PRIEST & ASSOCIATES CONSULTING, LLC

ENGINEERING EVALUATION

DuPont Thermax Insulation Products in NFPA 285 Assemblies

Project No. 10955

Prepared for:

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Abstract

An existing DuPont Engineering Evaluation lists their NFPA 285 approval constructions which includes various wall components. The purpose of this report is to determine Engineering Extensions for alternate stud wall insulation products which can replace the listed insulations in the referenced evaluation. This evaluation (based on actual tests and Engineering Extensions) references NFPA 285 data, cone calorimeter (ASTM E1354) data, and ICC-ES ESR allowances to create a matrix of constructions using various combinations of wall component products that could meet 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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March 9, 2021

Reviewed and Approved,

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President

March 9, 2021

INTRODUCTION

An existing DuPont ESR Engineering Evaluation (Ref. 1) lists their NFPA 285 constructions, including various components. Typical wall designs include interior sheathing, steel studs, cavity insulation, exterior sheathing, water-resistive barrier (WRB), exterior insulation, exterior WRB, air gap, and exterior cladding.

The purpose of this evaluation is to determine if replacing the stud insulation listed in the evaluation report (Ref. 1) with Huntsman/Icynene SPF products can meet NFPA 285. *NFPA 285 data, cone calorimeter (ASTM E1354) data, and ICC-ES ESR allowances* were used to evaluate the tested insulation products' substitutions in Reference 1 with Huntsman/Icynene/Demilec SPF products.

Note: Jensen Hughes and ICC-ES reports are sound Engineering and Fire Science principles based on actual test data and standard practices in granting Engineering Extensions (product substitutions) for fire tests.

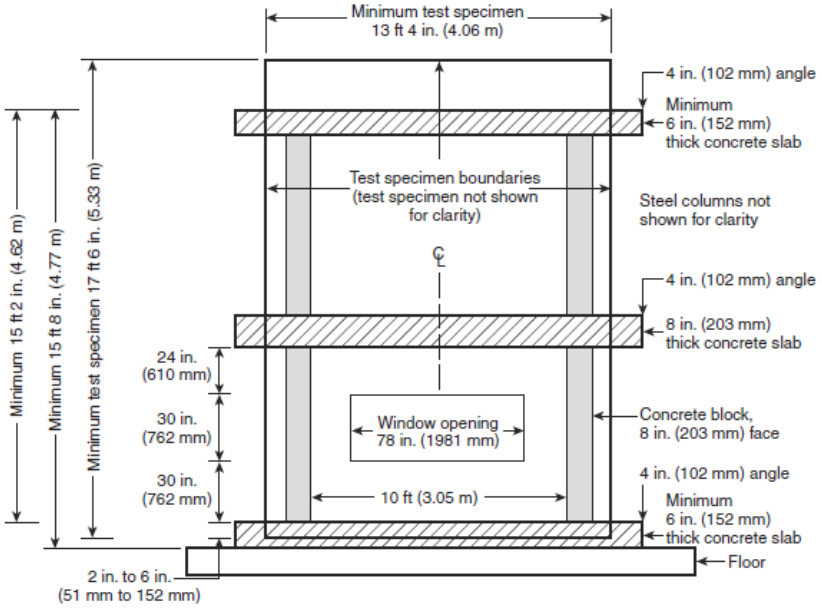
REFERENCED DOCUMENTS

1) *Jensen Hughes Evaluation 1JJB05306.011- DuPont Thermax Products NFPA 285 Evaluation Report*
2) *NFPA 285-12 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-loadbearing Wall Assemblies Containing Combustible Components*
3) *Huntsman/Icynene EEV 10236A & 10236B – NFPA 285 Evaluations for various Icynene SPF products.*
4) *Huntsman/Icynene EEV 10367Q - NFPA 285 Evaluations for various Icynene SPF products.*
5) *ICC-ES ESR 3500 - NFPA 285 approval for various Icynene SPF products.*
6) *Huntsman/Demilec 10378K - NFPA 285 Evaluations for various Icynene SPF products*

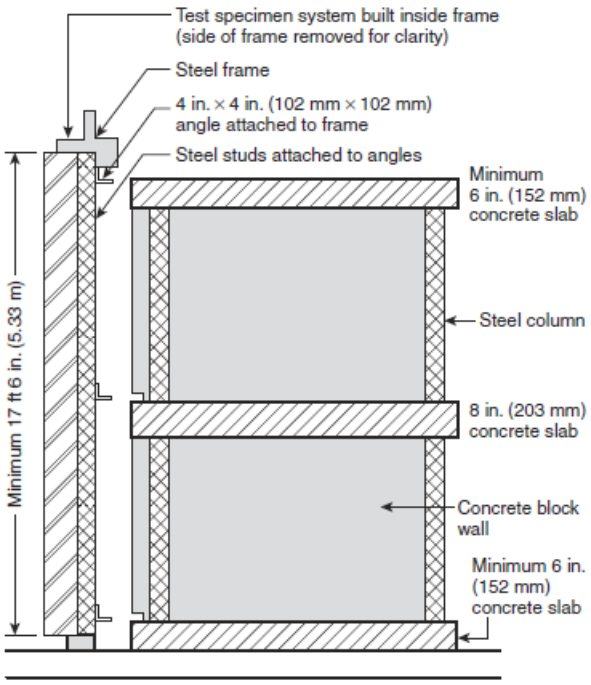
EVALUATION METHOD

NFPA 285 Criteria

The NFPA 285 fire test (see References section) 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 outer face of the rooms.

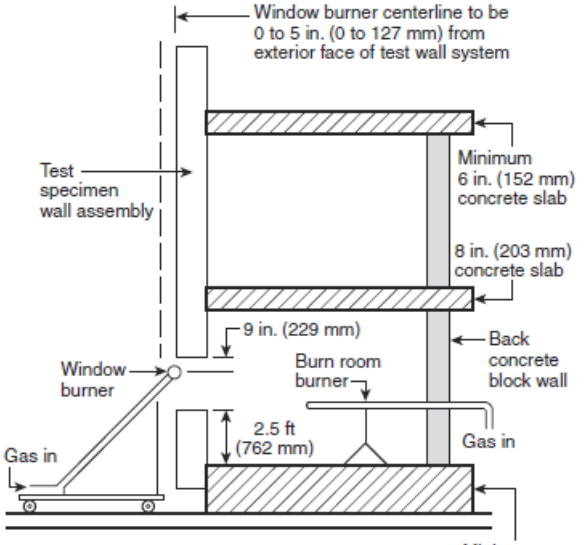


Front View of Test Specimen Superimposed over Test Apparatus (not to scale).



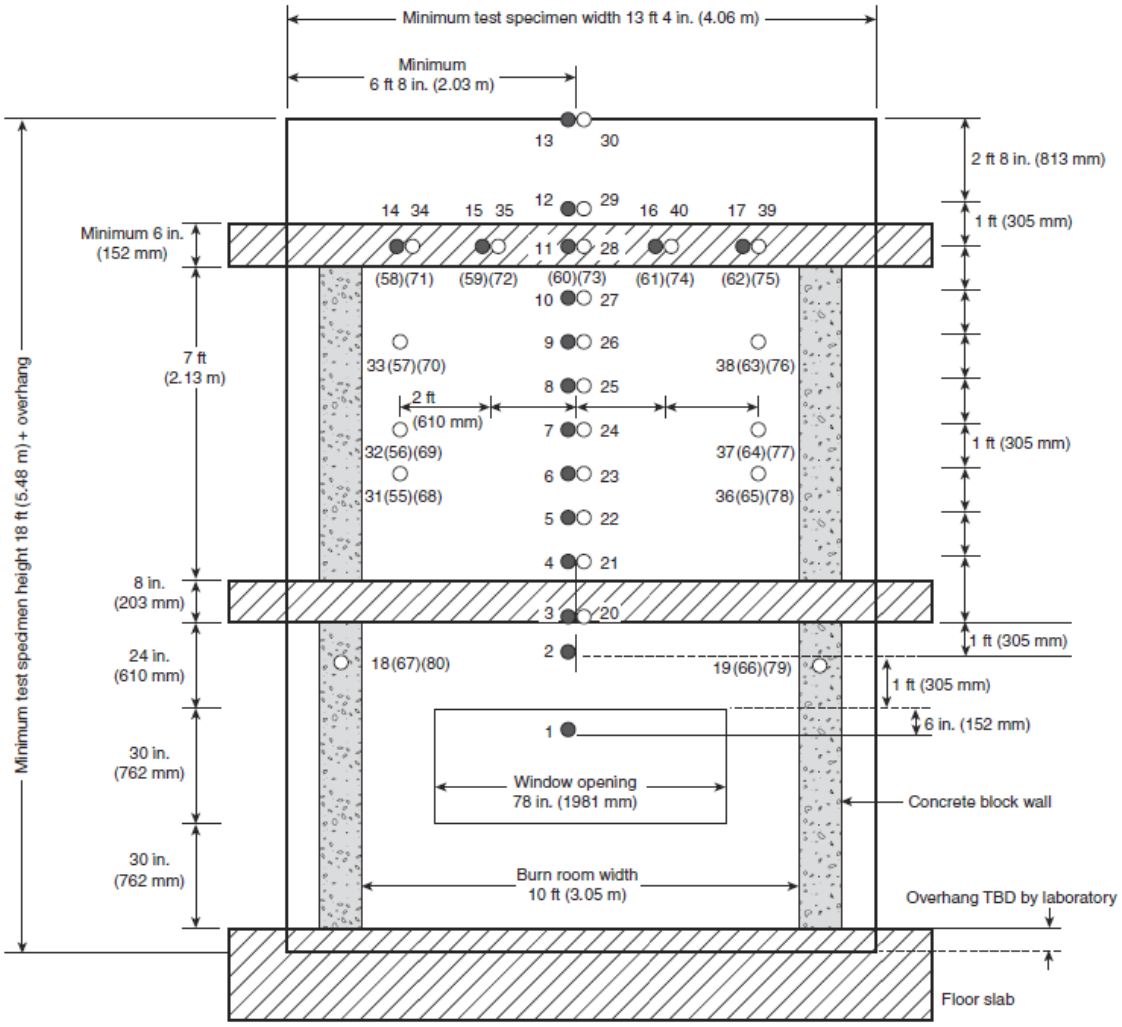
Side View of Test Apparatus with Test Specimen in Movable Test Frame (not to scale).

