JENSEN HUGHES

April 19, 2022

DuPont Performance Building Solutions
1501 Larkin Center Drive
Midland, MI 48642

RE: Engineering Analysis for Exterior Wall Assemblies Constructed using Fire Retardant Treated Wood (FRTW) Framing (Revision 3)
Jensen Hughes Project Number 1JJB05306.011

To Whom It May Concern:

Jensen Hughes has completed our engineering analysis of an exterior wall assembly constructed using fire retardant treated wood (FRTW) framing and sheathing for compliance with NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.* This analysis is applicable for exterior wall assemblies in Type III construction.

DuPont™ Performance Building Solutions (DuPont™) has performed a successful NFPA 285 test on an exterior wall assembly which incorporated FRTW wall studs and FRTW plywood exterior sheathing. The results of this test are documented in Intertek Testing Building & Construction Report No. M4492.03-121-24-R0, dated December 15, 2021. The exterior wall assembly was constructed as follows (interior to exterior):

1. One layer of ⅝-inch thick Type X gypsum wallboard
2. Pyro-Guard Fire Retardant Treated 2×4 wood studs spaced 16-inches on center with a single top and bottom plate. The exterior wall assembly was framed in two sections with first story framing unit and a second story framing unit.
3. 8-inch thick, 4-pcf ROCKWOOL Cavityrock mineral wool insulation installed in each wall stud cavity of the second story framing unit on the bottom plate.
4. CertainTeed Sustainable Insulation R-13 fiberglass batt insulation with kraft paper facing installed in all stud cavities and stapled into place.
5. One layer of nominal $^{15}/_{32}$-inch thick Pyro-Guard Treated plywood
6. One layer of 1-inch thick DuPont™ Styrofoam™ Square Edge ST-100 extruded polystyrene (XPS) installed over the FRTW plywood
7. One layer of DuPont™ Tyvek® CommercialWrap® water-resistive barrier (WRB) material
8. One layer of Tyvek® DrainVent™ Rainscreen drainage mesh

3610 Commerce Drive, Suite 817
Baltimore, MD 21227
D: +1-443-313-9891 | C +1-443-995-0381

9. Nominal $^{5}/_{16}$-inch thick, 8¼-inch HardiPlank Lap Siding installed per manufacturers installation instructions.

Detailed wall construction information, test photos, observations, and data are provided in the Intertek report.

Based on the results of the NFPA 285 test and our experience with the NFPA 285 fire test, it is our opinion that the various configurations of exterior walls described in Table 1 will meet the performance requirements of NFPA 285.

Table 1 – NFPA 285 Complying Wall Construction

Wall Component	*Materials*
Base wall system	1. Wood studs: Minimum 2 × 4-inch FRTW wood studs spaced a maximum of 16-inch O.C. Minimum one layer of ⅝-inch thick Type X gypsum wallboard installed on interior face of wood studs. Wall cavity filled with insulation as specified in '*Cavity Insulation*' item below. 2. Steel Studs: Minimum 3⅝-inch deep, minimum 20-gauge steel studs spaced a maximum of 24-inches O.C. Minimum one layer of ⅝-inch thick Type X gypsum wallboard installed on interior face of steel stud framing. Wall cavity filled with insulation as specified in *'Cavity Insulation'* item below.
Floor line firestopping	Minimum 8-inch deep, minimum 4 lb/ft^3 mineral wool insulation shall be friction fit in each wall stud cavity on top of the wall bottom plate at every floor line. Minimum two top plates at floorlines
Interior Vapor/Moisture barrier	1. None 2. Any 6-mil thick polyethylene film
Cavity Insulation – Use either 1 or 2	1. Minimum R-13 fiberglass batt insulation (faced or unfaced) 2. Mineral wool batt insulation (faced or unfaced)
Exterior sheathing – Use either 1, 2, or 3	1. $^{15}/_{32}$-inch thick FRTW plywood complying with Section 2303.2 of the IBC 2. ½-inch thick, exterior gypsum sheathing 3. ⅝-inch thick, Type X exterior gypsum sheathing
Exterior Insulation – use either 1,2 or 3	1. None 2. Maximum 1-inch thick DuPont™ Styrofoam™ Type IV or Type X per ASTM C578. XPS products include the Blue Styrofoam™, Grey Styrofoam™ (covered in ICC-ESR 2142), and Grey Styrofoam™ brand ST-100 Series (LIMS-274901) Styrofoam™ (covered in ICC-ESR 4755). XPS fastened to exterior sheathing using 1¾-inch long roofing nails spaced 12-inces OC around the perimeter and 16-inches OC in the field. 3. Maximum 1-inch thick DuPont™ Thermax™ polyisocyanurate foam plastic insulation
WRB materials applied over exterior insulation – Use either 1, 2, 3, 4, or 5	1. DuPont™ Tyvek® CommercialWrap® 2. DuPont™ Tyvek® CommercialWrap® D 3. DuPont™ Tyvek® ThermaWrap™ 4. WeatherMate™ 5. WeatherMate™ Note: As an option, WRB material may be applied over exterior sheathing instead of over exterior insulation. Only one layer of WRB material permitted in exterior wall assembly
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 above and with any exterior veneer when no air gap is present between the veneer and the DrainVent™

