ABTG

Research Report

Model Moisture Control Guidelines for Light-Frame Walls: A Building Code Supplement for Builders, Designers, and Building Officials

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Report Written by:

Applied Building Technology Group, LLC
appliedbuildingtech.com

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- *IBC* Section 104.11.1 and Section 1703.4.2 – "**Research reports.** Supporting data, where necessary to assist in the approval of materials or assemblies not specifically provided for in this code, shall consist of valid research reports from *approved sources*."
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About this Research Report:
Applied Building Technology Group (ABTG) is committed to using sound science and generally accepted engineering practice to develop research supporting the reliable design and installation of foam sheathing. ABTG's work with respect to foam sheathing is provided through a grant by the the Foam Sheathing Committee (FSC) of the American Chemistry Council. Foam sheathing research reports, code compliance documents, educational programs, and best practices can be found at www.continuousinsulation.org.

Introduction:

This Research Report provides actionable guidelines to effectively consider, evaluate, and manage the balance of wetting and drying potential in common above-grade, light-frame wall assemblies in a broad range of climate conditions. This objective involves the appropriate use and integration of a wide variety of light-frame wall construction methods and materials including various cladding types, water-resistive barrier types, insulation types, and vapor retarder types or classes. Therefore, the approach taken herein applies to a multitude of light-frame wall assemblies and material choices, including walls:

- with claddings that may or may not store water (e.g., reservoir claddings like Portland cement stucco or adhered masonry veneers) and which may or may not be back-ventilated,
- with water-resistive barriers having a wide range of water vapor permeance properties,
- with exterior sheathing materials having a wide range of water vapor permeance properties,
- with or without exterior continuous insulation and with varying amounts cavity insulation, both of high or low water vapor permeance,
- with a variety of interior vapor retarder choices suitable to a given climate or wall assembly condition, and
- with various combinations of the above materials in climates with different moisture control implications or challenges (e.g., wind-driven rain).

To achieve the above scope and objectives, the model guidelines included herein represent a digest of relevant building science knowledge to support a risk-consistent and performance-based prescriptive approach [1,2]. For additional study, the reader is referred to the References section as well as commentary provided with the guidelines included herein. In addition, a step-by-step worksheet is provided to aid in implementing the guidelines (see Appendix A).

A performance-based approach provides for flexibility and inclusiveness in making component material selections as governed by their method of integration into a variety of plausible and climate-appropriate wall assembly configurations. For example, a relatively high permeance water-resistive barrier may be used with a reservoir cladding like Portland cement stucco in moist climates when properly coupled with the practice of providing back-ventilation of the cladding to avoid high inward wetting potential that is inextricably linked with attempts to achieve high outward drying potential in this case. Similarly, low permeance materials can be used on the exterior side of assemblies with proper selection of interior vapor retarders in coordination with cavity and exterior insulation amounts that vary appropriately with climate to maintain proper balance of wetting and drying potential. Further, wetting and drying potential cannot be managed effectively by focusing only on properties of one or two materials or components forming only part of a wall system. These examples speak to the need for an integrated, inclusive, and performance-based approach as the model guidelines included herein strive to provide. These also speak to the importance of avoiding overly broad (too generalized) or, conversely, narrowly interpreted (taken out of context or exclusive) applications of otherwise useful building science concepts and principles.

The benefits of the above-described guideline approach are manifold:

- promotes risk-consistent performance across various conditions of use;
- makes key variables affecting moisture control performance more transparent such that they are not inadvertently overlooked, misunderstood, or misused in an attempts to achieve acceptable performance or improve performance;
- helps expose potentially harmful misapplications of building science concepts such as “drying potential”, “vapor permeable”, or “double vapor barriers” and brings them into proper balance with a system-based approach to moisture control;

- encourages intelligent decision-making, competition, and innovation founded on a level playing field with a more complete and consistent treatment of key interactions between various related design decisions making up a final wall assembly design and component material specifications; and,
- Provides actionable prescriptive guidelines that are accessible to a variety of end users including designers, builders, and code officials without requiring specialized knowledge or skill except as needed to implement guidance in a simple "look-up" fashion (e.g., figures, tables, etc.) and verify material properties and installation practices for compliance.

