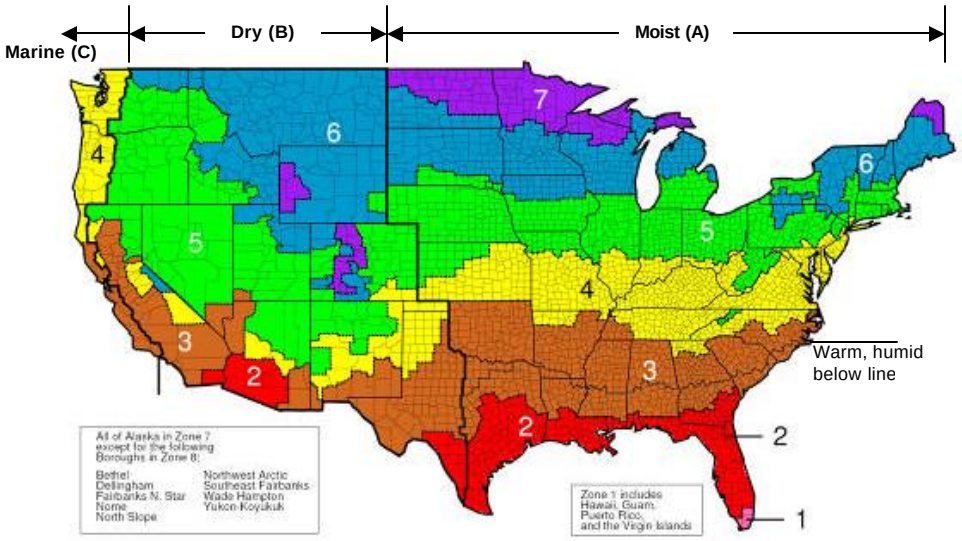
Incorporating Fully-Adhered Membrane Air Barriers into Wall Assemblies within Climate Zones 1 and 2

by:
Brian Carey
Product Manager - Air and Vapor Barrier Products
Carlisle Coatings and Waterproofing

Introduction:

This paper disseminates general, best-practice recommendations for use of fully-adhered membrane air barriers within United States Department of Energy (USDOE) Climate Zones 1 and 2. Climate Zone 1 is indicated in pink and Climate Zone 2 is indicated in red on the climate zone map, which is shown in Figure 1. Zone 1, Zone 2 Moist (2A) are Zone 2 Dry (2B) are covered in this paper.

Figure 1:
USDOE Climate Zone Map



WUFI 4.1 heat & moisture analysis software and field/market experience form the basis of the recommendations. The WUFI software is useful for assessing moisture management of a wall system when it is exposed to a given climate. However, this software cannot model air leakage. Numerous academic and case studies show that uncontrolled building envelope air leakage is detrimental to energy efficiency, durability and indoor conditions. The wall systems discussed in this paper have been shown to manage moisture effectively within climate zones 1 & 2 according to WUFI 4.1 while also incorporating an effective air barrier. Recommendations in this paper should be considered a good starting point for membrane air barrier product selection. These

recommendations are not a substitute for project building envelope design, which should be performed by experts based on the specific needs, applications and conditions.

Air Barriers in Building Envelope Construction:

It has been shown that the use of air barriers enables tremendous energy savings as well as prevention of moisture problems. Many materials can function as air barriers. Fully-adhered membranes are a proven means of achieving air tightness. These membranes are either self-adhering sheet membranes or fluid-applied at 0.040 inch (40 mil) thickness or more by spray, roller or trowel. They are typically installed on the exterior side of the wall and covered with a drained and vented cladding system.

Using this approach to provide an air barrier has a number of advantages. First is the ability to provide continuity. Because of the location within the wall assembly, the membrane products can be installed over transitions, around openings/penetrations, over joints/junctions, connected to the roof and foundation air barriers. The membrane is also self-sealing around penetrating fasteners from subsequent construction. The second advantage is the durability of these membranes. They are flexible, rubber-like and integrally-bonded to a sound substrate. They are water proof and installed to shed and discharge to the exterior any intruding moisture. Finally, they are built into the wall assembly so they are protected from exposure to the elements and temperature extremes.

Vapor Barrier or Vapor Permeable?

Table 1 shows vapor permeability classification of membrane for use in wall assemblies according to the International Energy Conservation Code (IECC) and the American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE) 90.1.

