ENGINEERING EVALUATION

National Gypsum PermaBase® CI Insulated Cement Board
Foam Insulation in NFPA 285 Assemblies

Project No. 10663, Revision 2

Prepared for:

National Gypsum Company
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Charlotte, NC 28211

November 23, 2019
Abstract

Atlas has granted use of their NFPA 285 Engineering Evaluation (and related data) to determine Engineering Extensions for use of National Gypsum PermaBase® CI Insulated Cement Board in previously approved Atlas polyiso NFPA 285 assemblies. This evaluation, along with NFPA 285 and Cone Calorimeter (ASTM E1354) data from National Gypsum were used to create a matrix of constructions using various combinations of Atlas/National Gypsum products which 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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November 23, 2019

Reviewed and Approved,

Deg Priest
President

November 23, 2019
INTRODUCTION

The purpose of this evaluation is to allow use of National Gypsum *PermaBase*® in previously evaluated Atlas NFPA 285 assemblies that can meet the requirements of NFPA 285 (Ref. 1). Cone Calorimeter and NFPA 285 data (Ref. 3) were submitted to evaluate *PermaBase*® for use in various Atlas constructions in EEV 10126 Ref. 4).

NFPA 285 is prescribed in the building codes for various combustible product categories where noncombustible construction is required (Type I-IV) for exterior walls. Considering the number of choices for each component used in exterior walls (interior gypsum sheathing, cavity insulation, cavity air gap, stud sizes, exterior gypsum sheathing, water resistant barrier (WRB) over base wall, exterior insulations, WRB over insulation, air gap, claddings), one can calculate that the number of possible constructions can reach into the tens of thousands of assemblies.

Since the inception of NFPA 285, Engineering Evaluations have been written for assemblies which have not been tested under NFPA 285, referencing NFPA 285 testing that has been conducted on worst-case assemblies which show that a specified alternative assembly (or array of assemblies) are determined to perform as well or better than the tested assembly (or assemblies). Most NFPA 285 approvals are based on this principle.

Engineering analyses based on known fire science principles are used to determine allowances of alternate materials or constructions which conclude that the alternate material or construction can perform the same or better than the baseline test (or tests) referenced. The basic premise of this Engineering evaluation follows this concept.

REFERENCED DOCUMENTS


3) Cone Calorimeter and NFPA 285 Data for PermaBase & Sto – Data Confidential between National Gypsum and Priest & Associates

4) Priest and Associates EEV 10126 – Atlas NFPA 285 Evaluation

5) DrJ Engineering TER 1306-03 Atlas Approved NFPA 285 Assemblies


Goal

The goal of this evaluation is as follows:

1) Since, the Atlas NFPA 285 approval (Refs. 4 & 5) allows fiber cement board cladding, the goal is to replace the fiber cement board with 5/16” *PermaBase*® and then apply the following finishes to the *PermaBase*® board:

   a) Direct-Applied EIFS – Coatings Only – NFPA 285 Approved
   b) Manufactured Stone
   c) Natural Stone
   d) Tile
   e) Thin Brick
   f) Calcium Silicate Stones
PermaBase

National Gypsum PermaBase is approved by UL for specific uses (Ref. 3) and is described therein as follows:

5. PRODUCT DESCRIPTION
PermaBase boards consist of a core made from cement, polystyrene beads and aggregates. Both sides of the board are embedded with fiberglass mesh with a smooth finish on one side and a coarse finish on the other side.

The boards are provided in various thicknesses such as 5/16 in. (7.9 mm), ½ in. (12.7 mm) and ⅝ in. (15.9 mm), and range from 32, 36 and 48 in. (813, 914 and 1219 mm) wide. The boards are provided in lengths of 48, 60, 64, 72 and 96 in. (1219, 1524, 1626, 1829 and 2439 mm).

The boards are depicted below:
PermaBase® CI Insulated Cement Board is the product above adhered (intermittent dabs of glue; hot melt, Elmer’s) to various Atlas Polyisoboard named within this report.

EVALUATION METHOD

NFPA 285 Criteria

The NFPA 285 fire test (Ref. 1) is designed to test the flame spread properties of exterior walls containing combustible components. Two noncombustible rooms are stacked to simulate two stories of a multi-story building. The wall assembly is then attached to the exterior face of the rooms. A typical test wall measures 14 ft x 18 ft with a 30 in. x 78 in. window opening placed on the bottom floor.

