JENSEN HUGHES

Advancing the Science of Safety

November 2, 2020

DuPont Building Solutions
1501 Larkin Center Drive
Midland, MI 48642

RE: Analysis and Extension of NFPA 285 Tests – Styrofoam™ XPS
Jensen Hughes Project No. 1JJB05306.011

To Whom It May Concern:

This letter provides a summary of NFPA 285 tests that incorporated extruded polystyrene (XPS) foam plastic insulation and the extension of those results to the Dupont™ Styrofoam™ XPS and to include other various exterior wall configurations which will meet the requirements of NFPA 285.

Section 2603.5.5 of the International Building Code (2000 through 2021 Editions) requires that exterior wall systems that incorporate foam plastic insulation shall meet the requirements of NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components*.

Several NFPA 285 tests that incorporated XPS have been conducted under the auspices of the Extruded Polystyrene Foam Association (XPSA). These tests were successful and met the requirements of NFPA 285. The results of the tests do apply to Styrofoam™ XPS, and XPSA has given authorization to DuPont™ to use these tests and reports. These tests are reported in the following test reports:

1. Southwest Research Institute, Final Report No. 01.06440.01.001, dated May 2003;
2. Underwriters Laboratories, Inc. Final Report 05CA2541, NC2650, dated January 10, 2005; and,
3. Southwest Research Institute, Final Report No. 01.13537.01.106, dated September 26, 2008.

Based on the results of these tests, additional NFPA 285 testing by Sto Corp. and Dryvit Systems, Inc., as well as additional small-scale tests of the water-resistive barrier (WRB) materials, and our experience with the NFPA 285 fire test, it is our opinion that the various configurations of exterior walls shown in Figures 1 and 2 and described in the attached Tables/Figures will meet the performance requirements of NFPA 285.

This analysis is based on the specific construction materials installed in the manner described in the referenced test report(s). Changes or modifications to the construction and/or materials used in the tested assembly may result in a different fire performance and may change this analysis.

This analysis does not address performance characteristics such as weatherability, durability, or structural issues.

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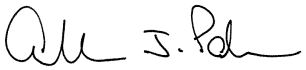
We trust this information is of assistance and if you have any questions, please feel free to contact me at 443-313-9891 or aparker@jensenhughes.com.

Sincerely,



Arthur J. Parker, P.E.
Sr. Fire Protection Engineer

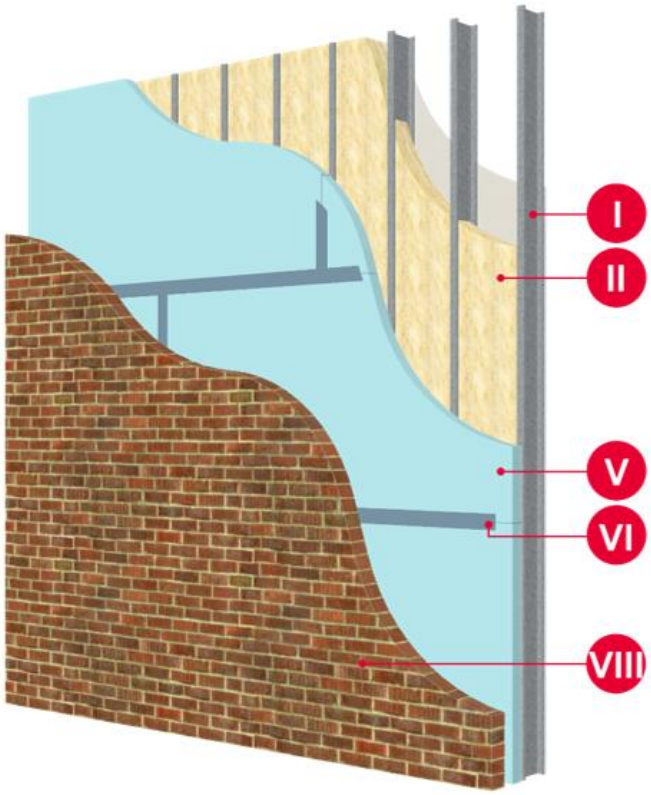


Figure 1

Figure 1 (*Left*): Typical Layer Assembly
Image shows a typical wall assembly using STYROFOAM™ brand XPS with numerals that correspond to Tables 1-6.
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 1-6 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 1-6 for layer and assembly options.

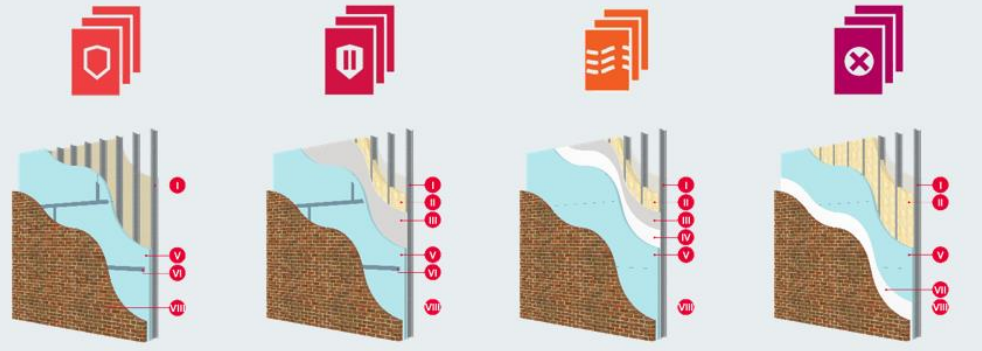


Figure 2-1 Max Armor
Insulation with seam treatment as WRB, empty stud cavity

Figure 2-2 Dual Armor
Insulation with seam treatment as WRB, exterior gypsum, insulation within stud structure

Figure 2-3 Classic
Insulation with separate WRB over exterior gypsum, insulation within structure

Figure 2-4 Other
Insulation with separate WRB over insulation, insulation within structure

Figure 2

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, or 4	1. Concrete wall 2. Concrete Masonry Unit (CMU) wall 3. Steel Studs: minimum 3⅝-inch depth, minimum 20-gauge at a maximum of 24-inch OC with lateral bracing every 4 ft. vertically. One layer of ⅝-inch thick Type X gypsum wallboard installed on interior face of studs. Gypsum wallboard joints shall receive at a minimum a Level 2 finish with all fasteners covered with joint compound. 4. 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, any thickness of plywood or OSB on exterior face of studs, and ⅝-inch thick Type X gypsum sheathing on exterior face covering studs, plywood or OSB. Minimum 2 top plates at floorlines.
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
II	Cavity Insulation – Use either 1, 2, or 3	1. None 2. Fiberglass blown-in or batt insulation (faced or unfaced) 3. Any con-combustible blown-in or batt insulation (faced or unfaced)
III	Exterior sheathing – Use either 1, 2 or 3	1. None 2. ½-inch thick exterior gypsum sheathing 3. ⅝-inch thick Type X exterior gypsum sheathing 4. ⅝-inch thick DensElement™ sheathing – The joints of the DensElement™ sheathing may be sealed with R-Guard® FastFlash® Liquid Flashing or approved equivalent. Note: Exterior gypsum sheathing is not required for Base wall system 1 or 2 above
IV	WRB Materials applied to gypsum sheathing – Use either 1 or 2	1. None 2. Any shown in Table 2 Note: Any WRB shown in Table 2 can be applied over Base wall system 1 or 2 above, where able.
V	Exterior Insulation	DuPont™ Styrofoam™ Type IV or Type X per ASTM C578. Total thickness to be minimum ½-inch to maximum 3-inches when installed using Special Conditions (see below)
VI	Sealing of exterior insulation – Use either 1 or 2	1. None 2. Seal all exterior insulation joints and as an option veneer tie penetrations with either: a) Dow LiquidArmor™ - CM Flashing and Sealant – maximum 60-mil wet thickness, maximum 5-inch width b) Dow LiquidArmor ™ - LT Flashing and Sealant – maximum 35-mil wet thickness, maximum 5-inch width c) Acrylic, asphalt or butyl-based sealing tape – maximum 4-inch width d) Dow Great Stuff Pro™ - Use on joints that are ≤ ¼-inch, vertical joints must be staggered & remove significant excess from the face of the XPS