Because current model and state/local building codes address some and not all matters of integrated moisture control for building wall assemblies, solely relying on compliance with minimum code requirements is no guarantee of successful performance. In short, there are hidden risks that can be avoided or better managed with an integrated prescriptive approach that considers all of the key variables affecting performance. This realization forms one of the main reasons for development of the supplemental model guidelines included in this report. However, these model guidelines are not intended to be used as a replacement for locally applicable building and energy code requirements; they are intended to be a supplement to ensure that the intent of the code is satisfied with a greater degree of reliability than may be achieved by merely following somewhat incomplete minimum code requirements. While written in a "mandatory language" style to ensure compatibility of use with the style used in model building codes and standards, these model guidelines are presented "as is" and should not be taken as a definitive or exhaustive representation of standardized or accepted practices. Therefore, the user must assume full responsibility for code compliance and for assessing the suitability of any information in this document for any purpose. The assistance of a properly qualified professional should be sought as needed.

These provisions are predicated on two important qualifiers. First, they are intended for "normal" use, occupancy, and operating conditions for typical light-frame commercial and residential buildings. Indoor relative humidity conditions should not exceed approximately 60% in the summer and, for the winter season, should not exceed approximately 45% in the warmer climates or 30% in the colder climates. Building occupants responsible for building operation should monitor and control interior relative humidity by way of minimizing interior moisture loads or managing them by use of properly designed ventilation systems and/or dehumidification. For buildings with occupancy and use conditions that result in significant indoor moisture generation, additional actions should be taken in the design of building envelope assemblies and HVAC equipment; a design professional should be consulted. Such conditions may include high occupancy buildings, sauna rooms, pool rooms, and other conditions that produce significant indoor moisture loads.

Second, these provisions assume a reasonable level of construction quality control. Significant defects in any one of the moisture control practices addressed herein may erode or negate the benefits of some or all of them. For example, major defects in flashing resulting in rain water penetration can easily overwhelm any reasonable attempt to control other wetting mechanisms, even when significant drying potential is provided. Similarly, a major defect in complying with water vapor and air-leakage control can negate the benefits of even a perfect execution of measures to prevent rain water intrusion. In summary, a building system is only as strong and durable as its weakest link.

Model Moisture Control Guidelines for Light-Frame Walls:

MODEL GUIDELINES

1.0 General. Light-frame, above-grade exterior wall **a**ssemblies shall comply with the locally applicable building and energy conservation codes, and the supplemental requirements of Sections 2.0, 3.0, 4.0, 5.0, and 6.0. Alternative solutions shall be permitted in accordance with provisions for alternative means and methods of design and construction in the locally applicable building code.

2.0 Control of Rain Water Intrusion to Reduce Wetting Potential

2.1 General. Exterior wall coverings, water-resistive barriers, fenestration, flashings, and other exterior wall components shall be designed, specified, and installed to resist rain water intrusion in accordance with the locally applicable building code and the corresponding product manufacturers' installation instructions. The water-resistance of water-resistive barriers and fenestration products and their installation methods shall comply with Section 2.2 or the locally applicable building code, whichever is more stringent. The additional requirements of Sections 2.3 and 2.4 shall be provided as applicable and, where not required, shall be permitted.

2.2 Wall System Water Resistance. In addition to other criteria necessary for code-compliance and in-service performance, water-resistive barrier assemblies including accessories, installation methods, and flashing or interfacing details for continuity of water resistance shall be qualified and specified in accordance with Section 2.2.1. Fenestration products shall comply with and be specified in accordance with Section 2.2.2.

2.2.1 The water-resistive barrier assembly shall be tested in accordance with ASTM E 331[4] using the following qualification and specification criteria:

1. The minimum test pressure differential shall be 15% of the allowable stress design wind load for a building wall determined in accordance with ASCE 7[5], the locally applicable building code, or Table 1 and Figure 1 for the intended design conditions.
2. The minimum water-spray test duration at the qualifying test pressure shall not be less than 15 minutes with a minimum total test duration of 1 hour at a test pressure differential of not less than 3 psf.
3. At the qualifying test pressure differential, no water leakage shall pass through the water-resistive barrier or related installation details

COMMENTARY

C1.0: *For additional guidance and resources related to various sections of these guidelines, commentary is provided in the right column in parallel with guidelines in the left column. For a step-by-step worksheet aid in applying these guidelines, refer Appendix A.*

C2.0 & 2.1: *Prevention of rain water intrusion is commonly considered the most important aspect of an overall approach to moisture control. In short, an ounce of prevention (e.g., reducing wetting due to water leaks) is worth a pound of cure (i.e., attempting to reduce its impact by way of increasing drying potential or specifying materials of higher moisture tolerance). For additional guidance on specification of cladding installation methods suitable to a given climate exposure condition, flashing, use of roof overhangs, and other matters supporting durable, moisture-resistant light-frame construction, refer to "Durability by Design, 2nd Edition" [3].*

