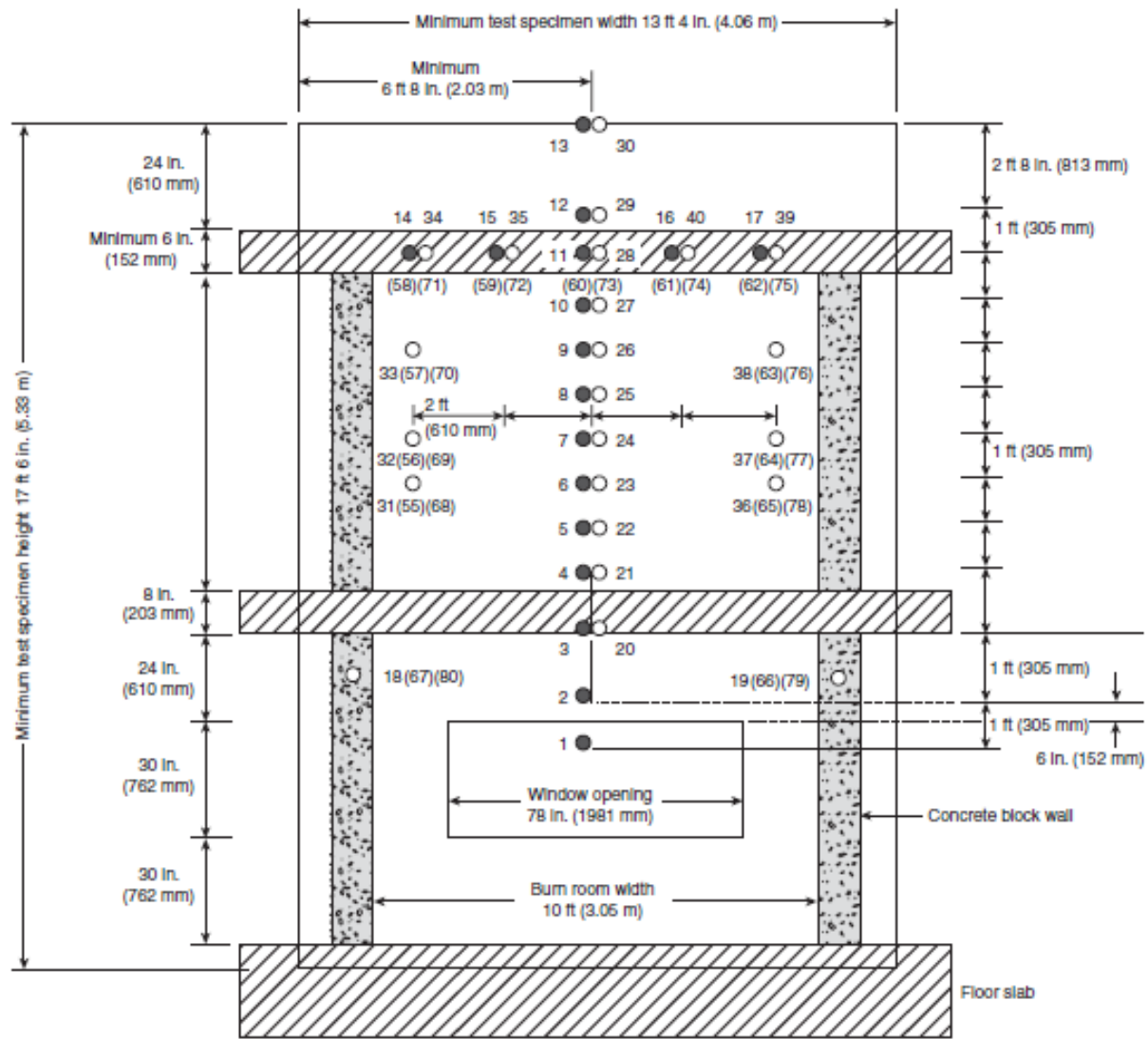
During a test, a calibrated fire starts in the bottom room. After 5 minutes, the exterior burner is ignited to produce a specific heat flux/temperature pattern on the exterior of the wall. Both burners remain ignited during the 30 minute test. Personnel monitor flame spread visually during the course of the test. A computer data acquisition system monitors and records the thermocouples temperatures. The criteria for passing (Ref. 13) are as follows (reworded in simpler terms for this analysis):

- 1) Flames shall not spread vertically 10 ft above the window opening as determined visually or by thermocouples located at the 10 ft level. Failure occurs when Thermocouples 11 or 14 - 17 exceed 1000 °F.
- 2) Flames shall not spread (visually) horizontally 5 ft on either side of the centerline of the window opening.
- 3) Flames shall not spread inside the wall cavity as determined by thermocouples placed within the wall cavity insulation and air-gaps if present. Failure occurs when Thermocouples 28 or 31 - 40 or 55 - 65 and 68 - 79 exceed 750 °F above ambient.