Layer	*Wall Component*	*Materials*
VII	WRB materials applied to exterior insulation – Use either 1 or 2	1. None 2. Any shown in Table 3
VIII	Exterior Veneer – Use either 1, 2, 3, 4, 5, 6, or 7	1. Brick – Standard nominal 4-inch thick clay bricks with 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. 2. Concrete – Minimum 2-inches thick with maximum 2-inch air gap between exterior insulation and concrete. Any standard non-open joint installation technique can be used. 3. Concrete Masonry Units – Minimum 4-inches thick with maximum 2-inch air gap between exterior insulation and CMU. 4. Stone Veneer – Minimum 2-inch thick limestone or natural stone or minimum 1½-inch thick cast artificial stone veneer. Any standard non-open joint installation technique can be used. 5. Stucco – Minimum ¾-inch thick 2- or 3-coat stucco on metal lath. This wall construction shall be as described in Table 4. 6. StoTherm® ci XPS System – This wall construction shall be as described in Table 5. 7. Dryvit Outsulation X™ System – This wall construction shall be as described in Table 6.
REQUIRED	Special Conditions	Use any header treatment shown in Figures 2 through 12 for all wall openings (windows, doors, etc.)
	Flashing of windows, doors, and other exterior wall penetrations.	As an option, flash window, door and other exterior wall penetrations with either: a) DuPont™ LiquidArmor™ CM Flashing and Sealant, maximum 60 mils wet film thickness, maximum 12-inch width. b) DuPont™ LiquidArmor™ LT Flashing and Sealant, maximum 35 mils wet film thickness, maximum 12-inch width. c) Limited amounts of acrylic, asphalt, or butyl-based flashing tape, maximum 12-inch width. 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.

Table 2. Allowed WRB Materials 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 • Delta®-Maxx Plus
DOWSIL™ - DEFENDAIR 200
Dryvit - Backstop® NT
DuPont™ • DuPont™ Tyvek® CommercialWrap® • DuPont™ Tyvek® CommercialWrap® D • DuPont™ Tyvek® ThermaWrap™ • DuPont™ Tyvek® Fluid Applied WB+ – nominal 25 wet mil thickness • WeatherMate™ • WeatherMate™ Plus
Grace Construction Products • Perm-A-Barrier® Aluminum Wall Membrane • Perm-A-Barrier® VPL • Perm-A-Barrier® VPL LT • Perm-A-Barrier® VPS • Perm-A-Barrier® NPL • Perm-A-Barrier® NPL 10
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 Weather STPE
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
Polyguard Products • Airlok Flex® applied at a maximum 40 mils WFT • Airlok Flex® WG applied at a maximum 20 mils WFT • Airlok Flex® VP applied at a maximum 32 mils WFT
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 3. Allowed WRB Materials Installed Over Foam Insulation – Layer VII

DuPont™ • DuPont™ Tyvek® CommercialWrap® • DuPont™ Tyvek® CommercialWrap® D • DuPont™ Tyvek® ThermaWrap™ • DuPont™ Tyvek® Fluid Applied WB+ – nominal 25 wet mil thickness • WeatherMate™ • WeatherMate™ Plus
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
VaproShield • RevealShield™ • RevealShield SA™

Note: All WRB materials to be installed at indicated or recommended application rates per manufacturer's installation instructions

Table 4. – Exterior Walls Constructed with Stucco and Styrofoam™ XPS Insulation

Layer	Wall Component	Materials
I	Base wall system – Use either 1, 2 or 3	1. Concrete wall 2. Concrete Masonry wall 3. Steel Studs: minimum 3⅝-inch depth, minimum 18-gauge at a maximum of 16-inch O.C. One layer of ⅝-inch thick Type X gypsum wallboard installed on interior face of studs. Gypsum wallboard joints shall receive at a minimum a Level 2 finish with all fasteners covered with joint compound.
REQ	Floor line Firestopping	4 lb/cu ft. mineral wool (e.g. Thermafiber) in each stud cavity and at each floorline – attached with Z-clips or equivalent
II	Stud Cavity Insulation – Use either 1, 2 or 3	1. None 2. Fiberglass batt insulation (faced or unfaced) 3. Any noncombustible material
III	Exterior sheathing – Use either 1 or 2.	1. ⅝-inch thick Type X glass mat gypsum sheathing 2. ½-inch thick glass mat gypsum sheathing Note1: Seal sheathing joints with materials and procedures that are provided in ESR-1233 Note 2: Exterior sheathing is optional for Base wall systems 1 and 2 above
IV	WRB material applied to exterior sheathing or Base wall systems No. 1 & 2 without exterior sheathing – Use either 1, 2, or 3.	1. Sto Gold Coat® 2. Sto Emerald Coat® 3. Sto ExtraSeal™
NOT SHOWN	Continuous insulation adhesive – Use either 1, 2 or 3	1. None 2. Sto TurboStick Adhesive 3. Sto ExtraSeal 4. Dow INSTA-STIK™ quick set polyurethane adhesive
V	Continuous insulation	ASTM C578 Type IV Styrofoam™ insulation board: ½-inch (minimum) to 3-inch (maximum). Insulation board joints may be covered with 4-inch (maximum) wide asphalt or butyl-based flashing tape.
VI	Sealing of exterior insulation – Use either 1 or 2	1. None 2. Seal all exterior insulation joints and as an option veneer tie penetrations with either: • Dow LiquidArmor™ - CM Flashing and sealant – maximum 60-mil wet film thickness, maximum 5-inch width • Dow LiquidArmor™ - LT Flashing and sealant – maximum 35-mil wet film thickness, maximum 5-inch width • Acrylic, asphalt or butyl-based sealing tape – maximum 4-inch width Dow Great Stuff Pro™ - Use on joints that are ≤ ¼-inch, vertical joints must be staggered & remove significant excess from the face of the XPS
VII	Secondary WRB material – Use either 1, 2 or 3	1. None 2. No. 15 Grade D building paper 3. Asphalt felt in compliance with ASTM D 226
VIII	Drainage Mat – Use either 1 or 2	1. None 2. Sto DrainScreen - installed over Air Barrier and weather-resistive barrier membrane or over continuous insulation
IX	Exterior Veneer	Stucco – Minimum ¾-inch thick, 2- or 3-coat Stucco complying with ASTM C926 applied over 2½-lb/yd^2 galvanized steel diamond mesh lath complying with ASTM C1063/C847. As an option, adhered masonry veneer, such as: Thin brick, manufactured stone, ceramic or porcelain tile may be installed over the Stucco.