C2.2 & C2.2.1 & C2.2.2: *Water resistive barriers and other wall components should have coordinated resistance to rain water penetration when used together on a wall system. Unfortunately, U.S. model codes and reference standards are not necessarily coordinated in this matter. In fact, some water resistive barrier materials and methods may not be required to be tested and pass a water-spray test like ASTM E 331[4]. Fenestration products are tested for water penetration resistance per ASTM E 547[8] (similar to ASTM E 331), but these tests are only for the product itself, not a wall assembly or the fenestration component interfaces (flashing) to a water-resistive barrier on a wall assembly. This section fills this gap by providing means to ensure that all the major components (fenestration, water-resistive barrier, and interface details) are coordinated in water-resistive performance. Other matters, such as material durability, wind pressure resistance, tensile strength, etc., should also be considered and are generally addressed in material standards and code evaluation criteria.*

The ASTM E 331 minimum test pressure differential is set at 15% of the wall and fenestration structural design wind pressure. This test pressure differential for evaluating and specifying water resistance of a wall assembly and components is consistent with the recommendation of a minimum ~3 psf value in ASTM E and onto wall framing materials concealed behind the water-resistive barrier.

4. Where the water-resistive barrier is tested together with and concealed by a cladding material (not tested exposed without cladding), the test result shall be applicable for use only with the particular cladding and installation method.

2.2.2 Fenestration products shall comply with and be specified in accordance with the locally applicable building code and NAFS[6]. The fenestration product's structural design wind pressure rating shall be equal to or greater than the allowable stress design wind load determined in accordance with Table 1 and Figure 1, ASCE 7, or the locally applicable building code for the building site and fenestration location on the building configuration.

User Note: *For Canada, water resistance test pressures and ratings for fenestration must comply with wind-driven rain design pressures as required by A440S1-09 [7].*

331 and also the NAFS[6] standard for fenestration which applies the same 15% of the fenestration structural design pressure (with a minimum of 2.9 psf).

Structural design wind pressures are most commonly determined in accordance with the ASCE 7 standard [5]; building code provisions and the values in Table 1 are based on ASCE 7 for the stated conditions of use. A larger test pressure differential than required by use conditions for a given project may be specified for fenestration and water-resistive barrier assemblies to achieve a greater level of expected performance.

Fenestration, water-resistive barriers, and flashing materials should be installed in accordance with the manufacturers' installation instructions or an approved/designed installation method for anchorage, support, and flashing of fenestration. Instructions should be reviewed and appropriately modified as needed to ensure compatibility and proper integration for a given application.

2.3 Fenestration Pan Flashing and Rough Opening Air-Leakage Sealing. Where the annual wind-driven rain receipt is greater than 16 inches per year in accordance with Figure 2, all rough openings for unprotected exterior windows and doors shall have sill or threshold pan flashing installed that is capable of draining intruded water outward onto the surface of the concealed water-resistive barrier or directly to the exterior of the cladding. The interior edge of the pan flashing and the rough opening gap around the window or door frame interior perimeter shall be sealed to prevent air-leakage and promote pressure equalization of the rough opening gap.

C2.3: *The 16 in/yr wind-driven rain receipt criteria is intended to represent reasonable judgment and experience with regard to climate hazard and fenestration water leakage vulnerability associated with product variance, installation variance, aging effects, and other factors. For supporting data related to the role of pan flashing and air-sealing to prevent water leakage around the fenestration-to-wall interface and for additional guidance on fenestration installation, pan flashing, and rough opening air-leakage sealing, refer to several documents related to window installation provided in References [3,9,10,11,12,13].*

2.4 Drainage Space. Where the annual wind-driven rain hazard is greater than 32 inches per year in accordance with Figure 2, a means of drainage shall be provided in accordance with one of the following:

1. A drained and unobstructed air space not less than 3/16-inch-thick located between the water-resistive barrier and the cladding;
2. An open drainage material, not less than ¼-inch thick and with a cross-section area that is not less than 80 percent open, installed between the cladding and backing;
3. Hollow-backed metal or vinyl siding loosely fastened to the backing substrate; or,
4. An alternative drainage design with drainage performance at least equivalent to Items 1, 2, or 3, or not less than 90% drainage efficiency as measured in accordance Annex A.2 of ASTM E2925[14] or ASTM E 2273[15].

