# TECHNICAL ARTICLE: WEATHER BARRIERS, WATER-RESISTIVE BARRIERS, AIR BARRIERS, AND VAPOR RETARDERS: ARE THEY NOT ALL THE SAME?

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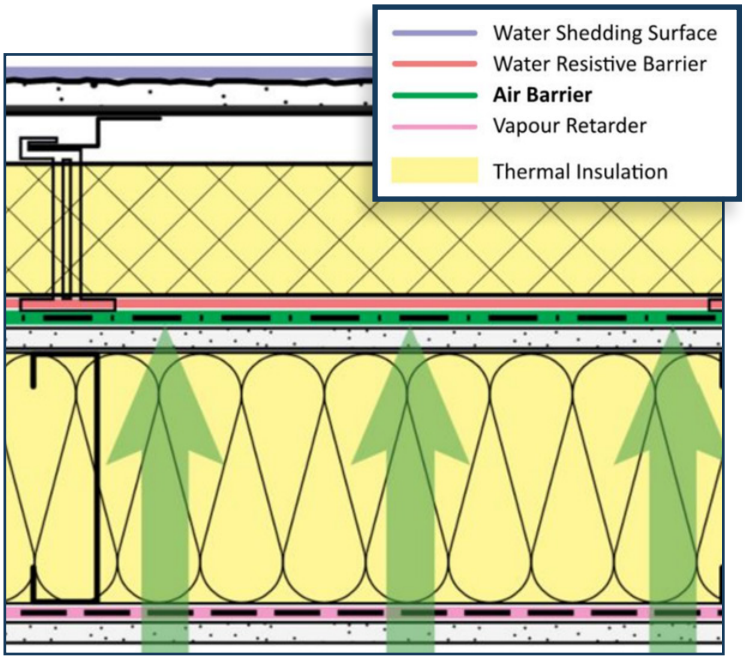
## PART 2: "CODE REQUIREMENTS FOR CONTROL LAYERS"

The building codes have requirements for the control layers and sets performance levels. It is up to the design professional or the builder to show that they have chosen a set of materials that can provide the control layer and that these materials meet the performance requirement set forth in the code. As an example, the codes require an air barrier and the material(s) used to provide that control function cannot have an air leakage rate greater than 0.02 L/(s·$^2$) at a pressure difference of 75 Pa (0.004 cfm/ft$^2$).

Many control layers require more than a single material. The control layer will be placed where it needs to provide the control which may the whole building or part of it. This Part focuses on the requirements included in the International Building Code, the International Residential Code and ASHRAE 90.1.

## WEATHER BARRIER

The weather barrier provides a barrier to all the elements of the weather, separating the inside environment from the outside environment. This environmental separator is the complete building enclosure providing protection from rain, hail, snow, wind, airborne debris, floods, solar, etc., and use the four control layers designed and incorporated into the building enclosure to be the weather barrier. It is all the assemblies together, made up of sub-assemblies, in turn made up of materials and accessories.




The weather barrier is all inclusive, but it is broken down to the four control layers. The control layers are designed and constructed differently depending where in the building they are providing the control layer. The ingress of liquid water is controlled differently depending on whether the control layer in part of the roof, wall or foundation assembly. The design and construction of the control layer will also be different depending on the location of the building and the loads on the building.

The 2021 International Building Code (IBC) and the 2021 International Residential Code (IRC) do not have a definition for weather barrier but has a definition for weather-exposed surfaces.

*Weather-Exposed Surfaces*
Surfaces of walls, ceilings, floors, soffits and similar surfaces exposed to the weather except for the following (it then lists three exceptions):

*2021 IRC 1402.2*
Weather Protection Exterior Walls shall provide the building with a weather-resistant exterior wall envelope. The exterior wall envelope shall include flashing, as described in Section 1404.4. The exterior wall envelope shall be designed and constructed in such a manner as to prevent the accumulation of water within the wall assembly by providing a water resistive barrier behind the exterior veneer, as described in Section 1403.2, and a means for draining water that enters the assembly to the exterior. Protection against condensation in the exterior wall assembly shall be provided in accordance with Section 1404.3. Two exceptions are then listed.

