Standard Specification for an Air Retarder (AR) Material or System for Low-Rise Framed Building Walls[1]

This standard is issued under the fixed designation E 1677; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers minimum performances and specification criteria for an air retarder (AR) material or system for framed walls of low-rise buildings. The intended users are purchasers of the AR, specifiers of the AR and regulatory groups. The provisions contained in this specification are intended to allow the user to design the wall performance criteria and increase AR specifications to accommodate a particular climate location, function, or design of the intended building. Air retarder performance and specification minimums were selected with the service life of the building wall in mind.

1.2 This specification focuses on ARs for opaque walls. Other areas of the exterior envelope, such as roofs, floors, and interfaces between these areas are not included in this specification.

1.3 This specification does not address air leakage into the wall cavity, that is, windwashing. No standardized test has been developed that adequately identifies all of the influencing factors and measures the impact of this effect on the wall's thermal performance.

1.4 The specifications in this standard are not intended to be utilized for energy load calculations and are not based on an expected level of energy consumption.

1.5 The values stated in inch-pound units are to be regarded as the standard. The values in parentheses are for information only and are closely approximated.

1.6 The following safety hazards caveat pertains only to the test method portion, Annex A1, of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 755 Practice for Selection of Vapor Retarders for Thermal Insulation[2]

E 96 Test Methods for Water Vapor Transmission of Materials[2]

E 241 Practices for Increasing Durability of Building Constructions Against Water-Induced Damage[3]

E 283 Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across Specimen[3]

E 330 Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Differences[3]

E 331 Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference[3]

E 1424 Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure and Temperature Differences Across the Specimen[3]

2.2 *ASHRAE Standard:*

ASHRAE 62 Acceptable Indoor Air Quality[4]

3. Terminology

3.1 *Definitions:*

3.1.1 *air exfiltration*—air leakage out of the building driven by negative pressure.

3.1.1.1 *negative pressure*—air pressure on the outdoor side of a building envelope lower than on the indoor side.

3.1.2 *air infiltration*—air leakage into the building driven by positive pressure.

3.1.2.1 *positive pressure*—air pressure on the outdoor side of a building envelope higher than on the indoor side.

3.1.3 *air leakage*—the movement/flow of air through the building envelope, which is driven by either or both positive (infiltration) and negative (exfiltration) pressure differences across the envelope.

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[1] This specification is under the jurisdiction of ASTM Committee E06 on Performance of Buildings and is the direct responsibility of Subcommittee E06.41 on Air Leakage and Ventilation.

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[2] *Annual Book of ASTM Standards*, Vol 04.06.

[3] *Annual Book of ASTM Standards*, Vol 04.11.

[4] Available from American Society for Heating, Refrigerating, and Air Conditioning Engineers, Inc., 1791 Tullie Crete, N. E., Atlanta, GA 30329.

3.1.3.1 *Discussion*—These pressure differences are caused by wind, mechanical systems, and temperature differences (stack effect).

3.1.4 *air leakage rate*—the time rate of air flow across the air retarder. Expressed as cubic feet per minute per square foot of AR surface at a stated pressure differential across the AR expressed in inches of H_2O. (Cubic meters per second per square meter of AR surface at a pressure differential in Pascals.)

3.1.5 *air retarder (AR)*—a material or system in building construction that is designed and installed to reduce air leakage either into or through the opaque wall.

3.1.6 *opaque wall*—all exposed areas of a wall that enclose conditioned space, except openings for windows, doors and building service systems.

3.1.7 *structural integrity*—for the purpose of this specification, it is the ability of the AR to maintain air leakage performance after exposure to elevated positive and negative pressure (see 5.1.2 for performance).

3.1.8 *vapor retarder*—a material or system that adequately impedes the transmission of water vapor under specified conditions.

3.1.8.1 *Discussion*—For practical purposes it is assumed that the permeance of a vapor retarder will not exceed one perm in inch-pound units (57.4 ng/(s· m^2· Pa)), although at present this value may only be appropriate for residential construction. For certain other types of construction the permeance must be lower.

3.1.9 *water leakage*—penetration of water onto the exterior plane of framing or cavity insulation under specified conditions of air pressure difference across the AR during a test period.

