




TECH SOLUTIONS 513.0  
THERMAX™ WALL SYSTEM



This document presents an overview of issues facing designers and contractors today, particularly in regard to steel stud wall construction, and describes how the THERMAX™ Wall System can address many design and construction challenges. General design considerations for steel stud walls, details on extensive testing that has been conducted on the THERMAX™ Wall System and sequencing guidelines are also included. For design guides, CAD details and BIM models, visit [www.thermaxwallsystem.com](http://www.thermaxwallsystem.com).



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**INTRODUCTION**

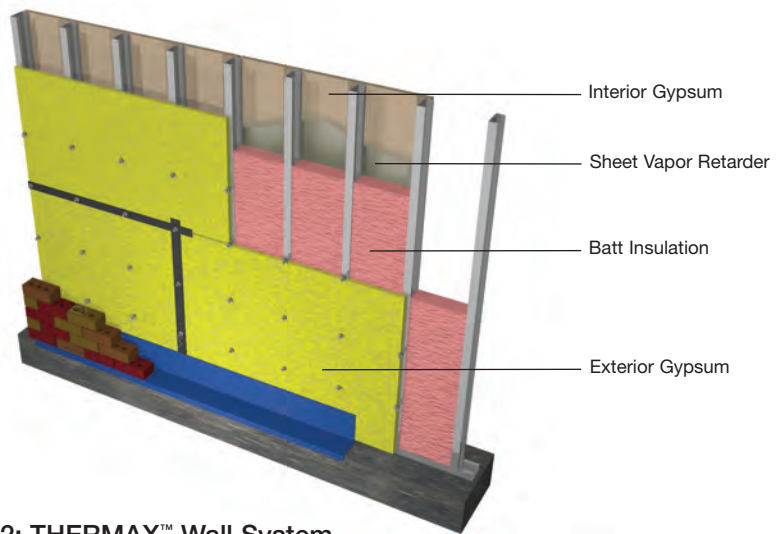
For more than 100 years, light gauge steel framing has been an important and growing part of the commercial wall construction market. Steel frame construction is light, strong, adaptable and consistent in tolerance and properties. The multitude of sizes and shapes of steel framing members far exceeds the number of wood-based options, enhancing the advantages of steel stud construction by offering designers and contractors versatility, along with saving time and money.

Among the many types of steel frame wall systems, one assembly style is most common: 3-1/2" to 6" deep steel framing members placed on 16" centers (Figure 1). Exterior gypsum is then attached to the outside framing surface; fiberglass batts are installed between the steel members; a sheet vapor retarder is added; and an interior sheathing of gypsum board is attached after the wiring and plumbing are installed. Often, an air/water-resistive barrier is installed over the exterior gypsum. Finally, an exterior finish is added – typically brick, architectural panels or some other aesthetic covering.

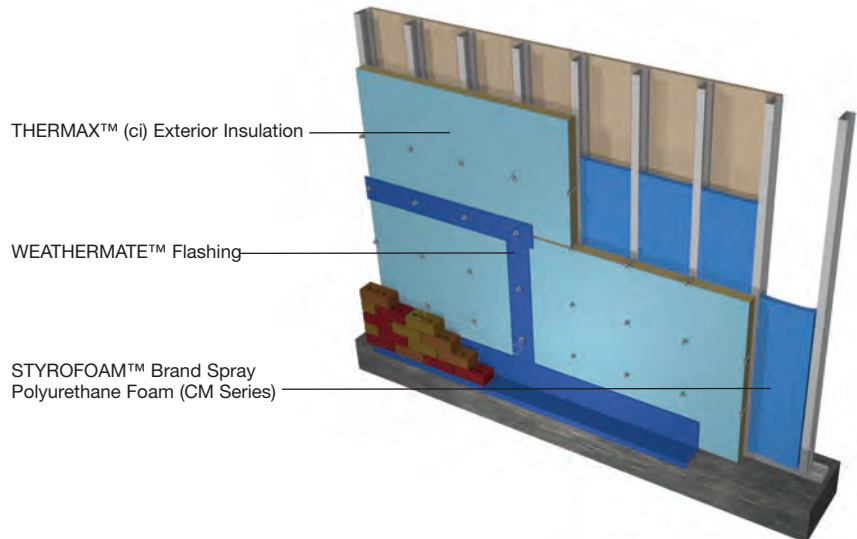
A wall assembly that uses the THERMAX™ Wall System, featuring continuous insulation, an air barrier and flashing, eliminates the need for batt insulation, exterior gypsum and a separate air/water-resistive barrier (Figure 2). With the THERMAX™ Wall System, once the steel framing members are in place, THERMAX™ (ci) Exterior Insulation is attached to

More than an insulated wall, the THERMAX™ Wall System eliminates the need for batt insulation and is a systematic approach to achieving efficiency at every level: simplified design, streamlined construction and reduced energy consumption. The three-in-one system includes insulation, an air barrier and flashing, and meets all applicable IBC and ASHRAE requirements.

**Figure 1: Typical Steel Stud Wall Assembly**



**Figure 2: THERMAX™ Wall System**



the outside framing surface, followed by WEATHERMATE™ Flashing and veneer steel stud ties. STYROFOAM™ Brand Spray Polyurethane Foam (SPF) (CM Series) is applied to the interior of the stud cavity.

The THERMAX™ Wall System provides designers and contractors with a fundamentally different steel frame construction option – one that can contribute to a more efficient building envelope.

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**ENERGY EFFICIENCY AND SUSTAINABILITY**

**Energy Efficiency**

Energy – and optimizing its use in buildings – is one of the most important issues facing designers. Excessive heat flow through steel framed walls has long-term consequences for both the building owner and society at large as commercial buildings require vast amounts of energy. In fact, 18 percent of all energy consumed in the United States is used in commercial buildings.\*

**Global Warming and Climate Change**

Typically, the energy used to condition commercial building interiors comes from fossil fuels. The carbon in these fossil fuels is converted into carbon dioxide (CO<sub>2</sub>) when burned, releasing more than a billion tons of CO<sub>2</sub> into the atmosphere every year.\* Concerns about the impact of these emissions on global climate change are driving efforts to design more efficient buildings with smaller carbon footprints.

**Sustainability**

The amount of fossil fuels available for energy generation is finite. The faster fossil fuels are used, the less time remains to develop alternative energy sources. Reducing fossil fuel use through more energy-efficient building envelopes can help ease the transition to sustainable energy alternatives.

**Economic Issues**

More than one-third of the fossil fuels used in the United States are imported.\* Excessive use of imported fossil fuels could have long-term economic consequences on the economy of the energy importing country. Ironically, efforts to save on initial building costs by reducing spending on insulation can result in higher life-cycle building costs. **As shown in Figure 3, improved building insulation systems are one of the most cost-effective ways to reduce energy consumption, which reduces greenhouse gas emissions.**

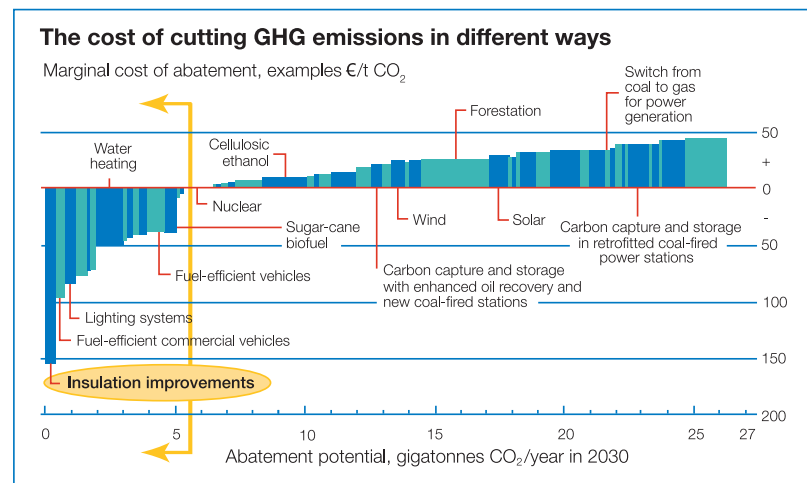
**LEED**

The THERMAX™ Wall System can help design professionals achieve credits in the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED) program. Relevant credits include, but may not be limited to:

- EA Prerequisite 2 (Minimum Energy Performance)
- EA 1 (Optimize Energy Performance)
- EQ 7.1 (Thermal Comfort)
- ID 1.1 to 1.3 (Innovation in Design)

To learn how the THERMAX™ Wall System can contribute to LEED points for new construction and major renovations, read the THERMAX™ Wall System and LEED information sheet (Form No. 179-04504) at [www.thermaxwallssystem.com](http://www.thermaxwallssystem.com). For more information on LEED, visit [www.usgbc.org](http://www.usgbc.org).

**Figure 3: Building Insulation Cost-Effectively Reduces Greenhouse Gas Emissions Globally**



Source: Study conducted by McKinsey & Company, and Vattenfall

McKinsey & Company studied the costs of implementing various GHG abatement options. "Insulation improvements" is among the more economical measures at the left of the arrows that provide the fastest payback and should be implemented before doing any of the other measures. And as the graph shows, "insulation improvements" is by far the best measure in terms of a negative marginal cost. This graph represents only a few of the abatement options researched. For the graph in its entirety, visit [www.mckinseyquarterly.com/A\\_cost\\_curve\\_for\\_greenhouse\\_gas\\_reduction\\_1911](http://www.mckinseyquarterly.com/A_cost_curve_for_greenhouse_gas_reduction_1911).

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\*Source: Annual Energy Review 2007, [www.eia.doe.gov](http://www.eia.doe.gov)

**THERMAL PERFORMANCE OF STEEL STUD WALLS**

Thermal performance is really about minimizing energy use. Achieving desired thermal performance from a steel stud wall requires an understanding of how heat moves through such a wall. The key is in understanding the thermal properties of steel and how this affects the thermal properties of the wall system as a whole.

**Properties of Steel and the Effect on Walls**

Steel is a very good conductor of heat. The R-value\*\* of steel varies with its precise makeup, but a representative value is about R-0.003 per inch according to the ASHRAE Fundamentals Handbook. Figure 4 shows how the R-value of steel compares with other selected construction materials. (Note that the R-value of steel is so low that it cannot be seen.)

The very low R-value of steel means that heat moves through it almost effortlessly. Even small amounts of steel can transport large amounts of heat from one place to another. This property has serious consequences in the real-world performance of steel stud walls. Typical steel stud wall design places batt insulation between the studs, which are then sheathed with other low R-value materials like gypsum board. This results in an uneven thermal distribution over the wall. The steel studs act as thermal short circuits, where heat moves rapidly around the batt insulation, reducing the system's thermal performance (Figure 5).

ASHRAE has tabulated both measured and calculated effective R-values for a variety of steel stud configurations, which reveals the actual effective thermal performance of batt insulation compared to its claimed R-value (Figure 6).

The groundbreaking THERMAX™ Wall System combines three simple parts – insulation, air barrier and flashing – into a system that achieves exceptional results.

The data clearly show that adding more insulation between the studs does not significantly improve effective thermal performance, nor does increasing the stud size (from 3-1/2" to 6") or stud spacing (from 16" to 24"). Currently it is physically impossible to design a steel stud wall system with a system R-value over R-10 using typical assemblies.

**Improving Performance With "ci"**  
The thermal performance of a steel stud wall can be improved with proper placement of the insulation. Insulation placed on the steel studs rather than between them will reduce thermal shorts in the system, resulting in better thermal performance.