Wall Component	*Materials*
Exterior Cladding – Use either 1 through 13	1. Minimum $^{5}/_{16}$-inch thick HardiPlank Lap Siding installed with a 1¼-inch overlap. 2. 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. 3. 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. 4. Natural or Artificial Stone – Minimum 2-inch thick 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. 5. Terracotta cladding – Minimum 1¼-inch thick terracotta cladding system. Any non-open-joint installation technique such as ship-lap, etc. can be used. 6. Concrete or precast concrete panels – Minimum 1½-inch thick 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 7. 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. 8. Corium Thin brick system 9. StoneLite natural stone wall panels by Stone Panels, Inc. 10. Glen-Gery Thin tech Elite Series – Masonry veneer 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.
Special Conditions - Wall Opening Protection	Use wall opening treatment shown in Figure 1 for cladding materials with no air cavity space between cladding and insulation/WRB. Header shall consist of minimum 5/4×4-inch window trim above window header, 1×1½-inch FRTW window rough opening extension under foam plastic insulation, and a minimum 2×6 vertical FRTW header on top of a minimum 2×4 FRTW horizontal header. When cladding materials incorporate air cavity space, wall opening header treatment shall be installed as shown in Figure 2. Note: Drainage plane behind DrainVent Drainage Mat is not considered an air cavity space within the wall assembly requiring wall opening treatments described above

Wall Component	Materials
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) DuPont™ DuraGard™ CM Transition Flashing – max. 12-inch width. d) 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.

Engineering Analysis

The analysis which follows provides the technical substantiation for modifications to the tested wall assemblies for the following wall construction features:

1. Alternate Base Wall Assembly Construction
2. Cavity insulation materials
3. Exterior sheathing materials
4. Additional continuous exterior insulation materials
5. Alternate WRB materials
6. Alternate thermally heavy exterior cladding materials

1.0 Alternate Base Wall Assembly Construction

The tested wall assembly utilized 2×4 wood stud wall framing members. Substituting the combustible wood framing for noncombustible steel framing will result a reduction in the amount of combustible material present in the wall assembly, and consequently, a reduction in overall wall combustibility. Since NFPA 285 is a surface burning test of an exterior wall assembly containing combustible components replacing the wood wall studs with noncombustible steel studs reduces the likelihood of any burning being supported within the wall cavities during a fire exposure test.

Additionally, the vast majority of NFPA 285 testing has been conducted on exterior wall assemblies constructed using light gauge steel wall framing. Steel studs remain intact and support the exterior wall components. Therefore, the performance of steel studs as the framing members for exterior wall assemblies is well documented and is the standard condition in tested assemblies compared to wood stud framing.

Based on the vast majority of NFPA 285 tests being conducted on wall assemblies incorporating steel wall studs, it is our engineering opinion that substituting the tested wood studs for noncombustible steel framing will maintain compliance with NFPA 285.

2.0 Cavity Insulation Materials

The tested assembly incorporated fiberglass insulation in the wall stud cavities. Replacing the fiberglass insulation with mineral wool insulation will not adversely impact the overall wall fire performance. The technical rationale for allowing non-combustible insulation materials to be installed in the wall cavity of an assembly

evaluated to NFPA 285 is provided by numerous UL design listings for wall assemblies in the UL Online Certifications Directory which have been tested to the more severe ASTM E119 fire exposure conditions. Many UL Designs (e.g., U305, U309, U317, V310) list the inclusion of fiberglass or mineral wool insulation as an optional item that can be incorporated into the assembly, and as such will not adversely impact the fire-resistance rating of the assembly. Rather, the addition of any noncombustible insulation materials will result in an improvement in the overall wall fire performance by increasing the overall insulation value of the wall, resisting the migration of heat from the exposed face to the unexposed face.

The fiberglass or mineral wool insulation can be faced or unfaced. The minimal amount of fuel loading added to the assembly by these materials is very low and the facers are protected on both faces by gypsum wallboard or gypsum sheathing.