C2.4: *The 32 in/yr wind-driven rain receipt criteria is intended to represent reasonable judgment and experience with regard to conditions where enhanced drainage may be warranted or advisable. The minimum drainage space conditions of Items 1 through 4 are intended to represent a reasonable minimum requirement for adequate rain water drainage purposes. Adequate drainage can be provided by spaces as little as 1/16-in-thick, although some may prefer a minimum of ¼-in-thick or more. Alternative drainage space or drainage materials can be qualified in accordance with Annex A.2 of ASTM E 2925[14] or ASTM E 2273[15]. The minimum drainage efficiency of 90% is consistent with established practice for evaluation of drained EIFS cladding using ASTM E2273 and this test method has been used for other applications than EIFS. The ASTM E 2925 test method is intended for rainscreen materials (e.g., drainage matts) and the test method is similar yet different enough that a 90% drainage efficiency with this test is not necessarily equal to 90% drainage efficiency by the ASTM E2273 test method. Many drainage materials or drain space configurations may exceed*

90% and even 95% drainage efficiency. Where practical, higher drainage efficiencies are preferable. Where the drainage space must also serve as a ventilated air space to back-ventilate reservoir claddings, refer to Section 3.3. The drainage requirements in Section 2.4 and drainage and ventilation requirements in Section 3.3 are similar to those found in Section 9.27 of the National Building Code of Canada [16] and Section R703.1.1 of the Oregon Residential Specialty Code [17].

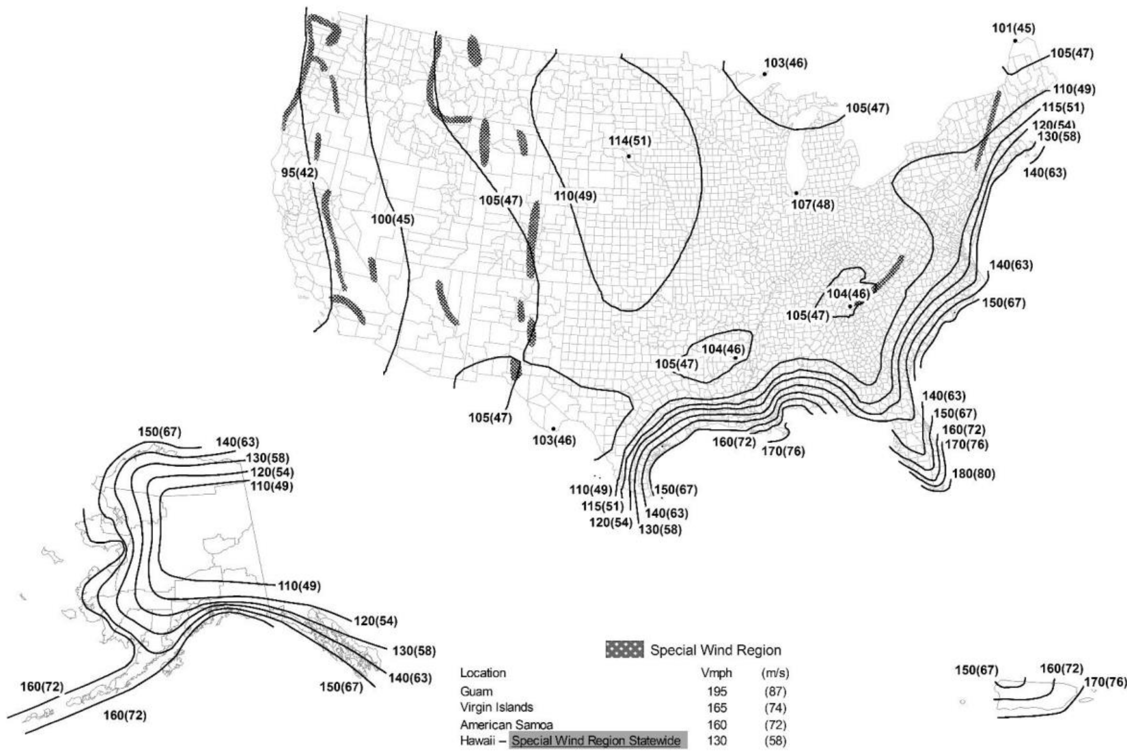
TABLE 1
Water-Resistance Test Pressures for Fenestration Products and Water-Resistive Barriers in Coordination with Required Allowable Stress Structural Design Wind Loads