Figure 4: R-Values of Common Materials

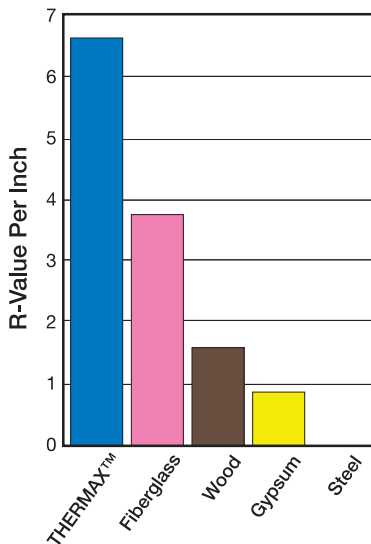


Figure 5: Steel Studs Act as Thermal Short Circuits

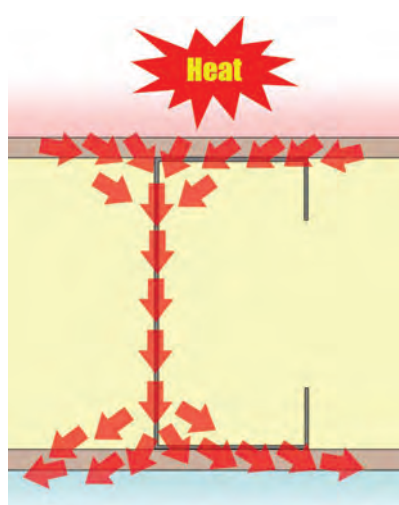
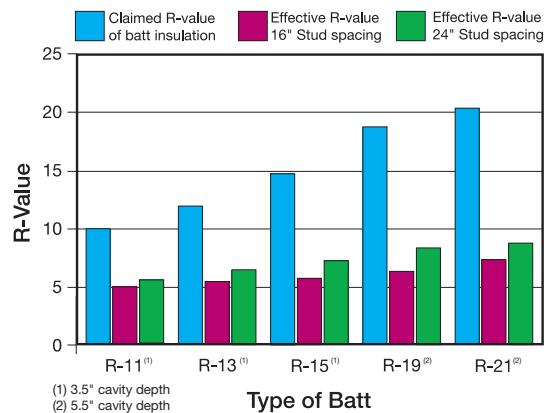


Figure 6: Effective R-Values of Batts at 16" and 24"



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\*\*R means resistance to heat flow. The higher the R-value, the greater the insulating power.

When installed on the exterior of the studs, THERMAX™ (ci) Exterior Insulation provides an effective means of improving thermal performance in a steel stud wall, significantly reducing thermal shorts. With the use of THERMAX™ (ci) Exterior Insulation, the thermal performance for the THERMAX™ Wall System can easily achieve R-16 or more (Figure 7).

### Meeting Energy Codes

The 2006 International Energy Conservation Code (IECC) published by the International Code Council (ICC) specifies two possible routes to meet code-required energy performance in commercial buildings:

1. The Energy Efficiency Guidelines in Chapter 5 of the IECC
2. ASHRAE 90.1, "Energy Standard for Buildings Except for Low-Rise Residential Buildings"

The THERMAX™ Wall System meets or exceeds these energy-performance requirements.

The 2009 IECC has the same prescriptive requirements as ASHRAE 90.1-2007. Because of these identical requirements, this THERMAX™ Wall System technical piece will only refer to them as the ASHRAE requirements going forward.

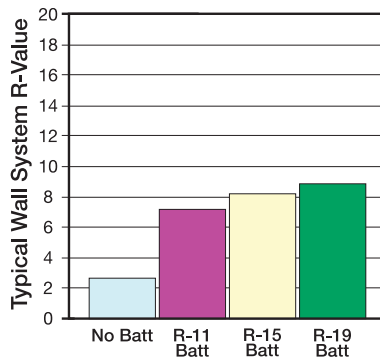
ASHRAE 90.1-2007 contains significant insulation requirement changes for steel stud wall assemblies in recognition of the dramatic thermal short heat paths provided by the steel studs. The changes mandate higher prescriptive levels of continuous insulation (ci) as a method to reduce the effect of thermal shorts and increase the energy efficiency and sustainability of the building (Table 1).

The prescriptive path to meeting the ASHRAE 90.1-2007 requirements outlines specific configurations for the various geographic locations or zones that must be used to meet the code requirements for walls, roofs and fenestrations (Figure 8).

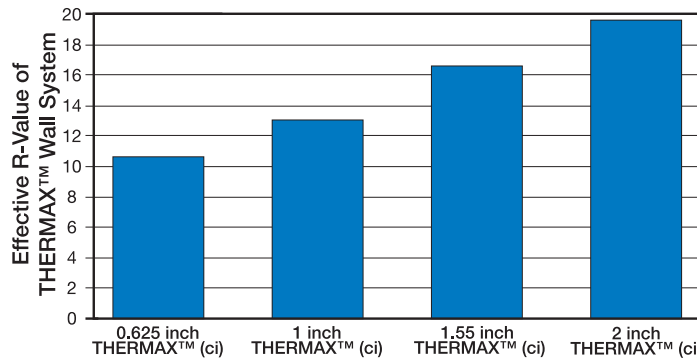
In Table 1, the insulation requirement changes are highlighted. R-13 refers to the R-value of the batt insulation placed between the steel studs. The number designated with "ci" indicates the R-value of the continuous layer of insulated sheathing applied over the steel studs. For example, ASHRAE 90.1-2007 in Zone 5 calls for R-13 batt insulation between the studs and a layer of R-7.5 continuous insulation over the studs. Table 2 lists the ASHRAE 90.1-2007 requirements as well as the resulting U-factor and total R-value for the THERMAX™ Wall System assembly.

Figure 7: Effective System R-Values<sup>(1)</sup> for Steel Stud Walls

Wall Assembly With Fiberglass Insulation



THERMAX™ Wall System, Which Includes STYROFOAM™ Brand SPF (CM Series) (1.5" thick) in the Cavity



(1) System R-value includes other wall assembly components, such as interior gypsum and exterior sheathing.

TABLE 1: CHANGES TO PRESCRIPTIVE INSULATION REQUIREMENTS FOR STEEL STUD WALL ASSEMBLIES								
Code	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7	Zone 8
2006 IECC	R-13	R-13	R-13	R-13	R-13+3.8 ci	R-13+3.8 ci	R-13+7.5 ci	R-13+7.5 ci
ASHRAE 90.1-2004	R-13	R-13	R-13	R-13	R-13+3.8 ci	R-13+3.8 ci	R-13+7.5 ci	R-13+7.5 ci
ASHRAE 90.1-2007	R-13	R-13	R-13+3.8 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci
2009 IECC	R-13	R-13	R-13+3.8 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci	R-13+7.5 ci

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TABLE 2: MEETING ASHRAE 90.1-2007 BUILDING ENVELOPE REQUIREMENTS<sup>(1)</sup> FOR U.S. CLIMATE ZONES USING THE THERMAX™ WALL SYSTEM

Climate Zone	Nonresidential <sup>(2)</sup> Requirements	THERMAX™ (ci) Thickness Required and Resulting U-Factor <sup>(3)</sup>	Residential <sup>(4)</sup> Requirements	THERMAX™ (ci) Thickness Required and Resulting U-Factor <sup>(3)</sup>
1	R-13 U= 0.124 R= 8.06	0.625" U= 0.092 R= 10.8	R-13 U= 0.124 R= 8.06	0.625" U= 0.095 R= 10.6
2	R-13 U= 0.124 R= 8.06	0.625" U= 0.092 R= 10.8	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8
3	R-13 + 3.8 ci U= 0.084 R= 11.90	1.0" U= 0.076 R= 13.2	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8
4	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8
5	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8
6	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8
7	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8	R-13 + 15.6 ci U= 0.042 R= 23.8	3.0" U= 0.039 R= 25.7
8	R-13 + 7.5 ci U= 0.064 R= 15.63	1.55" U= 0.059 R= 16.8	R-13 + 18.8 ci U= 0.037 R= 27.0	3.5" U= 0.035 R= 28.8

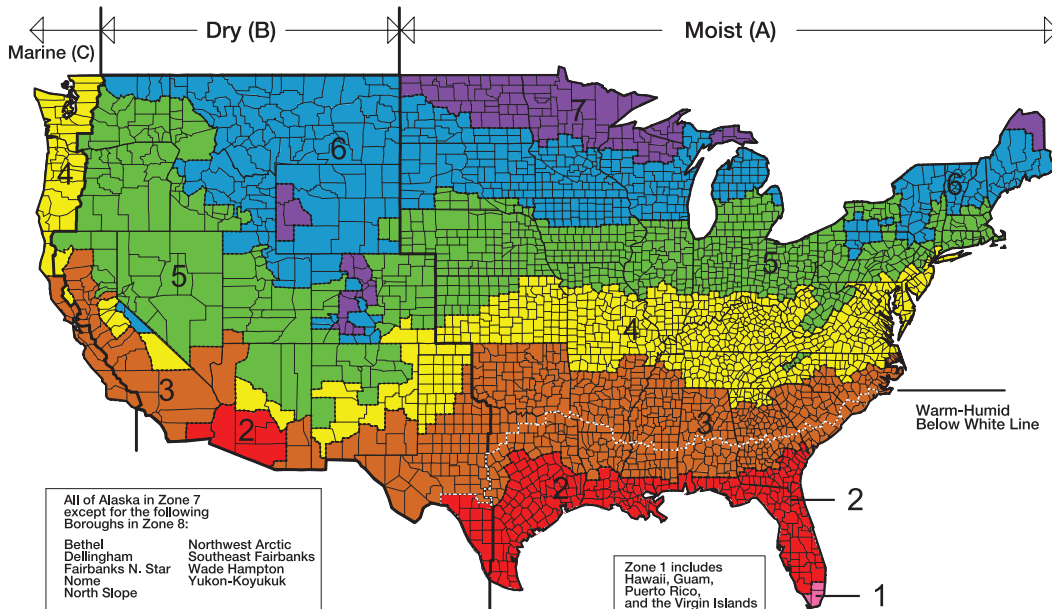
ASHRAE 90.1 is not only essential to meeting energy codes, it is a fundamental part of achieving the USGBC LEED credits. LEED EA Credit 1 is currently based on the 2004 version of ASHRAE 90.1. In the near future, the LEED system is expected to use ASHRAE 90.1-2007 as its baseline. At least two points in EA Credit 1 will be mandatory, making the LEED wall insulation requirements even more stringent than those outlined in Table 1.

(1) The ASHRAE commercial nonresidential requirements are used as the baseline for THERMAX™ Wall System.  
 (2) All occupancies other than residential  
 (3) Includes 1.5" layer of STYROFOAM™ Brand SPF (CM Series)  
 (4) Spaces in buildings used primarily for living and sleeping. Residential spaces include, but are not limited to, dwelling units, hotel/motel guest rooms, dormitories, nursing homes, patient rooms in hospitals, lodging houses, fraternity/sorority houses, hostels, prisons and fire stations.

“R U” Confused?

Component R-values or U-factor. Which is a more accurate measurement of thermal performance? Adding together component R-values does not result in an accurate wall system R-value. For example, heat moves around the batt insulation, reducing its effect on the overall wall system. Scientific measurements of whole wall systems have shown that R-13 batt insulation in 16" o.c. walls adds only R-5.3 to the assembly. However, the U-factor is a measure of heat transmission through the entire assembly. Therefore, the U-factor is more important when considering overall thermal performance. And the lower the U-factor, the more energy-efficient the wall assembly.

