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Evaluation of Hilti Rainscreen Façade Portfolio by NFPA 285 Criteria

This letter is to summarize the use of Hilti Rainscreen Façade brackets as a replacement for brackets that were tested as part of an NFPA 285 Certified assembly.

A 3rd party expert was utilized to evaluate the impact of using Hilti brackets on approved test assemblies deemed compliant with NFPA 285. This was evaluated by analyzing Hilti brackets according to ASTM E1354, to determine which bracket would be utilized in the NFPA 285 test. Once a bracket was chosen, a NFPA 285 assembly was built to confirm the use of these brackets would not add enough combustible material to affect the ability of the assembly to pass the test criteria.

According to attached report number 1079-12012020 issued by Perceptive Solutions, the Hilti Façade brackets listed below “do not detrimentally affect exterior wall assemblies (as described in the conclusions and table herein), which were tested to and compliant with NFPA 285”.

Brackets considered:

- MFT-Fox H
- MFT-Fox HI
- MFT-Fox HT L
- MFT-Fox HT M
- MFT-Fox VT L
- MFT-Fox VT M
- MFT-MF L
- MFT-MF M
- MFT-MFI L
- MFT-MFI M
- MFT-MW
- MFT-S2S U L
- MFT-S2S U M
- MFT-S2S U I

Yours sincerely,

Angus Robertson

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ENGINEERING EVALUATION

ISSUED TO:

HILTI North America
7250 Dallas Parkway, Suite 1000
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REPORT NUMBER: 1079-12012020

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Précis

The HILTI façade (a.k.a. cladding) mounting brackets (a.k.a clips), which are described and assessed in this Evaluation and other confidential and proprietary supporting documentation, do not detrimentally affect exterior wall assemblies (as described in conclusions and table herein), which were tested to and compliant with NFPA 285. HILTI manufactures several types of façade mounting brackets for use as a component of exterior walls. This website shows the details of the HILTI façade mounting brackets: https://www.HILTI.co.uk/c/CLS_FACADE_MOUNTING_SYSTEMS/CLS_BRACKETS. The following HILTI façade mounting brackets are covered by this Evaluation: MFT-FOX H; MFT-FOX HI; MFT-FOX HT L; MFT-FOX HT M; MFT-FOX VT L; MFT-FOX VT M; MFT-MF L; MFT-MF M; MFT-MFI L; MFT-MFI M; MFT-MW; MFT-S2S U L; MFT-S2S U M; MFT-S2S UI L; MFT-S2S UI M; and, VTR. Some of these HILTI's façade mounting brackets incorporate a plastic thermal break to reduce thermal bridging (outside energy transmission) into the building. Other HILTI façade mounting brackets cited herein are made from solid extruded aluminum or formed into stainless steel angles without thermal breaks.

Competence, Impartiality, & Independence

This Evaluation was written by Perceptive Solutions LLC, an independent third party, who is not affiliated or a subsidiary of HILTI. This Evaluation bears the Signature and Seal of a Licensed California Fire Protection Engineer, who is not connected to HILTI or PSL, directly or indirectly, and who independently reviewed and evaluated this document. The Licensed California Fire Protection Engineer has copies of all of the supporting confidential and proprietary test reports and other documents referenced in this Evaluation.

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1 Introduction

1.1. Scope

This Phase 3 Evaluation is limited to a single change being made to an *approved* test assembly deemed compliant with NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components*. The change is restricted to the substitution of HILTI façade mounting brackets cited herein in lieu of other façade mounting brackets. This Phase 3 Evaluation provides testing information and technical rationale based on sound fire science principles that support the use of HILTI façade mounting brackets cited herein in lieu of other façade mounting brackets that were tested as components in *approved* test assemblies deemed compliant with NFPA 285. The testing information and technical rationale has been provided to the Licensed California Fire Protection Engineer as part of the independent review. For purposes of this document, the term *Listing* has the same meaning as Listed[1], which is defined by the International Building Code® (IBC). The term also *Listing* includes national evaluation reports and code compliance reports published by third-party certification bodies accredited to ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*. Terms defined by the IBC, ASTM, and NFPA are italicized.

1.2. Bracket Types

There are four (4) basic types of HILTI's façade mounting brackets construction:

- Two (2) EN AW-6063 T66 aluminum extrusions separated by a molded polyamide thermal break (a.k.a. thermal isolator);
- One (1) U-shaped or L-shaped EN AW-6063 T66 aluminum extrusion with a molded polypropylene thermal break base; and,
- One (1) monolithic U-shaped or L-shaped EN AW-6063 T66 aluminum extrusion.
- One (1) monolithic L-shaped A4 1.4401/1.440 stainless steel.

This Evaluation also applies to other sizes of HILTI façade mounting brackets cited herein not shown on the HILTI websites. The HILTI façade mounting brackets cited herein are described in following HILTI websites:

https://www.HILTI.co.uk/c/CLS_FACADE_MOUNTING_SYSTEMS/CLS_BRACKETS
https://www.HILTI.se/content/dam/documents/e1/eurofox-data/Technical%20Manual%20VF_Section_06_U-Value.pdf

Website addresses change or are deleted, in order to obtain the most up-to-date Technical Manual and comprehensive documentation refer to www.HILTI.com.

[1] **LISTED.** Equipment, materials, products or services included in a list published by an organization acceptable to the *building official* and concerned with evaluation of products or services that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services and whose listing states either that the equipment, material, product or service meets identified standards or has been tested and found suitable for a specified purpose.

1.3. NFPA 285 Test Purpose

NFPA 285-2012 states, "The purpose of this *standard* is to provide a standardized fire test procedure for evaluating the suitability of exterior non-load-bearing wall assemblies and panels used as components of curtain wall assemblies, constructed using *combustible material*s or that incorporate *combustible* components, for installation on *buildings* where the *exterior wall*s are required to be noncombustible." This statement referencing "a standardized fire test procedure" includes a standardized fire exposure and provides a method to compare a NFPA 285 tested *exterior wall* to a similar assessed NFPA 285 *exterior wall*.

1.4. Testing

All Phase 1 and Phase 2 testing conducted as part of this Phase 3 Evaluation has been performed by laboratories that comply with the requirements contained in ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*. These laboratories are accredited to ISO/IEC 17025 by an accreditation body that is a signatory to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA), which is required to demonstrate technical competence, impartiality, and independence to *building officials* and *authorities having jurisdiction*. Documentation supporting these accreditation claims has been provided to the Licensed California Fire Protection Engineer as part of the independent review.

2 General Information about NFPA 285

2.1. Scope

In order to understand some of PSL's observations and technical rationale, it is important to have a basic understanding of NFPA 285. This section provides a brief description of principles that can affect the *fire-test-response characteristics* (i.e. flammability and flame spread) of an NFPA 285 *test specimen*. Many variables affect the *fire-test-response characteristics* of an NFPA 285 test assembly subjected to NFPA 285 flammability and flame spread testing.