The two burners illustrated below are ignited to produce a specific time-temperature profile in the room and on the wall's exterior face.



Section View of Burner Placements for First-Story Test Room (not to scale).

A typical test wall measures 14 ft x 18 ft with a 30 in. tall x 78 in. wide window opening placed on the bottom floor. 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 the spread of flame.

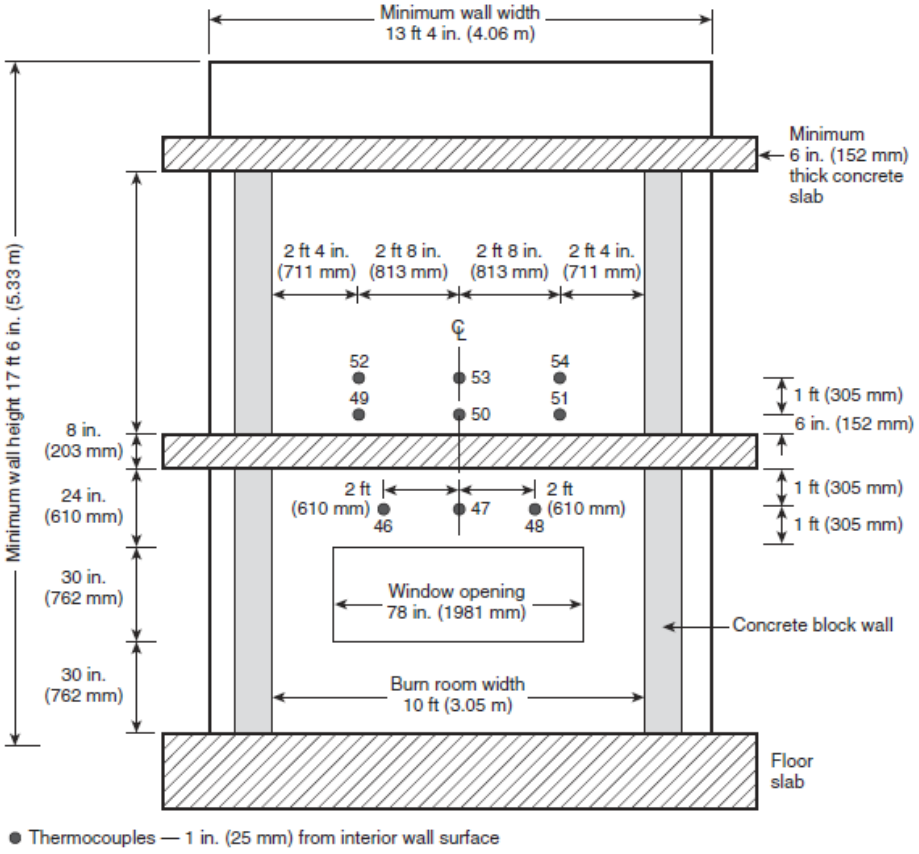


● Thermocouples — 1 in. (25 mm) from exterior wall surface

○ 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.

Figure not to scale



Interior View of the Test Specimen. Instrumentation arrangement.

During a test, a calibrated fire starts in the bottom room. After 5 minutes, the exterior (window) burner is ignited to produce a specific heat flux/temperature pattern on the exterior of the wall. Both burners remain ignited during the remainder of the 30-minute test, with the gas flow to each increasing every five minutes. During calibration, the temperatures at various locations throughout the 30 minutes must reach those indicated below.

Calibration Average Values for Time Periods Indicated

Thermocouple Location and Numbers	Temperature											
	0–5 min		5–10 min		10–15 min		15–20 min		20–25 min		25–30 min	
	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C	°F	°C
Test room ceiling: Nos. 18–22	1151	622	1346	730	1482	806	1600	871	1597	869	1648	898
Interior wall surface of test room: Nos. 15–17	1065	574	1298	703	1433	778	1578	859	1576	858	1655	902
1 ft (305 mm) above top of window opening: No. 2	602	317	870	466	952	511	992	533	1046	563	1078	581
2 ft (610 mm) above top of window opening: No. 3	679	359	1015	546	1121	605	1183	639	1245	674	1296	702
3 ft (914 mm) above top of window opening: No. 4	646	341	971	521	1096	591	1174	634	1245	674	1314	712
4 ft (1219 mm) above top of window opening: No. 5	577	302	858	459	982	528	1063	573	1135	613	1224	662
5 ft (1524 mm) above top of window opening: No. 6	521	272	765	407	875	469	949	509	1007	542	1106	597
6 ft (1829 mm) above top of window opening: No. 7	472	244	690	366	787	419	856	458	913	489	1010	543

Also, during the calibration procedure, the radiant flux at the identified locations and times must reach those indicated in the table below.

Calorimeter Locations and Numbers	Heat Flux (W/cm²)					
	0–5 min	5–10 min	10–15 min	15–20 min	20–25 min	25–30 min
2 ft (610 mm) above top of window opening: Letter C–2ft	0.9 ± 0.2	1.9 ± 0.4	2.5 ± 0.5	2.9 ± 0.6	3.4 ± 0.7	3.8 ± 0.8
3 ft (914 mm) above top of window opening: Letter C–3ft	1.0 ± 0.2	2.0 ± 0.4	2.6 ± 0.5	3.2 ± 0.6	3.7 ± 0.7	4.0 ± 0.8
4 ft (1219 mm) above top of window opening: Letter C–4ft	0.8 ± 0.2	1.5 ± 0.3	2.0 ± 0.4	2.5 ± 0.5	3.0 ± 0.6	3.4 ± 0.7

Both the room and window burners are under programmed PID control, so once they are calibrated to meet the above requirements, they repeat the same exposure for each test wall.

Personnel monitor flame spread visually during the test; a computer data acquisition system monitors and records the thermocouple temperatures. The criteria for passing are as follows (reworded in more straightforward terms for this analysis):

1) Flames shall not spread vertically 10 ft or more 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 or more on either side of the window opening centerline.
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, 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, 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 bottom story room wall/wall intersection.

Constructions Tested

This evaluation is based on the evaluation report submitted for analysis (Ref. 1). The approval report (portions of which are reproduced below) lists NFPA 285 tests as the basis for the approval. It is assumed that these tests utilized various wall designs incorporating DuPont Thermax insulation products and various other wall components (WRB, SPF insulation, sheathing, studs, etc.). A typical construction utilizes interior sheathing, steel studs, cavity insulation, exterior sheathing, water-resistive barrier (WRB), exterior insulation, exterior WRB, air gap, and exterior cladding.

Note – All test reports referenced are confidential and may not be shared.

The list of Thermax tests is presented below.

DuPont™ (previously Dow Chemical) has performed several NFPA 285 fire tests on various exterior wall systems that have incorporated one or more of the above mentioned foam plastic Insulations. These tests include:

1. Brick exterior wall construction – Reported in Southwest Research Institute Final Report No. 01.05805.01.001, dated November 2002.
2. Brick exterior wall construction – Reported in Southwest Research Institute Final Report No. 01.13104.01.001c, dated September 5, 2008.
3. Metal Composite Material Panel exterior wall construction – Reported in Southwest Research Institute Final Report No. 01.13104.01.001d, dated September 5, 2008.
4. Brick exterior wall construction – Reported in Southwest Research Institute Final Report No. 01.15210.01.607a, dated May 24, 2010.

DuPont™ (previously Dow Chemical) has performed several NFPA 285 fire tests on various exterior wall systems that have incorporated one or more of the above mentioned foam plastic Insulations. These tests include:

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3. Metal Composite Material Panel exterior wall construction – Reported in Southwest Research Institute Final Report No. 01.13104.01.001d, dated September 5, 2008.
4. Brick exterior wall construction – Reported in Southwest Research Institute Final Report No. 01.15210.01.607a, dated May 24, 2010.
5. Brick exterior wall construction - Reported in Southwest Research Institute Final Report No. 01.15822.01.001, dated September 9, 2010.
6. Aluminum Composite Material (ACM) Panel exterior wall construction – Reported in Intertek Testing Final Report No. J0651.01-121-24-R0, dated April 24, 2019.

Tested Assemblies Excerpted from Ref. 1

Additionally, Huntsman/Icynene evaluations (Ref. 3, 4 & 5) were based on various Huntsman/Icynene NFPA 285 tests and comparative analysis via ASTM E1354 (Cone Calorimeter).