In the tested assembly, the fiberglass batt insulation was stapled into place prior to the installation of the layer of interior gypsum wallboard. During the fire test, the fiberglass insulation remained in the wall cavity and provided some protection to the FRTW plywood sheathing. Any insulation material installed in the wall stud cavity must either be mechanically fastened (stapled) or be rigid batt insulation in order to ensure the insulation remains in-place, even if the interior gypsum wallboard layer is compromised and falls away. Blown in insulation materials cannot be assured to remain in-place during a fire exposure if the gypsum wallboard layer were to fall away.

3.0 Exterior Sheathing Materials

The FRTW wall studs of the tested wall assembly were sheathed by $^{15}/_{32}$-inch thick FRTW plywood. FRTW wood materials shall comply with Section 2303.2 of the IBC where chemicals are pressure impregnated into the wood product.

The tested combustible FRTW plywood can be replaced with exterior gypsum sheathing (½-inch thick regular code or ⅝-inch thick Type X core). Replacing the combustible FRTW plywood with the noncombustible exterior gypsum sheathing will reduce the overall wall fuel loading and the exterior gypsum sheathing will provide additional protection to the wood wall framing from the exterior fire source. The exterior gypsum sheathing will also provide additional protection to the combustible insulation and WRB materials from the interior room fire source. Any ASTM C1177 complying exterior gypsum sheathing material is acceptable for use in this NFPA 285 compliant exterior wall assembly.

4.0 Additional Continuous Exterior Insulation Materials

A 1-inch thickness of the DuPont™ Styrofoam™ Square Edge ST-100 XPS insulation was installed on the test wall assembly. When the exterior cladding was removed after the test, the XPS insulation and the WRB materials were burned away directly over the window opening but did not spread laterally. Test Photos 19 through 22 show the extent of fire damage to the XPS foam insulation, WRB materials, and the FRTW plywood. When exposed to the exterior window burner, the XPS foam, which is a thermoplastic material, began to melt and burn back away from the fire plume impingement area.

Removing the combustible continuous exterior insulation will reduce the overall wall combustibility which would be expected to improve the overall wall fire performance. Compliance with NFPA 285 will, therefore, be maintained without any combustible insulation.

Replacing the tested XPS insulation with a maximum 1-inch thickness of the DuPont™ Thermax™ Brand polyisocyanurate foam plastic insulation material will not adversely affect the burning behavior of the exterior wall assembly. The Thermax™ Brand Insulation is a thermoset material, which will burn, but leave a char layer which will insulate and protect the combustible FRTW plywood during the fire more than the XPS insulation

which melted and burned away, leaving the FRTW plywood unprotected. Additionally, all compliant exterior wall assemblies will be covered by thermally heavy exterior cladding materials which will remain in place through a fire exposure and will not promote flame propagation over the exterior surface of the wall. These heavy masonry claddings will provide a flame barrier to prevent direct fire impingement on the foam plastic insulation and the FRTW plywood sheathing.

Given the combination of the DuPont™ Thermax™ Brand Insulation material being a thermoset material which will result in the formation of a char layer covering the FRTW plywood and the noncombustible, thermally heavy exterior cladding materials, it is our engineering opinion that the DuPont™ Thermax™ Brand polyisocyanurate foam plastic insulation installed over the FRTW wood stud and exterior sheathing base wall assembly will maintain compliance with NFPA 285.

5.0 Alternate WRB Materials

In the tested assembly, the DuPont™ Tyvek® CommercialWrap® WRB and the DuPont™ Tyvek® DrainVent™ Rainscreen product were installed over the continuous exterior insulation and under the HardiPlank Lap Siding. Alternate sheet good WRB products having similar flammability properties as the tested WRB are included in Table 1. Comparative fire performance properties were developed by testing conducted by Jensen Hughes on these materials in accordance with ASTM E1354 (Cone Calorimeter apparatus). Given that these alternate materials would be expected to perform similarly based on comparative fire performance properties, it is our engineering opinion that the materials listed in Table1 will not adversely impact the overall wall fire performance and will maintain compliance with NFPA 285.

6.0 Alternate Thermally Heavy Exterior Cladding Materials

The tested HardiPlank Lap Siding was the sole means of preventing direct flame impingement from the NFPA 285 apparatus exterior flame plume on the combustible insulation, WRB, and sheathing material of the tested assembly. All of the alternate exterior cladding materials listed in Table 1 will provide the same or better protection to the underlying combustibles as the tested HardiPlank Lap Siding. The brick, stones, stucco, concrete/precast panels, and concrete masonry units are thicker than the tested HardiPlank Lap Siding, have an increased ability to absorb heat, and have been tested in numerous other NFPA 285 compliant exterior wall assemblies protecting thicker amounts of foam plastic and spray polyurethane foam (SPF) insulation materials. Testing has also been conducted on exterior wall assemblies protected by ceramic tile and thin brick systems over greater insulation thicknesses and provided the thermal protection to these combustible materials. All of the thermally heavy exterior cladding materials listed in Table 1 are to be installed using any standard non-open jointed installation technique so there is no direct path for the exterior fire to pass through the cladding material and ignite the combustible materials below.