2.2. NFPA 285 Limitations

NFPA 285 is limited to two (2) fire-test-response characteristics: flammability and flame spread. Therefore, this Phase 3 Evaluation has those same limitations. NFPA 285 is not a *fire resistance* test, such as ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials* (similar to NFPA 251, UL 263, ISO 834[2], BS 476[3]), etc., which are used to fire test *fire barriers* and *fire partitions*.to establish a *fire-resistance rating.* Unlike ASTM E119 that measures a change in temperature based on Btu increases, NFPA 285 is a temperature limit test. Set temperature limitations cannot be exceeded. This means that an identical test assembly subjected to an NFPA 285 test may have different results depending on the initial temperature at the start of the test. Consider a Listed and *approved* test assembly detailed in an *approved* agency's Design

[2] Proper "Part" of the standard's series must be used
[3] Proper "Part" of the standard's series must be used

Number. If this Listed and *approved* test assembly passed but reached the maximum allowable temperature limit when tested at the lowest allowable initial test temperature of 50°F, then if this Listed and *approved* test assembly was retested at the highest allowable initial test temperature of 90°F, this temperature increase may cause a test assembly failure by 40°F. Therefore, the HILTI façade mounting brackets cited herein must be assessed based on the understanding that all of the NFPA 285 test conditions and materials of the original qualifying NFPA 285 test are identical.

NFPA 285 is cited in the International Building Code® (IBC). The following sections of the IBC are not addressed herein: *1408.4 Structural design*; *1408.5 Approval*; *1408.6 Weather resistance*; *1408.7 Durability*; *1408.8 Fire-resistance rating*; *1408.9 Surface-burning characteristics*; *1408.10 Type I, II, III and IV construction*, except 1408.10.4; *1408.11 Alternate conditions*; *1408.12 Type V construction*; and *1408.13 Foam plastic insulation*, which is *combustible insulation*. ASTM E84 measures flame spread and smoke generation (surface-burning characteristics) using a horizontal *test specimen*. ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials* (similar to UL 723 and ULC S102.2), is not the same as NFPA 285 because it does not measure flammability on a vertical *test specimen*.

This Phase 3 Evaluation is limited to flammability and flame spread under NFPA 285 and does not apply to any other performance criteria (e.g. *fire resistance*, mechanical, environmental, durability etc.). Further, the Phase 3 Evaluation does not address installation techniques or details and materials other than those tested, except for the possible substitution of HILTI façade mounting brackets cited herein for existing façade mounting brackets.

2.3. Required Specific Joint Testing Locations

Joint location often affects the *fire-test-response characteristics* of an NFPA 285 test assembly. The NFPA 285-2019 Edition requires at least one horizontal joint or seam in the exterior veneer extending the full width of the *test specimen shall* be installed and located between 1 ft (305 mm) and 3 ft (914 mm) above the top of the window opening; and at least one vertical joint or seam in the exterior veneer extending the full height of the *test specimen shall* be installed and located within ±12 in. (152mm) of the window opening's vertical center line. The Phase 2 NFPA 285 test complied with both the horizontal and vertical joint location requirements. The locations are deemed a worst-case test scenario because the joints are located within the hottest part of the flame plume of the NFPA 285 fire exposure.

2.4. Flammability

To understand the basis of this Evaluation, one must be familiar with the performance criteria of NFPA 285, which assesses flammability of *combustible material*s. The following information is a description of NFPA 285, which provides a method of determining the flammability characteristics of non-load bearing *exterior wall*s, which contain *combustible* components. The test method is intended to simulate the "full-scale" *fire performance* of the *exterior wall* being evaluated. The

primary performance characteristics evaluated in this test are the capability of the *test specimen* to resist the following:

1. Flame propagation over the exterior face of the system,
2. Vertical flame spread within the *combustible* core components from one story to the next,
3. Vertical flame spread over the interior (room side) surface of the panels from one story to the next, and
4. Lateral flame spread from the compartment of fire origin to adjacent spaces.

The above are assessed through visual observations and temperature data obtained during the test. The following Test Results table was extracted from Intertek Test Report G104403639-SAT-001R0 as it relates to the NFPA 285 *Conditions of Acceptance*:

TEST REQUIREMENTS	TEST RESULTS	PASS/FAIL
Flames did not reach 10 ft. above the window opening header.	Flames did not reach 10 ft. above the window opening header.	PASS
Flames did not reach a lateral distance of 5 ft. from the vertical centerline.	Flames did not reach a lateral distance of 5 ft. from the vertical centerline.	PASS
Flames did not propagate beyond the limits of the first story test room.	Flames did not propagate beyond the limits of the first story test room.	PASS
No visible flaming in the second story test room	No visible flaming in the second story test room.	PASS
TC's 11 and 14-17 (1000°F limit)	TC's 11 and 14-17 did not exceed their 1000°F limit.	PASS
TC's 18-19, 28, and 31-40 (1000°F limit)	TC's 18-19, 28, and 31-40 did not exceed their 1000°F Limit.	PASS
TC's 49-54 (500°F above ambient)	TC's 49-54 did not exceed 500°F above their ambient temperatures.	PASS

Intertek Test Report G104403639-SAT-001R0 of NFPA 285 states "The assembly described and tested in this report met the Conditions of Acceptance of NFPA 285-2012 and NFPA 285-2019"

2.5. Performance Attributes

The three (3) primary factors affecting NFPA 285 performance are dynamic and influence the *fire-test-response characteristics* of the NFPA 285 Wall System: integrity, stability, and combustion. Therefore, NFPA 285 Wall System reaction to fire must be considered.

Integrity means "the quality or state of being complete or undivided."[4] In a typical Evaluation, integrity of the Façade System (a.k.a. Cladding system) is breached when the panels or framing, or both, begins to degrade.

[4] http://www.merriam-webster.com/dictionary/integrity

Stability is defined as "simply the quality or state of something that is not easily changed or likely to change."[5] In this Evaluation, stability of *combustible* panels is overcome when they combust. The stability of the NFPA 285 Façade System is usually a function of the melting temperature of aluminum an *elementary material*, which is the typical framing material. NFPA 285 performance is usually increased the longer the Façade System remains intact.