3.1.10 *water resistance*—the capability of a material or system to retard water leakage.

3.1.11 *water vapor diffusion*—the process by which water vapor spreads or moves through permeable materials caused by a difference in water vapor pressure.

3.1.12 *water vapor permeance*—the time rate of water vapor transmission through unit area of flat material or construction induced by unit vapor pressure difference between two specific surfaces, under specified temperature and humidity conditions.

3.1.12.1 *Discussion*—Permeance is a performance evaluation and not a property of a material. An acceptable unit of permeance is the perm: expressed in the units grain/h · ft^2 in. Hg (metric perm = expressed in the units ng/(s · m^2· Pa)).

4. Classification

4.1 This specification covers two types of ARs. The performance requirements are shown in Table 1.

TABLE 1 AR Classifications

Performance Properties	Classifications	
	Type I	Type II
Air leakage	in accordance with 5.1.1	in accordance with 5.1.1
Structural integrity	in accordance with 5.1.2	in accordance with 5.1.2
Water resistance	in accordance with 5.1.3	not required
Water vapor permeance	in accordance with 5.1.4	in accordance with 5.1.4
Supplemental requirements	in accordance with Section 6	in accordance with Section 6

5. Performance Requirements

5.1 This specification does not prohibit a user from increasing a specification performance requirement, however the specification shown shall not be reduced. The user shall consult Annex A1 for additional mandatory requirements, for example, test specimen and procedure. Appendix X1-Appendix X3 contain additional considerations. The performance requirements are not intended to be used to predict specific levels of performance in the field, however they are intended to be used in the evaluation of ARs.

5.1.1 *Air Leakage*—AR shall be tested in accordance with Test Method E 283. Air leakage rate shall not exceed 0.06 cfm/ft^2 at 0.3 in. H_2O. (0.3×10^{-3} $m^3/(s \cdot m^2)$ at 75 Pa.)

NOTE 1—Air leakage rate of 0.06 cfm/ft^2 at 0.3 in. H_2O corresponds approximately to a low rise building (floor area = 125 m^2) with an air leakage rate of 1.0 to 2.0 air changes/h at 0.2 in. H_2O (50 Pa) in which 25 % of the leakage occurs through the opaque walls.

5.1.2 *Structural Integrity*—Air retarder shall be tested in accordance with Test Method E 330, Procedure A—no deflection information is required. The AR shall withstand sustained minimum pressure of 2 in. H_2O (500 Pa) (equivalent wind speed of approximately 65 mph or 29 m/s) for 1 h. The specimen shall pass this test by retesting the air leakage performance requirement and passing the requirement in 5.1.1.

NOTE 2—The user can consult the map in Fig. 1, reference **(1)** and Test Method E 330 (Significance and Use Section) for guidance on wind speeds for the area where the building will be located. This requirement does not address gust wind loads where the windspeed can be significantly higher but for a very short period of time. If an AR is used in a high gust area, the user may require testing at a higher pressure for a shorter period to simulate gust conditions.

5.1.3 *Water Resistance*—Type I ARs shall be tested in accordance with Test Method E 331. No water penetration shall occur onto the exterior plane of framing or cavity insulation, at 0.11 in. H_2O (27 Pa) pressure difference (equivalent wind speed of approximately 15 mph) during a 15-min. test period (see Table 1).

5.1.4 *Water Vapor Permeance*, or water vapor transmission rate of an AR material or materials of a system shall be determined and reported in accordance with Test Method E 96, Procedure A. The test shall utilize standard test conditions of 73.4°F (23°C) and a relative humidity of 50 ± 2 %.

NOTE 3—This test specification is specific to the AR material or materials that make up the system. The user can consult X2.3 for information on permeance.

6. Supplemental Requirements

6.1 Air retarder manufacturers shall provide field application instructions on how to install the AR to achieve continuity.

6.2 Air retarder manufacturers shall make available upon request the test configuration used to achieve the performance requirements of Section 5.

6.3 If an AR is susceptible to ultraviolet (UV) degradation, the AR manufacturers shall provide application/installation instructions that indicate the amount of UV exposure the product can withstand. The AR manufacturer shall also provide upon request test configuration and procedure for UV testing.