1) *Intertek Test Reports*
   a. *Intertek Test Report 100820570SAT-006 Rev 1. NFPA 285 Icynene ProSeal ECO*
   b. *Intertek Test Report G100215432-SAT009 NFPA 285 Fire Test on MD-C-200 foam.*
   c. *Intertek Test Report G10009333-SAT004Rev2 NFPA 285 Fire Test on Classic foam.*
   d. *Intertek Test Report 102590730SAT-001 NFPA 285 Test ProSeal, Classic Plus w/ Brick*
2) *Priest & Associates Consulting EEV 10125 NFPA 285 Engineering Extensions for ProSeal ECO Insulated Wall Assembly.*
3) *Priest & Associates Consulting EEV 10107 Icynene ProSeal Equivalency in NFPA 285 and ASTM E119 Reports for ESR 3199, Cone Calorimeter Evaluation.*
4) *Priest & Associates Consulting EEV 10139 Icynene MD-C-200 and ProSeal ECO Equivalency in NFPA 286, Cone Calorimeter Evaluation.*
5) *Priest & Associates Consulting EEV 10152 Addition of StoTherm Classic EIFS (1 inch) to Icynene MD-C-200 and Classic.*
6) *Priest & Associates Consulting Engineering Letter 10166A Thermal Analysis of Claddings for NFPA 285 Engineering Extensions.*
7) *Priest & Associates Consulting Engineering Letter 10168 Allowable Air Cavity in NFPA 285 Walls.*
8) *Cone Calorimeter Data for Icynene, Henry, BASF, Carlisle, W.R. Grace, Prosoco and VaproShield – Data Confidential between manufacturers and Priest & Associates.*
9) *White, R.H., and Dietenberger, M.A., Wood Handbook Chapter 18 "Fire Safety of Wood Construction".*
10) *Benichou, N., Sultan, M.A., Kodur, V.R., Fire resistance performance of light weight framed wall assemblies: effects of various parameters, key design considerations and numerical modelling. NRCC-45688, Institute of Research in Construction, National Research Council, Ottawa, Canada.*
11) *Lindholm, et.al., Cone Calorimeter – a Tool for Measuring Heat Release http://www.ffrc.fi/FlameDays_2009/4B/LindholmPaper.pdf*
12) *Babrauskas, et.al., 10 Years of Heat Release Research NIST Publication http://fire.nist.gov/bfrlpubs/fire93/PDF/f93048.pdf*
13) *ICC-ES ESR 1826*
14) *ICC-ES ESR 3500*

List Excerpted from Ref. 3

Also, NFPA 285 tests from Ref. 6 are used in this evaluation:

1) *NFPA 285-19 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-loadbearing Wall Assemblies Containing Combustible Components*
2) *Jensen Hughes Report 1AJP00158.000 on HeatLok HFO in NFPA 285 Assemblies*
3) *Intertek Report 102680245SAT-009 – NFPA 285 test on HeatLok HFO with Brick*
4) *Intertek Report 102680245SAT-30 – NFPA 285 test on HeatLok HFO Base Wall*
5) *NTA Report DIO62620-14 – NFPA 285 Test on HeatLok HFO Pro (with coating) with Aluminum Panels*
6) *Intertek Report K7379.01-121-24-R0 – NFPA 285 test on HeatLok HFO Pro with Steel Cladding*
7) *3rd Party NFPA 285 Approvals*
   a. *DrJ Engineering TER 1306-03 and 1402-01 and 1309-03 and 1601-06 NFPA 285 Assemblies*
   b. *ICC-ES ESR 1659 NFPA 285 Assemblies*
8) Babrauskas et al., *10 Years of Heat Release Research,* NIST Publication http://fire.nist.gov/bfrlpubs/fire93/PDF/f93048.pdf
9) Lindholm, et al., Cone Calorimeter – a Tool for Measuring Heat Release http://www.ffrc.fi/FlameDays_2009/4B/LindholmPaper.pdf

List Taken from Ref. 6

Engineering Extensions

When making flammability comparisons of NFPA 285 wall systems, the elements which could potentially cause increased flame spread should be considered. The wall systems referenced (Ref. 1) have similar design elements – differing only in brand/type/model of components for each element. Typical wall specimens contain a base wall consisting of steel studs, stud sheathings (interior and/or exterior), WRB over exterior sheathing, exterior insulation, exterior WRB, air gap, and exterior cladding.

In this case, we are substituting an allowed SPF product with another SPF product to be used only in the stud cavity, based solely on the alternate SPF product testing – not a comparative analysis. Per Reference 3, 4, 5 & 6, the following is allowed:

Cavity Insulation – Use either 1, 2, 3, 4, 5 or 6	1) None 2) ProSeal HFO (8 in. max. thickness with no air gap, 6 inch max thickness with air gap) 3) Any noncombustible insulation per ASTM E136. 4) Any Mineral Fiber (Board type Class A, ASTM E84 faced or unfaced). 5) Any Fiberglass (Batt Type Class A, ASTM E84 faced or unfaced). 6) Any cavity insulation which has been tested per ASTM E1354 (at a min. of 20 kW/m^2 heat flux) and shown by analysis to be less flammable (improved T_{ign}, Pk. HRR) than ProSeal ECO. Additionally, the cavity insulation shall represent a thickness such that the total heat release (THR) is less than or equal to the THR of the exterior insulations listed above.
Exterior Sheathing – Use either 1 or 2	1) None (for base wall systems 1 or 2 above). 2) Min. ½ in. exterior gypsum sheathing.

Ref. 4 Allowed Stud Cavity SPFs

Cavity Insulation Use either 1, 2, 3 or 4; or combinations of 2 with 3 or 4	1) None 2) Full wall stud cavity depth or less of HeatLok® HFO Pro SPF (max. 3⅝ inch foam – min. 3⅝ inch stud depth) applied using exterior gypsum sheathing of Base Wall System 3 as the substrate and covering the width of the cavity and the inside of the steel wall stud framing flange. 3) Fiberglass batt insulation (faced or unfaced) 4) Mineral wool insulation (faced or unfaced)
Exterior Sheathing	⅝ inch thick Type X exterior type gypsum sheathing (for Base Wall System 3 above)

Ref. 6 Allowed Stud Cavity SPFs
Per confidential data, HFO Pro allows HFO as an option.

The exterior sheathing of the base wall acts as a thermal break between the exterior insulation/cladding (Wall Region 1) and the cavity insulation/interior sheathing (Wall Region 2). The fire response of Region 1 has very little to do with the fire behavior of Region 2 when separated by gypsum sheathing. The two wall regions behave independently of each other when separated by gypsum sheathing. This allows tested or approved SPF products in stud cavities as long as the two regions are separated by ⅝" gypsum sheathing.

CONCLUSIONS

An existing DuPont NFPA 285 evaluation report (Ref. 1) lists their approved NFPA 285 constructions, including various wall components. The purpose of this evaluation was to determine if replacing the stud cavity insulation listed in the evaluation report (Ref. 1) with Huntsman/Icynene SPF products can meet NFPA 285. NFPA 285 data, cone calorimeter (ASTM E1354) data, and ICC-ES ESR allowances were used to evaluate the tested insulation products' substitutions in Reference 1 with Huntsman/Icynene/Demilec SPF products.

The table of substitutions below outlines the allowed constructions based on the analysis of the referenced report (Ref. 1) and alternate components described in this report.

The layers referred to in Column 1 in the tables below are depicted as follows:

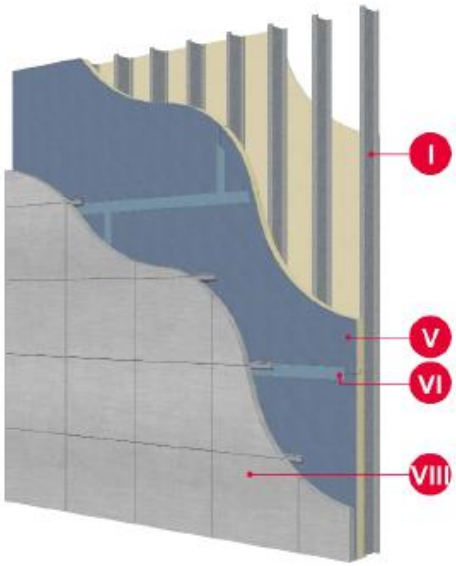

Figure 1 – Typical Layer Assembly

Figure 1 (Left): Typical Layer Assembly
Image shows a typical Thermax™ Wall System assembly with numerals that correspond to Tables 1-5.
Note that not all layers shown here are required in assembly, not all possible layers are shown, and layers have several different material selection options.
See Tables 1-5 for all layer and material selection options, and Figure 2 for examples of other common layer assemblies.

Figure 2 (Below): Example Layer Assemblies
Images in Figures 2-1 through 2-4 show four common layer assemblies. Note that not all assembly options are shown. See Tables 1-5 for layer and assembly options.

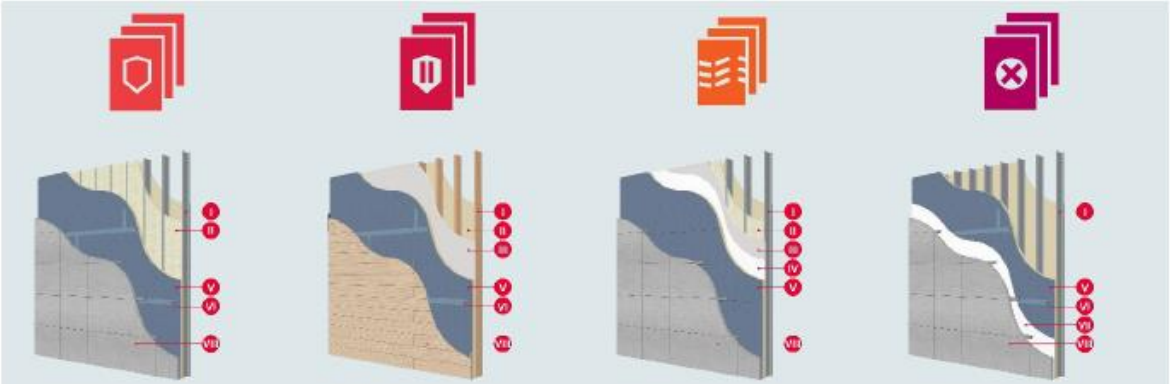

Figure 2-1 Max Armor	*Figure 2-2 Dual Armor*	*Figure 2-3 Classic*	*Figure 2-4 Other*
Insulation with seam treatment as WRB, insulation within stud cavity	Insulation with seam treatment as WRB, exterior gypsum	Insulation with separate WRB over exterior gypsum, insulation within structure	Insulation with seam treatment, separate WRB over insulation

Figure 2 – Example Layer Assemblies

TABLES OF SUBSTITUTIONS

Table 1 – Base Wall Assemblies
(See Tables 2 and 3 for additional wall components)