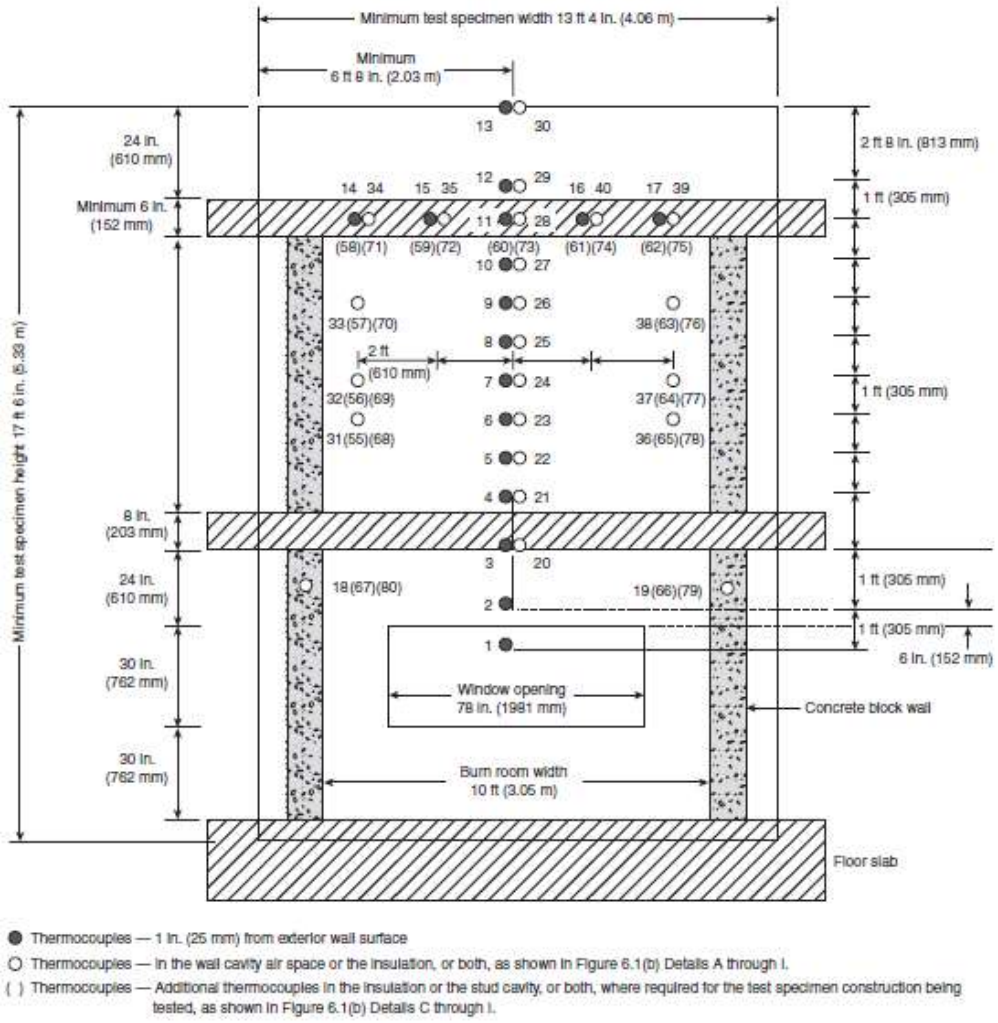


Figure 1 – Elevation of Test specimen Outline &Test Apparatus (no scale) Figure 5.2 (a)

The combustion of the panel is typically affected by the ignition of the *flammable material*. The ignition of the *flammable material* is a prime factor when assessing NFPA 285 performance of a panel. The ignition of the *flammable material* is a function of the Façade System's thermal inertia. The mass and type of the *flammable material* are usually a constant in a single manufacturer panel's

[5] http://www.merriam-webster.com/dictionary/stability

thickness. The time to ignition and combustibility of the *flammable material* generally affect the temperatures registered and the flame spread during the NFPA 285 test.

2.6. *Exterior wall*

The NFPA 285 test assesses an *exterior wall* as a *test specimen*. The *test specimen* is created with the approximate center of its elevation being located at the floor line separating two (2) rooms: one below and one above this floor assembly. The spandrel area is located in respect to the test apparatus' floor line. Figure 1 shows Figure 5.2 (a) taken from NFPA 285. Figure 1 provides and illustrates an understanding of how the *test specimen* (building's *exterior wall*) is positioned on the test apparatus.

One of the most common initial *test specimen*s only tests the Façade System so that its flammability and flame spread performance can be assessed. This Evaluation can be based on temperature measurements being taken in compliance with NFPA 285, Detail F shown in Figure 2, which is very rudimentary, using a base wall assembly, which is typically exterior sheathing, steel studs, and interior wall membrane.

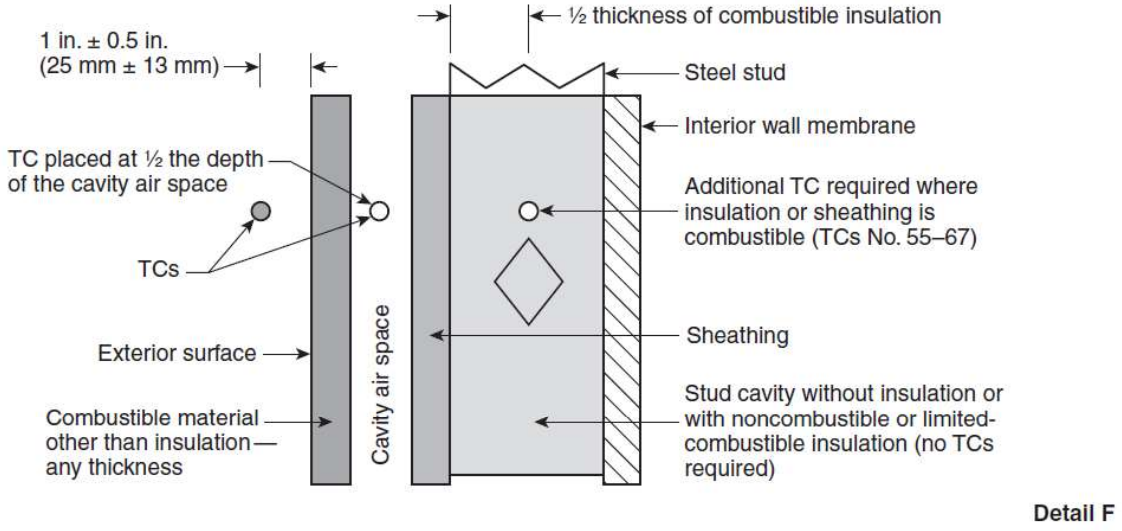


Figure 2 – Instrumentation Arrangement Figure 6.1 (b) Detail F

2.7. NFPA 285 – Façade System's Typical Reaction to Fire

When there are no *combustible*s on the *exterior wall*'s surface, such as the calibration wall, the maximum flame plume height typically impacts the floor line above the window opening. This information is important because the flame plume height increases based on the additional fuel contribution of the *combustible material*s used to create the *test specimen*. Normally, this fuel is in the form of *combustible* gases and liquefied plastics when testing NFPA 285 Systems.

This is an NFPA 285 fire scenario regarding the degradation of a Façade System that meets the requirements of NFPA 285. For example, consider an Aluminum Composite Material (ACM) Façade System attached to a *standard* base wall constructed without any other *combustible* components. When heated the finish on the ACM sandwich panel's aluminum face begins to degrade (ripple, blister, and melt off). The continuing fire exposure begins to combust the plastic core of the ACM panel. In most cases, the plastic core material begins to emit *combustible* gases before the ACM panel's fully enveloped combustion occurs. The core's *combustible* gases increase the recorded exterior surface temperatures.