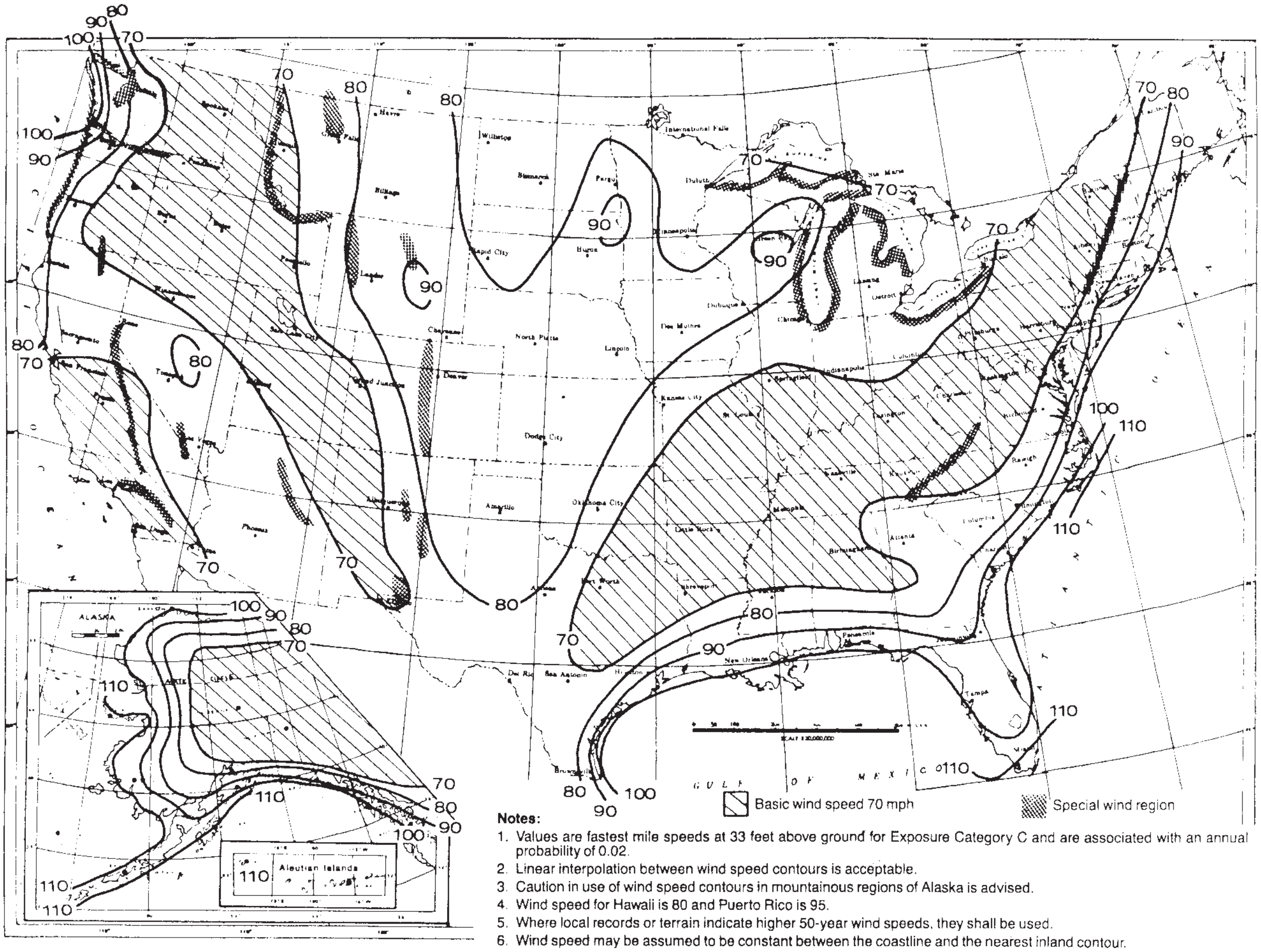

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FIG. 1 Basic Wind Speeds in Miles Per Hour

6.4 The classification of ARs shall be clearly identifiable either in the accompanying literature, on their packaging, or on their product. (See Table 1 for classification of ARs.)