Figure 8: Climate Zones for the United States (2004 Supplement to the IECC)



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Designers are not strictly confined to the specific steel stud configurations for each zone. Wall systems can comply if they meet the resulting U-factor for the specific configuration as indicated in the standard's Appendix A:

*5.5.3.2. Maximum U-Factor, C-Factor or F-Factor for the entire assembly*

*The values for typical construction assemblies listed in Normative Appendix A shall be used to determine compliance.*

As long as designers maintain the same or lower U-factor for a proposed wall assembly as is achieved by the specific wall configuration prescribed for the same zone using the methods outlined in Appendix A, the proposed wall assembly will meet the requirements of ASHRAE 90.1-2007.

**AIR INFILTRATION IN STEEL STUD WALLS**

While insulation is the primary way to increase a building's energy efficiency and to manage heating and cooling costs, it is important to consider another cause of significant energy loss – air infiltration. Air sealing the wall assembly creates a tighter building, which helps optimize energy savings, manage moisture intrusion, reduce demand on the heating and cooling system, and minimize carbon footprint.

**Spray Foam Test Results**

To address the high cost of air infiltration, several regions of the United States have air barrier requirements for commercial walls

– a growing trend in the industry. A number of air barrier material characterization test methods have been used for many years; however, there are few air barrier assembly tests. So Dow put the THERMAX™ Wall System, including its air barrier component – STYROFOAM™ Brand SPF (CM Series) – to the test.

**The THERMAX™ Wall System has passed ASTM E2357** “Standard Test Method for Determining Air Leakage of Air Barrier Assemblies,” a relatively new standard in the industry that has strong support from industry associations such as the Air Barrier Association of America and the U.S. Department of Energy.

Unlike air barrier material tests of the past, ASTM E2357 tests the air leakage of an 8' x 8' wall assembly. The test involves two walls – an opaque wall and a penetrated wall. The standard specifies that penetrations meet specific requirements for size, type and location. The walls are tested for air leakage and are then subjected to a series of wind loadings. They are then tested again for air leakage. The wind loadings begin with sustained positive and negative pressure for one hour, followed by 2,000 cycles of combined positive and negative wind loading, and finally, 3-second gust loading at 25.08 psf maximum.

Following the required test standard parameters, the THERMAX™ Wall System was subjected to extreme wind loading conditions, beyond the force of Hurricane Katrina, to demonstrate the assembly's strength and integrity.

To pass this test, the air leakage rate following the test must be below the required level, and there must be no evidence of cracks, buckles or visible damage of any kind. The extreme loading (10-second loading both positive and negative forces) was performed on the opaque and penetrated systems to a pressure >130 psf with no visible signs of damage. Results are given in Table 3.

**STYROFOAM™ Brand SILL SEAL Foam Gasket**

Another air sealing product from Dow is an ideal choice for steel stud wall assemblies. STYROFOAM™ Brand SILL SEAL Foam Gasket is a flexible polyethylene foam gasketing strip that can help reduce air infiltration between a concrete foundation and sill plate, around windows and doors – and even between floors. The closed-cell polyethylene foam compresses to seal gaps in irregular surfaces, helping reduce air infiltration for a tighter building envelope and enhanced energy savings. It provides excellent and enduring resistance to water and water vapor.

TABLE 3: ASTM E2357 TEST RESULTS FOR THERMAX™ WALL SYSTEM

Opaque Wall	Test Pressure	Before Loads	After Sustained, Cycled and Gust Loading
Infiltration	6.27 psf	<0.01 cf <sub>m</sub> /ft <sup>2</sup>	<0.01 cf <sub>m</sub> /ft <sup>2</sup>
Exfiltration	6.27 psf	<0.01 cf <sub>m</sub> /ft <sup>2</sup>	<0.01 cf <sub>m</sub> /ft <sup>2</sup>
Penetrated Wall	Test Pressure	Before Loads	After Sustained, Cycled and Gust Loading
Infiltration	6.27 psf	<0.01 cf <sub>m</sub> /ft <sup>2</sup>	<0.01 cf <sub>m</sub> /ft <sup>2</sup>
Exfiltration	6.27 psf	<0.01 cf <sub>m</sub> /ft <sup>2</sup>	<0.01 cf <sub>m</sub> /ft <sup>2</sup>

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## MOISTURE CONSIDERATIONS

### Moisture Condensation in Steel Stud Walls

Moisture damage to wall systems can be expensive for both owners and designers. Moisture condensation in a wall system (as opposed to bulk water intrusion from leaks) is an insidious means by which moisture damage can occur. There are many methods to help reduce moisture problems caused by condensation. The first step to selecting the right method for a given steel stud wall system is to understand how condensation works.

#### *Principles of Condensation*

Condensation is the change of water vapor into liquid water. The temperature at which this change occurs is the dew point. **Condensation occurs when the temperature of the air holding the water vapor is lowered to the dew point temperature.** Cold temperatures increase the likelihood of condensation; warm temperatures reduce it.

#### *Controlling Condensation in Steel Stud Walls*

Adjusting the permeability of the layers in a wall assembly can help manage moisture. But such design strategies require exacting installation and the presumption of consistent long-term permeability properties of the influential layers.

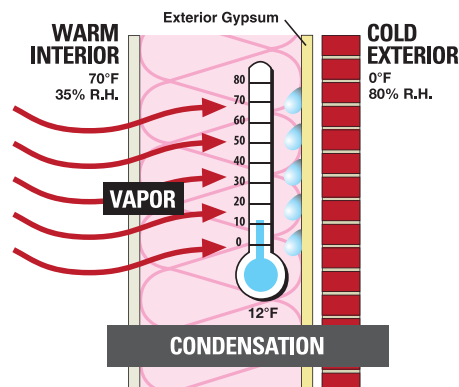
However, since condensation is caused by temperature changes, the ultimate method for controlling condensation is to **control the temperature within the wall assembly** with the proper application of thermal insulation. Thermal insulation not only reduces heat flow, it

also changes the temperature gradient in the wall. Proper placement of the right amount of insulation can dramatically reduce the potential for condensation in a steel stud wall.

A typical steel stud wall consists of steel studs with batt insulation in the stud cavity. The outside surface of the steel stud assembly is typically faced with exterior gypsum with a brick exterior fascia. Figure 9 shows the temperature of the interior surface of the exterior gypsum when it is analyzed with the conditions of 70°F and 35 percent relative humidity on the inside and 0°F and 80 percent relative humidity on the outside.

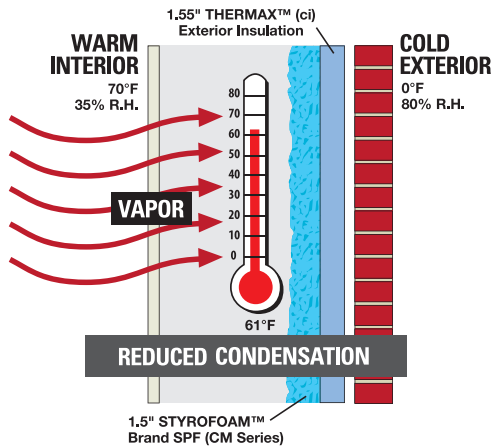
In Figure 9, the interior surface of the exterior gypsum is 12°F. At this low temperature, the potential for condensation of any water vapor that reaches this surface is very high. Sealing the cavity with low permeance materials like polyethylene film is a possible solution, but it demands excellent installation and the wall will forever be dependent on the film's quality. In addition, the thermal performance of this solution is not very good. The entire system will have an effective R-value of about R-9.31, far less than the R-13 anticipated from the installation of batt insulation in the cavity.

Figure 9: Temperature Within a Typical Steel Stud Wall



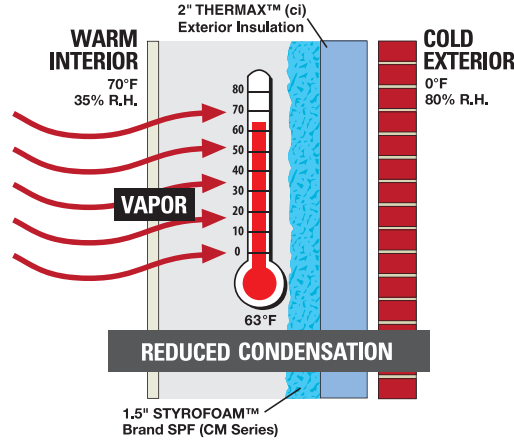
The THERMAX™ Wall System solution replaces the exterior gypsum with 1.55" thick THERMAX™ (ci) Exterior Insulation and the batt insulation with 1.5" thick STYROFOAM™ Brand SPF (CM Series) (Figure 10). The inside surface temperature has warmed up to 61°F. The effective R-value of this wall is R-16.8.

Figure 10: Temperature Within a Steel Stud Wall With 1.55" THERMAX™ (ci) Exterior Insulation and 1.5" Layer of STYROFOAM™ Brand SPF (CM Series)



The wall's performance can be improved even more by using 2" thick THERMAX™ (ci) Exterior Insulation (Figure 11). The temperature of the insulation's interior surface has been increased to 63°F. The cavity is now essentially a conditioned space and the chance for condensation is near zero. This increase in the thickness of THERMAX™ (ci) Exterior Insulation results in a total effective R-value of R-19.7.

Figure 11: Temperature Within a Steel Stud Wall With 2" THERMAX™ (ci) Exterior Insulation and 1.5" Layer of STYROFOAM™ Brand SPF (CM Series)



#### Drying Potential

A related issue to condensation is evaporation, or drying potential. Drying potential is important as it plays a role in the ability of a wall assembly to dry out if bulk water intrusion (e.g., a leak) has occurred. Many experts often discuss drying potential as it relates to water vapor permeability, but rarely discuss the relationship between drying potential and temperature. Temperature has a very strong effect on drying potential: The warmer the surface, the more rapidly it will dry. Unlike a typical steel stud wall assembly, the THERMAX™ Wall System provides a warm, conditioned cavity, which allows water that enters the cavity to evaporate faster.

## DESIGN CONSIDERATIONS

### Structural Considerations for Steel Stud Wall Design

Steel stud wall construction requires lateral bracing in order to effectively transfer wind and seismic loads to the studs and from there to the primary structural components of the building. The system of studs braced effectively will also resist twisting motion from the applied load according to the engineered design. International Building Code (IBC) Chapter 22, covering the use of steel in commercial construction, requires that the lateral bracing design follow the recommended design practice provided by the American Iron and Steel Institute (AISI). Out-of-plane (or suction/transverse) loads must also be considered and will be discussed briefly.

#### *AISI All-Steel Bracing Design Method*

The AISI All-Steel Method is the recommended bracing practice for the THERMAX™ Wall System based on both structural and building sequencing factors.

The all-steel method is a bracing design that uses horizontal or diagonal steel members that are attached through the center of a stud space via cutouts or on the face of the stud on the interior and exterior (Figures 12-14). Combinations of these techniques are commonly used and can be mixed to account for openings and other design situations. A large variety of products are available for bracing designs.

Many steel stud manufacturers also produce accessory lines that include bracing products. Some steel stud manufacturers provide guidance and recommendations on designs for common wall designs.