Layer	*Wall Component*	*Materials*
I	Base wall system – Use either 1, 2, 3, 4, 5 or 6	1. Concrete wall 2. Concrete Masonry Unit (CMU) wall 3. Standard clay brick wall 4. Adobe block wall 5. Wood studs: nominal 2-inch × 4-inch or greater at a maximum of 24-inch OC. Cavity without insulation or with fiberglass batt insulation (faced or unfaced) or mineral wool insulation (faced or unfaced), ⅝-inch thick, Type X gypsum wallboard on interior face. As an option, any thickness of plywood or OSB on exterior face of studs. ⅝-inch thick, Type X gypsum sheathing on exterior face covering studs, or if used, plywood or OSB. Minimum 2 top plates at floorlines 6. Steel studs: minimum 3⅝-inch depth, minimum 20-gauge at a maximum of 24-inch OC with lateral bracing every 4 ft. vertically with: a) One layer of ⅝-inch thick Type X or ½-inch thick Type X gypsum wallboard on interior face of studs. Gypsum wallboard joints shall receive at a minimum a Level 2 finish with all fasteners covered with joint compound Note: Items in #6 must be installed with full coverage over the wall, i.e., from floor line to underside of floor deck above.
REQUIRED	Floor line firestopping - required in curtain-wall construction	4 lb./cu ft. mineral wool (e.g., Thermafiber) in each stud cavity and at each floor line – friction fit in cavity, attached with Z-clips, or equivalent
NOT SHOWN	Interior Vapor / Moisture barrier for use with Base Wall #5 or #6	1. None 2. Any 6-mil thick polyethylene film
II	Cavity Insulation – Use either 1, 2, 3, 4, 5 or 6 or a combination of 2 & 4 or a combination of 3 and 4 or a combination of 5 & 4 or a combination of 6 and 4. Note – Item 5 to be used with ½" or thicker exterior gypsum sheathing. Item 6 to be	1. None – Screw end of fasteners that protrude into the stud cavity can be covered with a maximum of 1½-inch diameter plug of DuPont™ Froth-Pak Class A rated per ASTM E 84 2. Full stud depth or less thickness of DuPont™ Styrofoam™ Brand Spray Polyurethane CM 2060 or CM 2045 or CM 2030 applied using sheathing or insulation as substrate and covering the width of the cavity and inside the stud flange 3. 2-inch max thickness of BASF SPRAYTITE® 81206 SPF applied using sheathing or insulation as substrate and covering the width of the cavity and inside the stud flange. Must cover the SPRAYTITE® 81206 above any window, louver or door opening with minimum 2-inch thickness of mineral wool insulation (1½-inch mineral

Layer	*Wall Component*	*Materials*
	used with 5/8" thick gypsum sheathing.	wool cover in 3½-inch deep studs). The mineral wool insulation must be installed from top of opening to bottom of floor deck above. Additionally, a special construction of the header must be used. Options for this construction are as shown in Figures 3, 4, 5, and 6. 4. Fiberglass blown-in or batt insulation (faced or unfaced) or mineral wool blown-in or batt insulation (faced or unfaced) 5. Huntsman ProSeal HFO (8 in. max. thickness with no air gap, 6 inch max thickness with air gap) for use with ½" or thicker exterior gypsum sheathing. 6. Full wall stud cavity depth or less of Huntsman HeatLok® HFO or HFO Pro SPF (max. 3⅝ inch foam – min. 3⅝ inch stud depth) for use with 5/8" exterior gypsum sheathing.
III	Exterior sheathing – Use either 1, 2 or 3	1. None (only with cavity insulation 1, 2, 3 & 4) 2. ½-inch thick, exterior gypsum sheathing (not for cavity insulation 6) 3. ⅝-inch thick, Type X exterior gypsum sheathing
IV	Weather-resistive barrier applied to exterior sheathing #2 or #3 – Use either 1 or 2	1. None 2. Any shown in Table 4
NOT SHOWN	Drainage Mat – Use either 1 or 2	1. None 2. DuPont™ Tyvek® DrainVent™ Rainscreen – Limited to use as: Must be used in conjunction with any WRB shown in Table 5. Exterior veneers #1 thru #6 in Layer VIII of Table 2 when no air gap is present between the veneer and the DrainVent™ Exterior veneers #2 thru #15, #16b thru 16m, #17 and #19 in Layer VIII of Table 3 when no air gap is present between the veneer and the DrainVent™
	Remainder of wall assembly	See Table 2 or Table 3

Table 2 – Walls with a Maximum of 4.25-inch Thick Thermax™

Layer	*Wall Component*	*Materials*
V	Exterior insulation – Use either 1, 2, 3, or 4	1. None (Exterior sheathing must be Item 2 or 3 listed in Table 1. 2. DuPont™ Thermax™ Brand Rigid Insulation – Total thickness to be a minimum of ⅝-inch to maximum of 4¼-inches. 3. DuPont™ Styrofoam™ Brand Spray Polyurethane CM 2060 or CM 2045 or CM 2030 – to a maximum of 3½-inches thick. 4. Combination of Item 2 and Item 3 – Total thickness of combination not to exceed 4¼-inches and thickness of Item 3 not to exceed 3½-inches.

Layer	*Wall Component*	*Materials*
VI	Exterior insulation joint flashing – Use either 1 or 2	1. None – Only when a water-resistive barrier is applied to the exterior sheathing per Layer IV in Table 1 or when a water-resistive barrier is applied to the exterior insulation 2. Flash all exterior insulation joints and veneer tie penetrations with one of the following: a) DuPont™ LiquidArmor™ - CM Flashing and Sealant – max. 60-mil wet thickness, max. 5-inch width b) DuPont™ LiquidArmor™ - LT Flashing and Sealant – max. 35-mil wet thickness, max. 5-inch width. c) DuPont™ LiquidArmor™ - QS Flashing and Sealant – max. 60-mil wet thickness, max. 5-inch width d) DuPont™ WeatherMate™ Flashing – max. 4-inch width e) Asphalt, acrylic, or butyl-based flashing tape – max. 4-inch width f) DuPont™ Great Stuff Pro™ - Use on joints that are ≤ ¼-inch, vertical joints must be staggered & remove significant excess from the face of the Thermax™ g) DOWSIL™ DEFENDAIR 200 or DOWSIL™ DEFENDAIR 200C Note: With either d) or e), a small amount of spray primer may be used to aid in adhesion; maximum 5-inch width.
VII	Weather-resistive barrier applied to exterior insulation #2 – Use either 1 or 2	1. None 2. Any shown in Table 5
NOT SHOWN	Drainage Mat	1. None 2. DuPont™ Tyvek® DrainVent™ Rainscreen – Limited to use as: Must be used in conjunction with any WRB shown in Table 5 Exterior veneers #1 thru #6 in Layer VIII when no air gap is present between the veneer and the DrainVent™
VIII	Exterior Veneer – Use either 1, 2, 3, 4, 5 or 6	1. Brick – Standard type brick veneer anchors, installed a maximum of 24-inches OC vertically on each stud. A maximum 2-inch air gap between the exterior insulation and the brick. Use standard nominal 4-inch thick clay bricks 2. Stucco – Minimum ¾-inch thick exterior cement plaster and lath. A secondary water-resistive barrier can be installed between the exterior insulation and the lath. The secondary water-resistive barrier can be 1 or 2 layers of asphalt building paper but shall not be full-coverage asphalt or butyl-based self-adhered membranes. 3. Minimum 2-inch thick limestone or natural stone veneer or minimum 1½-inch thick cast artificial stone veneer. Any standard non-open-joint installation technique such as ship-lap, etc., can be used. 4. Terracotta cladding – Minimum 1¼-inch thick terracotta cladding system. Any non-open-joint installation technique such as ship-lap, etc. can be used. 5. Concrete or precast concrete panels – Minimum 1½-inch thick

Layer	*Wall Component*	*Materials*
		panel, with a 2-inch maximum air gap between exterior insulation and concrete panel. Any standard non-open-joint installation technique such as ship-lap, etc. can be used 6. Concrete Masonry Units - Minimum 2-inch thick panel with a 2-inch maximum air gap between exterior insulation and the interior face of the exterior CMU. Any standard non-open-joint installation technique can be used.
NOT SHOWN	Flashing of window, door, and other exterior wall penetrations.	As an option, flash window, door and other exterior penetrations with either: a) DuPont™ LiquidArmor™ – CM Flashing and Sealant – max. 60-mil wet thickness, max. 12-inch width. b) DuPont™ LiquidArmor™ – LT Flashing and Sealant – max. 35-mil wet thickness, max. 12-inch width. c) DuPont™ LiquidArmor™ – QS Flashing and Sealant – max. 60-mil wet thickness, max. 12-inch width. d) Limited amounts of acrylic, asphalt or butyl-based flashing tape – max. 12-inch width. e) Hohmann & Barnard Textroflash™ Flashing f) DOWSIL™ DEFENDAIR 200 or DOWSIL™ DEFENDAIR 200C Note: Flashing tape used in wall openings may extend the wall width plus extend up to a maximum of 4 inches onto the exterior face of the sheathing. Flashing tape may be used on sheathing exterior corners where the flashing tape may extend a maximum of 4 inches onto the sheathing face on either side of the corner.
Not Shown	Mortar Net	As an option, non-full wall coverage mortar drop and drainage nets and meshes can be installed at base of wall and at shelf angles to permit water drainage.

