UNDERSTANDING THE TERMINOLOGY:

Air Barriers, Vapor Retarders, and Water-Resistive Barriers

By Patricia Aguirre, REWC, PE, CDT

Air barriers, vapor retarders, and water-resistive barriers are critical components in the building envelope. However, there seems to be some confusion within the industry regarding the terminology and what materials function in which manner. The goal of this article is to provide a quick primer on what each term means, how they function within the building envelope, and their relevant material properties.

AIR BARRIERS

Air barriers are defined by the model energy code[1] as "materials assembled and joined together to provide a barrier to air leakage through the building envelope." The code requires that air barrier materials have a tested air permeance of less than 0.004 cfm/ft^2 (0.02 L/[s-m^2]) at a test pressure of 1.57 psf (75 Pa). There are two key terms in the code definition and requirement: "air leakage" and "air permeance." "Air leakage" describes air that passes around the material at joints, seams, holes, and gaps. "Air permeance" refers to air that passes through the material itself. Thus, the purpose of an air barrier is to minimize air intrusion through the building envelope. By definition, an air barrier material does not necessarily limit vapor or moisture migration.

A wide variety of materials meeting the code requirements can be used as part of a building envelope's air barrier system, including proprietary sheet and fluid-applied products. The code also lists the following as acceptable air barrier materials as long as joints are sealed:

- Minimum ⅜-in. plywood or oriented strand board (OSB) sheathing
- Minimum ½-in. extruded polystyrene (XPS) or foil-backed polyisocyanurate (polyiso) insulation board
- Minimum 1½-in. closed-cell spray foam with minimum 1½-pcf density
- Minimum 4½-in. open-cell spray foam with density between 0.4 pcf and 1.5 pcf
- Minimum ½-in. exterior or interior gypsum or cement board
- Built-up roofing membrane
- Modified bituminous roofing membrane
- Fully-adhered single-ply roofing membrane
- Minimum ⅝-in. Portland cement/sand parge coat or gypsum plaster
- Cast-in-place and precast concrete
- Fully grouted concrete masonry units (CMU)
- Steel or aluminum sheet
- Solid or hollow masonry constructed of clay or shale masonry units

Continuity of the air barrier is of paramount importance and is required by the model energy code. To comply with this code requirement, all joints, seams, holes, and gaps must be sealed. Air barrier materials on the roofs, walls, and below grade must be properly integrated to form a continuous air barrier system. This means that, when looking at a building section on a design drawing, it should be possible to trace the air barrier around the entire building without lifting the pencil from the page. If there is a break or gap at any point in the system, the air barrier does not comply with the code requirement.

Vapor Retarder Class	Vapor Permeance[3]	Examples
Class I	≤ 0.1 perm	• Polyethylene sheeting • Nonperforated aluminum foil
Class II	0.1 perm < material permeance ≤ 1.0 perm	• Kraft paper-faced insulation • Some paints
Class III	1.0 perm < material permeance ≤ 10 perms	• Some latex and enamel paints

Table 1 – Vapor retarder classification.

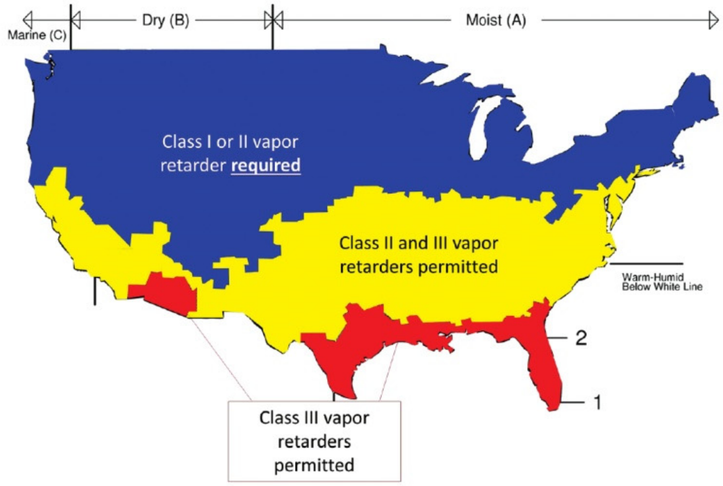

Figure 1 – General vapor retarder requirements per 2015 IBC Section 1405.3.1.