During a test, a calibrated fire starts in the bottom room. After 5 minutes, the exterior burner is ignited to produce a specific heat flux/temperature pattern on the exterior of the wall. Both burners remain ignited during the 30 minute test. Personnel monitor flame spread visually during the course of the test. A computer data acquisition system monitors and records the thermocouples temperatures. The criteria for passing (Ref. 1) are as follows (reworded in simple terms for this analysis):

1) Flames shall not spread vertically 10 ft above the window opening as determined visually or by thermocouples located at the 10 ft level. Failure occurs when thermocouples 11 or 14 - 17 exceed 1000°F.
2) Flames shall not spread (visually) horizontally 5 ft on either side of the centerline of the window opening.
3) Flames shall not spread inside the wall cavity as determined by thermocouples placed within the wall cavity insulation and air-gaps if present. Failure occurs when thermocouples 28 or 31 - 40 or 55 - 65 and 68 - 79 exceed 750°F above ambient.
4) Flames shall not spread horizontally within the wall cavity past the interior room dimension as determined by wall cavity thermocouples. Failure occurs when thermocouples 18 - 19, or 66 - 67, or 79 - 80 exceed 750°F above ambient.
5) Flames shall not spread to the second story room as determined by interior wall surface thermocouples. Failure occurs when thermocouples 49 - 54 exceed 500°F above ambient.
6) Flames shall not occur in the second story (visually).
7) Flames shall not escape (visually) from the interior to the exterior at the wall/wall intersection of the bottom story room.
Two burners are ignited to produce a specific time-temperature profile in the room and on the exterior face of the wall.

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

In the depictions below, thermocouples 1 - 10, and 20 - 27 are not used for compliance purposes. The remainders are used to monitor flame spread.
Thermocouples — 1 in. (25 mm) from exterior wall surface

○ Thermocouples — in the wall cavity airspace 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.
Constructions Tested

This evaluation is based on Atlas EEV 10126 (Ref. 4) as the basis document. The EEV was based on several NFPA 285 tests deemed as worst case assemblies allowing various component options based on the testing. Each report describes a specific construction tested per NFPA 285. The specific constructions are confidential, but included various combinations of wall components. These include cavity insulation, exterior sheathing, water resistive barrier (WRB), exterior insulation, exterior WRB, air gap, claddings, and window details.

Additionally, cone calorimeter data and an NFPA 285 report (Ref. 3) for National Gypsum PermaBase® and Sto were used for this analysis.

PermaBase Performance

In NFPA 285 testing (Ref. 4), PermaBase® did not spread flames and remained intact for the entire fire duration.

Note - The NFPA 285 test pictured below was conducted in a manner more severe than a standard NFPA 285 test (longer duration and more severe burner fire intensity) due to a window burner malfunction during the first 10 minutes. The window burner was ignited during its 2nd step (in an automated multi-step flow regime) and the test was allowed to continue for 6 minutes past the required 30 minute duration.
In cone calorimeter testing (Ref. 3), when tested at 50 kW/m² heat flux (a flux higher than the NFPA 285 window burner heat flux), the HRR was too low to measure accurately. The worst case result (shown below) was from testing ½ inch PermaBase (⅝ inch was also tested with lower results).

The time to ignition was over 5 minutes while the peak HRR was less than 25 kW/m². All other PermaBase results ranged from 0 to 17 kW/m² with the majority near the mid-point.

For comparison, the code allows combustible WRB’s in NFPA 285 assemblies if they are the only combustible and meet specific criteria. (See IBC 1403.5 below). In this case, the pk HRR limit is 150 kW/m². The worst case PermaBase result is less than 15% of the allowed pk HRR in the code for what is considered to be a low flammability limit.
Analysis
The Atlas NFPA 285 approval which lists ¼ inch fiber cement cladding as an approved cladding. In this case, there is an air gap behind the cladding. This air gap is a worst case compared to no air gap (the intended use of the Permabase product adhered to the atlas insulation). Where 5/16" (min.) PermaBase® will replace the fiber cement (adhered to Atlas insulation), the finished product is called:

*PermaBase® CI Insulated Cement Board*

The small amount of adhesive used to attach Permabase to Atlas will not affect NFPA 285 results since the adhesion is in dabs of intermittent glue. Ultimately, screws will be used to attach the finished product to the base wall.