Mapped Wind Speed (Fig 1) (mph)	Allowable Stress Structural Design Wind Loads (psf)[1]	Minimum Required Fenestration Structural Design Pressure Rating (psf)[2]			Minimum Required Wall System and Fenestration Water-Resistance Test Pressure (psf)[3]			Minimum WRB Water-Resistance Test Pressure for Exposed WRB Test Condition (psf)[4]		
		Wind Exposure[1]			Wind Exposure[1]			Wind Exposure[1]		
		B	C	D	B	C	D	B	C	D
≤110	-17.0 / +13.1	17.0	23.8	28.9	3.0	3.6	4.4	3.0	3.0	3.1
115	-19.0 / +14.3	19.0	26.6	32.3	3.0	4.1	4.9	3.0	3.0	3.4
120	-20.0 / +15.5	20.0	28.0	34.0	3.0	4.2	5.1	3.0	3.0	3.6
130	-24.0 / +18.2	24.0	33.6	40.8	3.6	5.0	6.1	3.0	3.5	4.3
140	-28.0 / +21.2	28.0	39.2	47.6	4.2	5.9	7.1	3.0	4.1	5.0
150	-32.0 / +24.3	32.0	44.8	54.4	4.8	6.7	8.2	3.4	4.7	5.7
160	-37.0 / +27.7	37.0	51.8	62.9	5.6	7.8	9.5	3.9	5.5	6.7
170	-41.0 / +31.2	41.0	57.4	69.7	6.2	8.7	10.5	4.3	6.1	7.4
180	-46.8 / +35.0	46.8	65.6	79.6	7.0	9.8	11.9	4.9	6.9	8.3

For SI: 1 psf = 0.048 kPa, 1 mph = 0.447 m/s

Table Notes & Commentary:

1. Tabulated design wind load pressure values are based on ASCE 7 for components and cladding allowable stress design wind loads on walls of Risk Category II buildings for wind exposure B (suburban/wooded), wall corner zone, effective wind area of 10 sqft, building mean roof height not exceeding 30 feet, and no topographic effect. For wind exposure C (open terrain) and D (coast/water exposure) multiply the allowable stress design wind load pressure values by 1.4 and 1.7, respectively. For other adjustments to account for building mean roof heights other than 30 feet, site topographic effects, wall areas away from building corners, and buildings of other risk categories, refer to ASCE 7.
2. Values for specifying the minimum fenestration structural design pressure rating are based on the larger magnitude negative pressure from the column of allowable stress design wind loads. For the U.S., fenestration design wind pressure rating labels as required by NAFS[6] only report a single design pressure rating value and do not distinguish whether it was controlled by a positive or negative wind pressure loading direction.
3. Values for wall system and fenestration water-resistance test pressure are based on NAFS[6] to help ensure consistency of performance. Therefore, the values are 15% of the allowable stress structural design wind load negative pressure value without consideration that water intrusion is driven by inward acting (positive pressure) wind loads and that negative pressures would serve to reduce water intrusion. With use of these pressures, the WRB is intended to be tested as part of a fully completed test wall assembly including interior finishes, cladding, and air-sealing practices all of which share and distribute portions of the overall wind load applied to the individual layers of a multi-layered assembly (refer to Commentary Section C30.1.5 of ASCE 7[5]).
4. In practice and where required to be tested in an installed condition, WRBs are commonly tested in an exposed condition without cladding installed to avoid the test results being limited to a specific cladding material and installation method. Therefore, values for minimum water resistance test pressure for an exposed WRB test condition are based on 70% of the pressures applied to the full assembly condition (see Note 3). The exposed WRB test condition excludes the cladding and interior finish layers such that, during the ASTM E 331 test, a substantial portion of the pressure differential occurs across the WRB layer in the absence of load sharing these other layers would provide in actual service. Also, the exposed WRB is subjected to the full ASTM E 331 spray rate in the absence of substantial water deflection provided by cladding.



Notes:
1. Values are nominal design 3-second gust wind speeds in miles per hour (m/s) at 33 ft (10m) above ground for Exposure C category.
2. Linear interpolation is permitted between contours. Point values are provided to aid with interpolation.
3. Islands, coastal areas, and land boundaries outside the last contour shall use the last wind speed contour.
4. Mountainous terrain, gorges, ocean promontories, and special wind regions shall be examined for unusual wind conditions.
5. Wind speeds correspond to approximately a 7% probability of exceedance in 50 years (Annual Exceedance Probability = 0.00143, MRI = 700 Years).
6. Location-specific basic wind speeds shall be permitted to be determined using www.atcouncil.org/windspeed

FIGURE 1. Ultimate Design Wind Speed Map for Typical Risk Category II Buildings (per ASCE 7 [5])