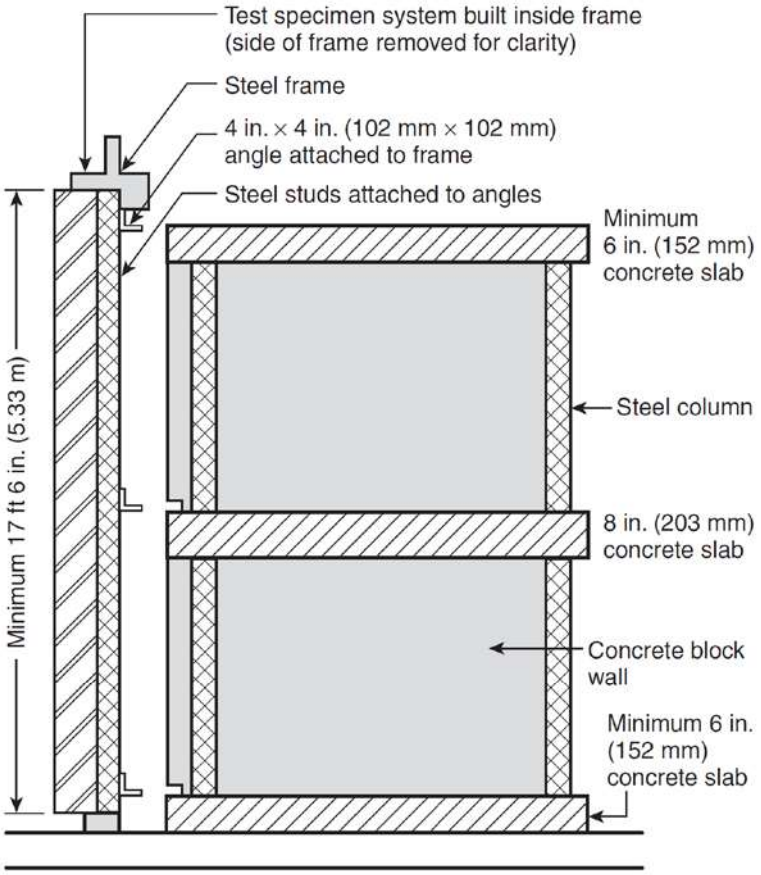


Figure 3 – Side Elevation View of Test specimen on Test Apparatus (not to scale)

In some instances, the ACM panel is heated from both sides after the aluminum window flashings melt away. Differential heating of one-side versus two (2) sides of the panel is also attributed to the metal framing matrix used. The more ACM panels degrade, the greater the emission of the *combustible* off-gases. The triangular burn through of the ACM panels is usually limited to directly above the window opening.

Commencement of Phase 2 NFPA 285 Test

Completion of Phase 2 NFPA 285 Test

Pictures 1 & 2 – Phase 2 NFPA 285 Testing

3 Test Assembly

3.1. General

There are many factors that determine the *fire-test-response characteristics* of test assemblies when tested to NFPA 285. Many of these factors interact with each other either increasing or decreasing *fire performance*. Many materials may be used as part of the wall assembly: Façade System; brackets (a.k.a. clips); weather resistant barriers (WRB)(for purposes of this Phase 3 Evaluation WRB includes moisture resistive barriers; *water-resistive barriers*; air resistive barriers); joint sealers; insulation; etcetera. Some of these materials are *flammable materials*. These materials are attached to the exterior sheathing or placed into the stud cavities of the base wall.

3.2. Base Wall

The base wall construction is directly associated with NFPA 285 flammability and flame spread testing. A base wall is required in order to attached the exterior wall components; seal the test assembly to the test apparatus; and, provide the standardized window opening. The base wall allows the first-story test room with a burner to be separated from the second-story test room with instrumentation. The base wall also represents the portion of the exterior wall assembly that separates the building's interior from the exterior environment. NFPA 285 does not have an exact test condition that isolates a single *combustible* component, which is designated a *flammable material* by the International Building Code®.

The base wall may include the following components: interior wall membrane; framing; cavity insulation; exterior sheathing; weather barrier; and wall cavity insulation. However, eliminating

cavity insulation, weather barrier; and exterior insulation creates an uncomplicated base wall assembly. The most common base wall assembly is represented by GA File Number WP 1072. Using a gypsum board/steel framed assembly extends the field of application to a concrete or CMU wall assembly. Concrete and CMU walls can be used in lieu of wood or steel framing clad with gypsum board, provided that they have an equivalent fire-resistance rating. The rationale is based upon the thermal mass and thermal inertia of these cementitious materials and constructions, as well as their superior stability and integrity. Unitized panel construction is typically unique and each type must be tested when used as a base wall.

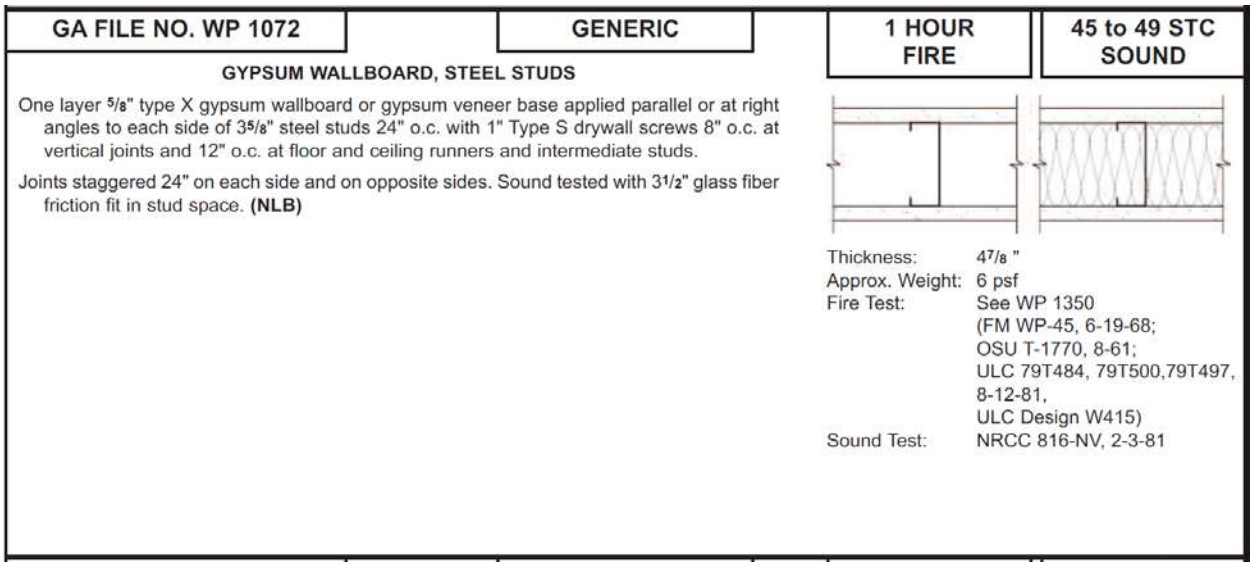


Figure 4 – GA File Number WP 1072

There are variables contained in GA File Number WP 1072. These variables can extend the field of application to other construction features. For example, the wall assembly uses 3-5/8-inch deep steel studs. Increasing the depth of the steel studs would not detrimentally affect the base wall's NFPA 285 performance because it increases their mass. The spacing of the steel studs is 24 inches on center. Decreasing the spacing of the steel studs would not detrimentally affect the base wall's NFPA 285 performance because the thermal mass of steel would increase.

3.3. Interior Wall Membrane

The vast majority of interior wall membranes are 5/8-inch thick gypsum board. However, if 1/2-inch thick gypsum board is used then thicker gypsum board is allowed because the temperature raise of the gypsum board would be slowed based on the increase in the calcination process time.

3.4. Wall Cavity Insulation

The wall cavity is typically created by stud framing but is also present in CMU and other types of unitized panel construction used as exterior walls. The wall cavity can either be empty or contain

some amount of wall cavity insulation: The most common forms of the wall cavity insulation are batts, sheets, blow, injected, or rolls. *Mineral wool*, fiberglass, polyiso foam, SPF foam, XPS foam, EPS foam and blown cellulosic materials are typical insulation options. *Mineral wool* and fiberglass insulation typically resist combustion (sound fire science principle) based on testing to ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C* (similar to ISO 1182).