All-steel method designs ignore bracing contributions from the rigid sheathing and stand alone to provide lateral bracing strength to the structure. It is understood that the addition of rigid sheathing to the surface of the studs will aid in bracing the wall when initially installed; but what is not clearly understood is how to design for a reduction in this value due to wind loading on the wall that causes the rigid sheathing to hollow out around the mechanical fasteners.

Figure 12: Lateral Bracing With CR-Channel Bridging

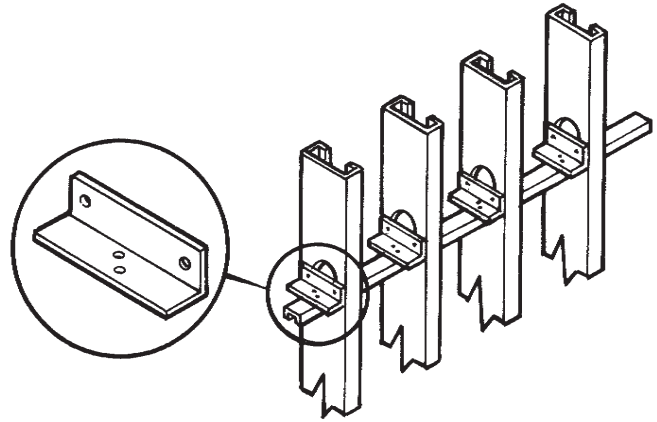


Figure 13: Diagonal Cross-Bracing

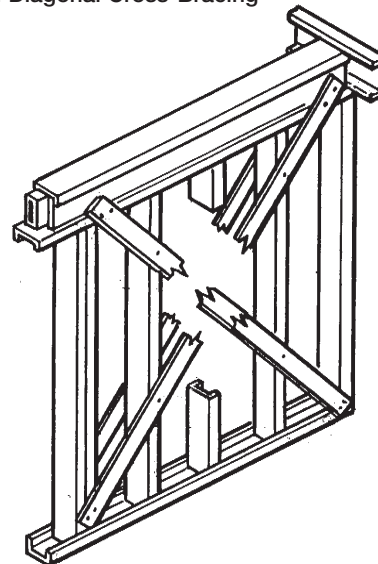
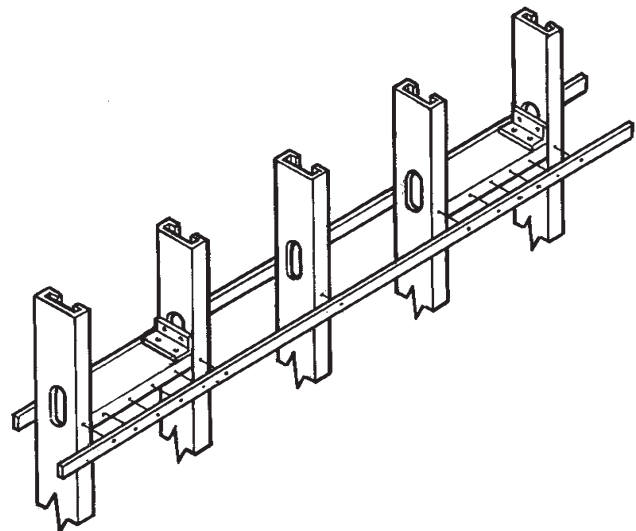


Figure 14: Lateral Bracing With Solid Bridging



This technique allows greater flexibility in the types of sheathing products that can be used in a steel stud wall design. It also allows for greater flexibility in determining when interior drywall is installed – a benefit that buys time for other trades to complete work in the stud cavity before it is enclosed.

By using all-steel bracing, foam plastic insulation can be placed outboard of the studs. This continuous thermal break provides a great energy benefit.

#### *Transverse Loading*

A final consideration for bracing of cavity wall construction is transverse loading that would tend to pull the veneer away from the primary framing unless anchored appropriately.

The IBC Chapter 14 (Exterior Walls) requires that the veneer (brick or other material) be connected directly to the stud on a regular grid horizontally and vertically. Review the recommended veneer-tie products for this application on page 19. The manufacturer can provide further information on the spacing required (generally every 16" on center). Alternate veneers should be designed with attachment points to meet these requirements.

#### **Fire Design Considerations for Steel Stud Walls Using Foam Plastic Insulation**

In order to meet energy code requirements (refer to ASHRAE 90.1 and the IECC) for conditioned buildings, steel stud designs need insulation. Foam plastic insulation is frequently incorporated into commercial wall designs as a single component or in combination with other insulation products to meet insulation U-factor requirements. When specified for a steel stud project, foam plastic insulation and the full wall assembly design must first comply with several requirements in order to be used successfully.

#### *Use of Foam Plastic Insulation in Wall Construction*

Two methods are common for installing foam plastic insulation: in the stud cavity space that is frequently filled with fiberglass and outboard of the primary framing.

Installing foam plastic insulation in the stud cavity space is useful when insulation outboard of the stud is not possible due to space considerations or when a direct replacement for fiberglass is desired. In many cases, this interior solution is used on an exterior single-wythe masonry wall, and the stud space is created by Z-furring as part of a finished gypsum interior wall. Either rigid foam plastic insulation or spray polyurethane foam plastic insulation may be used.

When installed on the exterior of the studs, foam plastic insulation can provide a full thermal break from the interior to the exterior of a structure. This is a common installation for anchored veneer masonry and steel stud cavity wall construction.

The THERMAX™ Wall System combines these two approaches. The THERMAX™ (ci) Exterior Insulation is installed outboard of the steel studs, creating a continuous enclosed envelope. Then, 2-pcf STYROFOAM™ Brand Spray Polyurethane Foam (SPF) (CM Series) is installed on the interior in the stud cavity space against the back side of the THERMAX™ (ci) Exterior Insulation.

#### *2006 IBC Foam Plastic Insulation*

Foam plastic insulation products have some of the most stringent requirements governing their use, especially in commercial construction. The 2006 IBC Chapter 26 (Plastic) regulates use of plastic materials used in construction. Insulation products made with materials other than plastics will have different requirements; however, these products have other limitations that must be understood.

This discussion on the THERMAX™ Wall System follows the prescriptive compliance path laid out in the 2006 IBC, Chapter 26, Section 2603.5: "Exterior Walls of Buildings of Any Height."

### *Seven Elements of IBC Chapter 26*

There are seven elements to this section of the code that define foam plastic insulation products and their specific use in a commercial wall of Type I, II, III or IV construction.

#### **2603.5.1 Fire-Resistance Rated Walls**

Commercial walls may need to meet fire-resistance requirements (ASTM E119, hourly rating) based on the type of construction, occupancy of the structure, or separation distance from other structures. **The THERMAX™ Wall System, with brick veneer, has achieved a 1-hour rating as a non-load bearing wall assembly per assembly V482.** This assembly may be accessed via the UL directory:

<http://database.ul.com/cgi-bin/XYV/cgifind.new/LISEXT/1FRAME/index.html>

#### **2603.5.2 Thermal Barrier**

Any foam plastic must be separated from the interior of a building by an approved thermal barrier per Section 2603.4. The THERMAX™ Wall System incorporates a 5/8" Type X gypsum layer on the interior of the steel studs to serve this purpose.

#### **2603.5.3 Potential Heat**

The potential heat energy of foam plastic insulation in any portion of the wall cannot exceed the potential heat energy of the foam plastic insulation contained in the wall assembly tested in accordance with Section 2603.5.5. The National Fire Protection Association's NFPA 285 testing has been conducted on the THERMAX™ Wall System and approvals have been obtained with several veneers as listed on page 15. The potential heat energy of THERMAX™ (ci) Exterior Insulation per NFPA 259 testing is approximately 9,000 Btu/lb. For STYROFOAM™ Brand SPF CM 2045 and CM 2060, it is 11,700 Btu/lb and 11,800 Btu/lb, respectively.

#### **2603.5.4 Flame Spread and Smoke Developed Indices**

Foam plastic insulations must have a flame spread index of 25 or less and a smoke developed index of 450 or less as determined in accordance with ASTM E84. THERMAX™ (ci) Exterior Insulation complies with this requirement up to a maximum thickness of 4.25". STYROFOAM™ Brand SPF (CM Series) also complies with this requirement.

#### **2603.5.5 Test Standard NFPA 285**

The wall assembly must be tested in accordance with NFPA 285. The test is referred to in the industry as the Multistory Flammability Test. The THERMAX™ Wall System is approved with several veneer types per NFPA 285 testing (see page 15).

#### **2603.5.6 Label Required**

This section requires proper labeling of the foam plastic by an approved agency. The bundle unit label of THERMAX™ (ci) Exterior Insulation shows the Underwriters Laboratories (UL) logo as its approved agency. STYROFOAM™ Brand SPF (CM Series) shows either the UL or Southwest Research Institute (SwRI) logo as its approved agency.

#### **2603.5.7 Ignition**

A wall assembly must not ignite from the exterior side of the wall when tested in accordance with NFPA 268. The following exceptions are approved as outside protection layers and can be used on the THERMAX™ Wall System to eliminate the need for testing:

- Thermal barrier
- Concrete or masonry (min. 1" thick)
- Metal panel veneer (min. .019" thick aluminum or .016" thick corrosion-resistant steel)
- Stucco (min. 0.875" thick)

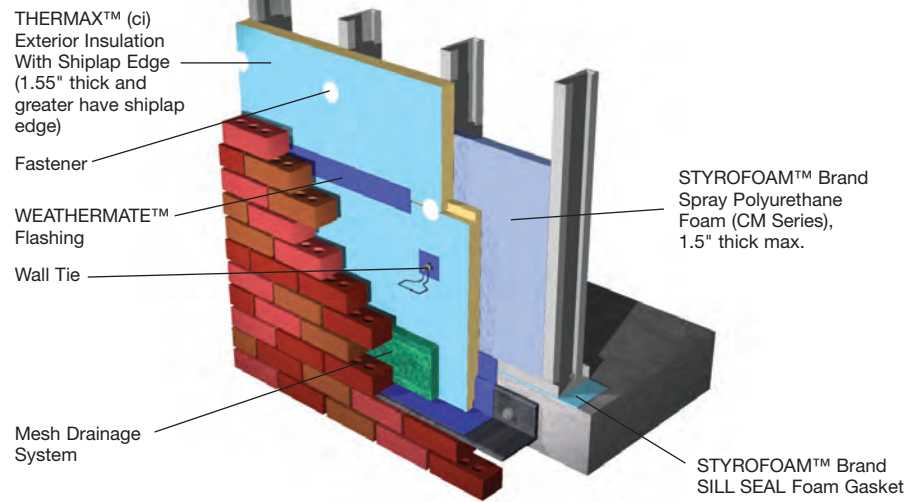
*Approved Veneers*

Based on extensive third-party NFPA 285 testing, the following veneers are approved for use with the THERMAX™ Wall System:

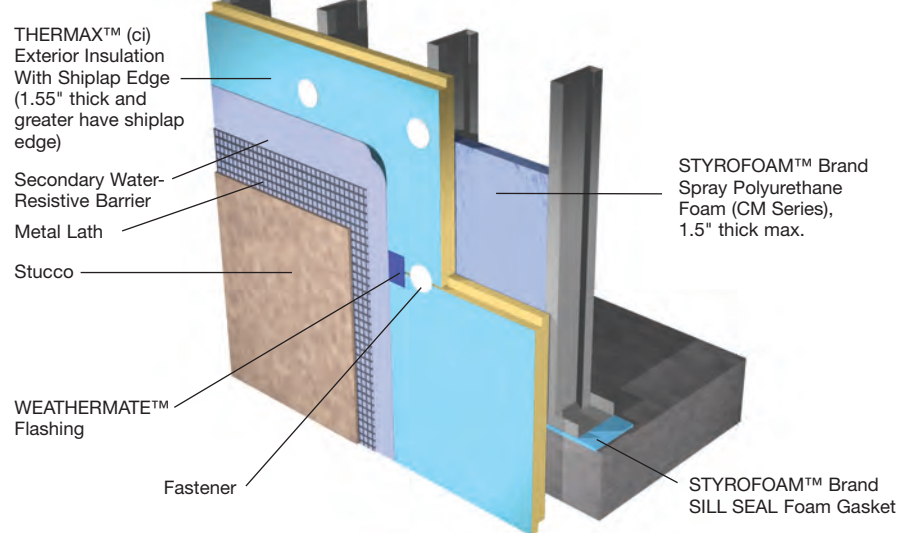
- Brick (clay) (Figure 15)
  - Standard nominal 4" thick
  - Standard anchors installed max. 24" o.c. vertically on each stud
- Stucco (Figure 16)
  - Minimum 3/4" exterior cement plaster and lath
  - Secondary water-resistive barrier between exterior insulation and lath (not full-coverage asphalt or butyl-based self-adhered membrane)
- Metal Composite Metal (MCM) (Figure 17)
  - Any NFPA 285 approved MCM system per manufacturer testing
- Terracotta cladding
  - Standard terracotta system (min. 1-1/4" thick)
  - Any standard installation technique
- Metal panel (Figure 17)
  - Steel, aluminum or copper material
  - Any standard installation technique
- Cement board siding
  - Noncombustible siding per ASTM E136
  - Any standard installation technique

Design guides, CAD details and BIM models may be found at [www.thermaxwallsystem.com](http://www.thermaxwallsystem.com).

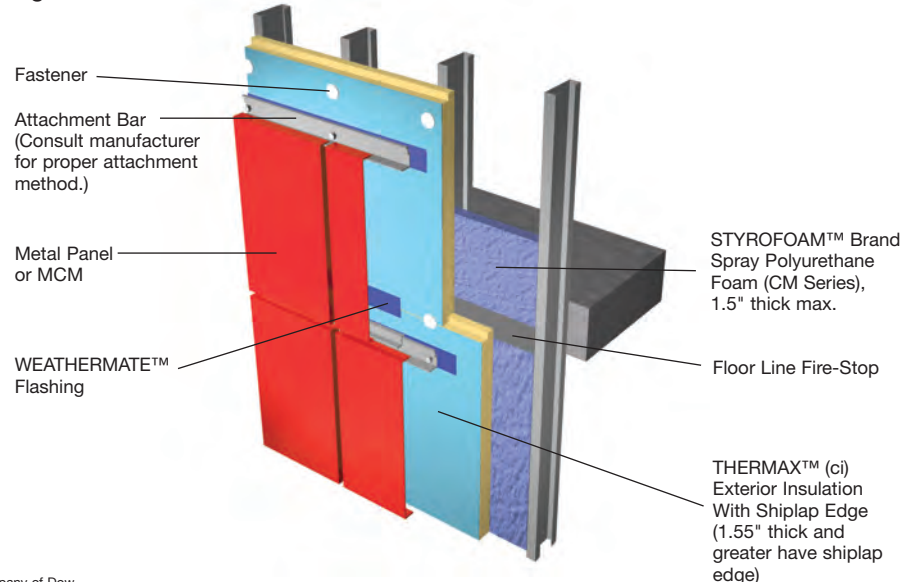
**Figure 15: Brick**



**Figure 16: Stucco**



**Figure 17: Metal Panel or MCM**



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## Weather Protection for Exterior Wall Assembly

### Drainage Plane

Commercial steel stud wall construction must shed water effectively to the exterior to meet the requirements of the IBC. Chapter 14 (Exterior Wall) of the IBC describes the necessary requirements for a drainage plane in a variety of wall constructions using a prescriptive method including a water-resistive barrier (WRB) and flashing. However, the IBC also provides an exception in Section 1403.2 that allows a wall system to be tested under ASTM E331 in order to show an appropriate level of water resistance to meet the commercial code requirements. This exception removes a requirement for an explicit WRB and flashing, and in some cases, a combination of the exterior sheathing and flashing materials can be used to create a system that works as the drainage plane.

The THERMAX™ Wall System was tested in accordance with ASTM E331 and has passed its rigorous testing requirements. Although the exception does not require flashing explicitly, the use of flashing material on the areas listed in this section of the code are all areas that require attention when detailing a system that can pass the ASTM E331 test protocol.

### 2006 IBC Section 1405.3 (Flashing)

*Flashing shall be installed in such a manner so as to prevent moisture from entering the wall or to redirect it to the exterior. Flashing shall be installed at the perimeters of exterior door and window assemblies, penetrations and terminations of exterior wall assemblies, exterior wall intersections with roofs, chimneys, porches, decks, balconies and similar projections and at built-in gutters and similar locations where moisture could enter the wall. Flashing with projecting flanges shall be installed on both sides and the ends of copings, under sills and continuously above projecting trim.*

### ASTM E331 Testing

ASTM E331 was selected to demonstrate the water-resistive nature of the THERMAX™ Wall System as it is referenced specifically in the building code, and is a readily accepted standard in the industry.

This test method consists of a complete 8' x 8' wall mock-up that is secured to a polycarbonate panel and exposed to a calibrated nozzle water spray rack while under pressure. The pressure differential is applied to simulate wind-driven rain. This test simulates 8" of wind-driven rainfall/hour. The pressure can be increased in an attempt to further draw the water through the system, simulating hurricane wind conditions.

Dow tested the wall mock-up at greater pressures than the required 6.24 psf to simulate wind-driven rain in hurricane-force sustained

wind patterns. The pressure was increased to 12 psf, which is typically used by window manufacturers for the Florida coastline, and then to 15 psf and finally, to 30 psf.

The IBC requires that the test be run for 2 hours at each pressure. There must be no visible leak for the wall to pass this test. The wall is examined thoroughly for any transport of water through the wall, fasteners or other penetrations and also at each component interface. No leaks were identified in the THERMAX™ Wall System assembly, thus resulting in a pass of ASTM E331. Dow conducted the ASTM E331 test at a third-party, ICC-approved testing laboratory.

### Lab Penetration HydroHead Testing

The Heckmann Building Products POS-I-TIE System was used as the brick veneer wall tie in the ASTM E331 tested assembly. Dow tested other veneer ties to ensure they would meet or exceed the same water hold-out potential as the POS-I-TIE System. Dow built small wall mock-ups of alternate wall ties penetrating WEATHERMATE™ Flashing, through the THERMAX™ (ci) Exterior Insulation and fastened to a steel stud. Dow used a modified HydroHead test apparatus (AATCC 127) to place a head (based on pressures seen in the ASTM E331 test) of water on the surface of the lab screen (tie/flashing/board sample). The sample was then allowed to sit for an extended period of time and examined for leaks.

The results of this testing led Dow to offer recommendations for proper sealing of the wall tie to the face of the flashing tape. For veneer tie penetrations through the face of the THERMAX™ (ci) Exterior Insulation, WEATHERMATE™ Flashing must be used over the insulation board before the veneer tie is installed. For veneer ties that are installed from the stud cavity to the exterior, such as the FERO slotted stud tie, the penetration on the face of the insulation board should be caulked or sealed with GREAT STUFF PRO™ Gaps & Cracks Insulating Foam Sealant.

Brick tie manufacturers have also conducted their own ASTM E331 testing. Test results can be found in their product guides.

**WEATHERMATE™ Flashing**

WEATHERMATE™ Flashing is a self-sealing, self-healing, fully adhered flashing engineered for exceptional adhesion. It is used to protect the building superstructure from moisture intrusion at critical areas. Butyl-based WEATHERMATE™ Flashing contains no asphalt. A polymeric-coated paper release liner provides a more consistent peel than plain paper liners.

In the THERMAX™ Wall System, WEATHERMATE™ Flashing is used to seal joints of THERMAX™ (ci) Exterior Insulation and thru-wall penetrations, such as windows and doors. WEATHERMATE™ Flashing should be used behind all veneer tie penetrations.

**Exposure Rating**

*Water Absorption Testing*

It is important to understand the water absorption characteristics of common sheathing materials used in cavity wall construction due to the possibility that water may penetrate the sheathing layer. A common sheathing material is 5/8" thick exterior gypsum. Water absorption testing was conducted by Dow comparing 5/8" thick exterior gypsum sheathing to 5/8" thick THERMAX™ (ci) Exterior Insulation.

Table 4 outlines the results of three water absorption test procedures: ASTM C473, which is used by the gypsum sheathing industry, and ASTM C272 and ASTM D2842, which are both used by the foam sheathing industry. The samples were prepared for testing according to three different protocols:

- #1 Standard sample ("control")
- #2 Gouged, where a cement trowel was dragged across the surface of the sample, gouging the board facer and core
- #3 1/4" Hole, where a 1/4" drill bit was used to drill a hole through the sample thickness

The average value of three repeated tests for each sample is listed in Table 4. The data show that per ASTM C473 testing the exterior gypsum had a water absorption approximately 21 times that of THERMAX™ (ci) Exterior Insulation. The data also show that according to ASTM D2842 testing the exterior gypsum had a water absorption approximately 17 times that of THERMAX™ (ci) Exterior Insulation.

TABLE 4: WATER ABSORPTION TESTING OF 5/8" EXTERIOR GYPSUM AND 5/8" THERMAX™ (ci) EXTERIOR INSULATION

Property and Test Method	Control Gypsum #1	Gouged Gypsum #2	1/4" Hole Gypsum #3	Control THERMAX™ (ci) #1	Gouged THERMAX™ (ci) #2	1/4" Hole THERMAX™ (ci) #3
Water Absorption, ASTM C473, Section 14, 2-hour test, % by volume	1.9	2.3	2.1	0.1	0.1	0.1
Water Absorption, ASTM C578-03b and ASTM C272-01, % by volume	7.5	9.1	5.8	0.3	0.3	0.3
Water Absorption, Procedure B, ASTM D2842-01, % by volume	15.2	19.0	16.7	0.8	1.0	1.0

Note: Test results apply only to the material being tested. Values represent the average of three tested samples.

*UV Testing*

The THERMAX™ Wall System has been tested for suitable performance when left exposed up to 180 days. THERMAX™ (ci) Exterior Insulation was exposed to outdoor elements in both subtropical and cold northern U.S. climates for more than six months with no detrimental effects noted in the durability or physical appearance of the product.

*Exposure to Mortar*

The exterior facer of THERMAX™ (ci) Exterior Insulation was also tested for extended contact with a high pH material per ASTM D1308. Testing was conducted with a solution that had a pH of approximately 12.5, which is similar to the pH of uncured mortar/concrete. This solution was placed on the surface of the THERMAX™ (ci) Exterior Insulation and allowed to sit for a period of 28 days while maintaining the pH of 12.5. During this 28-day period the samples were checked for any detrimental effects that the solution would have on the surface of the THERMAX™ (ci) Exterior Insulation, such as facer deterioration or discoloration. No detrimental effects were noted during this testing, thus qualifying this material for incremental contact with mortar during the build-up of a brick veneer assembly.