Table 5. – Exterior Walls Constructed with StoTherm® ci and Styrofoam™ XPS Insulation

Layer	Wall Component	Materials
I	Base wall system – Use either 1, 2 or 3	1. Concrete wall 2. Concrete Masonry wall 3. Steel Studs: minimum 3⅝-inch depth, minimum 18-gauge at a maximum of 16-inch O.C. One layer of ⅝-inch thick Type X gypsum wallboard installed on interior face of studs. Gypsum wallboard joints shall receive at a minimum a Level 2 finish with all fasteners covered with joint compound.
REQ	Floor line Firestopping	4 lb/cu ft. mineral wool (e.g. Thermafiber) in each stud cavity and at each floorline – attached with Z-clips or equivalent
II	Stud Cavity Insulation – Use either 1, 2 or 3	1. None 2. Fiberglass batt insulation (faced or unfaced) 3. Any noncombustible material
III	Exterior sheathing – Use either 1 or 2.	1. ⅝-inch thick Type X glass mat gypsum sheathing Note1: Seal sheathing joints with materials and procedures that are provided in ESR-1233 Note 2: Exterior sheathing is optional for Base wall systems 1 and 2 above
IV	WRB material applied to exterior sheathing or Base wall systems No. 1 & 2 without exterior sheathing – Use either 1, 2, or 3.	1. Sto Gold Coat® 2. Sto Emerald Coat® 3. Sto ExtraSeal™
NOT SHOWN	Continuous insulation adhesive – Use either 1, 2 or 3	1. None 2. Sto TurboStick Adhesive 3. Sto BTS® Plus – use with Base Coats 1, 2, or 3 and Finish coats 1 or 2 4. Sto BTS Xtra - Use with Base coats 1, 2 or 3 and Finish coats 1 or 2 5. Dow INSTA-STIK™ quick set polyurethane adhesive 6. Sto Primer/Adhesive – Use with Base coats 4 or 5 & Finish coat 3 7. Sto Primer/Adhesive-B – Use with Base coats 4 or 5 & Finish coat 3
V	Continuous insulation	ASTM C578 Type X Styrofoam™ insulation board: minimum ½-inch to maximum 3-inches thick. Insulation board joints may be covered with 4-inch (maximum) wide asphalt or butyl-based flashing tape.
VIII	Base Coat – Use either 1, 2, 3, 4, or 5	1. Sto BTS Plus – Use with Finish coats 1 and 2 2. Sto BTS Xtra - Use with Finish coats 1 and 2 3. Sto RFP - Use with Finish coats 1 and 2 4. Sto Primer/Adhesive – Use with Finish coat 3 5. Sto Primer/Adhesive-B – Use with Finish coat 3
	Mesh	Sto Mesh embedded in base coat
	Finish coat – Use either 1, 2 or 3	1. Sto Textured Finish - Stolit® Lotusan® 2. Sto Textured Finish - Stolit® 3. Sto Textured Finish: Sto Essence DPR

Table 6 – Exterior Walls with Dryvit Outsulation X™ and Styrofoam™ XPS Insulation

I	Base wall system – Use either 1, 2 or 3	1. Concrete wall 2. Concrete Masonry wall 3. Steel Studs: minimum 3⅝-inch depth, minimum 18-gauge at a maximum of 16-inch O.C. One layer of ⅝-inch thick Type X gypsum wallboard installed on interior face of studs. Gypsum wallboard joints shall receive at a minimum a Level 2 finish with all fasteners covered with joint compound.
REQ	Floor line Firestopping	4 lb./cu ft. mineral wool (e.g. Thermafiber) in each stud cavity and at each floorline – attached with Z-clips or equivalent
II	Stud Cavity Insulation – Use either 1, 2 or 3	1. None 2. Fiberglass batt insulation (faced or unfaced) 3. Any noncombustible material
III	Exterior sheathing – Use 1 or 2.	1. ½-inch thick exterior type gypsum sheathing 2. ⅝-inch thick, Type X gypsum sheathing Note1: Seal sheathing joints with materials and procedures that are provided in ESR-1233 Note 2: Exterior sheathing is optional for Base wall systems 1 and 2 above
IV	WRB material applied to exterior sheathing or Base wall systems No. 1 & 2 without exterior sheathing – Use either 1 or 2.	1 – Dryvit Backstop NT Texture 2 – Dryvit Backstop NT Smooth
	Continuous insulation installation	Genesis® - applied in vertical ribbons plus mechanical fasteners. See ESR-3295 for details
V	Continuous insulation	ASTM C578, Type X, Dow XNERGY™ Rigid Insulation: Minimum ½-inch thick to maximum 4-inch thick. Insulation board joints may be covered with 4-inch (maximum) wide asphalt, acrylic, or butyl-based flashing tape.
VIII	Base Coat	Genesis®
	Mesh	Standard Plus Reinforcing Mesh (6.0 oz./yd2) embedded in base coat
	Finish coat – Use either 1 or 2	1 – Dryvit DPR 2 – Dryvit PMR