7. Keywords

7.1 air exfiltration; air infiltration; air leakage; air leakage rate; air retarder; opaque wall; structural integrity; vapor retarder; water leakage; water resistance; water vapor permeance

ANNEX

(Mandatory Information)

A1. TESTING AIR LEAKAGE, STRUCTURAL INTEGRITY, AND WATER RESISTANCE

A1.1 Test Apparatus

A1.1.1 Test apparatus shall conform to Test Methods E 283, E 330, and E 331 except as modified by this specification.

A1.2 Test Specimen

A1.2.1 Wall shall be constructed 8 ft by 8 ft or larger, 2 in. by 4 in. framing, and stud spacing of 16 in. on center. (Any additional material attached to this frame shall be considered part of the AR.)

A1.2.2 The AR tested shall not include installation procedures that are different from those in field application instructions. Seams representative of those in the field application shall be included within the test area.

A1.2.2.1 If a component of an exterior AR is installed as 4 ft by 8 ft sheathing (with long dimension vertically installed) or less, at least two vertical seams shall be within the test area.

A1.2.2.2 If an AR is less than 8 ft in the vertical direction, at least one horizontal seam shall be within the test area. More seams are required with narrow (less than 4-ft wide) products.

A1.2.2.3 Both vertical edges of the wall shall be sealed with caulk, gasket, or tape. The AR manufacturer shall specify how the top and bottom of the wall shall be treated. If the wall has caulking, gasketing, or tape utilized at the top or bottom, or both, it shall be considered part of the AR, and shall be prescribed by the manufacturer for field application.

A1.2.3 If interior wallboard, or similar type material, is used as part of the AR, the following practices shall be incorporated.

A1.2.3.1 The wallboard shall be installed by sealing seams at the top and both vertical edges of the wall. The bottom shall remain unsealed to simulate normal construction practice. If sealing of the bottom edge is called for by the AR manufacturer it is then considered part of their system. Vertical or horizontal seams within the field of the test area shall be sealed to simulate taping.

A1.2.3.2 A minimum of one electrical receptacle shall be installed through the interior wallboard surface (14 in. off the floor for every 64 ft^2 of test area). The outlet shall be nongasketing with a minimum of 2 open knockouts. Holes shall be drilled (5⁄8 in. not less than 14 in. from the floor) through each internal stud to simulate wiring penetration and allow for pressure equalization of each stud cavity. Wiring shall not be installed in tested assembly. If any gasketing/caulk is requested by the AR manufacturer, it shall be considered part of the AR.

A1.2.4 For negative and positive pressure difference testing, use either of the following two test options to simulate the installation of an exterior finish/cladding. If the exterior finish/cladding is the AR the following two test options are not required (see reference **(2)** and **(3)** for additional guidance).

A1.2.4.1 To simulate a lap siding install 1 in. by 1 in. wood strips placed horizontally 9 in. apart to the face of the exterior AR. Install the specimen in the test apparatus so the AR is observable, particularly during the structural integrity test.

A1.2.4.2 To simulate brick veneer, install brick ties in a 16 in. by 16 in. grid pattern to the face of the exterior AR. Install the specimen in the test apparatus so the AR is observable, particularly during the structural integrity test.

A1.3 Test Procedure

A1.3.1 For this specification, conduct both Test Methods E 283 and E 330 utilizing both negative and positive pressure differences.

A1.3.2 *Structural Integrity*—(Test Method E 330) Conduct sustained loading on the specimen at a positive and negative pressure difference of 2 in. H_2O, (500 Pa) (approximately 65 mph) for a period of 1 h. The specimen shall have passed this test for structural integrity by retesting the air leakage performance requirement and passing the requirement in 5.1.1. No adjustments or alterations shall be made to the specimen or AR between the completion of the structural integrity test (Test Method E 330) and the completion of the air leakage test (Test Method E 283). Users can require more stringent sustained load requirements. See Fig. 1 for information on the wind speeds in various geographic locations. See gust wind load discussion in 5.1.2, Note 2.