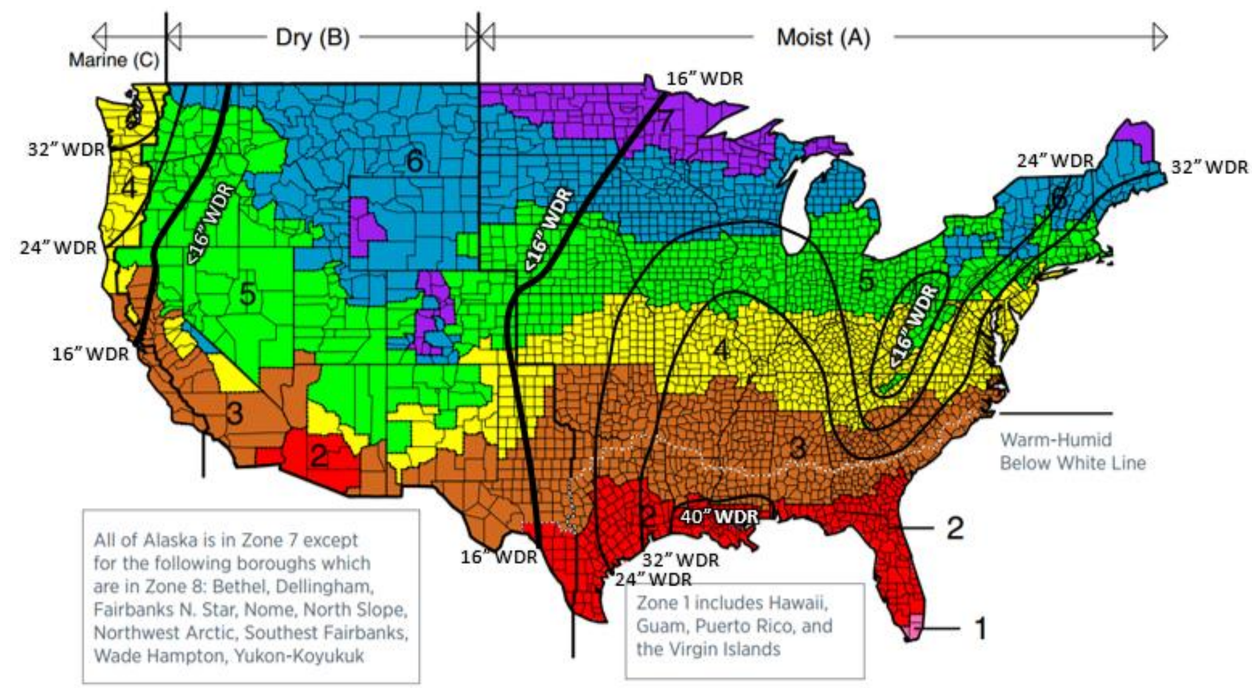


FIGURE 2. Climate Zone and Wind-Driven Rain Map
[Source: US EPA for climate zone map and U. of GA [18] and ASTM [19] for WDR contours]

3.0 Control of Water Vapor Diffusion to Manage Wetting and Drying Potential

3.1 General. The location and properties of insulation components, vapor retarders, and other material layers on light frame, above-grade exterior wall assemblies as illustrated in Figure 3 shall comply with Table 2(A) or Table 2(B). The requirements of Sections 3.2, 3.3, and 3.4 shall be additionally satisfied as applicable. Where insulation is used as a means to control water vapor in accordance with Table 2(B), insulation solutions also shall comply with the locally applicable energy conservation code.

> **Exception:** Table 2(B) shall be used where the net water vapor permeance of material layers on the exterior side of wall studs is unquantified or does not comply with the minimum net water vapor permeance values in Table 2(A) for the climate and specified interior vapor retarder class.

User Note: *A means of determining net water vapor permeance is provided in footnote 'b' of Table 2(A). Use of Table 2(A) and other provisions in this section require the availability and use of the water vapor permeance properties of specified material layers. These properties should be obtained from manufacturer data for the specified materials using test methods as indicated herein. Preferably, this data should be based on testing by an approved agency or approved source (e.g., certified independent, third-party laboratory).*

C3.1: *Section 3.1 provides two methods to systematically specify properties of material layers (e.g., thermal resistance and/or vapor permeance) on the interior and exterior sides (and middle) of wall assemblies to reduce water vapor diffusion wetting potential. They offer a broad range of solutions that also coordinate adequate drying potential as appropriate for most typical climate conditions; additional requirements for drying potential in moderate to severe wind-driven rain climates are found in Section 3.2.*

Table 2(A) provides an approach focused on controlling the vapor permeance of materials on both sides of a wall assembly to ensure overall system performance. Table 2(B) provides an approach that controls vapor diffusion wetting by using exterior continuous insulation on a wall assembly in a manner that keeps internal surfaces warm enough to suppress the occurrence of high surface humidity or condensation. It uses an "insulation ratio" approach that varies with climate and the interior vapor retarder class, filling in the gaps where U.S. model building codes only explicitly address continuous insulation requirements when a Class III (e.g., latex paint) interior vapor retarder is used.