- 4) Flames shall not spread horizontally within the wall cavity past the interior room dimension as determined by wall cavity thermocouples. Failure occurs when Thermocouples 18 - 19, or 66 - 67, or 79 - 80 exceed 750 °F above ambient.
- 5) Flames shall not spread to the second story room as determined by interior wall surface thermocouples. Failure occurs when Thermocouples 49 - 54 exceed 500 °F above ambient.
- 6) Flames shall not occur in the second story (visually).
- 7) Flames shall not escape (visually) from the interior to the exterior at the wall/wall intersection of the bottom story room.

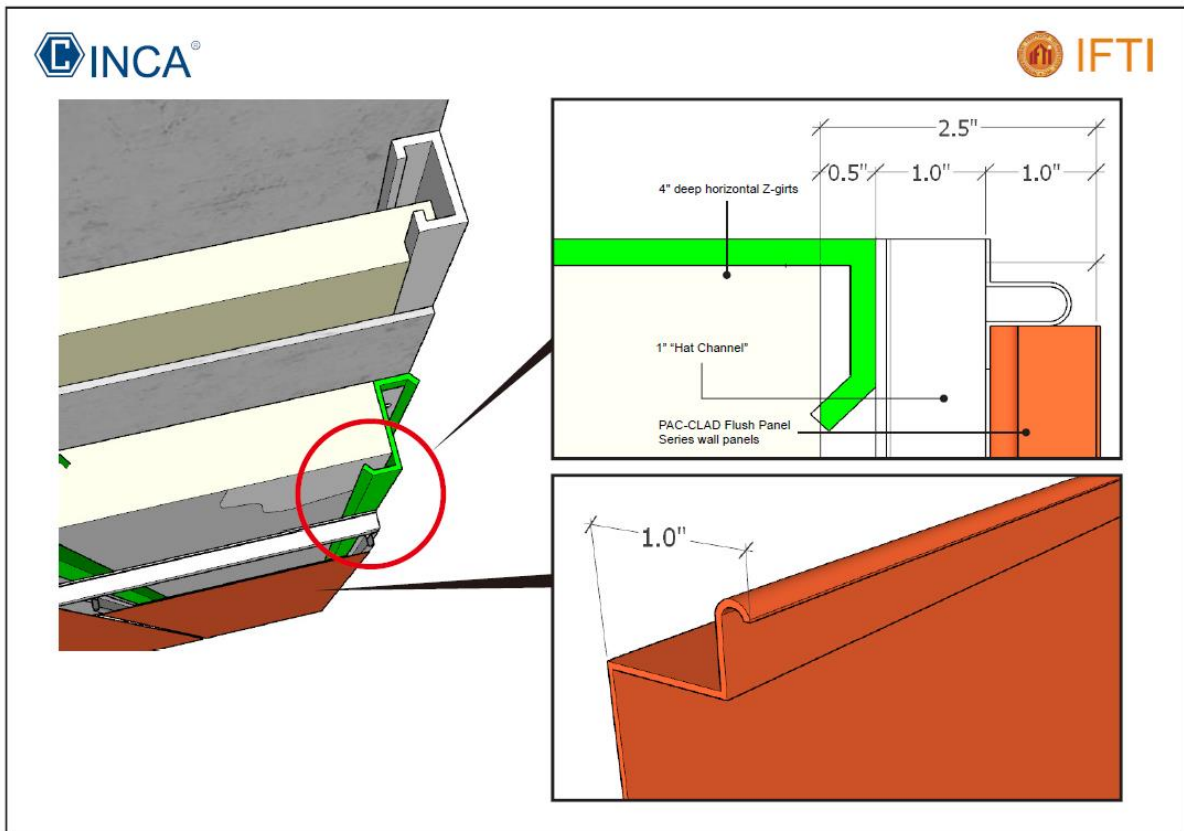
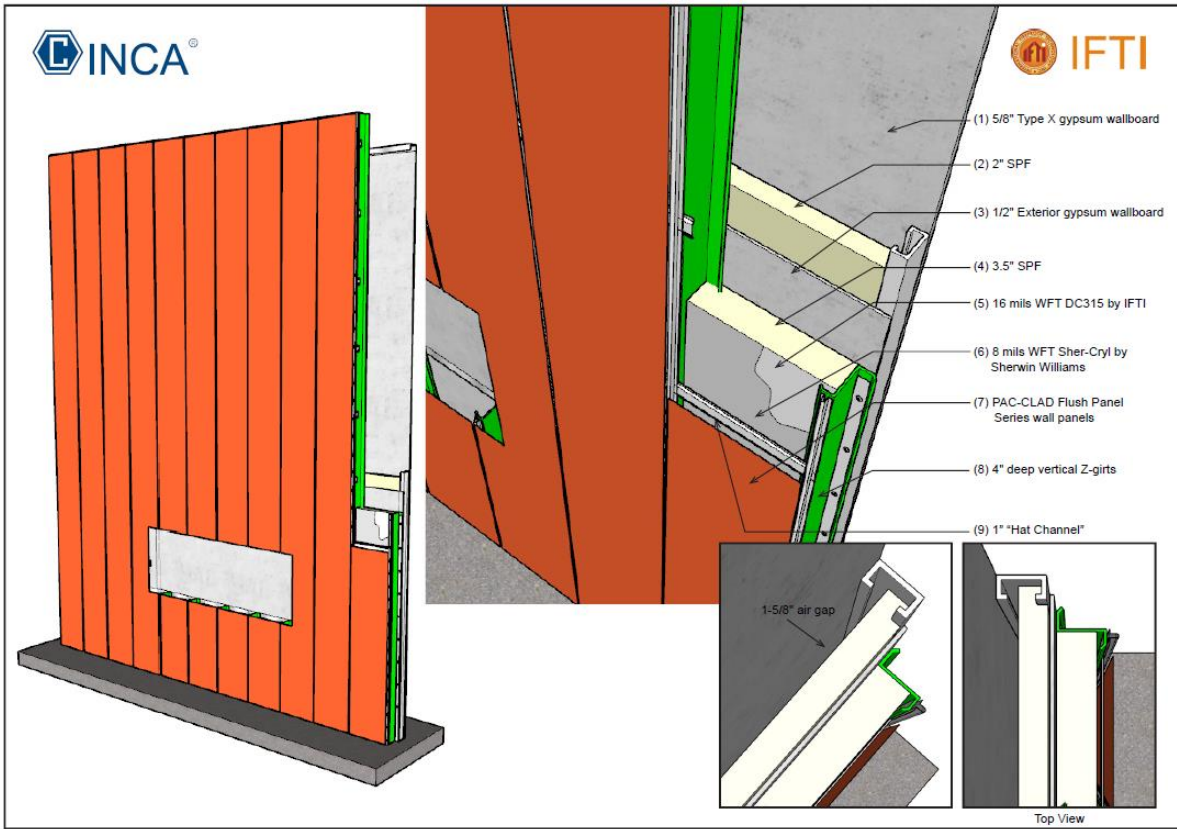




- Thermocouples — 1 in. (25 mm) from exterior wall surface
- Thermocouples — In the wall cavity air space or the insulation, or both, as shown in Figure 6.1(b) Details A through I.
- ( ) Thermocouples — Additional thermocouples in the insulation or the stud cavity, or both, where required for the test specimen construction being tested, as shown in Figure 6.1(b) Details C through I.







## UL Approval

The UL approval allows the following:

### Alternate base wall

- 1) Cast Concrete Walls
- 2) CMU Concrete Walls
- 3) 3 $\frac{5}{8}$ " (min.), 20 GA. (min.), steel studs spaced 24 in. OC (max.)  
Min  $\frac{5}{8}$ " type X gypsum board interior

### Stud Cavity SPF

SealTite Pro Closed Cell (Winter) - Partial or full fill with maximum air gap of 1 $\frac{5}{8}$ "

Stud Cavity Firestop – 4", 4 pcf mineral wool firestop at each floor line

### Exterior Gypsum Sheathing

$\frac{1}{2}$  inch (min.) glass matt exterior gypsum sheathing.