## WATER-RESISTIVE BARRIER

Both the IBC and the IRC uses the same definition for the term – water-resistive barrier. Much of the rain that lands on the face of the cladding is shed off. Intentionally or not, water will get past the cladding system and the water-resistive barrier is intended resist the water ingress and keep the building assembly dry. The water-resistive barrier includes the use of flashings to expel the water to the exterior face of the wall and not just to the exterior face of the water-resistive barrier assembly.

The International Energy Conservation Code (IECC) and ASHRAE 90.1 do not have a term for water resistive barrier.

IBC Section 1403.2 requires that the water-resistive barrier - not fewer than one layer of No. 15 asphalt felt, complying with ASTM D226 for Type 1 felt or other approved materials, shall be attached to the studs or sheathing, with flashing as described in Section 1404.4, in such a manner as to provide a continuous water-restive barrier behind the exterior wall veneer.

IRC Section 703.2 requires for the water-resistive barrier – one layer of No. 15 asphalt felt, free from holes and breaks, complying with ASTM D226 for Type 1 felt or other approved water-resistive barrier shall be applied over studs or sheathing of all exterior walls. No. 15 asphalt felt shall be applied horizontally, with the upper layer lapped over the lower layer not less than 2 inches (51 mm). Where joints occur, felt shall be lapped not less than 6 inches (152 mm). Other approved materials shall be installed in accordance with the water-restive barrier manufacturer's installation instructions.

The No. 15 asphalt felt or other approved water-resistive barrier material shall be continuous to the top of walls and terminated at penetrations and building appendages in a manner to meet the requirements of the exterior wall envelope as described in Section R703.1.

Both IBC and IRC require the water resistive barrier material to provide the performance listed in ASTM D226. In ASTM D226 it requires the following for Type 1.

| PHYSICAL REQUIREMENTS OF ASPHALT-SATURATED ROOFING FELT | |
|---|---|
| Average breaking strength, min, kN/m [lb/in.] of width: | |
| With fiber grain | 5.3 [30] |
| Across fiber grain | 2.6 [15] |
| Pliability at 25°C [77°F] | 12.7-mm |
| The ten strips tested shall not crack when bent 90° at a uniform speed over a rounded corner of: | [1/2-inch] radius |
| Loss on heating at 105°C [221°F] for 5 h, max % | 4 |

The building code includes minimum requirements, and these minimum requirements may not provide the performance required by the design professional. Each material type will require additional performance requirements to ensure that the material will perform as intended. The installation requirements need to be specific for the function the material is to provide.

## AIR BARRIER

The air barrier is the control layer intended to reduce the air leakage rate both through a material and through the cracks, joints, holes, cracks, etc. This control layer is made up of many materials, accessories, components, and assemblies combined to provide the air barrier system:

Air Barrier Material: Primary element that provides a continuous barrier to the movement of air.

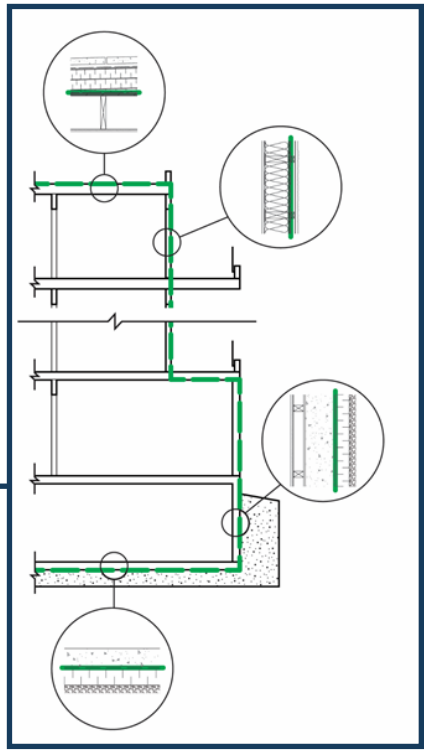
Air Barrier Accessory: Transitional component designated to maintain airtightness between air barrier materials, air barrier assemblies and air barrier components, or to fasten them to the structure of the building, or both (e.g., sealants, tapes, backer rods, transition membranes, nails/ washers, ties, clips, staples, strapping, primers).

**Air Barrier Component:** Pre-manufactured elements, such as windows, doors and service elements that are installed in the environmental separator.