Therefore, testing empty stud cavities allows application of unfaced or faced *mineral wool* and fiberglass insulation. When polyiso foam, SPF foam, XPS foam, EPS foam are used then options apply: [1] using a reduced thickness of these insulations are also allowed because the thermal mass is reduced, which in turn reduces its *combustible* content (caloric value); [2] installing other brands of the same chemical type of insulation that are equal to or less *combustible* to the NFPA 285 tested insulation as determined by ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*; and [3] substituting other NFPA 285 insulations, with equal or less than the caloric value and combustion resistance, that were tested within the same exterior sheathing and the same interior wall membrane.

3.5. Exterior Sheathing

Most *buildings* today use a proprietary gypsum board with a fiberglass mat as the exterior sheathing, e.g. DensGlass®. This 1/2-inch or 5/8-inch thick gypsum board with a fiberglass mat is a Type X gypsum board. A new product called DensElement® (a proprietary Type X, 5/8-inch thick, gypsum board with a fiberglass mat with AquaKor™ Technology that integrates the WRB-AB forming a hydrophobic monolithic surface) also acts as a WRB and does not require a separate WRB material or application. Testing any Type X gypsum board as NFPA 285 exterior sheathing also qualifies other Type X gypsum boards (including proprietary gypsum boards) of the same or greater thickness as NFPA 285 exterior sheathing. This allowance is based on the sound fire science principle of calcination, which is explained in confidential and proprietary documentation provided to the Licensed California Fire Protection Engineer as part of the independent review.

3.6. Weather Barriers (WRB)

WRBs control leakage into and out of the building envelope. WRB products may take several forms:

- Mechanically-attached membranes
- Self-adhered membranes
- Fluid-applied membranes, including polymeric based and asphaltic based materials
- Closed-cell, spray-applied foam insulation
- Open-cell, spray-applied foam insulation
- Boardstock, which includes foam panel insulation[6]

[6] http://en.wikipedia.org/wiki/Air_barrier

There are four (4) categories to consider when assessing the application of WRBs as part of the base wall assembly:

- Air/Vapor Barriers Covered by a Non-*Combustible* Insulation
- Air/Vapor Barriers Covered by a *Combustible* Insulation
- Air/Vapor Barriers Covering *Combustible* Insulation
- Air/Vapor Barriers Covered only by an Façade System

For exterior walls tested to NFPA 285, the two (2) most common types of WRBs are liquid/pastes or films/papers. Most of these products are very thin and are applied to the exterior sheathing or exterior insulation. There are vast numbers of products contained in these two (2) broad categories. It is not practical to test them all in NFPA 285 test assemblies.

Based on the sound fire science principle of combustion, which is explained in confidential and proprietary documentation provided to the Licensed California Fire Protection Engineer as part of the independent review, ASTM E1354 is used to determine the combustibility of materials. Therefore, NFPA 285 and ASTM E1354 testing a WRB will permit less *combustible* WRBs to be used instead.

3.7. Exterior Insulation

Due to moisture concerns, exterior insulation is usually limited to *mineral wool*, polyisocyanurate (a.k.a. PIR, polyiso, or ISO) foam, spray polyurethane foam (SPF), extruded polystyrene (XPS) foam, and expanded polystyrene (EPS) foam. Polyiso, SPF, XPS, and EPS foams are very *combustible*. In contrast, most *mineral wool* is deemed very resistant to combustion or noncombustible when ASTM E136 compliant.

The majority of initial NFPA 285 tests conducted by façade manufacturers were performed on test assemblies without exterior insulation. However, many in the architectural community desire an exterior insulation option and exterior insulation is now a common component.

3.8. Cavity Air Space

The cavity air space is located between the exterior sheathing and the external *combustible* material exposed to the outside environment, the Façade System, as shown in Figure 2 – *Instrumentation Arrangement Figure 6.1 (b) Detail F*. However, the surface boundaries determining the measurement of the cavity air space are not defined in Figure 2 – *Instrumentation Arrangement Figure 6.1 (b) Detail F*. The depth of the cavity air space could be measured from the exterior face of the exterior sheathing to the interior face of the exterior *combustible* material; or, the cavity air space could be measured from the exterior face of the exterior sheathing to the exterior face of the exterior *combustible* material; or, the cavity air space could be measured from the exterior face of the exterior sheathing to the interior face of the supporting framing. Historically, the typical cavity air space measurement calculation is from the exterior face of the exterior sheathing to the interior

face of the exterior *combustible* material. Testing a deeper cavity air space is a worst-case and allows smaller cavity air spaces because the air flow and oxygen is decreased.

3.9. Façade System

The Façade System is typically composed of façade panels modified during fabrication to allow their attachment to supporting framing. There are many types of noncombustible and *combustible* Façade Systems. The primary noncombustible Façade Systems include, but are not limited to, the following: brick, CMU, cementitious products, terra-cotta, stucco, steel, aluminum, glass curtain walls, and various stones (e.g. granite, marble), etc. The *combustible* Façade Systems include, but are not limited to, the following: *metal composite materials* (*MCM*) including facing materials of aluminum (ACM), copper (CCM), zinc (ZCM), steel (SCM); high-pressure laminates (HPL), resin based products with natural or artificial stone, fiber reinforced plastics (FRP), wood sheathing, etc.

3.10. Façade Mounting Brackets

Most manufacturers of the façade panels do not design or fabricate the Façade System. The attachment of the Façade System can be directly attached to the exterior sheathing, which is covered by a WRB. However, there are no standardized components or methodology for framing system attachment of the façade panels. Most framing systems supplied as part of the Façade System are not designed for the application of exterior insulation.

Many Façade Systems incorporate façade mounting brackets to which a framing system (supporting construction) is attached. The façade mounting brackets facilitate the installation of the Façade System and exterior insulation shielding a WRB covering the exterior sheathing as well as creating a cavity air space as part of the exterior wall assembly.

There are many types of façade mounting brackets made from numerous materials. Most of the façade mounting brackets, which include a thermal break to reduce thermal bridging, contain a *combustible* material. This *combustible* material makes these façade mounting brackets subject to NFPA 285 testing even though the mass of the *combustible* material is typically very limited and sporadically located in the test assembly.

4 Evaluation

4.1. Scope

Based on a confidential and proprietary Evaluation/Test Plan initially prepared for HILTI, there are three (3) phases involved in assessing HILTI façade mounting brackets cited herein for use in NFPA 285 test assemblies: Phase 1 is testing to ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*; Phase 2 is testing to NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation*

Characteristics of Exterior Wall Assemblies Containing Combustible Components; and, Phase 3 is this Evaluation of the *fire-test-response characteristics* of the HILTI façade mounting brackets cited herein and their effect on tested and compliant NFPA 285 test assemblies. As part of this Phase 3 Evaluation, the confidential and proprietary Evaluation/Test Plan initially prepared for HILTI has been provided to the Licensed California Fire Protection Engineer as part of the independent review.

The use of HILTI façade mounting brackets cited herein in NFPA 285 test assemblies is assessed based on testing and accepted fire science principles. The most *combustible* HILTI façade mounting brackets' thermal break having the greatest mass was subjected to the NFPA 285 fire exposure.