Table 1:
Classification of Membrane used in Wall Assemblies

IECC version 2006	**IECC 2007 Supplement**	**ASHRAE 90.1 Version 2004 and Version 2007**
Vapor Barrier =1 perm	Type I Vapor Retarder =0.1 perm	Vapor Barrier =1 perm
	Type II Vapor Retarder >0.1 perm, =1 perm	
Vapor Permeable =5 perms Basis: AC-38, Acceptance Criteria for water resistive barriers applied over sheathing	Type III Vapor Retarder >1 perm, =10 perms	No threshold value for vapor permeable material

Language in all of these established standards indicates that a material exhibiting water vapor permeance of 1 perm or less is a vapor barrier. There is no agreement on what constitutes a vapor permeable product. Commercially available membrane air barriers fitting the recommendations of this paper typically have a perm rating of 5 to 15 perms where they are marketed as “vapor permeable”.

Membrane air barriers for wall systems may also be vapor barriers, in which case they are called "air/vapor barriers" or they can be vapor permeable, in which case they are called "vapor-permeable air barriers". Building walls with either of these types of membranes has its advantages and limitations. The wall system design must be considered for proper incorporation of these materials into the assembly.

Code Requirements for Insulation and Vapor Barriers:

Like any wall system, those incorporating membrane air barriers must be code compliant. Insulation and vapor barrier code requirements factor into the wall system designs endorsed by this paper. A summary of code requirements for insulation and vapor barriers is listed in Tables 2, 3 and 4 below.

Table 2:

Zone 1 Commercial Construction Insulation Requirements for Wall Assemblies

	2006 International Energy Conservation Code (IECC)		ASHRAE 90.1 Version 2004		ASHRAE 90.1 Version 2007	
Wall Type	Residential	Non-Residential	Residential	Non-Residential	Residential	Non-Residential
Mass	R-3	NR	R-5.7 ci	NR	R-5.7 ci	NR
Steel Stud	R-13 + 5 R-15 + 4 R-21 + 3	R-13	R-13	R-13	R-13	R-13
Wood Stud	R-13	R-13	R-13	R-13	R-13	R-13

ci = continuous insulation

NR = no requirement

Table 3:

Zone 2 Commercial Construction Insulation Requirements for Wall Assemblies

	2006 International Energy Conservation Code (IECC)		ASHRAE 90.1 Version 2004		ASHRAE 90.1 Version 2007	
Wall Type	Residential	Non-Residential	Residential	Non-Residential	Residential	Non-Residential
Mass	R-4	NR	R-5.7 ci	NR	R-7.6 ci	R-5.7 ci
Steel Stud	R-13 + 5 R-15 + 4 R-21 + 3	R-13	R-13	R-13	R-13 + R5.7 ci	R-13
Wood Stud	R-13	R-13	R-13	R-13	R-13	R-13

ci = continuous insulation

NR = no requirement

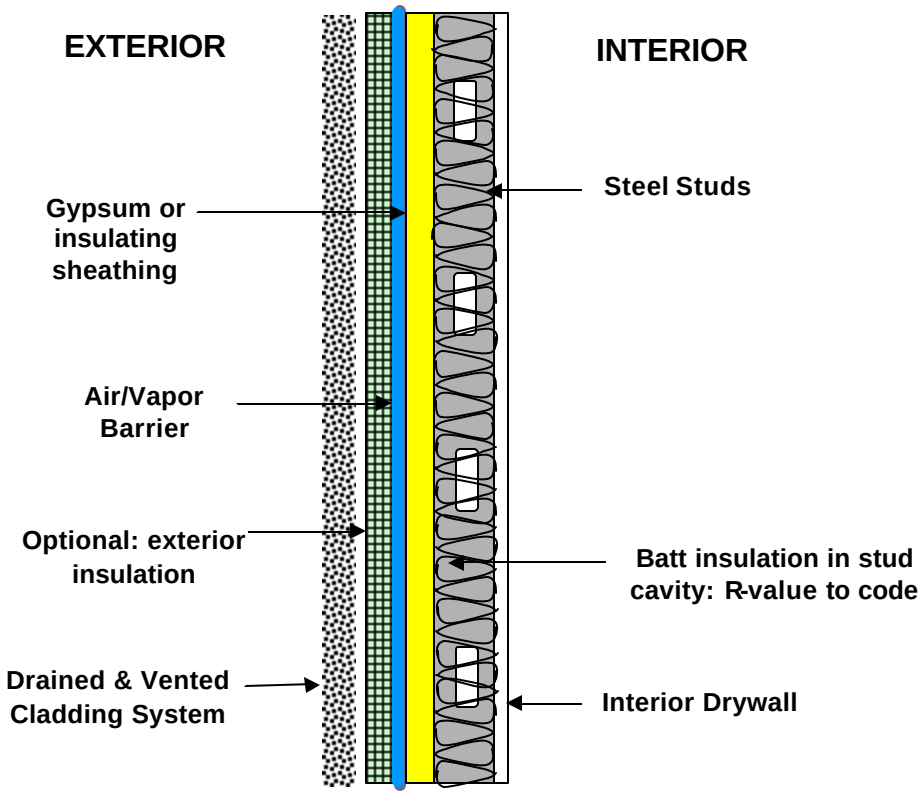
Table 4:

Zones 1&2 Commercial Construction Vapor Barrier Requirements for Wall Assemblies

IECC version 2006	IECC 2007 Supplement	ASHRAE 90.1 Version 2004, 2007
No vapor barrier required	No vapor barrier required	No vapor barrier required

Incorporating Air/Vapor Barriers into Wall Systems:
Zones 1 and 2 are warm climate zones with a very mild or no winter. Air/vapor barriers can be incorporated into wall systems in both of these zones without the use of exterior insulation. Air/vapor barriers are especially beneficial in Zone 1 and Zone 2A (moist), where the outdoor conditions are almost always warm and humid and there is a lot of rain. Particularly in these areas, the air/vapor barrier is also serving as waterproofing and it is stopping the prevailing vapor drive from the exterior. These wall systems must be able to dry to the interior, since moisture cannot dry through the air/vapor barrier membrane. Therefore, a vapor barrier on the interior side of the wall, such as 6 mil polyethylene, must NEVER be installed in wall systems incorporating an air & vapor barrier on the exterior. The best practice for incorporating an air/vapor barrier into a steel stud wall system within Zones 1 and 2 is shown in Figure 2.

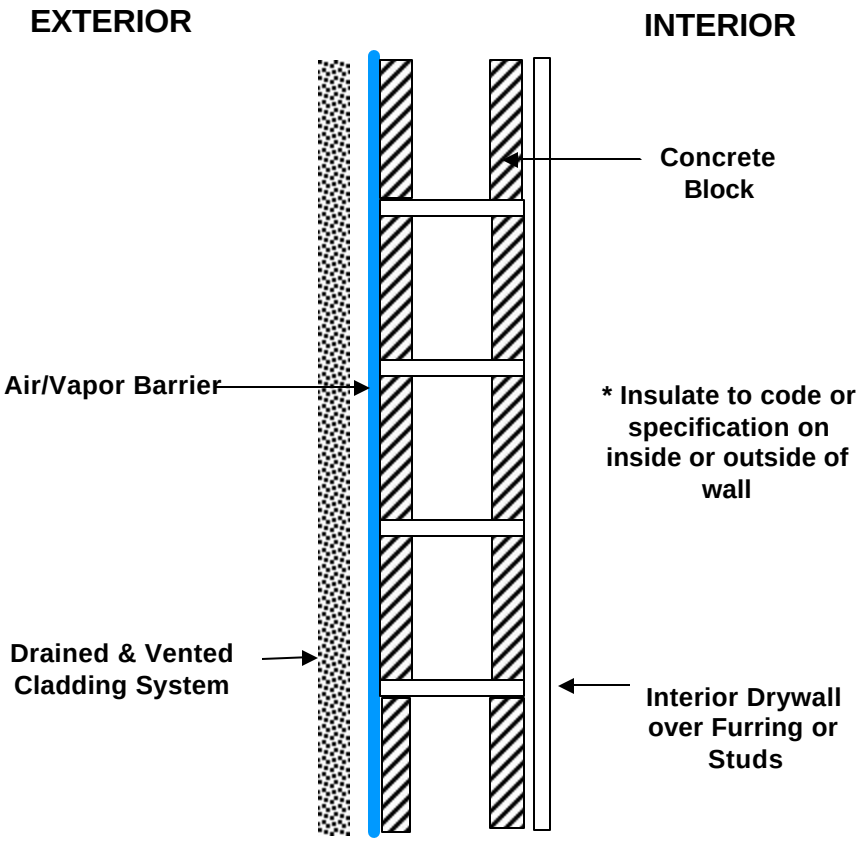
Figure 2:
Steel Stud Wall System with Air/Vapor Barrier for Zones 1 and 2



Where continuous insulation is desired or specified, board insulation can be installed on either side of the air/vapor barrier or insulating sheathing can be used.

A mass wall system incorporating an air/vapor barrier is shown in Figure 3. Mass wall systems sometimes require insulation in these zones. The insulation can be placed outside or inside of the air/vapor barrier. The concrete block is coated and waterproofed with the air/vapor barrier membrane.