Table 3 – Walls with a Maximum of 3-inch Thick Thermax™

Layer	*Wall Component*	*Materials*
V	Exterior insulation – Use either 1 or 2	1. None (Exterior sheathing must be either 2 or 3 listed in Table 1) 2. DuPont™ Thermax™ Brand Rigid Insulation – Total thickness to be a minimum of ⅝-inch to maximum of 3-inches
VI	Exterior insulation joint flashing – Use either 1 or 2	1. None – Only when a water-resistive barrier is applied to the exterior sheathing per Layer IV in Table 1 or when a water-resistive barrier is applied to the exterior insulation 2. Flash all exterior insulation joints and veneer tie penetrations with one of the following: a) DuPont™ LiquidArmor™ - CM Flashing and Sealant – max. 60-mil wet thickness, max. 5-inch width b) DuPont™ LiquidArmor™ - LT Flashing and Sealant – max. 35-mil wet thickness, max. 5-inch width c) DuPont™ LiquidArmor™ - QS Flashing and Sealant – max. 60-mil wet thickness, max. 5-inch width d) DuPont™ WeatherMate™ Flashing – max. 4-inch width

Layer	*Wall Component*	*Materials*
		e) Asphalt, acrylic, or butyl-based flashing tape – max. 4-inch width f) DuPont™ Great Stuff Pro™ - Use on joints that are ≤ ¼-inch, vertical joints must be staggered & remove significant excess from the face of the Thermax™ g) DOWSIL™ DEFENDAIR 200 or DOWSIL™ DEFENDAIR 200C Note: With either d) or e), a small amount of spray primer may be used to aid in adhesion; maximum 5-inch width.
VII	Weather-resistive barrier applied to exterior insulation #2 – Use either 1 or 2	1. None 2. Any shown in Table 5
NOT SHOWN	Drainage Mat	1. None 2. DuPont™ Tyvek® DrainVent™ Rainscreen – Limited to use as: Must be used in conjunction with any WRB shown in Table 5. Exterior veneers #2 thru #15, #16b thru #16m, #17 and #19 in Layer VIII when no air gap is present between the veneer and the DrainVent™.
VIII	Exterior Veneer – Use either 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18 or 19	1. ACM System - Use any Aluminum Composite Material (ACM) system that has been successfully tested by the panel manufacturer via the NFPA 285 test method. Acceptable NFPA 285 testing shall consist of successful NFPA 285 test results on a wall assembly incorporating a comparable thickness of combustible foam insulation (e.g., polyiso) behind the ACM. These ACM panel systems include: ○ Reynobond® FR ACM ○ Alpolic®fr ACM ○ Alucobond® PLUS ACM 2. Terracotta cladding – Use any terracotta cladding system in which terracotta is minimum 1¼-inch thick. Any standard installation technique can be used.
		3. Metal exterior wall coverings such as steel, aluminum, copper, zinc, etc. Any standard installation technique can be used. 4. Fiber-cement siding (noncombustible) – minimum ¼-inch thick. Any standard installation technique with noncombustible furring can be used. A maximum 1½-inch air gap allowed behind the fiber-cement siding. 5. Brick - Standard nominal 4-inch thick, clay brick with standard type brick veneer anchors, installed maximum 24-inches OC vertically on each stud. Air gap between exterior insulation and brick to be a maximum of 2-inches. WRB from Table 5 can be used over the exterior insulation. 6. Stucco – Minimum ¾-inch thick, exterior cement plaster and lath. A secondary water-resistive barrier can be installed between the exterior insulation and the lath. The secondary water-resistive barrier can be 1 or 2 layers of asphalt building paper but shall not be full-coverage asphalt or butyl-based self-adhered membranes. WRB from Table 5 can be used as the secondary water-resistive barrier. 7. Corium™ Thin brick system.

Layer	*Wall Component*	*Materials*
		8. Minimum 1¼-inch thick limestone or natural stone veneer or minimum 1¼-inch thick cast artificial stone veneer. Any standard installation technique such as ship-lap, etc. can be used. 9. StoneLite natural stone wall panels by Stone Panels, Inc. 10.Glen-Gery Thin Tech Elite Series – Masonry veneer 10. Concrete or precast concrete panels – Minimum 1½-inch thick panel. Air gap between exterior insulation and concrete panel shall be as per wall design. Any standard installation technique can be used. 11. Ceramic tile (min. ⅜-inch thick) bonded using noncombustible mortar adhesive to minimum ½-inch thick cement board or gypsum sheathing. 12. Thin brick (min. ¾-inch thick clay brick) fully adhered with cementitious mortar (standard or polymer modified) to min. ½-inch thick cement backer board or gypsum sheathing. A secondary water-resistive barrier can be installed between the board/sheathing and the brick. The secondary water-resistive barrier shall not be full-coverage asphalt or butyl-based self-adhered membranes. 13. Natural stone or artificial stone (min. ¾-inch thick clay brick) fully adhered with cementitious mortar (standard or polymer modified) to min. ½-inch thick cement backer board or gypsum sheathing. A secondary water-resistive barrier can be installed between the board/sheathing and the stone. The secondary water-resistive barrier shall not be full-coverage asphalt or butyl-based self-adhered membranes 14. Concrete Masonry Units -successfully tested by the panel manufacturer via the NFPA 285 test method. Any standard installation technique can be used. These ACM panel systems include: Reynobond® FR ACM Alpolic®fr ACM Alucobond® PLUS ACM b) Terracotta cladding – Use any terracotta cladding system in which terracotta is minimum 1¼-inch thick. Any standard installation technique can be used. c) Metal exterior wall panels or coverings such as steel, aluminum, copper, zinc etc. Any standard installation technique can be used. d) Brick - Standard nominal 4-inch thick, clay brick with standard brick veneer anchors, installed maximum 2-inches OC vertically on each stud. Air gap between exterior insulation and brick to be as per wall design. WRB from Table 5 can be used over the exterior insulation. e) Stucco – Minimum ¾-inch thick, exterior cement plaster and lath attached to minimum ½-inch thick backer board. A secondary water- resistive barrier can be installed between the exterior sheathing and the lath. The secondary water-resistive barrier can be 1 or 2 layers of asphalt building

Layer	*Wall Component*	*Materials*
		paper but shall not be full coverage asphalt or butyl- based self-adhered membranes. WRB from Table 5 can be used as the secondary water-resistive barrier. f) Corium™ Thin brick system g) Minimum 1¼-inch thick Limestone or natural stone veneer or minimum 1¼-inch thick cast artificial stone veneer. Any standard installation technique such as ship-lap, etc. can be used. h) StoneLite natural stone wall panels by Stone Panels, Inc. i) Glen-Gery Thin Tech Elite Series – Masonry veneer j) Concrete or precast concrete panels. Minimum 1½-inch thick panel. Air gap between exterior insulation and concrete panel to be as per wall design. Any standard installation technique can be used. k) Ceramic tile (min ⅜-inch thick) bonded using noncombustible mortar adhesive to minimum ½-inch thick cement board or gypsum sheathing. l) Thin brick (minimum ¾-inch thick clay brick) fully adhered with cementitious mortar (standard or polymer modified) to min. ½-inch thick cement backer board or gypsum sheathing. A secondary water-resistive barrier can be installed between the exterior/sheathing and the stone. The secondary water-resistive barrier shall not be full-coverage asphalt or butyl-based self-adhered membranes. m) Natural stone or artificial stone (minimum ¾-inch thick clay brick) fully adhered with cementitious mortar (standard or polymer modified) to min. ½-inch thick cement backer board or gypsum sheathing. A secondary water-resistive barrier can be installed between the exterior/sheathing and the stone. The secondary water-resistive barrier shall not be full-coverage asphalt or butyl-based self-adhered membranes. 15. Cornerstone Building Products to include: • PBR Panel (Exposed fasteners) • PBU Panel (Exposed fasteners) • AVP Panel (Exposed fasteners) • Designer™ Series Panels (Exposed fasteners) • Shadow Rib™ Panels (Exposed fasteners) • NuWall® Panels (Exposed fasteners) • MasterLine 16 (Concealed fasteners) 16. FUNDERMAX Gmbh "M Look" panels – 7-mm thick, installed with 1 to 1½-inch air gap behind the panels and using exposed fasteners. 17. Tabs II Plus Wall System w/o Tabs II Plus "RainScreen" with Pre-attached wrap. Must use a WRB from Table 5
	Flashing of window, door and other exterior wall penetrations.	As an option, flash window, door and other exterior penetrations with either: a) DuPont™ LiquidArmor™ – CM Flashing and Sealant – max. 60-mil wet thickness, max. 12-inch width. b) DuPont™ LiquidArmor™ – LT Flashing and Sealant – max. 35-mil wet thickness, max. 12-inch width. c) DuPont™ LiquidArmor™ – QS Flashing and Sealant – max. 60-mil wet thickness, max. 12-inch width.

Layer	*Wall Component*	*Materials*
NOT SHOWN		d) Limited amounts of acrylic, asphalt or butyl-based flashing tape – max. 12-inch width. e) Hohmann & Barnard Textroflash™ Flashing f) DOWSIL™ DEFENDAIR 200 or DOWSIL™ DEFENDAIR 200C Note: Flashing tape used in wall openings may extend the wall width plus extend up to a maximum of 4-inches onto the exterior face of the sheathing. Flashing tape may be used on sheathing exterior corners where the flashing tape may extend a maximum of 4-inches onto the sheathing face on either side of the corner.
Not Shown	Mortar Net	As an option, non-full wall coverage mortar drop and drainage nets and meshes can be installed at base of wall and at shelf angles to permit water drainage. Maximum 12-inch high.

Table 4. Allowed Water-resistive Barriers Applied over Sheathing and Under Foam Insulation – Layer IV

3M™ – 3M™ Self-Adhered Air and Vapor Barrier 3015
BASF • MasterSeal AWB 660 • MasterSeal AWB 660l
Carlisle • CCW-705FR w/ Primers • Barritech™ VP • Barritech™ NP
Dörken Systems • Delta®-Foxx • Delta®-Foxx Plus • Delta®-Fassade S • Delta®-Vent S/Plus
Grace Construction Products • Perm-A-Barrier® Aluminum Wall Membrane • Perm-A-Barrier® VPL • Perm-A-Barrier® VPL LT • Perm-A-Barrier® VPS
DOWSIL™ • DEFENDAIR 200 • DEFENDAIR 200C
Dryvit - Backstop® NT
DuPont™ • WeatherMate™ • WeatherMate™ Plus
DuPont™ (see Figures 7, 8, and 9)

- DuPont™ Tyvek® CommercialWrap®
- DuPont™ Tyvek® CommercialWrap® D
- DuPont™ Tyvek® ThermaWrap™
- DuPont™ Tyvek® Fluid Applied WB+ – nominal 25 wet mil thickness

Henry Company

- Air-Bloc® 32MR
- Air-Bloc® 31MR
- Air-Bloc® 33MR
- BlueskinVP™ 160
- Air-Bloc® 21 FR
- Metal Clad™
- Foilskin®
- Air-Bloc® 17MR
- Air-Bloc® All WeatheSTPE

Hohmann & Barnard

- Enviro-Barrier™
- Enviro-Barrier™ VP

JX Nippon ANCI, Inc.