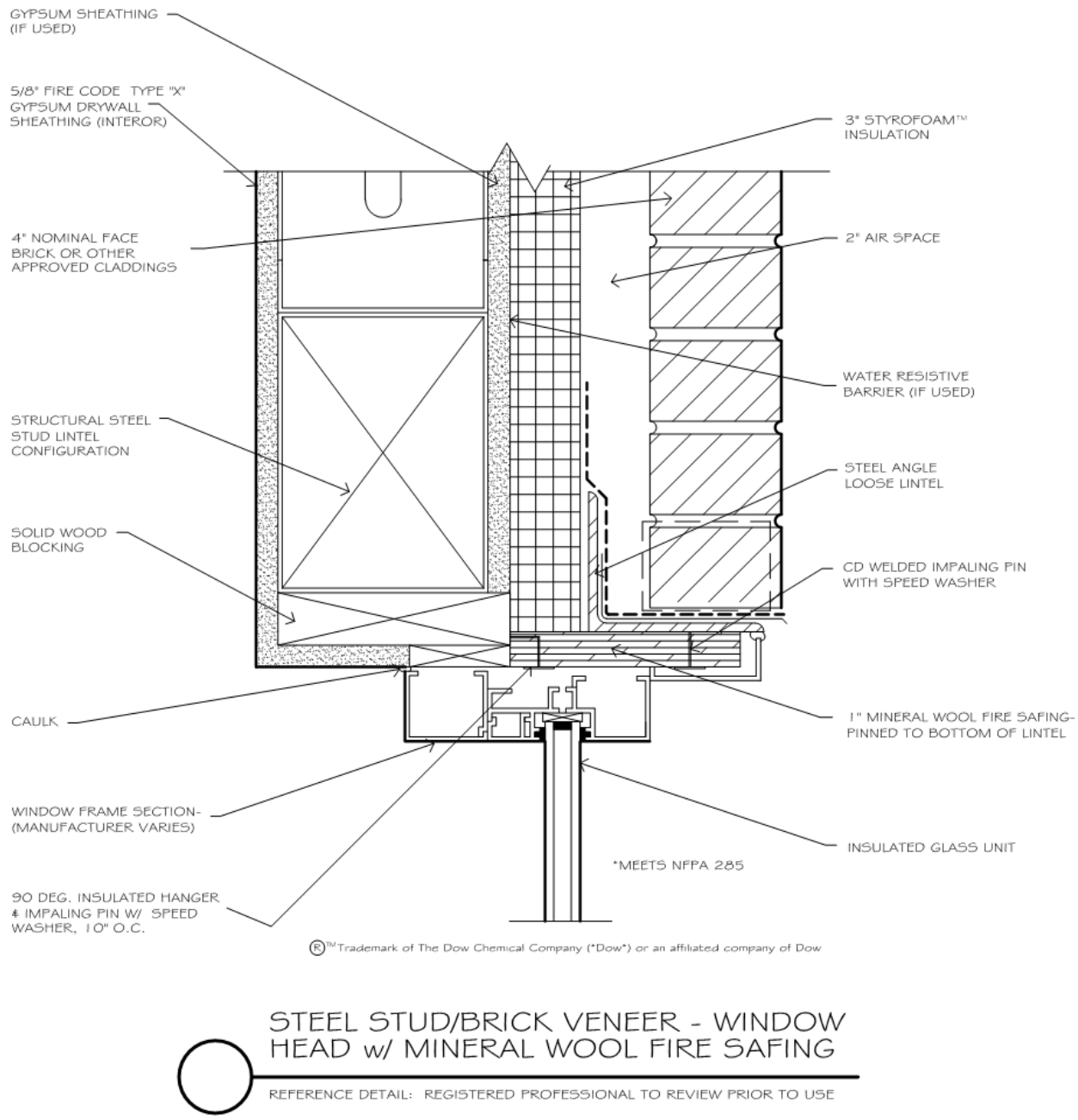


Figure 3 – Window/Door Opening Detail – Mineral Wool

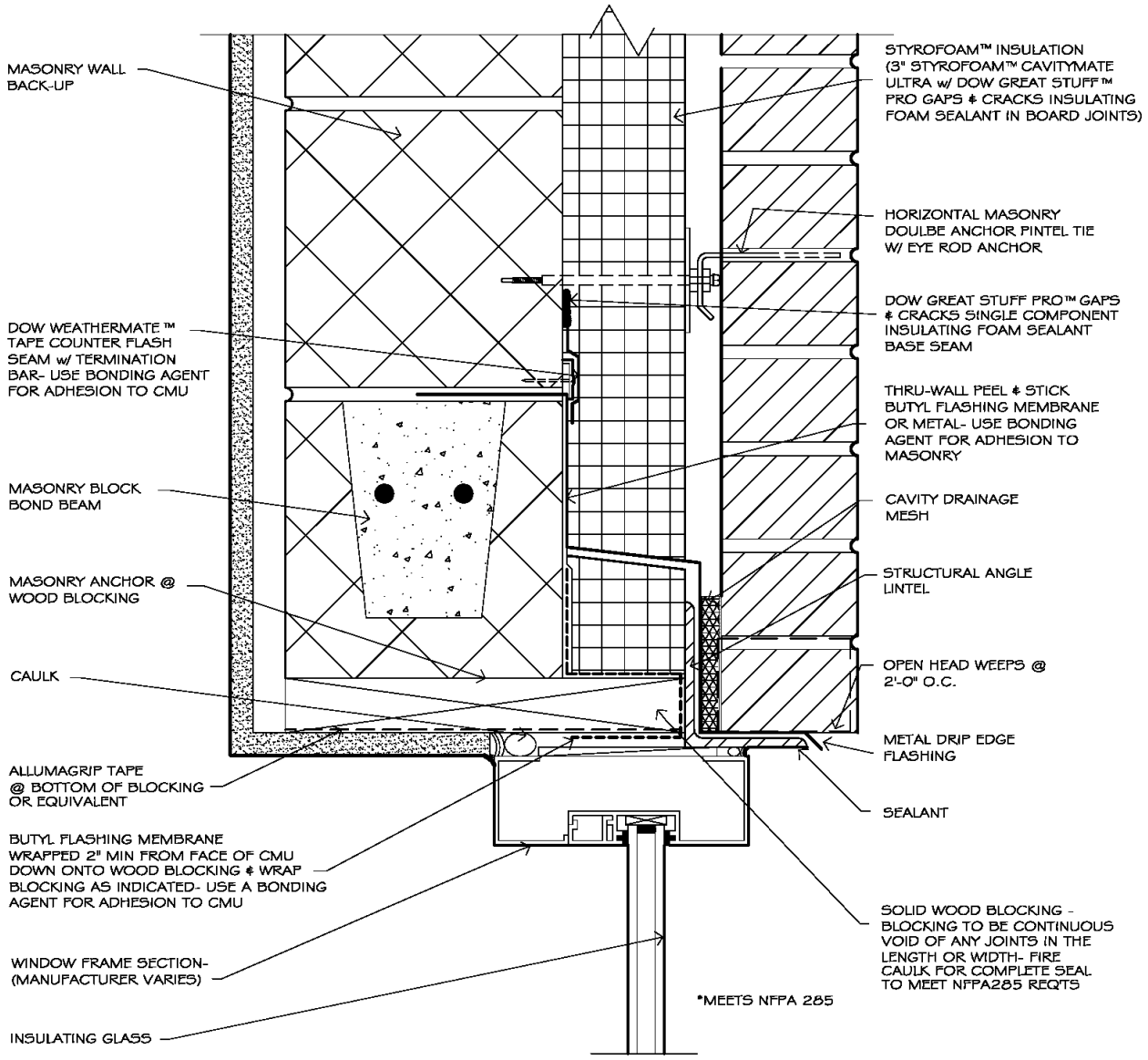


Figure 4 – Window / Door Header Detail with FR Wood Blocking

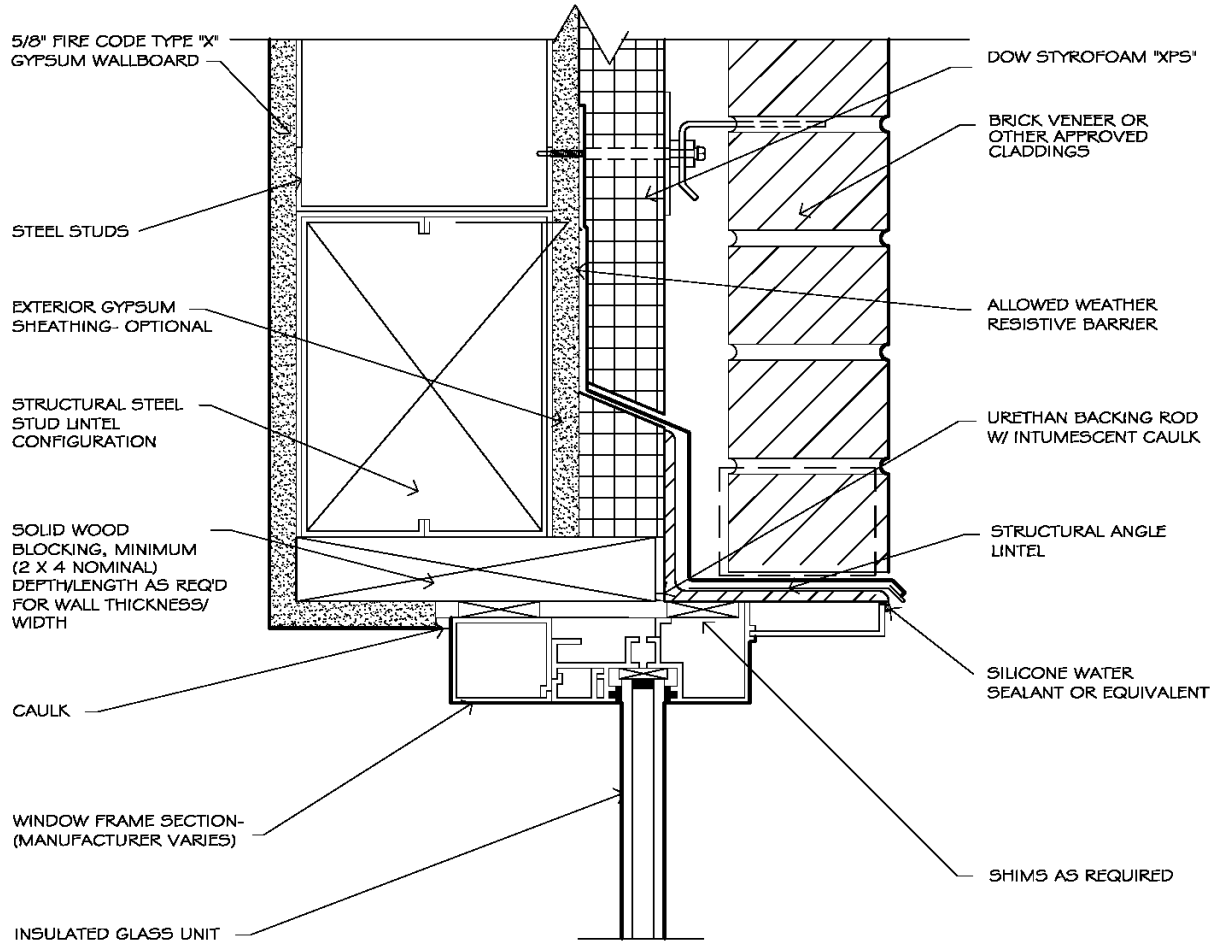