**Air Barrier Assembly:** The air barrier materials and accessories that provide a continuous designated plane to the movement of air through portions of building enclosure assemblies. Insert a picture of an air barrier wall assembly and an air barrier roof assembly.

**Air Barrier System:** A combination of air barrier assemblies installed to provide a continuous barrier to the movement of air through building enclosures.

Each assembly transition must be detailed to provide continuity between systems and trades.



The 2018 IBC does not contain the definition for an air barrier. IBC has a definition for ***air impermeable insulation*** but not for an ***air barrier***.

***air impermeable insulation***
An insulation having an air permeance equal to or less than 0.02 l/s x m² at 75 Pa pressure difference tested in accordance with ASTM E2178 or ASTM E283.

**The IRC has a similar definition for *air impermeable insulation*:**
An insulation having an air permeance equal to or less than 0.02 l/s x m2 @ 75 Pa (0.004 cfm/ft2 @ 0.3 inch of water guage (w.g) pressure difference tested in accordance with ASTM E2178 or ASTM E283. For the definition applicable in Chapter 11, see Section N1101.6.

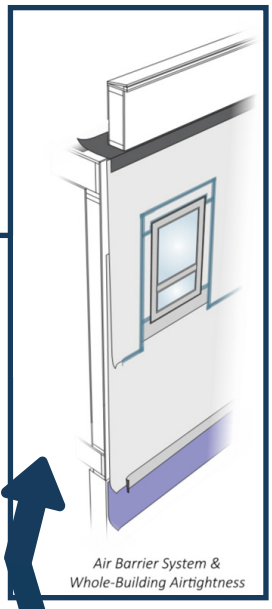
Section 11 Energy Efficiency – General provides a definition for both ***air impermeable insulation, air barrier*** and ***continuous air barrier.***

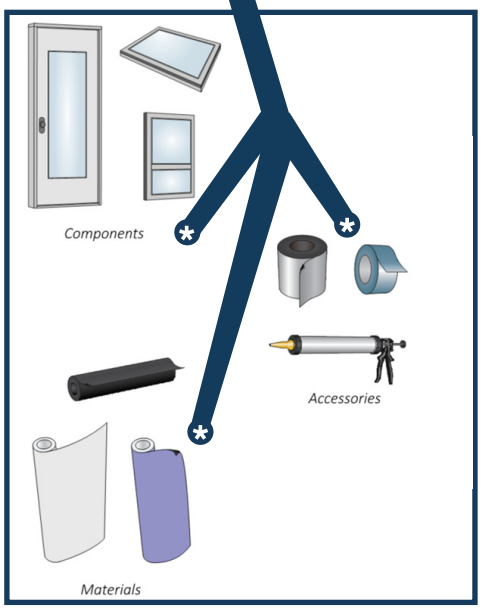
***air impermeable insulation***
An insulation that functions as an air barrier material.

***air barrier***
One or more materials joined together in a continuous manner to restrict or prevent the passage of air through the building thermal envelope and its assemblies.

***continuous air barrier***
A combination of materials and assemblies that restrict or prevent the passage of air through the building thermal envelope.

In ASHRAE 90.1 ***continuous air barrier*** is defined as "the combination of interconnected materials, assemblies, and sealed joints and components of the building envelope that minimize air leakage into or out of the building envelope."



The terms and definitions between the different codes are somewhat harmonized but all the terms relate to providing a control layer function.

The IBC Section 13 Energy Efficiency in Clause 1301.1.1 Criteria requires that buildings be designed and constructed in accordance with the International Building Code.

The IRC Section N1102.4 (R402.4) Air Leakage (Mandatory) requires the building thermal envelope shall be constructed to limit air leakage in accordance with the requirements of Sections N1102.4.1 through N1102.4.5.

Section N1102.4.1 (R402.4.1) Building thermal envelope requires the building thermal envelope shall comply with Sections N1102.4.1.1 and N1102.4.1.2. The sealing methods between dissimilar materials shall allow for differential expansion and contraction. In those two sections the installation is required to follow the manufacturer's instructions and the criteria in Table N1102.4.1.1. The building or dwelling unit is required to be tested and verified that the air leakage rate is not greater than five air changes per hour in Climate Zones 1 and 2 and three air changes per hour in Climate Zones 3 through 8. The testing is to be done in accordance with RESNET/ ICC 380, ASTM E779 or ASTM E1827 and reported at 0.2 inch w.g. (50 Pascals). The building official can require that the testing be done by an approved party with the report signed by the third party. The clause goes on to set out additional requirements.