- JX ALTA Commercial Wrap
- JX Alta HP Wrap
- X ALTA LP Wrap

Kingspan

- Kingspan® GreenGuard® Max™ Building Wrap
- Kingspan® GreenGuard® Classic Building Wrap
- Kingspan® GreenGuard® C2000 Building Wrap
- Kingspan® GreenGuard® Raindrop® 3D Building Wrap
- Kingspan® GreenGuard® HPW™ Building Wrap

Momentive Performance Materials

- GE SEC2500 SilShield* AWB
- GE SEC2600 SilShield* AWB
- GE SEC2600-R SilShield* AWB

Sto Corp

- Sto Gold Coat® with StoGuard Fabric
- Sto Emerald Coat® with StoGuard Fabric
- Sto ExtraSeal™ w StoGuard Mesh

STS, Inc. - Wall Guardian™ FW-100A

VaproShield

- WallShield®
- WrapShield®
- RevealShield™
- RevealShield SA™

W.R. Meadows

- Air-Shield™ LMP (Gray)
- Air-Shield™ LMP (Black)
- Air-Shield™ TMP
- Air-Shield™ LSR

Note: all barriers to be installed at indicated or recommended application rates and per manufacturer's installation instructions. Table as of 07-09-2020

Table 5. Allowed Water-Resistive Barriers Installed over the Foam Insulation – Layer VII

DuPont™ • WeatherMate™ • WeatherMate™ Plus
DuPont™ (see Figures 7, 8, and 9) • DuPont™ Tyvek® CommercialWrap® • DuPont™ Tyvek® CommercialWrap® D • DuPont™ Tyvek® ThermaWrap™
Kingspan • Kingspan® GreenGuard® Max™ Building Wrap • Kingspan® GreenGuard® C500 Building Wrap • Kingspan® GreenGuard® Raindrop® 3D Building Wrap
VaproShield • RevealShield™ • RevealShield SA™

Note: all barriers to be installed at indicated or recommended application rates and per manufacturer's installation instructions.

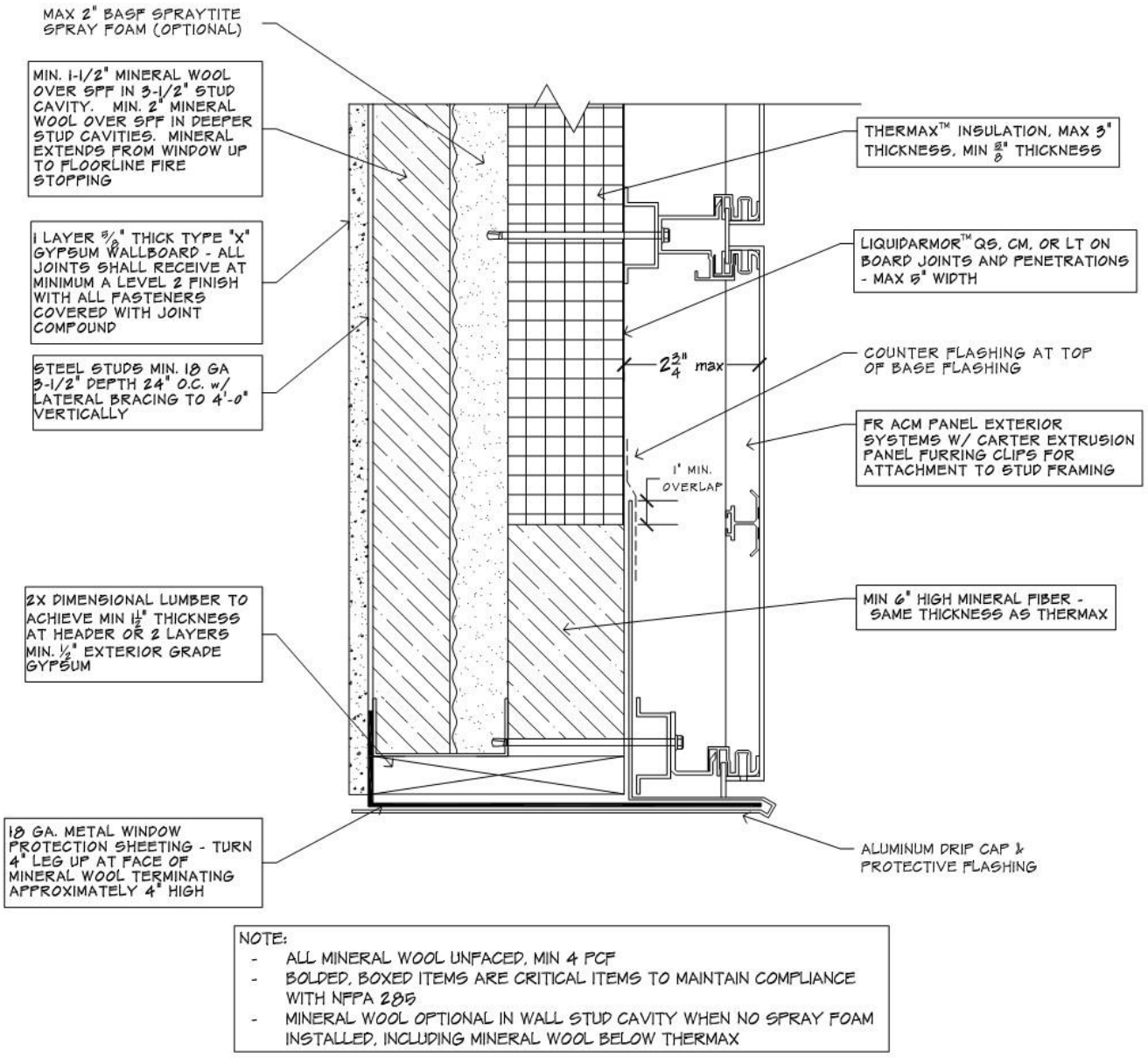

Figure 3 – Required Opening Head Protection When BASF SPRAYTITE® 81206 Spray Foam Is Used in the Cavity – OPTION 1

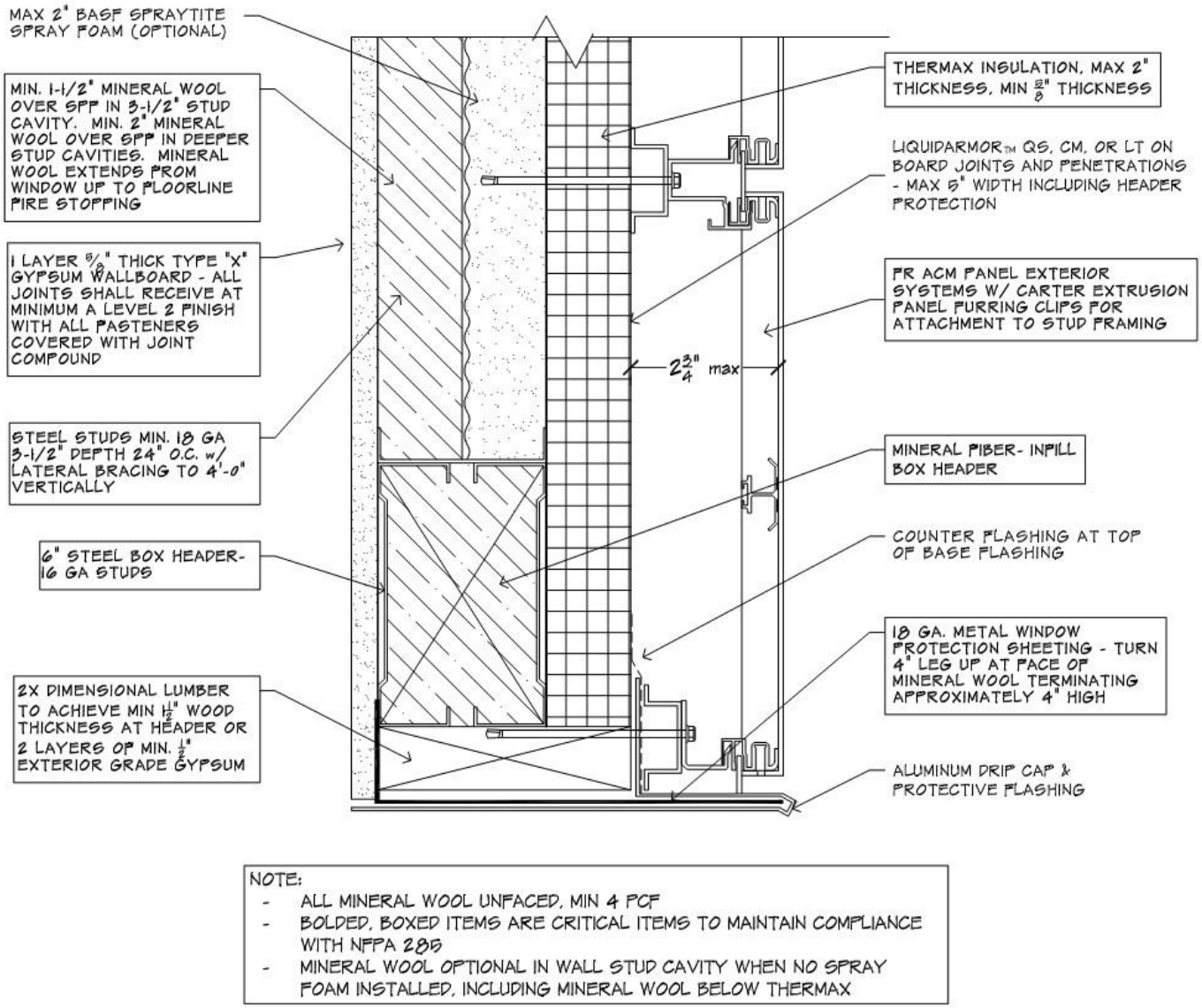

Figure 4 – Required Opening Head Protection When BASF SPRAYTITE® 81206 Spray Foam Is Used in the Cavity – OPTION 2