4.1.1. Phase 1 ASTM E1354

The intent of the Phase 1 ASTM E1354 testing was to determine the worst-case (most *combustible*) HILTI façade mounting bracket for testing as part of the NFPA 285 test. The Phase 1 test data generated by twenty-four (24) ASTM E1354 tests has been assessed. As part of this Phase 3 Evaluation, the confidential and proprietary ASTM E1354 test reports and the test data analysis have been provided to the Licensed California Fire Protection Engineer as part of the independent review.

4.1.2. Phase 2 NFPA 285

The intent of the Phase 2 NFPA 285 test was to test the worst-case (most *combustible*) HILTI façade mounting bracket in an NFPA 285 test assembly. The NFPA 285 test assembly used the highest *combustible* content of the HILTI façade mounting brackets cited herein based on using the maximum number possible in typical construction, which is documented in the confidential and proprietary NFPA 285 test report. Intertek Test Report G104403639-SAT-001R0 of NFPA 285 states "The assembly described and tested in this report met the Conditions of Acceptance of NFPA 285-2012 and NFPA 285-2019" This NFPA 285 test data supports qualification of all of the HILTI façade mounting brackets cited herein. The NFPA 285 test assembly determined that the greatest fuel content and heat release of the HILTI façade mounting brackets cited herein will not diminish the *fire-test-response characteristics* of a certified *MCM* panel material Listed by an *approved* agency. The Phase 2 test data generated by the NFPA 285 test has been assessed. The confidential and proprietary NFPA 285 test report and the test data analysis have been provided to the Licensed California Fire Protection Engineer as part of the independent review.

4.2. ASTM E1354 & HILTI Façade Mounting Brackets

It is not practical to test every HILTI façade mounting bracket cited herein in every conceivable NFPA 285 test assembly. ASTM E1354 comparative testing has been accepted by the fire engineering community as a scientific means to assess and compare combustibility of materials. The HILTI façade mounting brackets cited herein made from solid extruded aluminum or formed into stainless steel angles do not add any *combustible* fuel. Therefore, these two (2) types of HILTI façade mounting brackets cited herein were not tested to ASTM E1354.

Phase 1 ASTM E1354 tests were conducted to compare the following HILTI molded polyamide and molded polypropylene thermal breaks to each other and determine a worst-case plastic for the Phase 2 NFPA 285 test assembly. ASTM E1354 test data verified a review of HILTI product literature that HILTI façade mounting brackets cited herein using polyamide thermal breaks have better *fire-test-response characteristics* than HILTI façade mounting brackets cited herein using polypropylene thermal breaks. HILTI façade mounting brackets cited herein using polypropylene thermal breaks are a worst-case fire testing scenario when subjected to a NFPA 285 fire exposure.

Phase 2 NFPA 285 testing was used to establish that the maximum number of worst-case HILTI façade mounting brackets cited herein with polypropylene thermal breaks installed per the NFPA 285 test assembly area will not adversely affect the *fire-test-response characteristic* of a very *combustible* Façade System.

4.3. NFPA 285 & HILTI Façade Mounting Brackets

To determine the energy contribution of the worst-case HILTI façade mounting brackets cited herein to the NFPA 285 test assembly, it is important that the façade degrades quickly exposing the plastic thermal breaks. An ACM Façade System melts the thin aluminum sheets sandwiching the *combustible* plastic core that ignites quickly. The degradation of an ACM Façade System is generally described in Section 2.7, *Façade System's Typical Reaction to Fire*.

The Phase 2 NFPA 285 test assembly contained the maximum concentration (number of brackets per test assembly) of the worst-case HILTI façade mounting brackets cited herein used in typical exterior wall construction; used the DensElement® Barrier System as the exterior sheathing; and created a ≈3-1/2-inch deep cavity air space is measured from the exterior face of the DensElement® sheathing (the exterior face of the exterior sheathing) to the interior face of the ACM panel (the interior face of the exterior *combustible* material). The Phase 2 NFPA 285 test assembly was constructed using ACM panels certified by an ICC-ES Evaluation Report, which has been provided to the Licensed California Fire Protection Engineer as part of the independent review.

4.4. NFPA 285 & Window Flashing

The window flashing (header/jambs/sill) affects the combustion of the flammable components used in an NFPA 285 test assembly. The test sponsor can use any type of flashing construction for the NFPA 285 test. However, the *fire-test-response characteristic* of the NFPA 285 test assembly is directly associated with the flashing construction and must be used in the field construction as tested or a more robust construction.

The 2019 Edition of NFPA 285 requires aluminum sheet metal conform to the following:

- be a maximum thickness of 0.04 in. (1 mm)
- provide a maximum 2 in. (51 mm) vertical leg on the interior face only

- be flush with the exterior face

Phase 2 NFPA 285 testing used a more severe flashing construction (0.02-inch thick aluminum with a 1-inch tall vertical leg) to create a more onerous fire test scenario for assessment of thermal break's flammability of the HILTI façade mounting bracket cited herein. This severe flashing construction allows any more robust flashing construction to be used in the field construction.

5 Conclusions

This Phase 3 Evaluation was limited to a single change being made to an *approved* test assembly deemed compliant with NFPA 285 *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components*. The change was limited to the substitution of HILTI façade mounting brackets cited herein in lieu of other façade mounting brackets (a.k.a clips). This Phase 3 Evaluation provided testing information and technical rationale based on sound fire science principles that support the use of HILTI façade mounting brackets cited herein in lieu of other façade mounting brackets that were tested as components in *approved* test assemblies deemed compliant with NFPA 285. The testing information and technical rationale referenced in the conclusions below has been provided to the Licensed California Fire Protection Engineer as part of the independent review.

The NFPA 285 test assembly's constructions are based on components cited in Table 1, *NFPA 285 Construction Components* tested to and deemed compliant with NFPA 285 by various third-party certification bodies accredited to ISO/IEC 17065, *Conformity assessment — Requirements for bodies certifying products, processes and services*, who issue *Listings*, Evaluation Reports, and reports for code compliance. The conclusions apply to compliant NFPA 285 test assemblies that were constructed of these components.

NOTE 1 – *Material approvals are made by any Certification Body accredited to ISO/IEC 17065 by an accreditation body that is a signatory to the International Laboratory Accreditation Cooperation (ILAC) Mutual Recognition Arrangement (MRA), which is required to demonstrate technical competence, impartiality, and independence to building officials and authorities having jurisdiction who must also approve the material for use.*

ISO/IEC 17025 Testing Laboratories issue test reports and ISO/IEC 17065 Certification Bodies create *Listings* of test assemblies compliant with NFPA 285 requirements and limitations based on fire testing to NFPA 285 alone or the use of sound fire science principles coupled with fire testing of a similar NFPA 285 test assembly. Table 1, *NFPA 285 Construction Components*, of this Phase 3 Evaluation references various materials that have been *approved* for use by ISO/IEC 17025 Testing Laboratories or ISO/IEC 17065 Certification Bodies, or both.

Based on the Phase 1 ASTM E1354 test data; Phase 2 NFPA 285 test data; technical rationale; supporting evidence; fire science principles; Phase 3 Evaluation information; and, limitations contained and referenced herein, it is Perceptive Solution's judgment based on sound fire technology principles that the following is true:

- Based on the Phase 2 NFPA 285 test assembly construction using the worst-case HILTI façade mounting brackets cited herein with polypropylene thermal breaks, resulting test data, and its assessment, any type of HILTI façade mounting bracket cited herein creating a maximum ≈3-1/2-inch deep cavity air space is allowed to be used with any tested and compliant NFPA 285 *combustible* Façade System, or any noncombustible NFPA 285 Façade System, installed over DensElement® Barrier System without exterior insulation.