### Exterior Insulation

SealTite Pro Closed Cell (Winter) – 3 $\frac{1}{2}$ " max.

**IMPORTANT:** The insulation was coated with IFTI DC315 (16 mil WFT) with Top Coat Paint (8 mils WFT Sherwin Williams Sher-Cryl). These must be used over the insulation.

### Alternate Claddings

A. Exterior Veneer – Brick – Nom 4 in. (102 mm) thick clay brick veneer offset to provide a max 2 in. (51 mm) air gap between exterior wall insulation (Item 7) and brick veneer with standard type veneer anchors, spaced a max 24 in. (610 mm) on center.

B. Concrete – Min 2 in. (51 mm) thick with max 2 in. (51 mm) air gap between exterior wall insulation (Item 7) and concrete.

C. Concrete Masonry Units – Min 2 in. (51 mm) thick with max 2 in. (51 mm) air gap between exterior wall insulation (Item 7) and concrete masonry units.

D. Stone Veneer – Min 2 in. (51 mm) thick natural stone veneer with any standard non-open joint installation technique.

E. Terracotta Cladding – Min 1-1/4 in. (32 mm) thick with any standard non-open joint installation technique such as ship lap.

F. Stucco – Min 3/4 in. (19 mm) thick exterior cement plaster lath.

## Analysis of Components

When making flammability comparisons of NFPA 285 wall systems, the elements which could potentially cause increased flame spread should be considered. The wall contained a base wall consisting of steel studs, stud sheathings (interior and/or exterior), SPF stud insulation, exterior insulation, FR coatings, air gap, and exterior cladding. The analysis below outlines the various brands/types/models of components used for each element, and criteria are established for interchanging/removing/adding brands/types/models of components for each element.



## Engineering Extensions

### Base Walls

Since the test submitted utilized a steel stud base wall system, other base wall types which tend to perform the same or better are allowed. These include:

- 1) Cast Concrete Walls
- 2) CMU Concrete Walls
- 3) 20 GA. (min.) 3 $\frac{5}{8}$ " (min.) steel studs spaced 24 in. OC (max.)  
     $\frac{5}{8}$ " Type X Gypsum Wallboard Interior

### Cavity Insulation

In addition to the insulation tested and as approved by UL (SealTite Pro Closed Cell (Winter) - Partial or full fill with maximum air gap of 1 $\frac{5}{8}$ " ), the following first 4 items may also be used since these are less combustible than the tested item.

- 1) None
- 2) Any noncombustible insulation per ASTM E136
- 3) Any Mineral Fiber (Board type Class A ASTM E84 faced or unfaced)
- 4) Any Fiberglass (Batt Type Class A ASTM E84 faced or unfaced)
- 5) SealTite Pro Closed Cell (Winter) - Partial or full fill with maximum air gap of 1-5/8",

### Exterior Sheathing

Since the tests submitted utilized  $\frac{1}{2}$  inch exterior gypsum based sheathing, other exterior sheathings with similar or better performance may be utilized. The list of approved sheathings is listed below:

$\frac{1}{2}$  inch (min.) exterior gypsum sheathing

### Exterior Insulation

Since the test submitted utilized 3 $\frac{1}{2}$  inch thick SealTite Pro Closed Cell (Winter) SPF, that is the maximum allowed.

IMPORTANT: The insulation was coated with IFTI DC315 (16 mil WFT) with Top Coat Paint (8 mils WFT Sherwin Williams Sher-Cryl). These must be used over the exterior insulation with all claddings listed in the NFPA 285 conclusion table.

The allowable exterior insulations are listed below:

3 $\frac{1}{2}$  inch thick SealTite Pro Closed Cell (Winter) SPF with IFTI DC315 (16 mil WFT) with Top Coat Paint (8 mils WFT Sherwin Williams Sher-Cryl)

### Air Gap Between Cladding and Insulation

The tested air gap was 2 $\frac{1}{2}$  inches. A draft NFPA standard on writing NFPA 285 evaluation allows the maximum air gap to be between up to  $\frac{1}{2}$  inch larger than the tested air gap. Based on this info, the maximum air gap allowed is up to 3 inches. The following is quoted:

*"A test on a light cladding with a specific air gap can allow the same air gap (+  $\frac{1}{2}$  inch) or less with other light claddings (or heavy masonry) as long as the tested cladding is worst case."*

Ref. (Guide for Extensions of Results from Assemblies that Meet NFPA 285 Test Requirements - Draft 2 – December 2019)

### Claddings (and attachment)

Since the test submitted utilized aluminum building panels (non-open joint) tested vertically (worst case), other claddings that are superior may be used vertically or horizontal (non-open joint).