*ASTM E330 Wind Load Testing*

This testing resulted in the assembly passing wind loading criteria (10-second loading period) of 50 psf when subjected to negative wind loading and 75 psf when subjected to positive wind loading. (Note: 50 psf is approximately 141 mph wind velocity under ideal conditions.)

To represent a wall system with the least strength, testing was conducted with 5/8" thick THERMAX™ (ci) Exterior Insulation only – and without WEATHERMATE™ Flashing, STYROFOAM™ Brand SPF (CM Series) in the stud cavity or any bracing of the studs. Testing was conducted on THERMAX™ (ci) Exterior Insulation alone as this is the first product to go on the wall, and applying the flashing tape over joints and behind penetrations as well as spray foam in the stud cavity may not immediately occur.

In the wind load test, 5/8" thick THERMAX™ (ci) Exterior Insulation was attached to 18 gauge steel studs using several different fastening schedules, and also at 16" and 24" o.c. stud spacings.

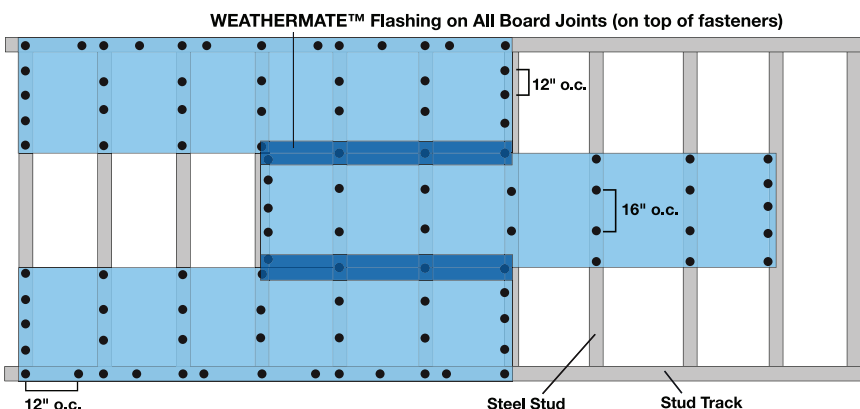
The goal of this testing was to determine the most robust fastening schedule that could be used to adhere THERMAX™ (ci) Exterior Insulation independent of the product thickness and stud spacing.

*Fastening THERMAX™ (ci) Exterior Insulation*

As a result of the ASTM E330 testing, Dow recommends a fastening pattern of 12" o.c. around the perimeter and 16" o.c. in the field (Figure 18). The Wind-Lock ci-LOCK fastener/washer series was used in this testing (fastener details on page 19). Perimeter fasteners can be detailed to bridge the gap of abutting board joints due to the 1.75" diameter of the washer used to fasten the board to the studs. This detail can be used to bridge a maximum of two board joints, thus two fasteners should be used at the intersection of three or four boards.

Figure 18: Fastening Pattern

**8' THERMAX™ (ci) Board With 16" o.c. Stud Spacing**

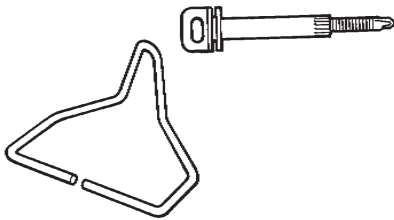


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*Recommended Fasteners and Veneer Ties (designed specifically for rigid foam sheathing)*

**Heckmann Building Products  
 POS-I-TIE System**

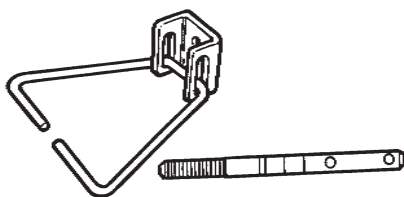
Original POS-I-TIE shown; Wing nut and thermal designs also available



www.heckmannbuildingprods.com  
 1-800-621-4140

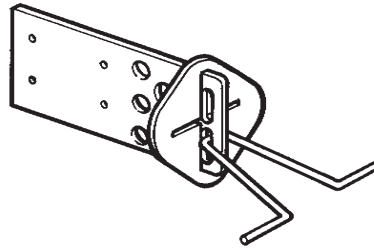
- Two-piece system for attaching brick veneer to various existing backups
- Incorporates barrel-screw piece, which allows easy installation
- Neoprene washer helps prevent moisture penetration by sealing the hole in insulation/gypsum board backup

**Drill Bolt System**



- Attaches to stud side
- U-Clip adjusts rotationally from outside
- Slot can be installed up or down, allowing for vertical adjustment

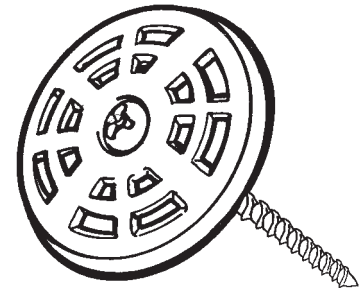
**FERO Slotted Stud Tie (Type II)**



www.ferocorp.com  
 1-780-455-5098

- Developed for brick veneer steel stud wall construction where significant differential movement between the veneer and the steel stud backup wall is expected, such as high walls or multi-story buildings with full height veneer
- Assembly consists of slotted stud plate (Type II), FERO V-Tie and an optional insulation support

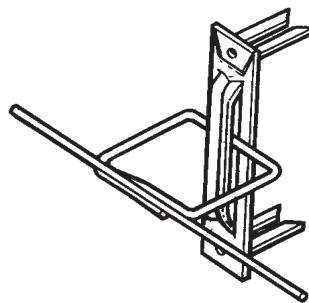
**Wind-Lock  
 ci-LOCK Fasteners and Washers**



www.wind-lock.com  
 1-800-872-5625

- Made of high-grade polypropylene
- Unique design allows plate to flatten out in application
- Large ribs stiffen plate, limit deflection

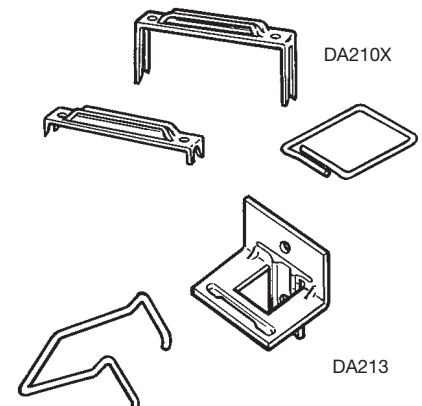
**Hohmann & Barnard  
 X-SEAL Anchor**



www.h-b.com  
 1-800-645-0616

- Prolonged legs bridge sheathing and abut steel stud, enabling independent, positive anchorage and helping prevent compression of sheathing by positive loads

**Dayton Superior  
 Dur-O-Wal Veneer Anchors**



www.daytonsuperior.com  
 1-888-977-9600

- DA210X: Legs pierce through rigid foam insulation, allowing transfer of compression loads directly to steel stud backing
- DA213: Recommend two fasteners per plate

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### Lintel and Brick Ledge Size

An important design consideration is to determine the appropriate size of lintels and brick ledge for adequate and uniform load bearing. A thicker sheathing such as THERMAX™ (ci) Exterior Insulation may require a wider lintel and brick ledge. Determining lintel and brick ledge size is the responsibility of the architect/designer.

According to the Brick Industry Association's Technical Note 31B:

*The steel for lintels, as a minimum, should comply with ASTM A36. Steel angle lintels should be at least 1/4" thick with a horizontal leg of at least 3-1/2" for use with nominal 4" thick brick, and 3" for use with nominal 3" thick brick. For most lintels of ordinary wall thickness, loads and spans, a depth of 8" to 16" above the apex is sufficient. If stack bonded masonry is used, horizontal joint reinforcement must be provided to ensure the arching action.*

Download details from [www.bia.org](http://www.bia.org).

### Masonry Drainage System

A masonry drainage system that prevents mortar droppings from forming a continuous dam is an important part of proper masonry construction. The system catches and permanently suspends mortar droppings in an irregular pattern above the weep hole vents, allowing weep holes to stay open.

### STYROFOAM™ BRAND SPF (CM SERIES)

STYROFOAM™ Brand Spray Polyurethane Foam (CM Series) ICC ESR-2670 is a spray-applied

insulating foam plastic produced by combining a polymeric isocyanate (Dow 3019 ISO or "A") component with the CM Series polyol or "B" component. STYROFOAM™ Brand SPF (CM Series) is applied as a liquid and then expands to fill cavities, cracks and crevices. The resulting insulating foam plastic is a rigid, medium-density, closed-cell, monolithic barrier for protection against water vapor and air on the interior of steel stud walls. The chlorofluorocarbon (CFC)-free spray foam successfully incorporates the Enovate 3000 blowing agent from Honeywell, which is a zero ozone-depleting product. STYROFOAM™ Brand SPF (CM Series) is available in three formulas. Typical physical properties are listed on page 24.

### Sizes

STYROFOAM™ Brand SPF (CM Series) is sold in 55 gal drum sets (one A isocyanate and one B polyol blend).

### Fire Protection

STYROFOAM™ Brand Spray Polyurethane Foam is combustible and may constitute a fire hazard. Do not expose foam to flame or temperatures above 240°F.

### Installation

The performance of STYROFOAM™ Brand Spray Polyurethane Foam (CM Series) can be affected by all the component parts of a structure, atmospheric conditions inside and outside the structure, equipment capabilities, and maintenance quality and frequency. Only personnel trained in spray polyurethane

foam application should install STYROFOAM™ Brand SPF (CM Series) per Dow Building Solution's qualification program.

### Safety and Conditions of Use

- Read the instructions and Material Safety Data Sheets carefully before use. MSDSs for STYROFOAM™ Brand SPF products are available at [www.dowbuildingsolutions.com/na](http://www.dowbuildingsolutions.com/na). Visit [www.spraypolyurethane.com](http://www.spraypolyurethane.com) for further details and supporting information covering a wide range of topics including an overview of SPF health and safety guidelines, suggested personal protective equipment (PPE), typical first-aid treatment, and regulations and information about "green" marketing.
- STYROFOAM™ Brand Spray Polyurethane Foam contains isocyanate, hydrofluorocarbon blowing agent and polyol. Do not breathe vapor or spray. Use only with a NIOSH-approved supplied air respirator (SAR) in accordance with your company's respiratory protection program. Supplied air respirator or an approved air-purifying respirator equipped with an organic vapor sorbent and a particle filter (P100) is required to maintain exposure levels below ACGIH, OSHA, WEEL or other applicable limits. For situations where the atmospheric levels may exceed the level for which an air-purifying respirator is effective, use a positive-pressure, air-supplying respirator (air line or self-contained breathing apparatus).
- Isocyanate is irritating to the eyes, skin and respiratory system, and may cause sensitization by inhalation or skin contact.

Sensitization, or the development of asthma, can lead to permanent respiratory problems.

- STYROFOAM™ Brand SPF will adhere to most surfaces and skin. Do not get foam on skin. When spraying polyurethane foam, wear MDI-resistant chemical gloves (e.g., nitrile) or fabric gloves coated in nitrile, neoprene, butyl or PVC. Spray applicators should wear chemically resistant coveralls or full body suits with hoods and MDI-resistant fitted boots or booties. Professional judgment is necessary to determine the appropriate PPE necessary for secondary activities such as cleaning and trimming of the cured foam. Cured foam must be mechanically removed or allowed to wear off in time.
- The contents are under pressure.
- STYROFOAM™ Brand SPF should be installed by a trained SPF applicator.