- Based on the fire tetrahedron (that includes all of these elements: oxygen, heat, fuel and a sustained chemical reaction), a sound fire science principle described in supporting confidential and proprietary documentation, when the *combustible* material of any HILTI façade mounting bracket cited herein is completely covered by ASTM E136 *mineral wool* that is a compliant exterior insulation, then any HILTI façade mounting bracket cited herein can be used in lieu of any other façade mounting bracket previously fire tested as a component of and compliant with an NFPA 285 test assembly by an ISO/IEC 17025 Testing Laboratory or as required by a *Listing* published by an ISO/IEC 17065 Certification Body.

- Based on non-combustion and thermal mass, sound fire science principles described in supporting confidential and proprietary documentation, the HILTI façade mounting brackets cited herein made from solid extruded aluminum or formed into stainless steel angles will not add any *combustible* fuel to any compliant NFPA 285 test assembly documented by a test report or *Listing*. Therefore, these two (2) types of HILTI façade mounting brackets cited herein can be used in lieu of any other façade mounting brackets provided that the cavity air space created by the addition of the HILTI façade mounting brackets cited herein is equal to or less than the cavity air space tested as part of the original NFPA 285 test assembly by an ISO/IEC 17025 Testing Laboratory or as required by a *Listing* published by an ISO/IEC 17065 Certification Body.

- Based on sound fire science principles described in supporting confidential and proprietary documentation, when the thermal break (i.e. polyurethane a *combustible* material) located at the base of any HILTI façade mounting bracket is completely covered by a *combustible* exterior insulation previously fire tested as a component of and compliant with an NFPA 285 test assembly by an ISO/IEC 17025 Testing Laboratory or as required by a *Listing* published by an ISO/IEC 17065 Certification Body, then these HILTI façade mounting brackets cited herein will comply with NFPA 285 limitations. Therefore, these HILTI façade mounting brackets cited herein can be used in lieu of the original qualified façade mounting brackets.

Table 1, *NFPA 285 Construction Components*, of this Phase 3 Evaluation represents materials *approved* for use in NFPA 285 test assemblies cited in ISO/IEC 17025 Testing Laboratories' test reports and ISO/IEC 17065 Certification Bodies' *Listings*. There are literally hundreds, maybe thousands, of material combinations that represent ISO/IEC 17025 Testing Laboratories' test reports and ISO/IEC 17065 Certification Bodies' *Listings* of test assemblies compliant with NFPA 285 requirements and limitations. Table 1, *NFPA 285 Construction Components*, of this Phase 3 Evaluation is not meant to be a source to mix and match construction components to create test assemblies that have not been fire tested by an ISO/IEC 17025 Testing Laboratories or assessed by an ISO/IEC 17065 Certification Bodies and deemed compliant to NFPA 285.

Table 1 – NFPA 285 Construction Components

Test Assembly Components	Component Description
Base Wall – Framing Use 1, 2, 3 or 4	**1.** Minimum 3-5/8-inch deep, minimum 20 GA galvanized steel studs spaced a maximum of 24 inches on center. Lateral bracing as tested to NFPA 285 or installed minimum every 4 ft vertically or as required by specifications. **2.** Concrete in lieu of Item 1 or as tested to NFPA 285 **3.** CMU in lieu of Item 1 or as tested to NFPA 285 **4.** Minimum 3-1/2-inch deep by 1-1/2-inch wide, wood studs (a.k.a. 2x4's) spaced a maximum of 24 inches on center. Lateral bracing as tested to NFPA 285 or installed minimum every 4 ft vertically or as required by specifications.
Base Wall – Interior Wall Membrane Use 1, 2 or 3 (Refer to NOTE 1)	**1.** Install on the exterior side of base wall framing: Minimum of one (1) layer of 5/8-inch thick Type X gypsum board; or, minimum of one (1) layer of 1/2-inch thick Type X gypsum board; or, minimum of one (1) layer ½-inch thick Type X fiberglass faced exterior gypsum board sheathing. **2.** Concrete in lieu of Item 1 or as tested to NFPA 285 **3.** CMU in lieu of Item 1 or as tested to NFPA 285
Base Wall – Fire Stopping at Stud Cavity at Floor Lines	Minimum 4-inch thick, minimum 4-pcf density, *mineral wool* (e.g. Roxul, Thermafiber) installed in each stud cavity at each floor line. Friction fit insulation between studs or installed using Z clips.

Base Wall – Wall Cavity Insulation Use 1, 2, 3, 4 or 5 (Refer to NOTE 1)	**1.** NONE (Refer to NOTE 2) **2.** Fiberglass (faced or unfaced) **3.** *Mineral wool* insulation (faced or unfaced) **4.** Any other noncombustible insulation material (faced or unfaced) **5.** Any *approved* SPF spray foam insulation *approved* for use in wall cavities in NFPA 285 compliant assemblies. ***NOTE 2 –*** *Exterior sheathing and interior wall membrane are required.*
Base Wall – Exterior Sheathing (Refer to NOTE 1)	**1.** Minimum 1/2-inch or 5/8-inch thick Listed or Certified exterior-type paper-faced gypsum board (Refer to NOTE 3). **2.** Minimum 1/2-inch or 5/8-inch thick Listed or Certified fiberglass-faced gypsum board (Refer to NOTE 3). **3.** NONE – (Refer to NOTE 4). ***NOTE 3 –*** *Test reports and Listings of the compliant NFPA 285 test assemblies specify the thickness of specific exterior sheathings (brands/types) and WRBs.* ***NOTE 4 –*** *Where no exterior sheathing is part of the compliant NFPA 285 test assembly, use the specific wall cavity insulation in the test report and Listing.*

WRB Covering Exterior Sheathing Use 1, 2 or 3 (Refer to NOTE 1)	**1.** NONE **a.** OPTION – Use with DensElement® Barrier System, which has been *approved* for use in a fire tested and compliant NFPA 285 test assembly as in Phase 2 NFPA 285 testing. **2.** Only for use with aluminum or steel HILTI façade mounting brackets without thermal breaks – Noncombustible exterior wall assemblies where the *water-resistive barrier* (WRB) is the only *combustible* component and the WRB meets the IBC exceptions. (Refer to NOTE 3) **a.** Noncombustible façade of brick, concrete, stone, terra cotta, stucco or steel with a minimum thickness specified by the IBC, or **b.** A WRB with a peak heat release rate of less than 150 kW/m^2, a total heat release of less than 20 MJ/ m^2 and an effective heat of combustion of less than 18 MJ/kg as determined in accordance with ASTM E1354; and, a flame spread index of 25 or less and a smoke-developed index of 450 or less as determined in accordance with ASTM E84 or UL 723. **3.** Any WRB covered by *mineral wool*, polyisocyanurate, SPF, EPS, or XPS insulation, which has been *approved* for use in a compliant NFPA 285 test assembly. (Refer to NOTE 3)
WRB Covering Exterior Insulation Use 1, 2 or 3 (Refer to NOTE 1)	**1.** NONE **2.** Only for use with aluminum or steel HILTI façade mounting brackets without thermal breaks – Noncombustible exterior wall assemblies where the *water-resistive barrier* is the only *combustible* component and the WRB meets the IBC exceptions. **a.** Noncombustible façade of brick, concrete, stone, terra cotta, stucco or steel with a minimum thickness specified by the IBC, or **b.** A WRB with a peak heat release rate of less than 150 kW/ m^2, a total heat release of less than 20 MJ/ m^2 and an effective heat of combustion of less than 18 MJ/kg as determined in accordance with ASTM E1354; and, a flame spread index of 25 or less and a smoke-developed index of 450 or less as determined in accordance with ASTM E84 or UL 723. **3.** Any WRB applied over *mineral wool*, polyisocyanurate, SPF, EPS, or XPS insulation, which has been *approved* for use in a fire tested and compliant NFPA 285 test assembly.