The test used Vertical Z girts with horizontal struts (free to flow air within the air gap). This is worst case since fire can travel vertically almost unimpeded past the horizontal struts. Horizontal Z girts may be used since these stop vertical flame spread better than vertical girts.

Per the UL report (Ref. 1), the following claddings are allowed:

- 1) Brick – Nominal 4" clay brick with maximum 2" air gap between exterior insulation and brick. Standard brick ties/anchors installed 24" OC (max.) vertically on each stud.
- 2) Concrete - minimum 2" thick with maximum 2" air gap between exterior insulation and cladding.
- 3) CMU - minimum 2" thick with maximum 2" air gap between exterior insulation and cladding.
- 4) Stone Veneer – minimum 2" thick with maximum 2" air gap between exterior insulation and cladding using any standard non-open joint installation technique.
- 5) Terra Cotta Cladding – minimum 1¼" thick (solid) using any standard non-open joint installation technique such as ship lap.
- 6) Stucco – ¾" (min.) exterior cement plaster and lath.

Substitutions based on approvals of competing systems and worst case analysis is discussed below.

Considering the approvals in Ref. 3, claddings deemed to be superior to aluminum are listed below on the basis of being more robust, noncombustible, thicker, or higher melting temperature. We used a zinc calculation to determine worst case. See Zinc calculation below for worst case analysis.

Zinc Panel Analysis

A thermal analysis has been conducted on zinc panels. Zinc is worst case compared to all claddings listed below based on its low melting temperature. Although zinc has a lower melting temperature than aluminum, the density of zinc is much greater, so it will take longer to heat up under a given heat exposure. A calculation of time to reach melting temperature was applied to each material. The time to melting temperature calculation utilized known thermal parameters for each product (melting temperature, density, thickness, specific heat). The table below outlines the thermal response comparison of the metal skins at 0.1 inch thickness (2.54 mm).

Property	Aluminum	Zinc
Density	2712 kg/m <sup>3</sup>	7135 kg/m <sup>3</sup>
Melting Temperature	635 to 654 °C	418 °C
Specific Heat	0.91 kJ/kg K	0.39 kJ/kg K
Emissivity	0.2	0.2
Skin Thickness	0.00254 m	0.00254 m
Volume of 1 m x 1 m panel	0.00254 m <sup>3</sup>	0.00254 m <sup>3</sup>
Mass of 1 m x 1 m panel	6.91 kg	18.14 kg

Note: emissivity depends on paint coating, but for this calculation, emissivity is the raw material oxidized surface applicable in fire tests.

In order to calculate the amount of energy to reach melting temperature for the metal skin, the following formula is used:

$$\text{Temperature } dT = \epsilon \frac{dQ}{m \times C}$$

Where:

- ε = emissivity,
- Q = applied total heat (kJ, time integral of NFPA 285 heat flux curve)
- m = mass of panel skin (kg)
- C = specific heat (kJ/kg K)

Assuming all of the absorbed energy is retained, resulting in increasing the metal's temperature (worst case), the amount of energy required to reach the melting point of both aluminum and zinc is calculated as follows.

$$dQ = \frac{dTmc}{\epsilon}$$



Where:

dT = The increase in temperature above ambient (25 °C) to reach the melting point of Zn and Al.

Note = when Aluminum skin thickness is set to 0.03 inches, the calculation yields 7.5 minutes while the tested assembly melted at 15 min per the ref UL report (Ref. 1). This indicates that all calculations herein are conservative.

dT for Aluminum = 610 K

dT for Zinc = 393 K

dQ = The amount of energy (assuming all energy transfer is radiative) falling on the metal skin.

$\epsilon$  = The surface emissivity of both metals is assumed to be 0.2.

The item to be determined is the amount of time it takes the NFPA 285 heating regime to deliver the amount of energy necessary to melt both metals. Using the calculations above (with 0.1" skin thickness), the times to reach the melting temperature of each metal are, then:

Aluminum (0.1") = 16.75 min.