#### Equipment Guidelines

- The drum contents are under pressure. Keep the drums out of sunlight and never use heating devices to warm drums. If the drums should cool below 60°F, allow drums to warm naturally to 60°F-90°F prior to application.
- Position drums to be used in a ventilated area out of rain or sunlight. The use of a sealable drum transfer pump is recommended. A transfer pump long

enough for totes will rest on the bottom of the drum. If the extra-long drum transfer pump cavitates as the drum empties, the pump can bounce against the bottom of the drum leading to damage and subsequent leakage of the contents.

- Open the bung with the proper tool to minimize damage to the bung cap. Open slowly until gas pressure (warm weather) or vacuum (cool weather) is released and then remove the bung cap completely.
- Never leave drums open for longer than 10 minutes. To prevent cavitation of the drum transfer pump, install a desiccated air dryer on the vent cap to keep the drums at atmospheric pressure. If the drum is not kept well sealed, moisture in the air will lead to solids formation in the isocyanate drums (A component), which can plug filters and pump check valves. Open polyol drums (B side) will allow the blowing agent to evaporate, which dramatically reduces foam yield.
- Empty isocyanate drums should be left uncapped prior to cleaning and disposal per local regulations. Ambient air contains moisture, which can combine with the residual isocyanate generating pressure in the drum.

- Keep the drums out of direct sunlight and out of the weather while applying the foam.
- Spray equipment must be capable of delivering the proper ratio (1:1 by volume) of polymeric isocyanate and polyol blend at the recommended temperatures and spray pressures (Table 5). To minimize the potential for off-ratio product, the use of a common drive on the positive displacement pumps of the proportioner is recommended.
- Follow the spray equipment manufacturer's guidelines for all spray operations. Spray units and guns come in a variety of capacities and styles and will require adjustments to achieve the desired spray pattern.

#### Ambient and Substrate Conditions

Substrate must be at least 5 degrees above dew point, with best processing results when the relative humidity is below 80 percent (<18 percent substrate moisture content if wood or concrete is the substrate). To minimize potential for moisture interference with adhesion of STYROFOAM™ Brand SPF (CM Series) to the substrate, spray only when the relative humidity is below 70 percent (<12 percent substrate moisture content if wood or concrete is the substrate).

TABLE 5: RECOMMENDED PROCESSING PARAMETERS – CM 2030, CM 2045 AND CM 2060

Type of Machine: H20/35, GX7 gun, #0.028 mix chamber or equivalent	Relative Humidity %: <80	Substrate Temp (°F) CM 2030: 30-60 CM 2045: 45-100 CM 2060: 60-120	Ambient Temp (°F) CM 2030: 30-70 CM 2045: 45-95 CM 2060: 60-100
Difference Between Ambient and Dew Point Temperatures (°F): >5	Primary Heater Temp (°F): 115-130 <sup>(1)</sup>	Hose Temp (°F): 115-130 <sup>(1)</sup>	
Dynamic Pressure "A" (psi): 600-1200 (800 <sup>(2)</sup> )	Dynamic Pressure "B" (psi): 600-1200 (800 <sup>(2)</sup> )	SPF max.: 1.5" thick	Mixing Ratio A/B: 1:1

(1) To minimize potential for stud line cracking, STYROFOAM™ Brand SPF CM 2030 should be applied at the higher end of temperature and pressure ranges.  
(2) Recommended initial pressure

### Surface Preparation

- The steel stud and THERMAX™ (ci) Exterior Insulation substrates must be free of moisture (dew or frost), grease, oil, solvents and other materials that would adversely affect the adhesion of the polyurethane foam. Poor adhesion will result in stud line cracking of the SPF.
- THERMAX™ (ci) Exterior Insulation and the steel studs do not need to be primed unless the studs are weathered or previously painted. If priming is desired, clean the surface per primer manufacturer's recommendations and use a primer known to be compatible with spray polyurethane foam.
- Most untreated and unpainted wood does not need to be primed.
- Substrate temperatures should not exceed 120°F for STYROFOAM™ Brand SPF CM 2060, 100°F for STYROFOAM™ Brand SPF CM 2045 and 60°F for STYROFOAM™ Brand SPF CM 2030. Excessive temperatures will lead to fast gel times and low yield.

### Application Guidelines

Due to the exothermic reaction of the isocyanate and polyol blend, STYROFOAM™ Brand SPF (CM Series) should be applied in layers 1/2" to 1-1/2" thick – with 3/4" the ideal layer thickness for maximum yield and a maximum overall thickness of 1.5". Allow foam to cool completely before applying successive layers. Excessive thicknesses can lead to void formation and even internal char, reducing the thermal and mechanical quality of the foam.

To minimize void formation where the sheathing is attached to the steel studs, apply foam in the cavity where the steel stud and sheathing meet (picture framing technique) prior to filling the cavity. Allow the foam to fully cool and then spray to the desired thickness by filling in the area between the previously applied foam using a side-to-side motion within each cavity.

STYROFOAM™ Brand SPF (CM Series) should be covered as soon as feasible during the construction process. There is no need to wait for any off-gassing of the foam as this happens immediately during application.

### Overspray Notes

Overspray can lead to several problems on the job site if not controlled properly. Overspray will coat all surfaces in a room and if windows and doorways are left open, the overspray can reach other rooms and vehicles outside the building.

Cover objects near the application area that might be coated with overspray. Excessive overspray can accumulate on areas that are intended for spray foam application. Overspray can be brittle and may affect the adhesion of the spray foam on oversprayed substrates. When spray foam is applied to an area coated with excessive overspray, delamination can result.

To minimize overspray, do not apply STYROFOAM™ Brand SPF (CM Series) if there is air movement in the room due to wind or fans. Point the gun perpendicular to the surface being sprayed and as close as possible without causing spattering or a popcorn pattern.

### Cold Weather Application

Applying STYROFOAM™ Brand SPF CM 2030 to the interior stud cavity side of THERMAX™ (ci) Exterior Insulation when outside temperatures are below 30°F can be accomplished with the following precautions:

- Heat the area to be sprayed to  $\geq 30^{\circ}\text{F}$  for both the ambient air and substrate temperature. This is best done with window and doorway areas closed to improve even heating.
- Check the substrates (sheathing and studs) and ensure no moisture condensation is present. After applying the spray foam, maintain the temperature at  $\geq 30^{\circ}\text{F}$  for 48 hours.

### Product Storage Recommendations

STYROFOAM™ Brand SPF (CM Series) has a shelf life of six months when stored dry between 60°F and 90°F. Avoid direct sunlight during shipping and storage on the job site. The drums should be protected from the weather to prevent moisture from entering the drums. Store the drums in compliance with local fire and safety requirements.

Caution should be exercised when opening containers as pressure may be present when material has been exposed to elevated temperatures. Empty drums are non-returnable and should be disposed of using current industrial practices in accordance with federal, state or local regulations.

**SPF Troubleshooting Tips**

Reduced yield and excessive shrinkage leading to stud line cracking are the more common issues that SPF applicators face. The best rule of thumb is to stop applying foam to the walls if the foam looks different. “Different” would include color changes, color swirls, faster/slower than normal cream, non-circular or smaller/larger than usual spray pattern, foam reversion and poor wetting of the substrate.

**TABLE 6: STYROFOAM™ BRAND SPF TROUBLESHOOTING TIPS<sup>(1)</sup>**

Observation	Cause	Potential Issues	Potential Solutions
Color changes	A/B off-ratio	<ul style="list-style-type: none"> <li>Poor foam properties</li> <li>Excessive shrinkage</li> <li>Stud line cracking</li> </ul>	<ol style="list-style-type: none"> <li>Ensure drum transfer pumps are working properly (steady static pressures).</li> <li>Ensure that chemical filters are not plugged and the check valves in the displacement pumps are operating correctly (steady dynamic pressures). A low polyol level will produce foam that is brittle and amber colored. A low isocyanate level will produce foam that is spongy and dark blue in color.</li> </ol>
Color swirls	Poor mixing	<ul style="list-style-type: none"> <li>Poor foam properties</li> <li>Excessive shrinkage</li> <li>Stud line cracking</li> </ul>	<ol style="list-style-type: none"> <li>Check the drum chemical temperatures and determine if between 60°F and 90°F.</li> <li>Determine if the dynamic pressures are approximately 800 psi or higher.</li> <li>Determine if the chemical temperatures are between 115°F and 130°F.</li> </ol>
Faster/slower than normal cream	High/low chemical temperatures; high/low chemical pressures	<ul style="list-style-type: none"> <li>Poor yield</li> <li>Poor foam properties</li> <li>Excessive shrinkage</li> <li>Stud line cracking</li> </ul>	<ol style="list-style-type: none"> <li>Verify that drum temperatures are at the appropriate temperature.</li> <li>Determine whether the heater block has the capacity to heat the chemicals to the temperature for spraying at the desired rate.</li> <li>Ensure the line temperatures are operating properly.</li> <li>Ensure that the dynamic pressures are in the recommended ranges.</li> <li>Minimize exposure of the line to direct sunlight or severe cold.</li> </ol>
Non-circular or smaller/larger than usual spray pattern	Plugging; high/low chemical temperatures or high/low pressures	<ul style="list-style-type: none"> <li>Poor yield</li> <li>Poor foam properties</li> <li>Excessive shrinkage</li> <li>Stud line cracking</li> </ul>	<ol style="list-style-type: none"> <li>Check the drum chemical temperatures and determine if between 60°F and 90°F.</li> <li>Determine if the dynamic pressures are approximately 800 psi or higher.</li> <li>Determine if the chemical temperatures are between 115°F and 130°F.</li> <li>Clean gun tip or remove and soak gun's mixing chamber. If mixing chamber cannot be cleaned with solvents, a burn-out oven may be required.</li> </ol>
Foam reversion	High chemical temperatures	<ul style="list-style-type: none"> <li>Poor yield</li> <li>Poor foam properties</li> <li>Excessive shrinkage</li> <li>Stud line cracking</li> </ul>	Foam reversion occurs when the mixing chemicals exit the gun as a froth or foam and then collapse. This is often due to excessively high temperature leading to boiling of the blowing agent in the mixing chamber.
Poor wetting of the substrate	Dirty substrate	Poor adhesion	Clean the substrate.
	Substrate incompatible with SPF	Poor adhesion	Prime the substrate.

<sup>(1)</sup> Contact equipment supplier if you are unfamiliar with equipment maintenance or these troubleshooting tips.

**THERMAX™ WALL SYSTEM PROPERTIES AND APPROVALS**

**TABLE 7: TYPICAL PHYSICAL PROPERTIES OF THERMAX™ (ci) EXTERIOR INSULATION**

Property and Test Method	Value
Thermal Resistance <sup>(1)</sup> , ASTM C518, R-value	6.5
Compressive Strength <sup>(2)</sup> , ASTM D1621, psi	25.0
Flexural Strength, ASTM C203, psi	55.0
Water Absorption, ASTM C209, % by volume	<0.05
Water Vapor Permeance, ASTM E96, perms	<0.03
Maximum Use Temperature, °F	250
Surface Burning Characteristics <sup>(3)</sup> , ASTM E84	
Flame Spread	25
Smoke Developed	<450
UV Resistance, days	180

(1) R-value at 1" @ 75°F mean temperature. R-value expressed in ft<sup>2</sup>•h•°F/Btu.  
 (2) Vertical compressive strength is measured at 10 percent deformation or at yield, whichever occurs first.  
 (3) Calculated flammability values for this or any other material are not intended to represent hazards that may be present under actual fire conditions.