Figure 5 – Window / Door Header Detail with FR Wood Blocking

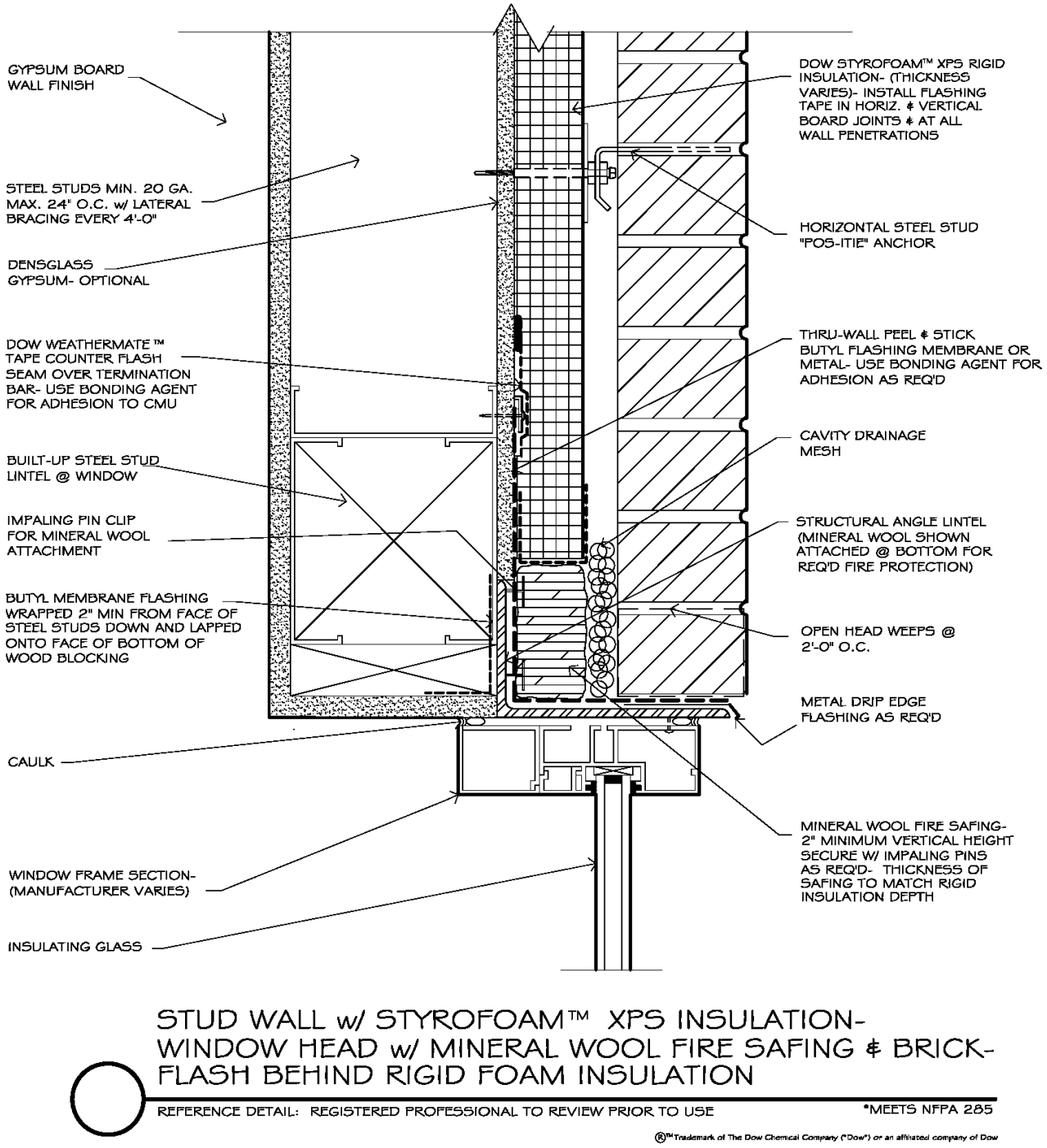


Figure 6 – Window Head with Mineral Wool Safing

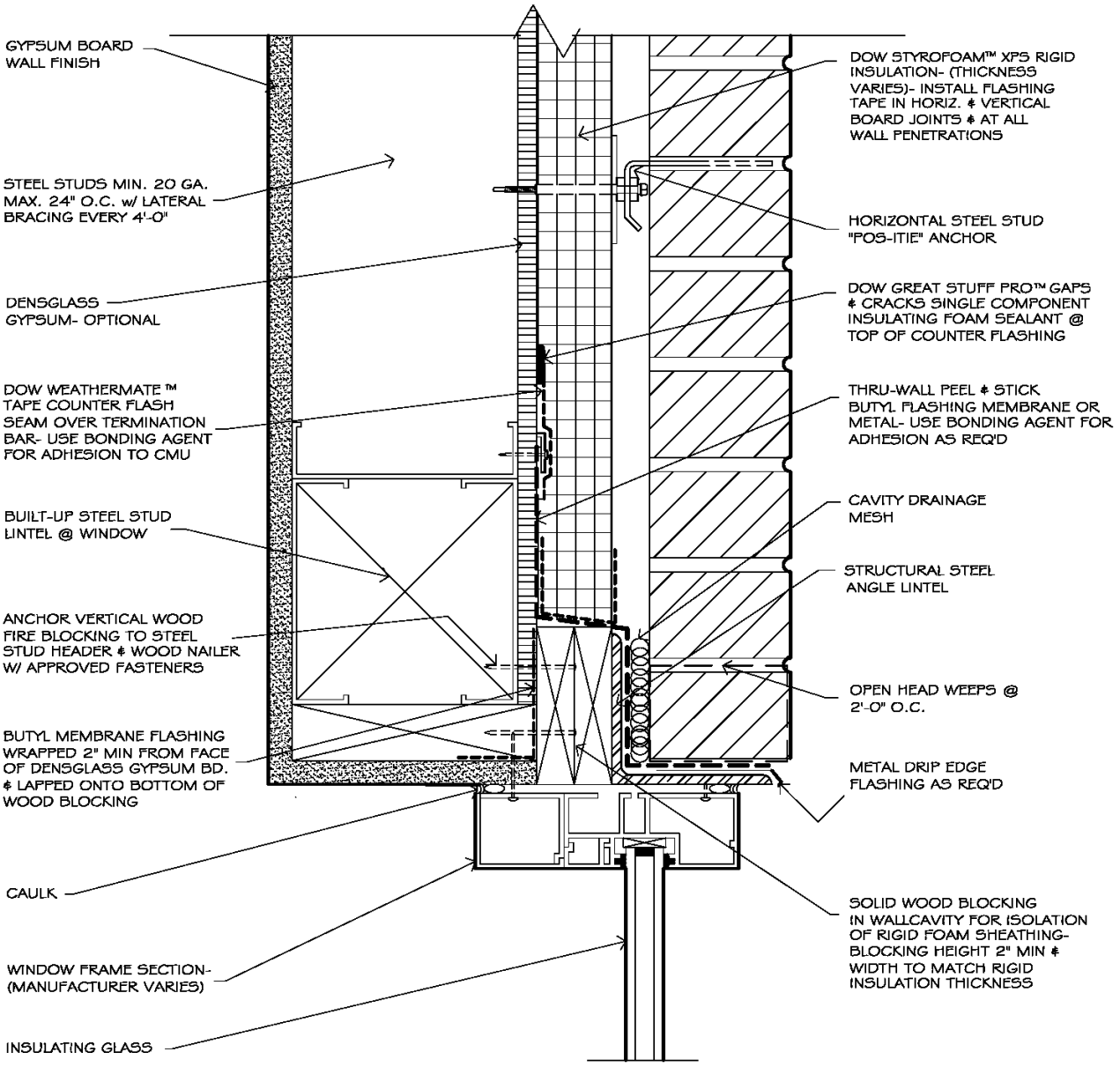


Figure 7 – Window Head with Fire Treated Wood Blocking