A1.3.3 *Air Leakage*— (Test Method E 283) Measure the air leakage rate of the specimen by maintaining for 1 min. a positive and negative pressure difference of 0.30 in. H_2O (75 Pa) (approximately 25 mph). AR manufacturers shall provide two additional data points both above and below 0.30 in. H_2O (75 Pa), for example, 0.20, 0.25, 0.30, 0.35, and 0.40 in. H_2O (50, 62, 75, 87 and 100 Pa).

APPENDIXES

(Nonmandatory Information)

X1. COMMENTARY

X1.1 The purpose of an AR is to reduce the leakage of air into and through the opaque wall. To achieve this goal, ARs must provide a continuous cover of the opaque wall. ARs must cover joints provided by design as well as openings in the exterior wall created during the field construction process. Reduction of air leakage by the AR provides:

X1.1.1 *Energy Conservation*:

X1.1.1.1 Air leakage into and out of the conditioned space would have to be heated or cooled to the desired indoor air temperature **(2, 4)**.

X1.1.1.2 Air leakage into the opaque wall decreases the effectiveness of the wall insulation system **(2, 4, 5)**.

X1.1.1.3 Leakage of moist air from a heated interior or humid exterior can increase the moisture content of the wall, which increases energy consumption and decreases the thermal performance of insulation **(2, 4, 5)**.

X1.1.2 *Moisture Control*:

X1.1.2.1 ARs reduce leakage of moisture-laden air through the opaque wall that can create condensation/frost within the wall assembly. This can have a damaging effect on wall materials such as framing members and impact the thermal performance of other wall materials.

X2. Design Considerations

X2.1 For the AR to be effective it must reduce air flow. This resistance to air flow can only be achieved by maintaining continuity (no breaks or tears). Continuity of joints must be maintained by overlapping, sealing with weatherable adhesive tapes or caulkings/gaskets. Caulked joints must accommodate dimensional changes in framing members without loss of seal integrity. Such dimensional changes can be induced by lumber drying and settling. Special care (for example, gasketing, sealing) must be used to reduce air leakage around unavoidable penetrations such as plumbing, air ducts, electrical conduits and window/door edges (see 5.1.1 for air leakage performance requirement).

NOTE X2.1—Test Method E 1424 may be utilized to determine the effect of temperature on ARs.

X2.2 An AR must be capable of resisting wind loads when the wall is finished. The AR must resist both pressure and suction without rupturing or breaking away or detaching from its support (see 5.1.2 for structural integrity performance requirement). See also reference **(1)** and Test Method E 330, Section 4 (Significance and Use).

X2.3 ARs may have a range of permeance. All materials in a wall assembly must be considered in evaluating condensation, not just one material. It is the relationship of the total permeance of all the wall materials, the position of those materials in the opaque wall, and the temperature at those positions that influences condensation potential.

X2.3.1 Condensation analysis methods:

X2.3.1.1 A calculation method for determining if condensation might occur is provided in the *ASHRAE Handbook of Fundamentals*, Chapter 20 **(4)**. This method takes into account the permeance of all the wall materials, the position of those materials in the wall, and how temperature can influence the formation of condensation. Computer modeling of moisture transport is available **(6)**.

X2.3.1.2 A less accurate method is to compare just the permeance of materials on either side of the insulation cavity. Generally, a ratio of at least 5:1, outside to inside, for heating dominated climates, is recommended so that moisture vapor has the possibility to escape the wall. (Some very cold geographic areas may require a higher ratio that is, 20:1 and other climates, such as hot and humid may require the ratio to be reversed **(7)**).

X2.3.2 Possible corrective action when the potential exists for condensation.

X2.3.2.1 The designer can either choose to use more permeable materials to enhance the transfer of moisture out of the wall assembly or to insulate the wall and maintain the moisture in a vapor state. Climate considerations are noted below.

(*1*) In a moderate to cold climate the opaque wall must either be permeable to water vapor, or when the permeance of materials on the exterior is less than 1 perm it may be beneficial to insulate on the outside. When the exterior is permeable, moisture vapor from the opaque wall can escape to the outdoors without accumulating in the wall. When the exterior is insulated, the temperature of opaque wall is increased to minimize wall moisture accumulation (see 5.1.4 for the water vapor permeance performance requirement).