CONCLUSION

DuPont has conducted a successful NFPA 285 test on an exterior wall assembly utilizing FRTW wood studs and plywood sheathing. Based on this successful testing, alternative wall constructions were developed as detailed in Table 1 of this letter. The additional wall construction features will result in wall assemblies which will still meet NFPA 285 and provide a comparable level of fire performance as the tested wall assemblies. The technical justification for the use of additional wall system components is provided above to support their use in an exterior wall assembly which will continue to meet the conditions of acceptance of NFPA 285.

This analysis is based on the specific construction materials installed in the manner described in the referenced project drawings reviewed. 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.

We trust this engineering analysis will be of use to DuPont. Should you have any questions regarding our analysis, please contact us at 443-313-9891 or at **aparker@jensenhughes.com**.

Sincerely,

David Hintz
Lead Engineer

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

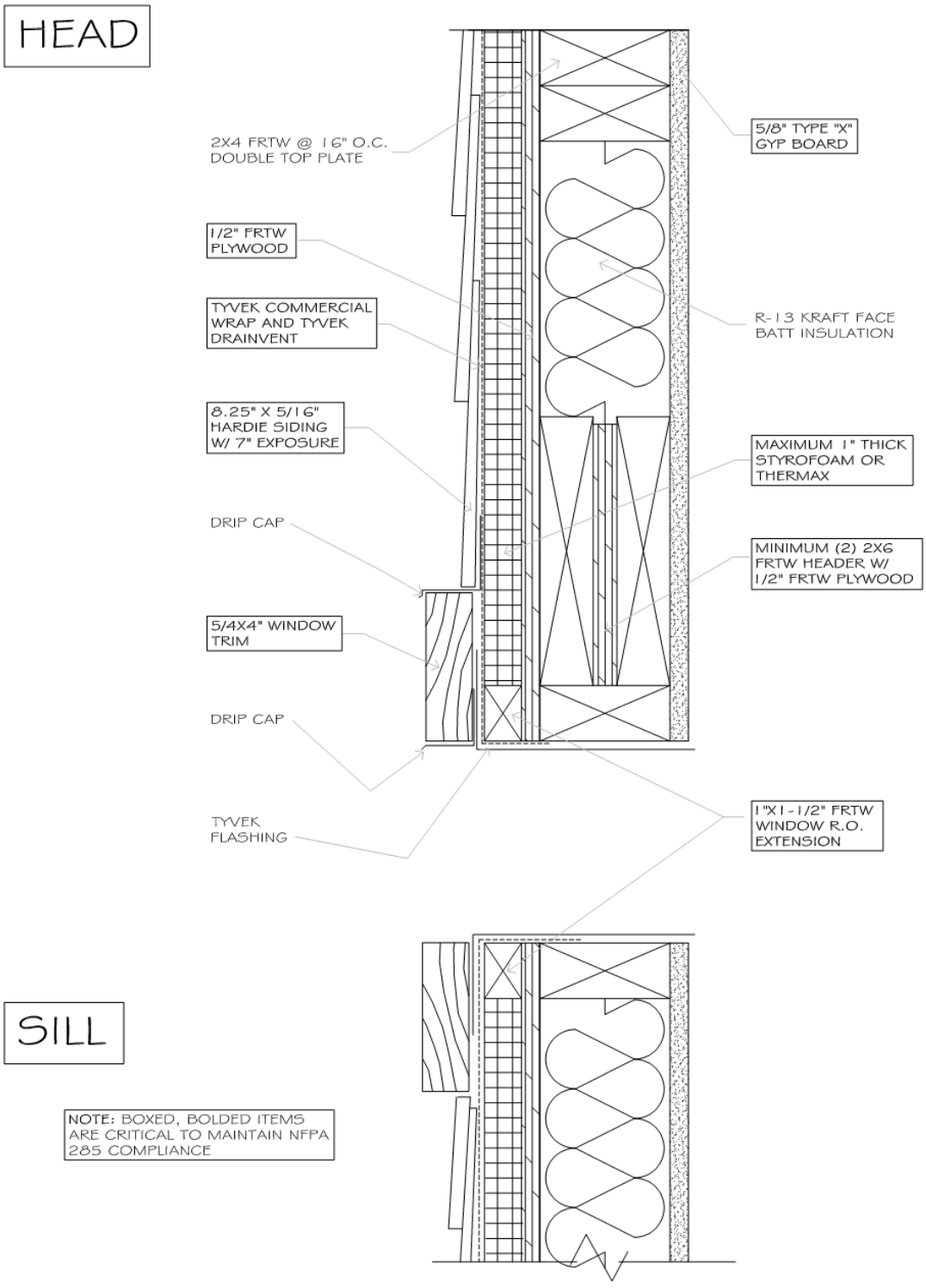

Figure 1. Wall opening treatment for cladding materials with no air cavity space

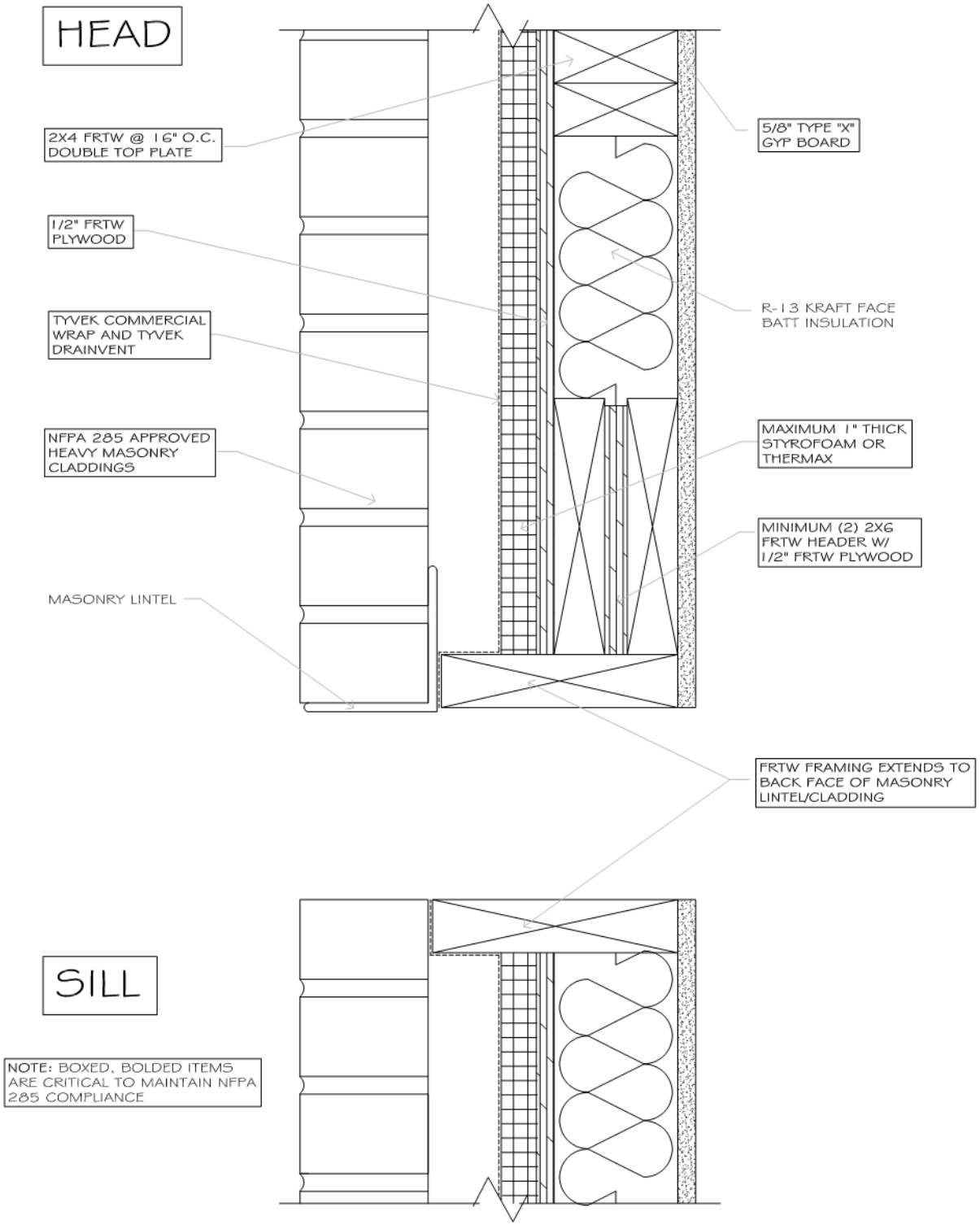

Figure 2. Wall opening treatment for cladding materials with air cavity space