Zinc (0.1") = 13.5 min

In order to make zinc melt at the same time as 0.03" aluminum (7.5 minutes) the zinc thickness must be 0.04". See calculation below (Excel).

	A	B	C	D	E	F	G	H	I	J	K	L
5	0.75	9	135	89.6	65.9	53.63047	67.94571		zinc thickness	0.04	7.254	1934.7585
6	1.00	9	135	111.2	79.6	63.17396	82.26094			1.016		
7	1.25	9	135	132.7	93.2	72.71745	96.57618		q=mcdT			
8	1.50	9	135	154.3	106.9	82.26094	110.8914		e = emmissivity			
9	1.75	9	135	175.8	120.5	91.80443	125.2066		dT=eQ/(mc)			
10	2.00	9	135	197.4	134.2	101.3479	139.5219					
11	2.25	9	135	218.9	147.8	110.8914	153.8371		alum thickness	0.03	2.073	2835.5579
12	2.50	9	135	240.5	161.5	120.4349	168.1524			0.762		
13	2.75	9	135	262.0	175.1	129.9784	182.4676					
14	3.00	9	135	283.6	188.8	139.5219	196.7828					
15	3.25	9	135	305.1	202.4	149.0654	211.0981					
16	3.50	9	135	326.7	216.1	158.6089	225.4133					
17	3.75	9	135	348.2	229.7	168.1524	239.7285					
18	4.00	9	135	369.8	243.4	177.6958	254.0438					
19	4.25	9	135	391.3	257.0	187.2393	268.359					
20	4.50	9	135	412.8	270.6	196.7828	282.6742					
21	4.75	9	135	434.4	284.3	206.3263	296.9895					
22	5.00	19	285	479.9	313.1	226.4737	327.2105					
23	5.25	19	285	525.4	341.9	246.6211	357.4316					
24	5.50	19	285	570.9	370.7	266.7684	387.6526					
25	5.75	19	285	616.3	399.5	286.9158	417.8737					
26	6.00	19	285	661.8	428.3	307.0632	448.0947					
27	6.25	19	285	707.3	457.2	327.2105	478.3158					
28	6.50	19	285	752.8	486.0	347.3579	508.5368					
29	6.75	19	285	798.3	514.8	367.5053	538.7579					
30	7.00	19	285	843.8	543.6	387.6526	568.9789					
31	7.25	19	285	889.3	572.4	407.8	599.2					
32	7.50	19	285	934.8	601.2	427.9474	629.4211		melt of 0.03" alum or 0.04" zinc			

Based on the analysis above and Ref. 3 approvals, the following are also allowed:

All claddings below – non-open joint. Vertical or horizontal install. Maximum air gap 2½ inches between exterior insulation and cladding.

- 7) Aluminum cladding - 0.030 inch min. thickness - non-open joint
- 8) Steel cladding - 0.0149 inch min. thickness - non-open joint



- 9) Copper cladding - 0.0216 min. thickness - non-open joint
- 10) Zinc cladding - 0.040 inch min. thickness - non-open joint
- 11) Terreal Zephir Evolution Rainscreen System (or similar terra cotta), minimum 9/16" thick - non-open joint
- 12) ¼ inch minimum fiber cement cladding - non-open joint
- 13) SwissPearl Carat Panels – 0.315" min. thickness - non-open joint
- 14) FunderMax M.Look (min. ¼") - non-open joint

Based on testing with 0.030 inch aluminum, some of the cladding thicknesses above (Claddings 1 - 6) can be reduced since the thicknesses for these claddings are based on testing with brick walls. The following is also proposed based on testing 0.030 inch aluminium:

- 15) Concrete - minimum 1" thick - non-open joint.
- 16) CMU - minimum 1" thick - non-open joint.
- 17) Stone Veneer – minimum 1" thick - non-open joint
- 18) One Coat Stucco – 3/8" (min.) exterior cement plaster and lath - non-open joint

Due to similarity to stucco, the following is allowed:

- 19) Thin Brick adhered (with non-combustible mortar) to stucco base (min. 3/4 inch) - non-open joint

**Materials for Openings Perimeters**

The referenced test used 0.03" aluminum flashing (worst case) so this is the minimum required.

Use of plastics for flashings is not permitted based on testing with aluminum.

**CONCLUSIONS**

An NFPA 285 test was conducted on a wall system design. The design incorporated many components including interior and exterior sheathing, stud cavity SPF, steel studs, exterior insulation, coatings, air gap, and aluminum cladding.