NOTE X2.2—Designers should evaluate the amount of insulation necessary to keep condensation from forming in the wall assembly when the AR is rated as a vapor retarder less than 1 perm and exterior applied.

(*2*) In hot and humid climates **(4)**, an exterior AR can also perform as a vapor retarder in order to aid in controlling vapor flow from the building exterior into the wall assembly (see 5.1.4 for permeance performance requirement). When vapor retarders are used on both sides of the opaque wall, precautions should be used to ensure that the building materials within the wall cavity have a moisture content below 19 % **(8)**.

NOTE X2.3—For more information on vapor retarders and their use, see Practice C 755. For additional information on water vapor flow see references **(4, 7)**.

X2.3.2.2 It is always a good practice to allow wall assemblies to dry prior to closure.

X2.4 A Type I AR protects water absorptive building materials from water penetration by being water-resistant. If the building is made of materials unaffected by moisture, a Type II AR is recommended (see Table 1 for AR classifications).

X2.4.1 Designers should consult Practices E 241 for additional practices for limiting water/moisture.

X2.5 To reduce potential for moisture accumulation, avoid ventilating the building through the walls. To achieve the appropriate ventilation, construction components specifically designed for this purpose, such as windows, vents, fans, fresh air intakes or systems should be provided. Uncontrolled air flow from the warm side of the wall can carry moisture into a cooler wall cavity at a rate of up to one hundred times greater than from moisture contributed by uncontrolled vapor diffusion **(9)**.

X2.6 An AR should be sufficiently durable to maintain its effectiveness for a period at least equal to the expected service life of the structure. There is not one test that can provide this information, however the standard performance requirements assist in evaluating significant exposure conditions that the AR could be exposed to during the life of the structure.

X2.7 While ARs are important for controlling air leakage, buildings still need a supply of fresh air to maintain acceptable indoor air quality, to provide for combustion air, and to reduce potential moisture accumulation. To ensure adequate indoor air quality is maintained, ASHRAE Standard 62 should be consulted.

X3. Application Considerations

X3.1 ARs can be designed or specified and installed in various locations in or on the wall. The various considerations, based on the rationale for ARs is discussed below.

X3.1.1 *Interior Application*:

X3.1.1.1 Considerations for installing an AR on the interior side of the insulation material are as follows.

(1) To reduce outside air leakage into the conditioned space.

(2) An interior vapor retarder, which reduces interior vapor diffusion into the opaque wall, can perform as an interior AR if it meets the performance requirements of 5.1.1 and 5.1.2.

(3) Interior side application protects the AR from large changes in temperature that can be encountered in the exterior application.

(4) Reduces interior air leakage into the opaque wall that can affect the R-value of the insulation.

(5) Reduces moist air leakage from the interior into the opaque wall, which may result in damage to structural properties, for example, framing, metal fasteners, masonry ties

(6) Interior side application does not provide protection from exterior side air and water leakage into the insulated opaque wall. Exterior driven air and water intrusions reduce the effectiveness (R-value) of the insulation, and increase the potential for moisture damage.

NOTE X3.1—When an AR is interior installed, designers should provide information for exterior air and water leakage protection of the opaque wall.

X3.1.2 *Exterior Application*:

X3.1.2.1 Considerations for installing an AR on the exterior side of the insulation material are as follows.

(1) Reduces outside air leakage into the conditioned space.

(2) Reduces outside air leakage within and around thermal insulation. Air movement, including convective currents within the opaque wall, can cause a loss of effective R-value **(4, 5)**.

(3) Reduces the potential that cold or hot air leakage will flow into the opaque wall.

(4) Can provide water-resistant protection for interior wall components, lumber, insulation, and other envelope materials.

(5) Exterior side application does not protect the wall cavity from interior side air and moisture vapor leakage into the insulated opaque wall.

(6) In moderate to cold climates, water vapor must be able to escape from the opaque wall, or be kept warm enough to reduce the likelihood of condensation. This would reduce the possibility of liquid moisture build-up, as discussed in Appendix X2 **(4, 7)**.

(7) In hot and humid climates, an AR can also serve as a vapor retarder. See Appendix X2 for further information.

REFERENCES

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