Vapor diffusion can cause repetitive annual wetting cycles of exterior material layers in the winter due to outward vapor drives. In the summer, vapor diffusion wetting of interior and exterior layers is caused by inward vapor drives (refer to Sections 3.3 and 3.4). Because drying potential is achieved by diffusion, the control of water vapor diffusion must balance wetting and drying. Specifying too much water vapor permeance for an inner or outer layer can cause more wetting potential than it provides drying in certain conditions or seasons. Similarly, too little permeance on both sides of a wall can cause too little drying in certain conditions. For further study and related data, analyses, and experience supporting Section 3.0 as a whole, refer to references [1,2,16,20,21,22] in the References section.

3.2 Drying Potential for Moist Climates with Severe Wind-Driven Rain. In climates with an annual wind-driven rain receipt exceeding 32 inches in accordance with Figure 2, inward or outward drying potential of the wall assembly shall be provided by one of the following practices in addition to maintaining compliance with Section 3.1:

1. Drying to the exterior – The minimum net permeance of exterior material layers, including the exterior sheathing, water-resistive barrier,

C3.2: *Section 3.2 provides minimum drying potential criteria in climate conditions where the risk of incidental water intrusion (a contributor to wetting potential) is relatively high and is intended to be used in conjunction with the requirements of Section 2.0 to reduce the risk and frequency of incidental rain water wetting. In areas of lower wind-driven rain hazard (i.e., dryer climates), the provisions of Section 3.1 are considered to provide adequate drying potential together with other provisions of this guide to control overall wetting potential.*

and any unvented air-impermeable cladding, shall be 1.5 perms or greater as measured by ASTM E 96[23] Procedure B (wet cup), or

2. Drying to the interior – The minimum net permeance of interior material layers, including the interior vapor retarder and interior finishes, shall be 1.5 perms or greater as measured by ASTM E 96 Procedure B (wet cup).

User Note: *Where using Item 1 above with Table 2(A) in areas with greater than 32 in/yr wind-driven rain per Figure 2, the minimum net water vapor permeance of 1.5 perms for exterior material layers may over-ride the minimum values for the same provided in Table 2(A) to ensure adequate drying potential to the exterior. Similarly, where using Item 2 above with Table 2(B) in areas with greater than 32 in/yr wind-driven rain per Figure 2, the selection of interior vapor retarder becomes limited to a Class II (Kraft paper) or Class III vapor retarder to ensure adequate drying potential to the interior. In either case, increasing net water vapor permeance to the exterior or interior, respectively, will improve drying potential of the assembly, but must be done in coordination with Section 3.1.*

For vapor diffusion drying to the exterior, the 1.5 perm minimum net permeance is based on use of OSB sheathing which has a wet-cup permeance typically exceeding 2.3 perms, a vapor-permeable water-resistive barrier which by definition has a minimum water vapor permeance of 5 perms, and an air-permeable or vented cladding which generally has an apparent water vapor permeance of greater than 30 perms. For vapor diffusion drying to the interior, the 1.5 perm minimum net water vapor permeance is based on Kraft paper (a Class II vapor retarder by ASTM E 96 dry cup measurement) having a wet cup water vapor permeance of approximately 1.8 perms per ASHRAE Handbook of Fundamentals [24] and typical interior latex paint (primer plus two coats) on ½" gypsum wall board being 9 perms or greater for a combined minimum net permeance of about 1.5 perms.

3.3 Reservoir Claddings (Solar-Driven Inward Water Vapor Drive). Reservoir claddings include Portland cement stucco, adhered masonry veneers, anchored masonry veneer, cement siding panels, and other claddings that have water absorption greater than 3% (volumetric moisture content) as measured in accordance with ASTM C209[25] 2-hour soak test. For reservoir claddings used in Moist (A) and Marine (C) regions of Figure 2 where the wind-driven rain is greater than 16 in/yr and where installed over moisture sensitive wall materials such as wood-based or gypsum-based sheathing, one of the following practices shall be used in addition to maintaining compliance with Section 3.1:

1. A drained and ventilated air space, complying with or exceeding the minimum requirements of Items 1, 2, or 4 of Section 2.4, located behind the reservoir cladding to the exterior side of the water-resistive barrier with ventilation air outlets and inlets at the top and bottom of each air space.
2. An alternative drainage and ventilation design with drainage complying with Item 4 of Section 2.4 and with ventilation performance at least equivalent to Items 1 or 2 of Section 2.4 with ventilation air outlets and inlets included. Ventilation performance shall be measured in accordance with Annex A1 of ASTM E 2925[14].