Exterior Insulation Use 1, 2, 3 or 4 (Refer to NOTE 1)	**1.** NONE – Only for use with aluminum or steel HILTI façade mounting brackets without thermal breaks – Noncombustible exterior wall assemblies where the *water-resistive barrier* is the only *combustible* component and the WRB meets the IBC exceptions. **a.** Noncombustible façade of brick, concrete, stone, terra cotta, stucco or steel with a minimum thickness specified by the IBC, or **b.** A WRB with a peak heat release rate of less than 150 kW/ m^2, a total heat release of less than 20 MJ/ m^2 and an effective heat of combustion of less than 18 MJ/kg as determined in accordance with ASTM E1354; and, a flame spread index of 25 or less and a smoke-developed index of 450 or less as determined in accordance with ASTM E84 or UL 723. **2.** Minimum 2-inch thick, minimum 4-pcf density, *mineral wool* insulation (e.g. Roxul, Thermafiber) allowed for use with WRB. **3.** Any polyisocyanurate, SPF, EPS, or XPS insulation, which has been *approved* for use in a fire tested and compliant NFPA 285 test assembly used with WRBs in Item 2 of WRB Covering Exterior Sheathing cited above. **4.** Any closed cell SPF insulation which has been *approved* for use in a fire tested and compliant NFPA 285 test assembly that has also qualified to be an effective WRB.
Cavity Air Space	**1.** NONE – Façade System is flush against exterior sheathing, whether or not it has a WRB applied. **2.** Maximum cavity air space in the fire tested and compliant NFPA 285 test assembly

Façade Systems (Refer to NOTE 1)	***NOTE 5 –*** *Follow HILTI façade mounting bracket installation instructions. Then follow the Façade System's manufacturer's installation instructions.* **1.** Any noncombustible Façade System used in a fire tested and compliant NFPA 285 test assembly with minimum 2-inch thick, minimum 4-pcf density, *mineral wool* insulation (e.g. Roxul, Thermafiber), including, but are not limited to, the following: brick, CMU, cementitious products, terra-cotta, stucco, steel, aluminum, glass curtain walls, and various stones (e.g. granite, marble), etc. **2.** Any *combustible* Façade System used in a fire tested and compliant NFPA 285 test assembly with minimum 2-inch thick, minimum 4-pcf density, *mineral wool* insulation (e.g. Roxul, Thermafiber), which has been *approved* for use in a fire tested and compliant NFPA 285 test assembly, including but not limited to, the following: adhered masonry, *metal composite material* (*MCM*) including facing materials of aluminum (ACM), copper (CCM), zinc (ZCM), steel (SCM); high-pressure laminates (HPL), resin based products with natural or artificial stone, fiber reinforced plastics (FRP), wood sheathing, etc. **a.** Adhered Masonry using minimum 3/4-inch thick tile set into cementitious *mortar* applied to a minimum 1/2-inch thick noncombustible sheathing. **3.** Any noncombustible or *combustible* Façade System used in a fire tested and compliant NFPA 285 test assembly used with polyisocyanurate, SPF, EPS, or XPS insulation, which has been *approved* for use in a fire tested and compliant NFPA 285 test assembly.
Window Flashing: Header/Jambs/Sill	**1.** Any window construction provided by the NFPA 285 test sponsor, which has been *approved* for use in a fire tested and compliant NFPA 285 test assembly, must be the same flashing material and at least the thickness tested and installed per the manufacturer's instructions. **2.** The 2019 Edition of NFPA 285 requires aluminum sheet metal conform to the following: **a.** be a maximum thickness of 0.04 in. (1 mm) **b.** provide a maximum 2 in. (51 mm) vertical leg on the interior face only **c.** be flush with the exterior face **3.** Phase 2 NFPA 285 testing used a more severe flashing construction (0.02-inch thick aluminum with a 1-inch tall vertical leg) to create a more onerous fire test scenario for assessment of thermal break's flammability of the HILTI façade mounting bracket.

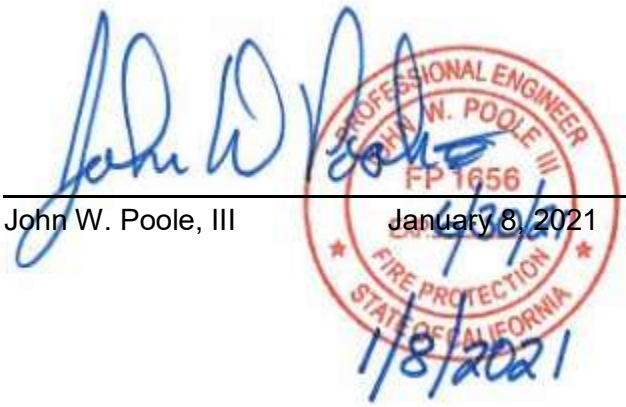
The Phase 3 Evaluation's General Conclusion is limited to a single change (substitution of HILTI façade mounting brackets cited herein in lieu of other façade mounting brackets) to an *approved* test assembly deemed compliant with NFPA 285 by ISO/IEC 17025 Testing Laboratories' test reports or ISO/IEC 17065 Certification Bodies' *Listings*, or both.

- **GENERAL CONCLUSION –** Based on the Phase 2 NFPA 285 testing and sound fire science principles described in supporting confidential and proprietary documentation, any HILTI façade mounting bracket cited herein is allowed to be substituted for any other combustible façade mounting bracket referenced in any NFPA 285 test report issued by an ISO/IEC 17025 Testing Laboratory or Listing issued by an ISO/IEC 17065 Certification Body, provided that these documents reference combustible Façade Systems or other *combustible materials*, or both and by doing so does not exceed any NFPA 285 construction requirement or limitation cited in those NFPA 285 documents, e.g. the maximum depth of the cavity air space.

IN WITNESS WHEREOF, Perceptive Solutions hereto freely, willingly, and without reservation or any form of coercion does set forth a duly authorized signature to this Phase 3 Evaluation as of the date and year set forth below.

PERCEPTIVE SOLUTIONS, LLC	
	John D. Nicholas
Signature of Duly Authorized Representative	Name of Duly Authorized Representative
December 15, 2020	**President**
Date of Signature	Title of Duly Authorized Representative
john@perceptivesolutionsllc.com	**210-601-1119**
Email Address of Duly Authorized Representative	Phone Number of Duly Authorized Representative

Reviewed and Evaluated by Licensed California Fire Protection Engineer:



John W. Poole, III January 8, 2021

6 Last Page and Revision Record

DATE	SUMMARY
December 15, 2020	Original
January 8, 2021	Revisions per the Engineer