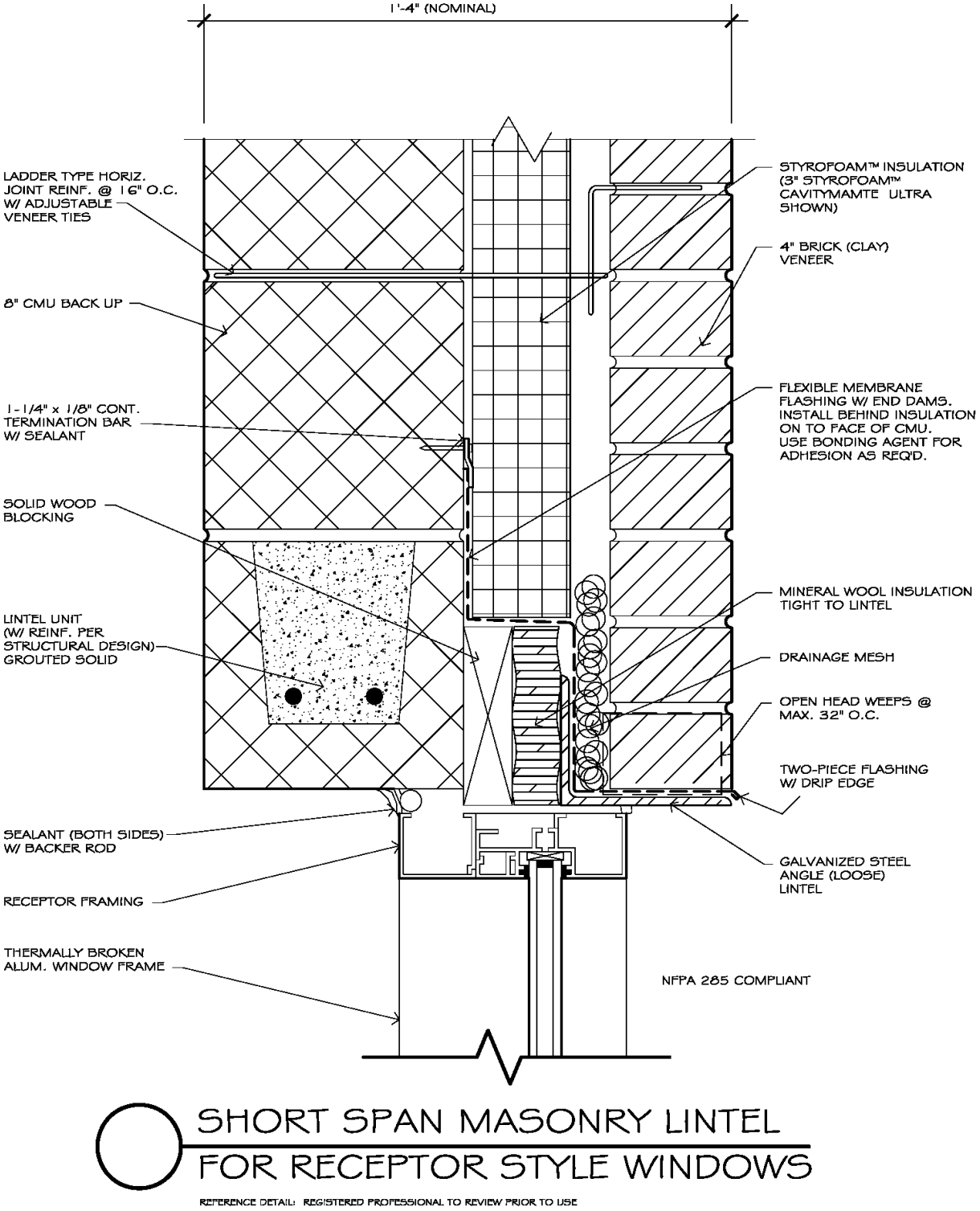


Figure 8 – Window / Door Opening Detail w/Mineral Wool & Fire Treated Wood Blocking

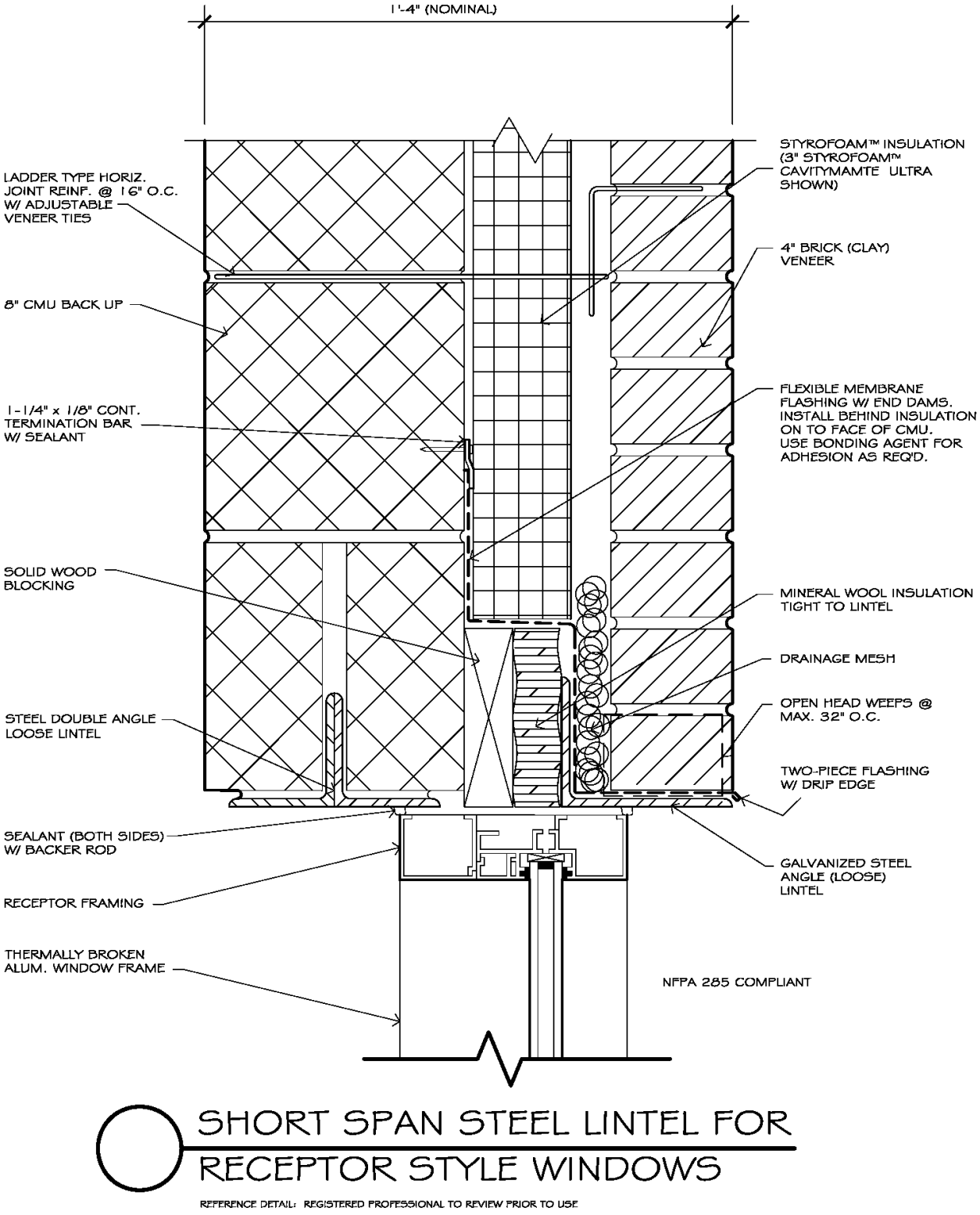


Figure 9 – Window / Door Opening Detail w/Mineral Wool & Fire Treated Wood Blocking