Figure 3:
Mass Wall System with Air/Vapor Barrier for Zones 1 & 2



These are the key features and benefits of the wall systems shown in Figures 2 and 3:

1) ***Improved Energy Efficiency:*** The air/vapor barrier membrane provides up to 15% annual HVAC energy savings by stopping envelope air leakage. The air/vapor barrier membrane also keeps batt insulation drier by stopping moisture deposition into the stud cavity from air leaks and by stopping bulk water intrusion from the exterior. In the case of the concrete block wall assembly, the air/vapor barrier membrane keeps the block from absorbing bulk moisture from the exterior. Wet concrete block drying to the interior can place a tremendous demand on the HVAC system to maintain a comfortable indoor humidity level.

2) ***Higher Insulating Value:*** Where continuous insulation is installed, these wall systems have an enhanced R-value. Continuous insulation provides an R-value in the wall assembly close to the insulation's nominal R-value. Insulation is tightly secured to the wall with fasteners or adhesive with joints filled with sealant. According to ASHRAE 90.1, batt insulation loses slightly more than half of its nominal R-value when bridged by steel studs in typical wall construction. Also note that many types of board insulation are virtually unaffected by exposure to moisture, while batt insulation will lose much or nearly all of its R-value when wet.

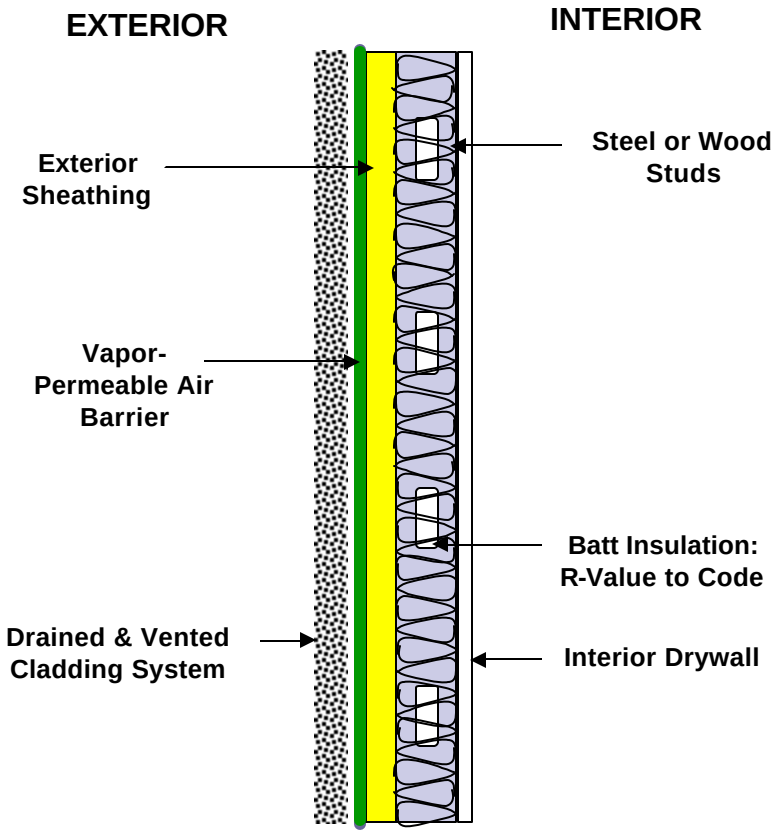
3) ***Improved Indoor Air Quality and Comfort:*** The air/vapor barrier provides complete separation of inside from outside. Moisture sensitive materials are kept dry, which prevents mold. The air tight envelope construction enables better function of the HVAC systems.

4) ***Improved Durability:*** In zones 1 and 2A, vapor drive is always from the exterior, since the outside environment is generally quite wet. The air/vapor barrier membrane protects the underlying construction from intruding moisture and vapor drive and stops all air leaks. The exterior cladding is drained and vented, able to function as a pressure-equalized rain screen because of the plane of air tightness created by the fully-adhered membrane. Moisture sensitive materials stay dry year-round, so the wall can achieve its maximum service life.

Incorporating Vapor-Permeable Air Barriers into Wall Systems:
Vapor-permeable membranes can be used in Zone 2B (dry). In the humid zones 1 and 2A, it is better to use an air/vapor barrier to stop the high vapor drive from the exterior.

A sheathing-over-stud wall incorporating a vapor-permeable air barrier is shown in Figure 4.