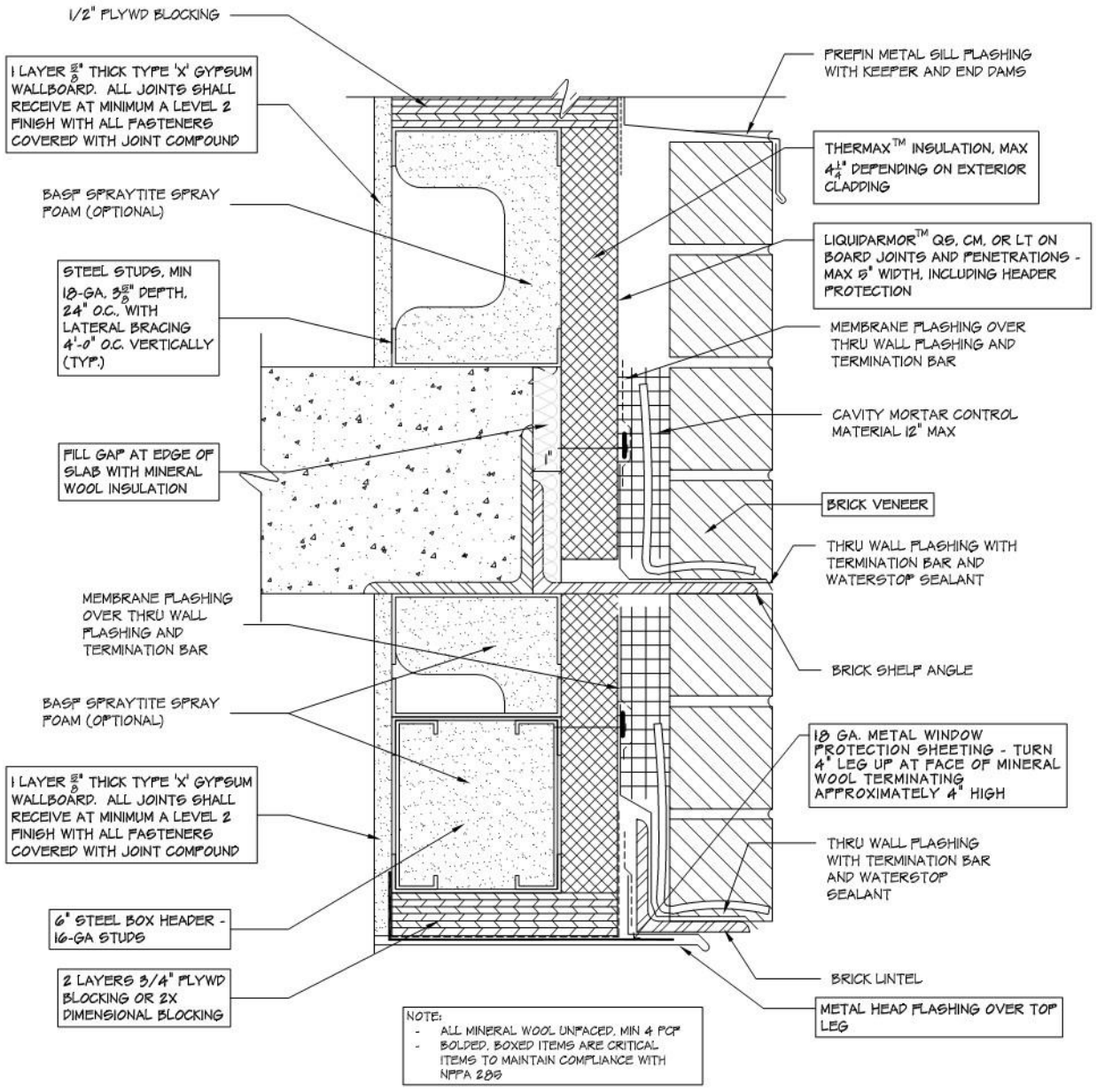

Figure 5. Required Opening Head Protection When BASF SPRAYTITE® 81206 Spray Foam Is Used in the Cavity (Infill Wall Construction with Brick Façade)

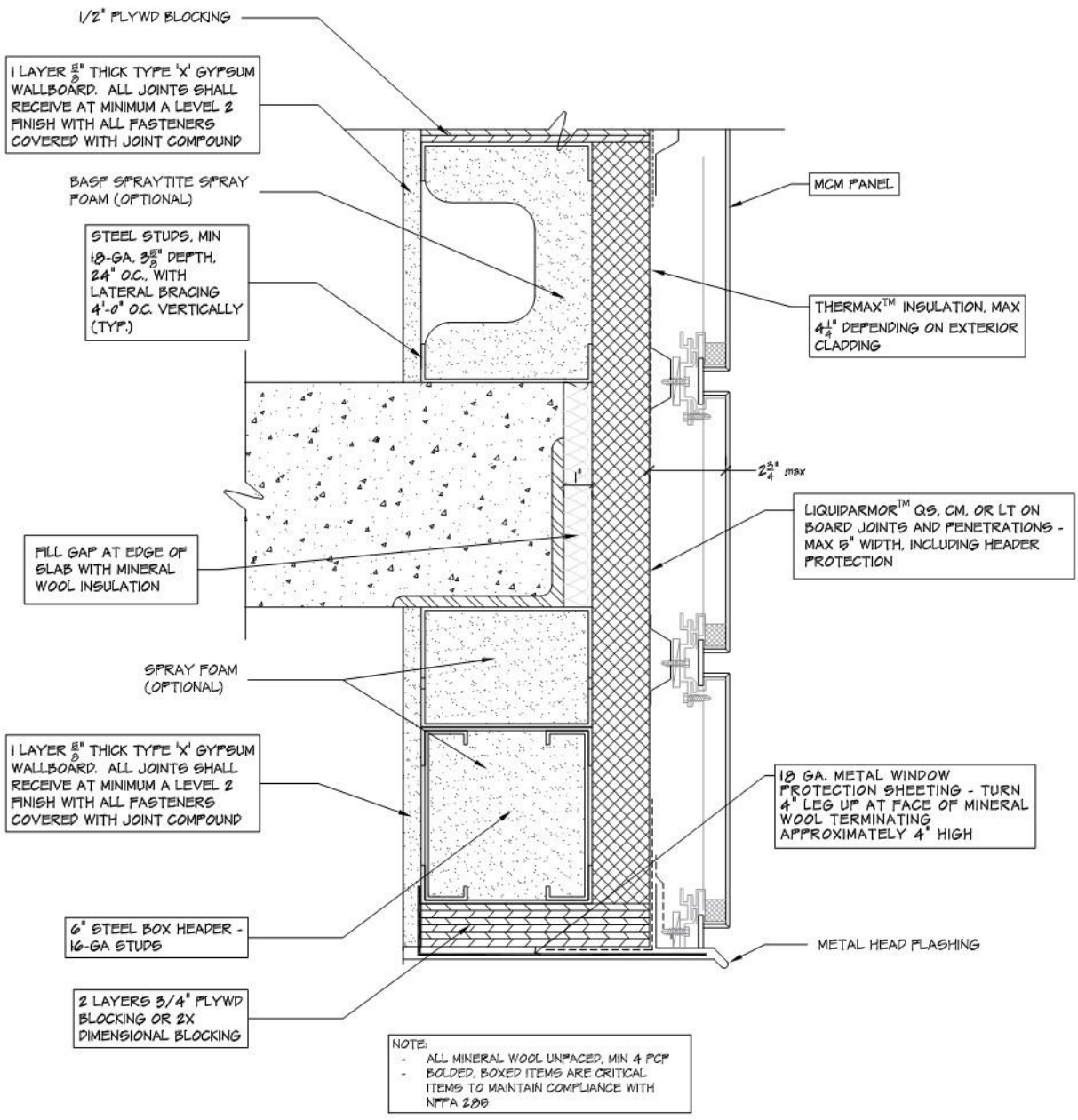

Figure 6. Required Opening Head Protection When BASF SPRAYTITE® 81206 Spray Foam Is Used in the Cavity (Infill Wall Construction with ACM Façade)