An old rule of thumb regarding the proper location of a vapor retarder within an above-grade wall section is to place it on the "warm-in-winter" side of the insulation. This can be problematic in areas where the number of heating degree days (HDD) is roughly equal to the number of cooling degree days (CDD). The model building code provides specific requirements based on Climate Zone for all areas of the United States and its territories with respect to which class of vapor retarder is permitted or required. For the 2015 International Building Code (IBC), these requirements for the contiguous United States are graphically represented in *Figure 1*.[4]

Vapor retarders are generally not required at the following locations:

- Basement walls
- Below-grade portions of any walls
- Construction where moisture or its freezing will not damage the materials
- Frame walls with foam plastic insulating exterior sheathing of less than

VAPOR RETARDERS

Vapor retarders are also commonly (and incorrectly) referred to as "vapor barriers." The Air Barrier Association of America (ABAA) describes vapor retarders as "materials used to slow or reduce the movement of water vapor." This means that a vapor retarder is not going to prevent all vapor transmission, nor is it necessarily desirable for it to do so. Additionally, even the least-permeable material may permit some degree of vapor transmission in a given set of circumstances, as a result of manufacturing tolerances, imperfections in installation, age, exposure, etc.

The model building code classifies vapor retarders based on their vapor permeance as shown in *Table 1*.[2] Materials with a permeance greater than 10 perms are not considered vapor retarders.

As the examples provided in the table show, a wide variety of materials may be classified as vapor retarders, including sheet goods and fluid-applied materials. Because of this variety, it is easy to accidentally provide multiple vapor retarders within a single building envelope cross-section. An example would be where foil-faced batt insulation is installed within a stud cavity, and vinyl wall coverings are installed as an interior finish. In this situation, moisture can become trapped between the two materials, unable to dry to either the interior or the exterior of the wall, and potentially deteriorating studs or other moisture-sensitive materials in the vicinity. Designers need to be aware of the permeance of the materials they specify throughout the entire building envelope.

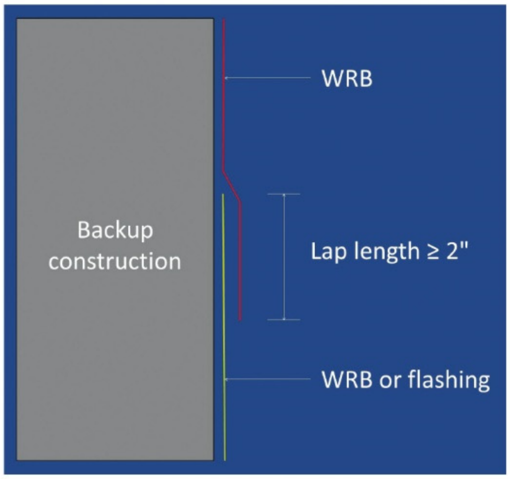

Figure 2 – Proper shingle lapping of WRBs.

Characteristic	Felts	Papers
Governing standard	ASTM D226	FS UU-B-790A UBC 14-1
Designation	Type I (No. 15) Type II (No. 30)	Type I, II, III, IV Grade A, B, C, D Style 1a, 1b, 2-11
Characteristics	• Multiple layers of loosely laid cellulose fibers • No requirements with respect to vapor transmission • Thicker and less pliable (prone to cracking at corners)	• Single-layer cellulose fibers • Gradation considers vapor transmission • Thinner and more pliable

Table 2 – Comparison of felts and papers used as WRBs.[10]

1 perm installed in conjunction with installation of a Class III vapor retarder on the interior

Hygrothermal analysis may be performed in order to determine the proper type and location of a vapor retarder within the building envelope. This can be particularly helpful in determining the effects of proposed repairs and renovations to existing structures.

WATER-RESISTIVE BARRIERS

In current model building codes published by the International Code Council (ICC), a water-resistive barrier (WRB) is defined as “a material behind an exterior wall covering that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the exterior wall assembly.”[5] Some model building codes published prior to the ICC’s I-Codes referred to this as a “weather-resistant barrier,” which implied that the material was intended to resist both air and water infiltration. This was a misnomer, however, as neither the building code nor typical installation instructions required taping or sealing of seams. While water generally runs downhill, meaning that simply shingle-lapping a WRB is sufficient to protect the underlying materials from water penetration, air can also travel up, necessitating sealing of seams to mitigate infiltration. In addition, many traditional WRB materials, such as felts and papers, are air-permeable.