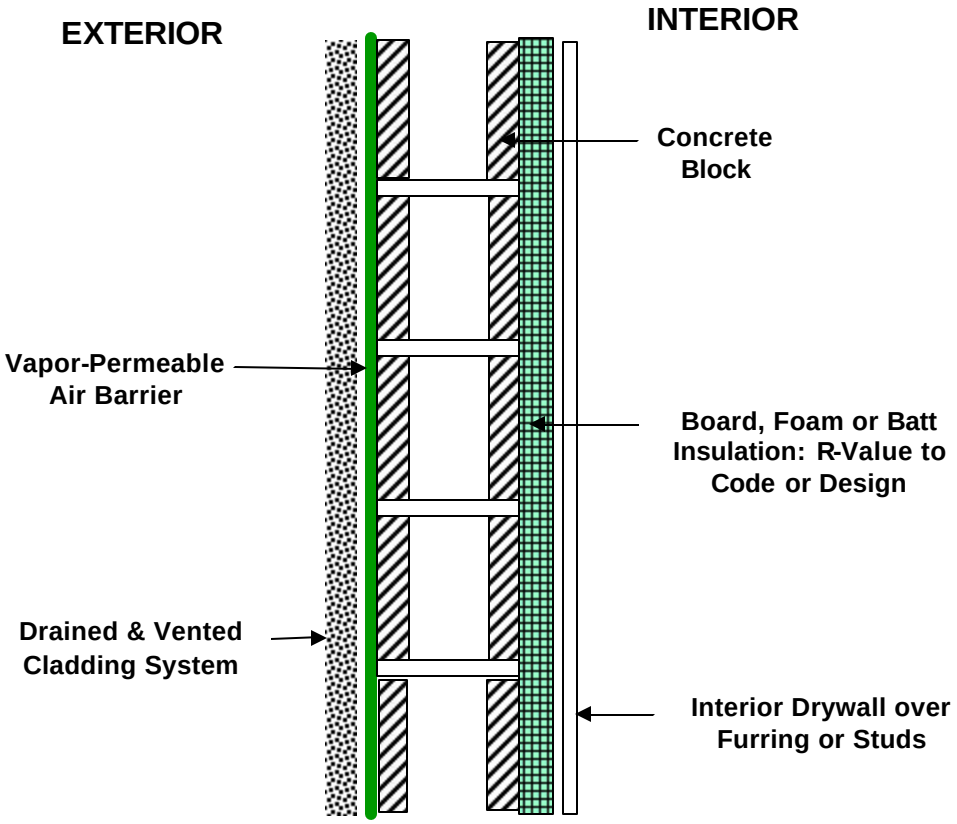
Figure 4:
Sheathing over Stud Wall System with Vapor-Permeable Air Barrier for Zone 2B (Dry)



This wall system has a fully-adhered, vapor-permeable membrane installed over the sheathing. No vapor barrier is installed on the interior side of the wall.

The wall system shown in Figure 5 has a fully-adhered, vapor-permeable membrane installed on the exterior side of the concrete block. Mass wall systems sometimes require insulation in this zone. The insulation in this wall system, which may or may not be continuous depending on code and design, is located on the interior side of the block wall. No vapor barrier is installed on the interior side of this wall system.

Figure 5:
Mass Wall System with Vapor-Permeable Air Barrier for Zone 2B (Dry)



These are the key features and benefits of the wall systems shown in Figures 4 and 5:

1) ***Improved Energy Efficiency:*** The air barrier membrane provides up to 15% annual HVAC energy savings by stopping envelope air leakage. It also keeps the insulation drier by stopping moisture deposition into the stud cavity from air leaks and by stopping bulk water intrusion from the exterior. In the case of the concrete block wall assembly, the membrane keeps the block from absorbing bulk moisture from the exterior. Wet concrete block drying to the interior can place a tremendous demand on the HVAC system to maintain a comfortable indoor humidity level.

2) ***Improved Indoor Air Quality and Comfort:*** The air barrier membrane protects the underlying construction from intruding moisture and stops all air leaks. Moisture sensitive materials are kept dry, which prevents mold. The air tight envelope construction enables better function of the HVAC systems.

3) ***Improved Durability:*** This wall system is designed to prevent accumulation of interior condensation by allowing drying in both directions. The membrane stops the majority of moisture loading, since it keeps out bulk moisture from the exterior and it stops air leaks. The exterior cladding is drained and vented, able to function as a pressure-equalized rain screen because of the plane of air tightness created by the fully-adhered membrane. These wall systems effectively manage moisture, so that moisture sensitive materials are not damaged by excessive wetting.

Conclusion:
Selection of Vapor-Permeable versus Vapor Barrier Membrane air Barriers in Zones 1 & 2

Use table 5 as a guideline for selection of either type of air barrier membrane in these climate Zones.

Table 5:

Scenario	Air/Vapor Barrier	Vapor-Permeable Air Barrier
Project Located in Zone 1 or Zone 2A (Moist)	X	
Project located in Zone 2B (Dry)	X	X