The air gap is eliminated and noncombustible (or previously approved EIFS coatings) material will be added (see list below, Items a - f), thus improving the thermal performance (added thermal mass) of the system compared to bare fiber cement board.

a) Direct-Applied EIFS – Coatings Only – NFPA 285 Approved
b) Manufactured Stone
c) Natural Stone
d) Tile
e) Thin Brick
f) Calcium Silicate Stones

Adhered masonry adds thermal mass to the system which allows less heat to transfer through to the insulation. For these systems, noncombustible mortar shall be used.

EIFS lamina that is NFPA 285 approved for use over cement board or EPS or XPS may be added to the PermaBase since the expected flame spread will be similar to the tested lamina flame spread which is already NFPA 285 compliant.

**Sto WRBs**
Sto EmeraldCoat was already listed in the referenced EEV. Sto Gold Coat, Sto AirSeal, Sto VaporSeal were analyzed via cone calorimeter data compared to the baseline WRB in the referenced EEV. These WRBs are less combustible that the baseline tested and may be added to the original WRB list for use under the foam insulation (on the base wall surface).

**CONCLUSIONS**
Based on the discussion above, the following Table of NFPA 285 Assemblies (Ref. Atlas EEV 10126) shall apply to National Gypsum.

**TABLE OF SUBSTITUTIONS**

<table>
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<tr>
<th>Wall Component</th>
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| **Base Wall** – Use either 1, 2, 3 or 4 | 1) Cast Concrete Walls (1 inch min.)  
2) CMU Concrete Walls (1 inch min.)  
3) 20 GA. (min.) 3¾ in. (min.) steel with % in. type X Gypsum Wallboard Interior  
4) FRT wood studs spaced 24 in. OC (max.) with % in. type X Gypsum Wallboard Interior |
| **Floor Line Fire- Stopping**. Use 1 or 2 | 1) FRT lumber fire-blocking (for Item 4 FRT framing above)  
2) 4 inch, 4 pcf mineral fiber (wool) safing insulation installed with z-clips |
| **Cavity Insulation** – Use any Item 1 - 16 | 1) None  
2) Any noncombustible insulation per ASTM E136  
3) Any Mineral Fiber (Board type Class A ASTM E84 faced or unfaced)  
4) Any Fiberglass (Batt Type Class A ASTM E84 faced or unfaced)  

Note: SPF Cavity insulations 5 - 16 must
| Use fire stopping at floor lines (compliant with Item 2) and ¾ inch exterior gypsum sheathing. | 5) 5½ inch (max.) Icynene LD-C-50 spray foam in 6 in. deep studs (max.) full fill without an air gap.  
6) 5½ inch (max.) Icynene MD-C-200 2 pcf spray foam in 6 in. deep studs (max.) full fill without an air gap.  
7) 5 inch (max.) Icynene MD-R-210 2 pcf spray foam in 6 in. deep studs (max.) full fill without an air gap.  
8) 6 inch (max.) SWD Urethane QS 112 2 pcf spray foam in 6 in. deep studs (max.) or partial fill with a maximum 2½ in. air gap.  
9) 3½ inch (max.) Gaco Western F1850 (3½ inch max.). Use with % inch interior sheathing in 3 in. deep studs (max.)  
10) 5½ inch (max.) Icynene MD-R-210 2 pcf spray foam in 6 in. deep studs (max.) full fill without an air gap.  
11) Demilec Selection 500 (3⅝ inch max). Use with % inch interior sheathing in 3⅝ in. deep studs (max.).  
12) Demilec HeatLok Soy 200 Plus (3.4 inch max). Use with % inch interior sheathing in 3⅝ in. deep studs (max.)  
13) Bayer Bayseal (3 inch max). Use with % inch interior sheathing.  
14) Lapolla FoamLok FL 2000 (3 inch max). Use with % inch interior sheathing in 3⅝ in. deep studs (max.)  
15) BASF SprayTite 81206 or WallTite (US & US-N) (3⅝ inch max). Use with % inch exterior sheathing in 3⅝ in. deep studs (max.)  
16) Accella (Premium Spray Products) Foamsulate 220 (3⅝ inch max.). Use with % inch exterior sheathing in 3⅝ in. deep studs (max.). |