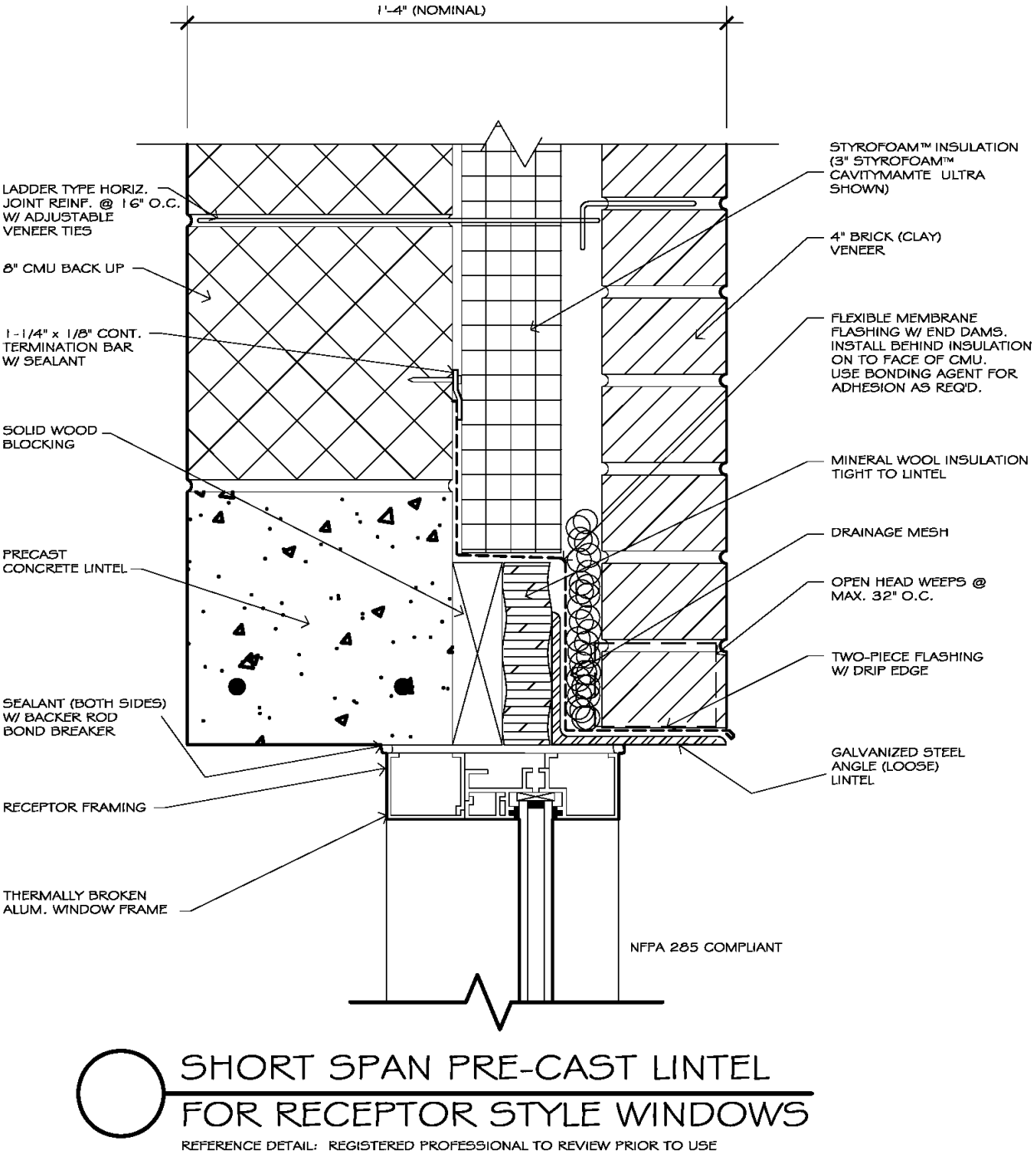


Figure 10 – Window / Door Opening Detail w/Mineral Wool & Fire Treated Wood Blocking