The purpose of this evaluation was to determine Engineering Extensions for alternate components that can meet the requirements of NFPA 285. From the wall system submitted, an analysis was conducted on the components tested. This allowed us to form a base wall system from which replacement components can be interchanged.

Additionally, several ESR/TER approved competing wall systems incorporating similar features to the tested wall system were examined. Some of the Engineering Extensions of those systems were also included in this report. In conclusion, we have determined that Engineering Extensions on various components of the tested wall designs can meet the criteria of NFPA 285 with specific limitations.

**TABLE OF SUBSTITUTIONS**

The results of the analysis is presented in the following table which lists the allowable substitutions based on the tests submitted and Engineering Extensions as detailed above.

Wall Component	
<b>Base Wall – Use either 1, 2, 3</b>	1) Cast Concrete Walls (1 inch min.) 2) CMU Concrete Walls (1 inch min.) 3) 20 GA. (min.) 3 5/8 in. (min.) steel with 5/8 in. type X Gypsum Wallboard Interior
<b>Floor Line Fire-Stopping.</b>	4 inch, 4 pcf mineral fiber (wool) safing insulation
<b>Cavity Insulation – Use any Item 1 - 5</b>	1) None 2) Any noncombustible insulation per ASTM E136



	<ul style="list-style-type: none"> <li>3) Any Mineral Fiber (Board type Class A ASTM E84 faced or unfaced)</li> <li>4) Any Fiberglass (Batt Type Class A ASTM E84 faced or unfaced)</li> <li>5) SealTite Pro Closed Cell (Winter) - Partial or full fill with maximum air gap of 1½ in.</li> </ul>
<b>Exterior Sheathing</b>	½ inch (minimum) glass matt exterior gypsum sheathing.
<b>Exterior Insulation –</b>	3½ inch thick (max) SealTite Pro Closed Cell (Winter) SPF with IFTI DC315 (16 mil WFT) with Top Coat Paint (8 mils WFT Sherwin Williams Sher-Cryl)
<b>Air Gap Between Cladding and Insulation</b>	Up to 3 inches
<p><b>Exterior Cladding - Use any item 1 – 19</b></p> <p>Air Gap cannot Exceed 2½ inches. All claddings non-open joint.</p> <p>Panel claddings may use vertical or horizontal Z girt attachment.</p> <p>Panel claddings may be vertical or horizontal.</p>	<ul style="list-style-type: none"> <li>1) Brick – Nominal 4" clay brick. Standard brick ties/anchors installed 24" OC (max.) vertically on each stud.</li> <li>2) Concrete - minimum 2½" thick with maximum 2" air gap between exterior insulation and cladding.</li> <li>3) CMU - minimum 2½" thick – non-open joint.</li> <li>4) Stone Veneer – minimum 2" thick – non open joint</li> <li>5) Terra Cotta Cladding – minimum 1¼" thick (solid) using any standard non-open joint installation technique such as ship lap.</li> <li>6) Stucco – ¾" (min.) exterior cement plaster and lath – non-open joint</li> <li>7) Aluminum cladding - 0.030" min. thickness - non-open joint</li> <li>8) Steel cladding - 0.0149" min. thickness - non-open joint</li> <li>9) Copper cladding - 0.0216" min. thickness - non-open joint</li> <li>10) Zinc cladding - 0.040" min. thickness - non-open joint</li> <li>11) Terreal Zephir Evolution Rainscreen System (or similar terra cotta), minimum 9/16" thick - non-open joint</li> <li>12) ¼" min. fiber cement cladding - non-open joint</li> <li>13) SwissPearl Carat Panels – 0.315" min. thickness - non-open joint</li> <li>14) FunderMax M.Look (min. ¼") - non-open joint</li> <li>15) Concrete – min. 1" thick - non-open joint.</li> <li>16) CMU – min. 1" thick - non-open joint.</li> <li>17) Stone Veneer – minimum 1" thick - non-open joint</li> <li>18) One Coat Stucco – ⅝" (min.) exterior cement plaster and lath - non-open joint</li> <li>19) Thin Brick adhered (with non-combustible mortar) to stucco base (min. ¾ inch) - non-open joint</li> </ul>
<b>Window Perimeter</b>	0.030 aluminum flashing.
	Plastic flashings not permitted.

END OF REPORT