**TABLE 8: TYPICAL PHYSICAL PROPERTIES<sup>(1)</sup> OF STYROFOAM™ BRAND SPRAY POLYURETHANE FOAM (CM SERIES)**

Property and Test Method	Value		
	CM 2030	CM 2045	CM 2060
Ambient (Substrate) Temperature Range, °F	30-70 (30-60)	45-95 (45-100)	60-100 (60-120)
Core Density, ASTM D1622, lb/ft <sup>3</sup>	2.5	2.5	2.2
Compressive Strength, ASTM D1621, lb/in <sup>2</sup> , parallel	25	25	20
Tensile Strength, ASTM D1623, lb/in <sup>2</sup> , parallel	60	60	60
Closed-cell Content, ASTM D6226, %	>95	>95	>95
Thermal Resistance, ASTM C518, 75°F mean temp., R-value <sup>(2)</sup> , ft <sup>2</sup> •h•°F/Btu Aged Value (90 days @ 140°F)			
@ 1"	6.0	6.4	6.5
@ 4"	25	24	24
Water Vapor Permeability, ASTM E96, perm-inch	2.2	2.2	2.2
Water Absorption, ASTM D2842, % by volume	1.2	2.5	1.5
Dimensional Stability, ASTM D2126, max. % linear change			
At -20°F, ambient R.H., 7 days	-0.1	0.4	0.1
At 158°F, ambient R.H., 7 days	-2.0	2.2	3.0
At 158°F, 97% R.H., 7 days	Pass <sup>(3)</sup>	Pass <sup>(3)</sup>	Pass <sup>(3)</sup>
Surface Burning Characteristics <sup>(3)</sup> , ASTM E84	Class A	Class A	Class A

(1) Not to be considered sales specifications. Properties determined by processing foam with Gusmer H2O/35 primary heater at 120°F (A,B), hose temperature of 120°F with GX7 gun; .028 drilled module with 70 PCD; dynamic pressures at 600 psi-1,000 psi.  
 (2) Pass AC 377  
 (3) Flammability values for this or any other material are not intended to represent hazards that may be present under actual fire conditions.

**TABLE 9: TYPICAL PHYSICAL PROPERTIES OF WEATHERMATE™ FLASHING**

Property	Value
Water Vapor Transmission, ASTM E96, perm	<1
Application Temperature, °F, min.	30
UV Resistance, days	180
Size	4" x 100', 6" x 100', 9" x 100'

**Approvals**

The THERMAX™ Wall System meets the following approval criteria and building codes:

- ASHRAE 90.1-2007 – Energy Standard for Buildings Except Low-Rise Residential Buildings
- 2000, 2003, 2006 and 2009 ICC (includes IBC and IECC)
- ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
- ASTM E330 – Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference
- ASTM E331 – Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference
- ASTM E2357 – Standard Test Method for Determining Air Leakage of Air Barrier Assemblies
- NFPA 285 – Standard Fire Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components Using the Intermediate-Scale, Multistory Test Apparatus

**THERMAX™  
WALL SYSTEM  
INSTALLATION GUIDE**

**Sequencing Overview**

Installation of the THERMAX™ Wall System can begin once the structural steel and exterior wall steel studs have been installed and braced.

By using the all-steel bracing design, a drywall or masonry contractor can begin immediately installing boards of THERMAX™ (ci) Exterior Insulation on the exterior of the building envelope. (Insulation can be left exposed for 180 days.) As the contractor applies succeeding boards, WEATHERMATE™ Flashing is adhered to adjoining board joints and at pre-determined thru-wall penetrations. Windows and other openings are flashed following the removal of excess THERMAX™ (ci) Exterior Insulation in these areas of the envelope.

With the building closed in, the structure has an insulated and weatherized envelope, which will allow for work to progress quickly on the interior of the structure. By completing this step, a building can begin to be conditioned, which can speed up the work of other trades beyond the exterior walls.

Once sections of insulation boards and flashing are in place, a contractor can follow this work and adhere a strip of flashing to the face of the insulation (where the tie will be inserted). Veneer ties used to anchor the final exterior of the building can then be mounted. When the necessary ties are in place, masonry work or installation of other veneers can begin on these areas of the building.

After the ties are secured to the steel studs on the interior, it is important to ensure that, if necessary, a floor line fire-stop is installed in the stud cavity. Spray foam can now be applied in the stud cavity, covering the fire-stop (if installed) back to the floor edge to complete the air barrier, to further seal and insulate the envelope. Spray foam should be applied after the chosen veneer ties are in place. This allows free access for proper attachment of the tie. However, once the ties are in place, bricks can be laid on the exterior while a spray foam contractor foams a similar portion of the wall on the interior side.

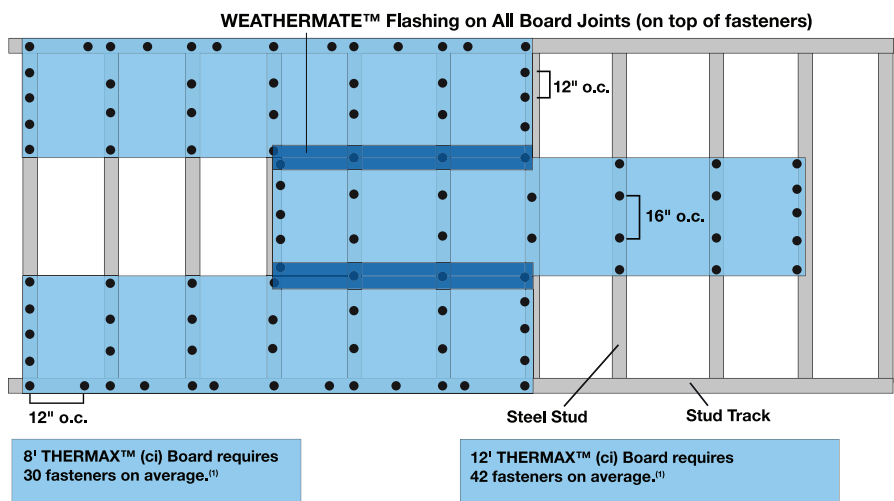
This system of products provides scheduling overlaps that can save significant time on a project, minimizing negative impacts and providing an opportunity for multiple contractors to engage in finishing the exterior wall throughout the project.

**Installation Recommendations**

1. With printed side facing to the exterior, install THERMAX™ (ci) Exterior Insulation horizontally with the shi lap edge up (for boards that contact the steel studs).
2. Use maximum board lengths to minimize number of joints. Locate edge joints parallel to and on framing flange. Center end joints over supports and stagger in each course.
3. Anchor to exterior face of exterior metal stud wall framing with appropriate fastener. Abut insulation boards tightly together around openings and penetrations.
4. Fasten boards of THERMAX™ (ci) Exterior Insulation to each support with fasteners spaced 12" o.c. at perimeter and 16" o.c. in the field. See page 19 for fastener details and Figure 19 for recommended fastening pattern.

Figure 19: Fastening Pattern for THERMAX™ (ci) Exterior Insulation

**8' THERMAX™ (ci) Board With 16" o.c. Stud Spacing**



(1) Average number stated may be less when washers are used to bridge adjoining boards or more when a true fastening perimeter outlines all four edges of the board.

- Set back perimeter fasteners 3/8" from board edges and ends. One approved fastener/washer can be placed to bridge a maximum of two board edges. Drive fasteners to bear washer tight and flush with surface of insulated sheathing. Do not countersink.
- For optimum performance and to create a water-resistive barrier, seal all end and edge joints, and thru-wall penetrations, such as window and door openings, with WEATHERMATE™ Flashing.
  - It is critical that flashing be attached in shingle fashion on the face of THERMAX™ (ci) Exterior Insulation and that all thru-wall penetrations are properly flashed to achieve a continuous drainage plane. A minimum overlap the width of the flashing is recommended. For example, if using 4" wide WEATHERMATE™ Flashing, overlap by at least 4".
  - THERMAX™ (ci) Exterior Insulation boards should be properly repaired if damaged during installation. Repairs may include applying a strip of flashing over a small hole or filling a large hole with a piece of the insulation board and then sealing with flashing.

- Veneer ties can now be secured to the steel stud walls by applying a section of WEATHERMATE™ Flashing to the surface of the THERMAX™ (ci) Exterior Insulation prior to penetrating it.
- If necessary due to stud placement, the floor line fire-stop should already be installed. Finally, STYROFOAM™ Brand SPF (CM Series) can be applied to the interior of the stud cavity by a qualified SPF applicator.

#### Product Storage Recommendations

- Do not leave THERMAX™ (ci) Exterior Insulation exposed to direct sunlight for more than 180 days.
- Store above standing water.
- If possible, store insulation boards indoors. If stored outdoors, keep insulation boards tarped or covered to protect from weather.
- If insulation boards get wet, allow them to air dry before covering with exterior coverings.
- Insulation boards are lightweight and can be blown around by wind. Weigh down loose boards until they are securely attached to the structure.
- For both indoor and outdoor storage, adhere to all local building and fire codes.  
(References include NFPA 230 "Standard for the Fire Protection of Storage," NFPA 13 "Standard for the Installation of Sprinkler Systems" and applicable ICC or local building codes.)

## DISCLAIMERS

Illustrations are not intended to replace the need for design by appropriate professionals such as architects or engineers.

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### Dow Polyisocyanurate Insulation

**CAUTION:** This product is combustible and shall only be used as specified by the local building code with respect to flame spread classification and to the use of a suitable thermal barrier. For more information, consult MSDS, call Dow at 1-866-583-BLUE (2583) or contact your local building inspector. In an emergency, call 1-989-636-4400.

**WARNING:** Rigid foam insulation does not constitute a working walkable surface or qualify as a fall protection product.

STYROFOAM™ Brand Spray Polyurethane Foam contains isocyanate, hydrofluorocarbon blowing agent and polyol. Read the instructions and Material Safety Data Sheets carefully before use. Wear protective clothing, gloves, goggles and proper respiratory protection. Supplied air or an approved air-purifying respirator equipped with an organic vapor sorbent and a particle filter is required to maintain exposure levels below ACGIH, OSHA, WEEL or other applicable limits. Provide adequate ventilation. Contents under pressure. STYROFOAM™ Brand SPF should be installed by a trained SPF applicator.

FROTH-PAK™ Polyurethane Spray Foam contains isocyanate, hydrofluorocarbon blowing agent and polyol. Read the instructions and Material Safety Data Sheets carefully before use. Wear protective clothing, gloves, goggles or safety glasses, and proper respiratory protection. Supplied air or an approved air-purifying respirator equipped with an organic vapor sorbent and a particle filter may be required to maintain exposure levels below ACGIH, OSHA, WEEL or other applicable limits. Provide adequate ventilation. Contents under pressure.

GREAT STUFF PRO™ sealant and adhesive contains isocyanate and a flammable blowing agent. Read the label and Material Safety Data Sheet carefully before use. Eliminate all sources of ignition before use. Wear gloves, and safety glasses or goggles. Provide adequate ventilation or wear proper respiratory protection. Contents under pressure.

Building and/or construction practices unrelated to building materials could greatly affect moisture and the potential for mold formation. No material supplier including Dow can give assurance that mold will not develop in any specific system.

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