| Exterior Sheathing –  Use either 1, 2 or 3 When SPF is used in cavity, exterior sheathing must be used. See specific sheathing thicknesses above. | 1) ½ in. or thicker exterior gypsum sheathing  
2) None – when cavity SPF insulation is not used.  
3) 2 in. precast concrete panels attached to structural elements of building. |

| WRB over Sheathing –  Use any item 1 – 23 | 1) None  
2) Tyvek Commercialwrap D – stapled (1 or 2 layers)  
3) Henry Air-Bloc 32MR (75 wet mils)  
4) Any WRB which has been tested per ASTM E1354 (at a minimum of 20 kW/m² heat flux) and shown by analysis to be less flammable (improved Tₘ, Pk. HRR) than those listed above. Examples of such are listed below:  
5) BASF Enershield HP, EnergyShield I  
6) CCW Fire Resist 705, 705 VP, or 705 FR-A, Fire Resist Barritech NP, VP, or VP LT  
7) Dow Corning DefendAir 200 Low Temp  
8) Dryvit Backstop NT, NT Smooth, NT Spray, NT Texture  
9) Dupont Fluid Applied (0.8 mm)  
10) GE Momentive Elemax 2600  
11) Grace Permabarrier PAB VPL LT, PAB NPL 10, PAB NPL, PAB NPS, PAB VPS, PAB VPL, PAB AWM or PAB VPL 50  
12) Henry Air-Bloc 31MR, Air-Bloc 33MR, Air Bloc 21 FR, VP 160  
13) Hohmann & Barnard Enviro-Barrier VP, X Barrier, Enviro-Barrier  
15) Parex WeatherSeal Spray and Roll On  
16) Prosoco R-Guard Spray Wrap, SprayWrap MVP, R-Guard MVP, R-Guard VB, R-Guard Cat-5 or Cat 5 Rainscreen  
17) Sto EmeraldCoat, Sto Gold Coat, Sto AirSeal or Sto VaporSeal  
18) STS Wall Guardian FW 100A  
19) Tremco Exo-Air 230 (31.5 mils), 130, or ExoAir 111  
20) Vaprosheild Wrapshield SA, Revealshield SA  
21) WR Meadows Air-Shield LMP (Gray), Air-Shield LMP (Black), Air-Shield TMP, Air-Shield LSR  
22) Soprema LM 204 VP, Sopraseal Stick VP, Sopraseal 1100T, Soprasolin HD  
23) Siga Majvest 500 SA |
### Exterior Insulation –
Use either 1, 2, or 3.

Items 1 - 3 may be multiple layers of 1 inch thick (minimum) with facers on each side.

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<thead>
<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>4 in. (max.) EnergyShield Pro (or Pro2)</td>
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<tr>
<td>2</td>
<td>4 in. (max.) RBoard Pro (or EnergyShield CGF Pro)</td>
</tr>
<tr>
<td>3</td>
<td>4¾ in. (max.) EnergyShield Ply Pro (4 in. EnergyShield CGF Pro w/ ¼ in. or ¾ in. FRT Plywood)</td>
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### Exterior Covering –
*PermaBase® CI Insulated Cement Board*

For Items b - f, noncombustible mortar shall be used.

Permabase adhered to Atlas using intermittent dabs of glue; hot melt, Elmer’s

5/16” (min.) PermaBase adhered to Atlas insulation above is named *PermaBase® CI Insulated Cement Board*, and the following finishes may be applied to the PermaBase surface:

a) Direct-Applied EIFS – Coatings Only – NFPA 285 Approved
b) Manufactured Stone
c) Natural Stone
d) Tile
e) Thin Brick
f) Calcium Silicate Stones

Adhere 5/16” (min.) Permabase to the Atlas Insulation named above, attach the *PermaBase® CI Insulated Cement Board* to the base wall using screws (per mfr’s instructions), then apply one of the finishes listed in Items a - f.

~ End of Report ~