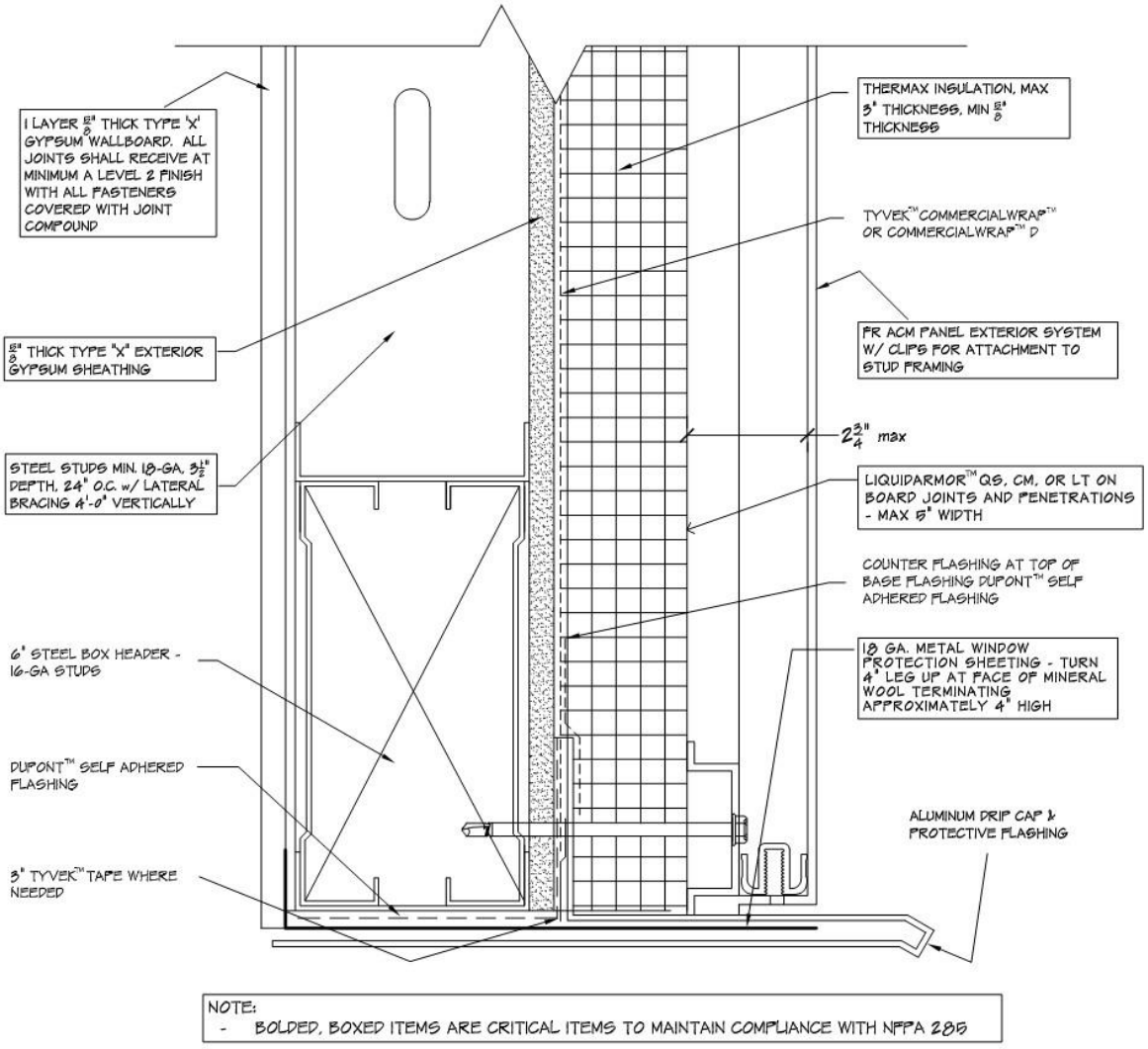

Figure 7. Use of Tyvek® CommercialWrap® or CommercialWrap® D WRB behind Thermax™ insulation

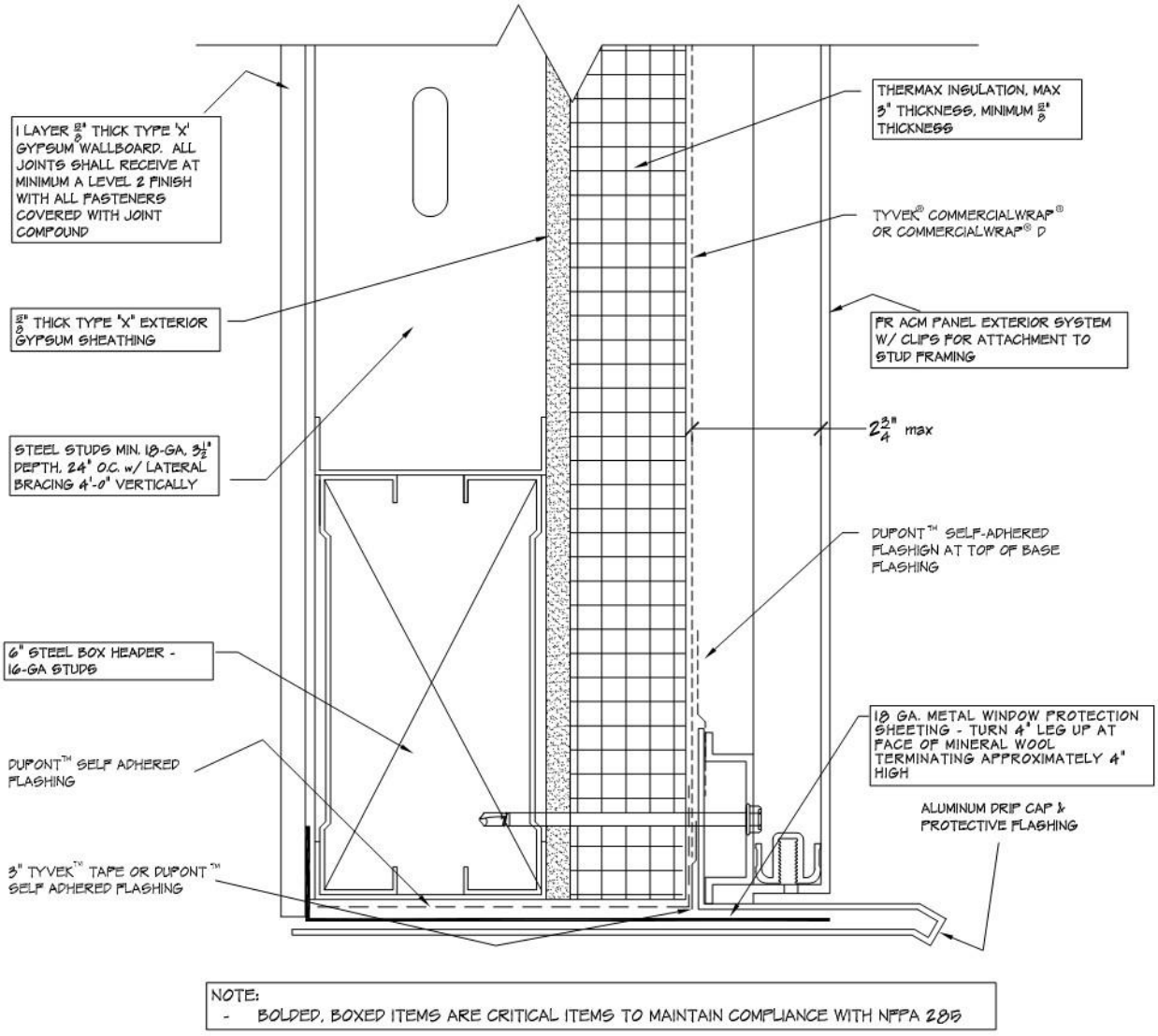

Figure 8. Use of Tyvek® CommercialWrap® or CommercialWrap® D WRB over Thermax™ insulation

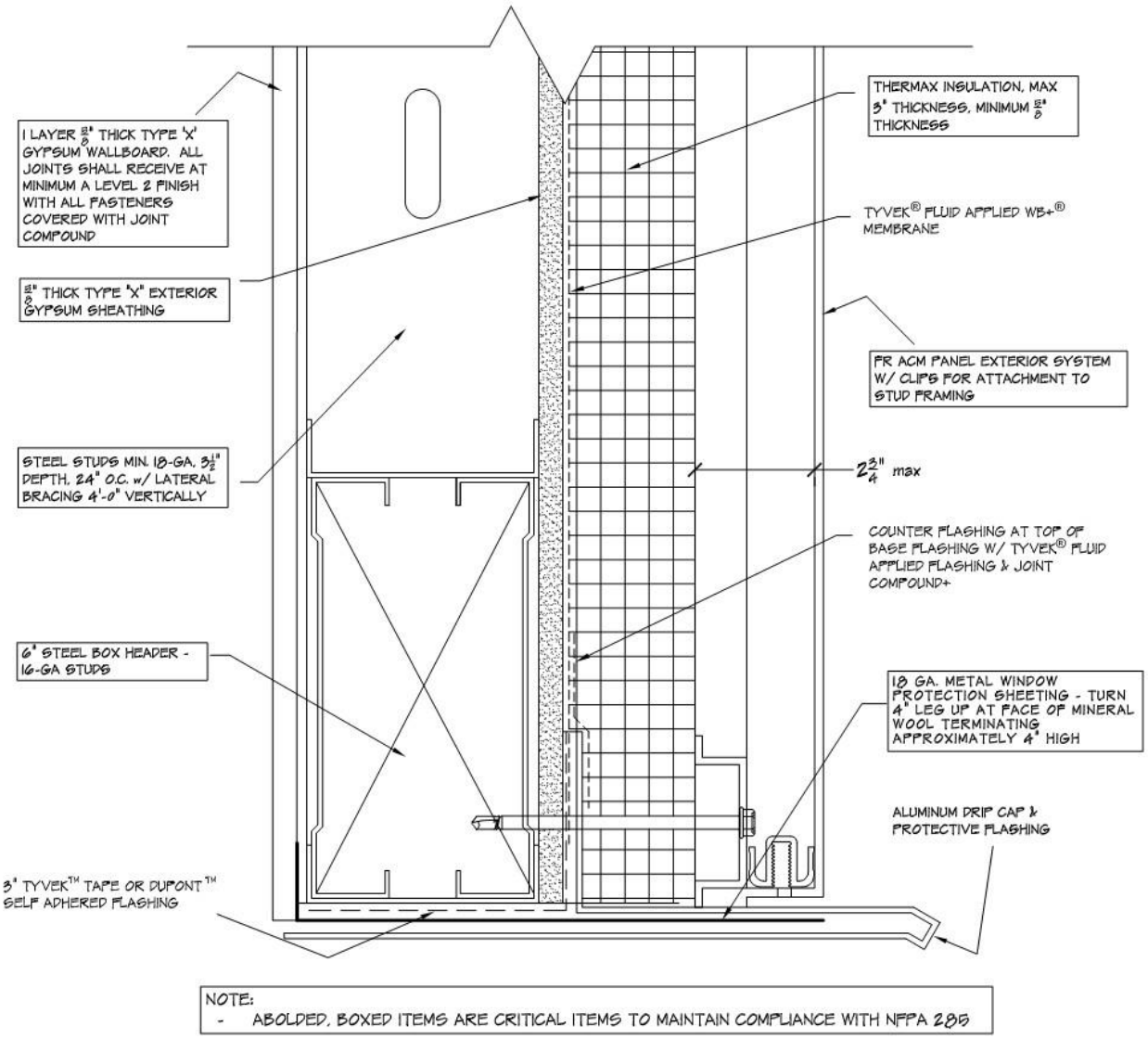

Figure 9. Use of Tyvek® Fluid Applied WB+® WRB behind Thermax™ insulation

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