WRB materials can be sheet or fluid-applied materials. Sheet materials include polymeric materials (“housewraps”), felts, and papers. Fluid-applied materials may be evaluated using ASTM E2570,[6] while sheet goods may need to comply with ASTM E2556,[7] depending on their method of attachment. It is important to understand that felts and papers are two different materials that are governed by different standards; i.e., there is no such thing as “felt paper.” Building paper is graded in accordance with Federal Specification (FS) UU-B-790A and Uniform Building Code Standard (UBC) 14-1. Felts used as a WRB must comply with ASTM D226.[8] Felts complying with ASTM D4869[9] are intended for use as underlayment for steep-slope roofing only and should not be used for other applications. Some key differences between felt and paper WRBs are summarized in *Table 2*.

Note that felt WRBs can be designated as “No. 15” or “No. 30” as described in ASTM D226. These terms do not describe the material’s weight or density, so reference to these felts as “15-lb.” or “30#” felt is misleading.

Installation of a WRB is required for most exterior wall systems by current model building codes (e.g., Section 1403.2 of the 2015 IBC). Exceptions to this requirement include the following:

- Where cladding is to be installed over concrete or masonry walls
- Where testing in accordance with ASTM E331 of the exterior wall envelope has been performed to demonstrate resistance to wind-driven rain

The model building code also requires that the WRB consist of a minimum of one layer of No. 15 felt, complying with ASTM D226 Type I or other approved material in combination with flashings to provide a continuous WRB. The exception to this requirement is where stucco is applied over wood-based sheathing. At such locations, “a water-resistive vapor-permeable barrier with a performance at least equivalent to two layers of water-resistive barrier complying with ASTM E2556, Type I" is to be applied.[11]

Regardless of the type of material, WRBs should always be installed with the higher layer shingle-lapped over the lower layer as shown in *Figure 2*. The required lap length may vary by manufacturer, but should be a minimum of two inches (unless otherwise specified) to mitigate wicking and capillary action. Taping or sealing of seams and joints generally is not required, although tears and holes do need to be repaired. Where more than one layer of WRB is to be applied, each layer is to be applied separately (i.e., installation of the first layer should be completed prior to beginning installation of the second layer).

FINALLY…

While each type of material discussed above has a different function, all share a common purpose in protecting our buildings. Some products can serve more than one of the functions described in this article, such as a fluid-applied vapor retarder that can also perform as an air barrier and a WRB; therefore, it is important to understand the properties of each specified material and how they interact to provide a properly functioning building envelope system.

REFERENCE

1. 2015 International Energy Conservation Code (IECC).
2. 2015 International Building Code (IBC).
3. Measured in accordance with the dessicant method of ASTM E96, *Standard Test Methods for Water Vapor Transmission of Materials.*
4. Refer to 2015 IBC for exceptions and clarifications.
5. 2015 IBC.
6. *Standard Test Methods for Evaluating Water-Resistive Barrier (WRB) Coatings Used Under Exterior Insulation and Finish Systems (EIFS) or EIFS With Drainage.*
7. *Standard Specification for Vapor-Permeable Flexible-Sheet Water-Resistive Barriers Intended for Mechanical Attachment.*
8. *Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.*
9. *Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep-Slope Roofing.*
10. For additional discussion of the differences between felts and papers, see "Organic Weather-Resistive Barriers: Understanding the Points of Papers and Facts of Felts," by Matthew J. Innocenzi and A. Rhett Whitlock, published in the February 2010 issue of *Construction Specifier.*
11. Section 2510.6 of 2015 IBC. Prior editions of the building code (2012 and earlier) required the WRB to have a performance equivalent to two layers of Grade D paper.

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AIA Expresses Concerns About Immigration Policy

The American Institute of Architects (AIA), in a recent press release, took a stand for "fair and impartial immigration policies" and noted "targeted immigration restrictions…can thwart recruiting efforts…[and] inhibit business activity."

The following statistics further support AIA's concern about the impact any newly imposed immigration or travel restrictions will have on the broader design and construction industry:

- Immigrant labor accounts for 23% of the total construction workforce in the U.S. (Source: U.S. Department of Commerce, American Community Survey)
- In 2015, billings by U.S. architectural firms for international projects totaled $1.6 billion. Projects in Middle East countries accounted for 18% of those billings. (Source: AIA Firm Survey Report, 2015)
- Half of U.S. large architectural firms have offices in the Middle East/North Africa, which is the largest reported share of international offices. (Source: AIA Firm Survey, 2015)
- In the 2014-2015 school year, 4,283 architecture students at accredited programs were nonresident aliens. This represents 18 percent of the total—up from 6 percent in 2009. (Source: NAAB annual report)
- In 2015, 889 of the 6,348 total degrees (14 percent) were awarded to nonresident aliens. (Source: NAAB annual report)
- The AIA has 1,538 members licensed outside the United States.

— aia.org