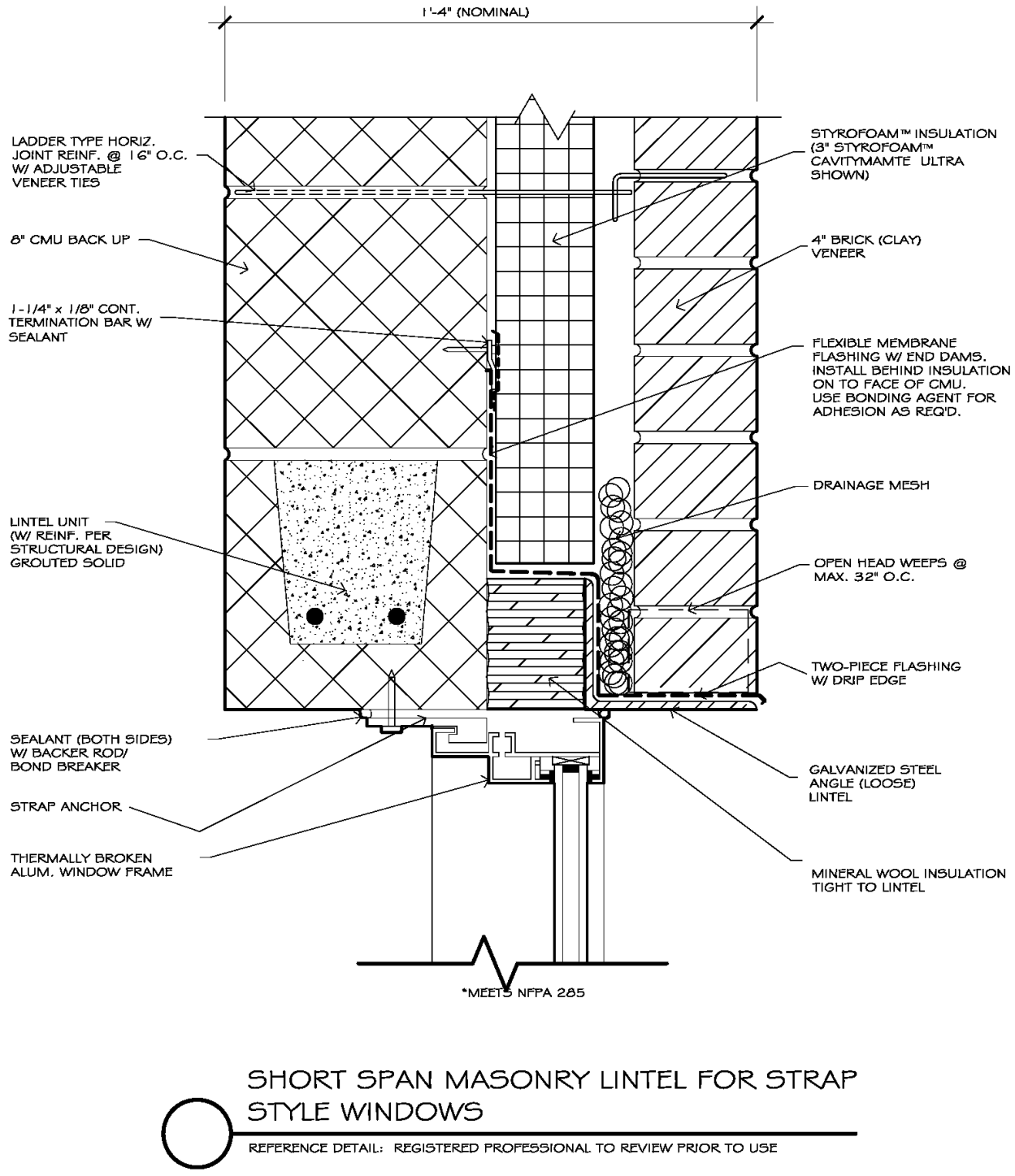


Figure 11 – Window / Door Opening Detail – Mineral Wool

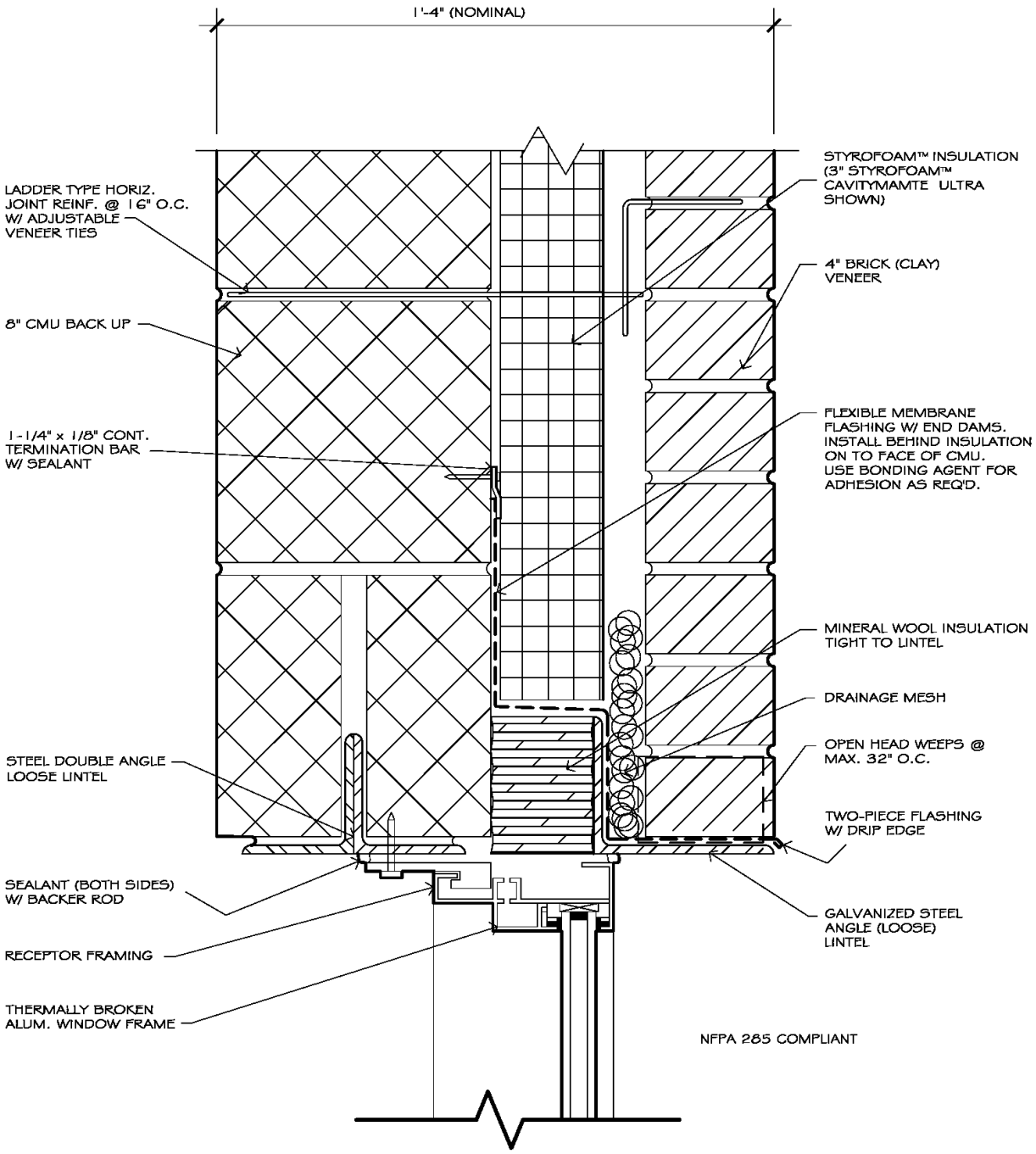


Figure 12 – Window / Door Opening Detail w/Mineral Wool

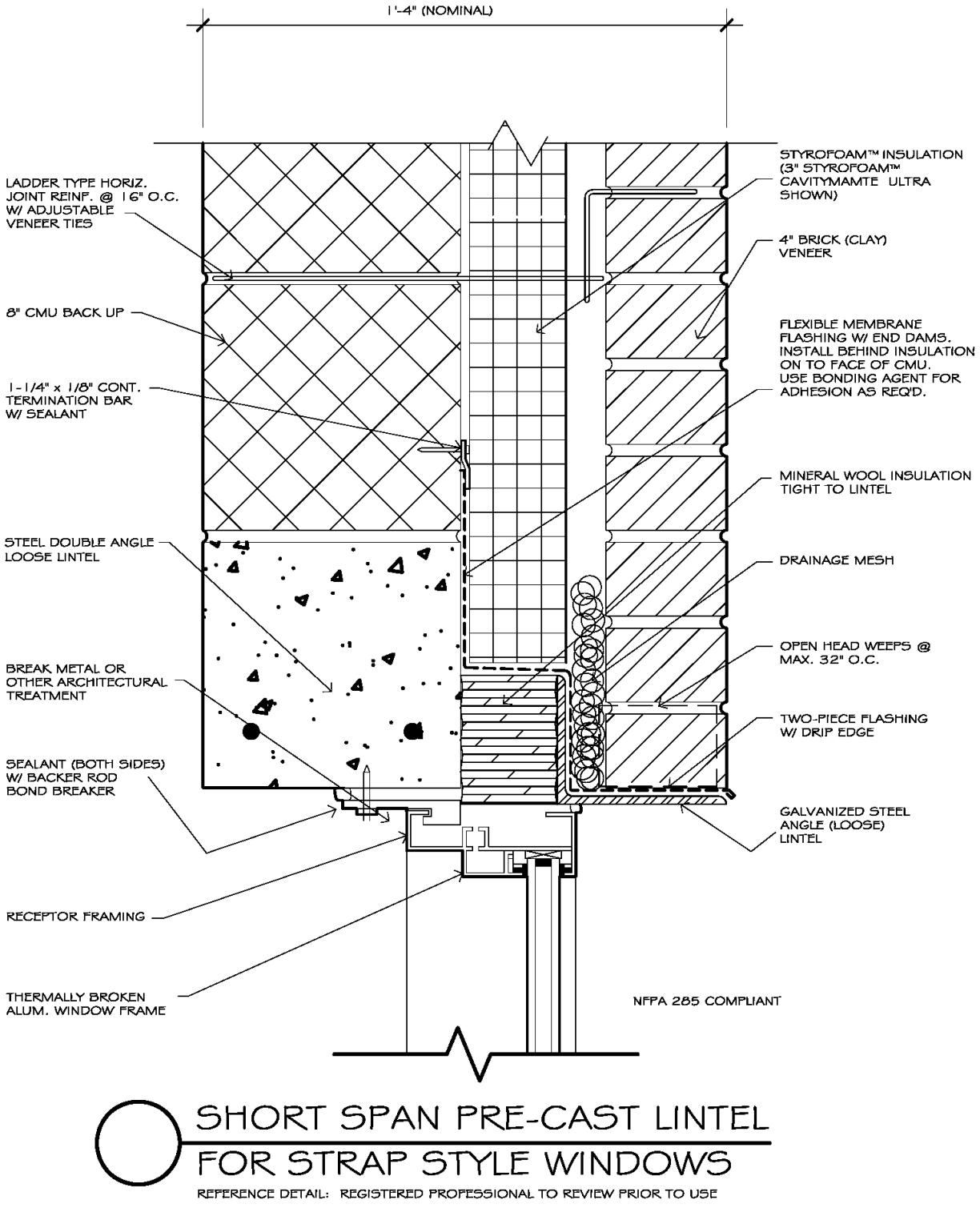


Figure 13 – Window / Door Opening Detail w/Mineral Wool