IECC Section C402.5 air leakage – thermal envelope (Mandatory requires the thermal envelope of buildings shall comply with sections C402.5.1 through C402.5.8, or the building thermal envelope shall be tested in accordance with ASTM E779 at a pressure difference of 0.3 inch water gauge (75 Pa) or an equivalent method approved by the code official and deemed to comply with the provisions of this section when tested air leakage rate of the building thermal envelope is not greater than 0.40 cfm/ft² (2.0 L/s ·m²). Where compliance is based on such testing, the building shall also comply with Sections C402.5.5, C402.5.6, and C402.5.7. The Sections require the air barrier to be continuous and can be located on the inside or the outside of the building envelope. The Section provides prescriptive requirements for sealing all joints and seams. The IRC then requires that the building meet Section C402.5.1.2.1 or C402.5.1.2.2. This allows compliance to be met through materials, assemblies or a system (whole building test.

Section C404.5.1.2.1 is a material requirement where the material can have an air permeability not greater than 0.004 cft/ft² (0.02 L/s ·m²) under a pressure difference of 0.3 inch water gauge. Sixteen materials are listed as meeting this requirement for the purposes of the IRC.

Section C402.5.1.2.2 is an assembly requirement – assemblies of materials and components with an average leakage not greater than 0.04 cfm/ ft² (0.2 L/s · m²) under a pressure difference of 0.3 inch of water gauge (w.g.) (75 Pa) when tested in accordance with ASTM E2357, ASTM E1677 or ASTM E283 shall comply with this section. It then lists three assemblies which are not really assemblies as then are simply units put together, no penetrations, terminations or fenestrations are included.

The 2019 ASHRAE 90.1 Section 5.4.3 Air leakage requires that air leakage control for the building envelope shall comply with this section. Materials and assemblies that are part of the continuous air barrier and fenestration and doors shall comply with Section 5.8.3.

Section 5.4.3.1 Continuous air barrier requires the exterior building envelope and the semi-exterior building envelope shall have a continuous air barrier complying with Sections 5.4.3.1.1 and 5.4.3.1.2.

Section 5.4.3.1.1 Whole-building air leakage requires that whole-building pressurization testing shall be conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air leakage rate of the building envelope shall not exceed 0.40 cfm/ft² under a pressure differential of 0.3 in. of water, with this air leakage rate normalized by the sum of the above-grade and below-grade building envelope areas of the conditioned space and semi-heated space. It goes on to discuss heated and semi-heated and then lists exceptions.

Section 5.4.1.2 Continuous air barrier design and installation lists a number of requirements for the air barrier.

Section 5.8.3 Air leakage and then in Section 5.8.3.1 Testing, acceptable materials and assemblies it states that air leakage for materials or assemblies used as components of the continuous air barrier shall be determined in accordance with the test method and minimum air pressure specified in Table 5.8.3.1 and shall not exceed the maximum air leakage specified in Table 5.8.3.1 when using Exception 3 of Section 5.4.3.1.1.

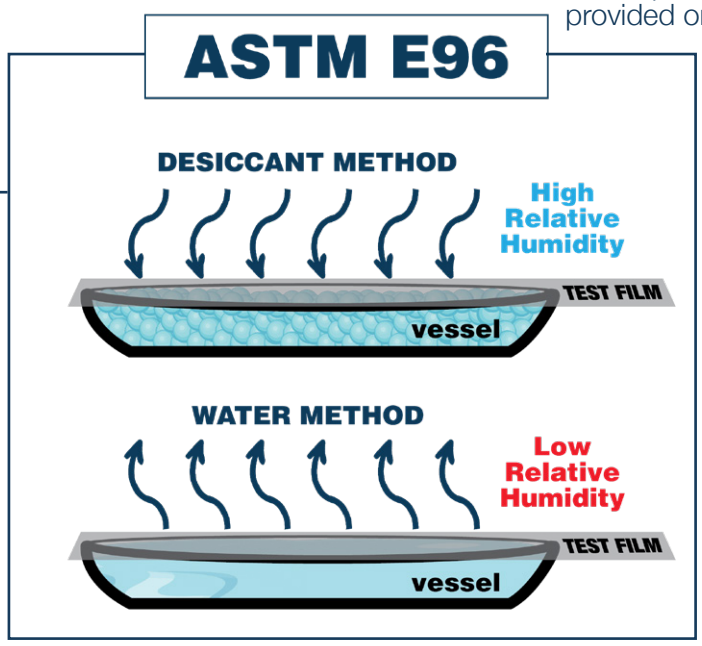
Table 5.8.3.1 lists the test methods to be used for materials and for assemblies and the performance requirements.

## VAPOR RETARDER (BARRIER)

The vapor retarder (barrier) is the control layer intended to reduce the water vapor transmission rate both through a material and through an assembly. Many people see this control layer as being provided by a single material whereas the complete building assembly will impact the moisture transport into and out of the building assembly. Wetting and drying

can be to the exterior or to the interior as all current materials allow the transfer to be in both directions. It is important to understand that as the material is tested at a single difference in atmospheres, this really is for comparison purposes only and the results for a material will change when the atmospheres change.

ASTM E96 test method is conducted at a single steady state atmosphere difference. The Procedure A desiccant method, there is 0% RH on one side and 50% RH on the other side with a 23°C temperature. The Procedure B water method, there is 100% RH on one side and 50% RH on the other side with a 23°C temperature. Change the atmosphere difference (R.H. or temperature) and you change the water vapor transmission.




The IBC and the IRC do not have a definition for the term vapor retarder or vapor barrier but has terms for vapor permeable and vapor retarder classes.

vapor permeable – the property of having a moisture vapour permeance rating of 5 Perms (2.9 x 10-10 kg/Pa x s x $m^2$) or greater, when tested in accordance with the desiccant method using Procedure A of ASTM W96. A vapor permeable material permits the passage of moisture vapor.

Vapor retarder classes – a measure of a material or assembly's ability to limit the amount of moisture that passes through that material or assembly. Vapor retarder class shall be defined using the desiccant method with Procedure A of ASTM as follows:

- Class I: 0.1 perm or less
- Class II 0.1 <perm ≤ 1.0 perm
- Class III: 1.0 <perm ≤ 10 perm

The IECC and ASHRAE 90.1 do not have a definition for a vapor retarder or a vapor barrier.

Some people have given names to the different classes, they give the following names to the different classes:

- Class I is called a vapor barrier
- Class II is called a vapor retarder
- Class III is called semi-permeable
- Class iv is called permeable

That would lead you to calling anything over 10 Perms a vapor permeable material.

The IBC Section 1404.3 vapor retarders requires that vapor retarders as described in Section 1404.3.3 shall be provided in accordance with Sections 1404.3.1 and 1404.3.2, or an approved design using accepted engineering practice for hydrothermal analysis.

Clause 1404.3.1 Class I and II vapor retarders shall not be provided on the interior side of the frame walls in Zones 1 and 2. Class I vapor retarders shall not be provided on the interior side of frame walls in Zones 3 and 4 other than Marine 4. Class I or II vapor retarders shall be provided on the interior side of frame walls in Zones 5,6,7,8 and Marine 4.

Clause 1404.3.2 states Class III vapor retarders shall be permitted where any one of the conditions in Table 1404.3.2 is met. Only Class III vapor retarders shall be used on the interior side of frame walls where foam plastic insulating sheathing with a perm rating of less than 1 is applied in accordance with Table 1404.3.2 on the exterior side of the frame wall.

Clause 1404.3.3 deems some materials to meet the requirement for the three classes.

In the IBC, R702.7 Vapor retarders requires Class I or II vapor retarders on the interior side of frame walls in Climate Zones 5,6,7,8 and marine 4 and then lists three exceptions.

Clause 702.7.1 states that Class III vapor retarders are permitted when any one of the conditions in Table R702.7.1 is met.

Clause 702.7.2 then lists material that are deemed to meet one of the classes.

## To Put This into Prospective

A perm is 57 ng per (m2·s·Pa) of water and a nanogram is one billionth of a gram. A drop of water is said to be 0.05 mL so its mass would be 0.05 grams. No matter how you look at this, it is not a lot of water, you need billions of nanograms to get one drop of water.

The intent of the code requirements is to limit how much moisture that will enter the building assemblies while at the same time, allowing the building assemblies to dry out.