   Exceptions: An air space for ventilation shall not be required for any of the following conditions:

C3.3: *When subject to moisture absorption due to rain exposure followed by solar radiation, significant inward vapor drives occur as a reservoir cladding dries inward and outward. The inward drying of a reservoir cladding creates inward wetting if not suppressed by use of lower water vapor permeance materials behind the reservoir cladding to help block inward vapor movement or by providing a ventilated air-space to remove the water vapor before it is driven into the wall assembly when higher permeance exterior layers are located behind the reservoir cladding. While a drained air space only requires bottom outlets or weeps to allow water to exit the air space, a ventilated air space requires bottom and top vent inlets and outlets in each unobstructed air space for ventilation air entry and exit. These vent inlets and outlets may include bug screens as necessary. However, bug screens will slow the ventilation air flow rate.*

Where ventilation air flow is used to mitigate inward vapor drives behind a reservoir cladding, increasing the ventilation air flow rate beyond the minimum achieved by Items 1 and 2 may be advisable depending on factors such as exposure of the assembly to rain, height of the air space (flow path), and other factors. Accepted practice is not clearly defined in practice or typical model code requirements. For example, code requirements for anchored masonry veneer (e.g., brick) typically require a nominal 1-inch-thick airspace (which necessarily is partially obstructed by mortar) with weeps at the base (which may include bug screens) and no specific requirement regarding ventilation outlets at the top (although for some types of construction the top is left open within the eaves of a ventilated roof assembly).

1. Foam plastic insulating sheathing complying with ASTM C 578 or ASTM C 1289 located between the reservoir cladding and underlying moisture sensitive wall materials. A drainage space shall be provided in accordance with Section 2.4 as applicable and compliance with Section 3.1 shall be maintained.
2. A water-resistive barrier, a substantially nonwater-absorbing layer, a bond-break layer, or combination of these materials between the reservoir cladding and underlying moisture sensitive wall materials provide a net water vapor permeance not exceeding 10 perms where each material's water vapor permeance is measured by ASTM E 96, Procedure B. A drainage space shall be provided in accordance with Section 2.4 as applicable and compliance with Section 3.1 shall be maintained.

User Note: *Where Exception 1 is used, the application of foam plastic insulating sheathing must comply with Section 3.1 and Table 2(B), particularly in the colder climate zones. Where Exception 2 is used, the permeance of the exterior material layers must comply with Section 3.1 and Table 2(A) or, otherwise, be insulated in accordance with Table 2(B), particularly in the colder climate zones and where the net water vapor permeance on the exterior side of the assembly is substantially less than 10 perms. The selection of an interior vapor retarder will also be affected by these design decisions to maintain compliance with Section 3.1 and also Section 3.2 where applicable.*

Regardless, such anchored masonry veneer installations may be considered to comply with or exceed the minimum drainage and ventilation air space requirements of Item 1. In a recent model building code, a ventilated air space requirement was added for stucco applications (as also used for adhered veneer), but only in Climate Zones 1A, 2A, and 3A. Ventilation performance requirements or minimum prescriptive requirements such as minimum air space thickness and use of inlet and outlet air vents was not specified (e.g., refer to Section 2510.6 of the 2018 International Building Code [26]).

Where the exceptions are used to avoid the requirement for a ventilated air space and control the inward movement of moisture by limiting the water vapor permeance of materials located behind the reservoir cladding, a drainage space may still be required for rain water drainage purposes as required in Section 2.4 for severe wind-driven rain climates. Where such a drainage space is required or otherwise provided for water intrusion control, it also will provide additional benefit for inward vapor drive control behind reservoir claddings.

Exception 1 addresses a common and successful Portland cement stucco installation variation whereby a generally non-vapor-permeable exterior insulating sheathing is placed over a separate water-resistive barrier and under the stucco (or reservoir cladding). In this case the foam sheathing also serves as a bond-break layer for the stucco. The foam sheathing layer may serve as the water-resistive barrier or be placed under a separate water-resistive barrier in which case a separate bond-break layer or nonwater-aborbing layer must be used between it and the stucco. Exception 2 permits various material layers commonly located between the reservoir cladding and water sensitive wall materials to serve the same purpose of providing resistance to inward water vapor movement by providing a net water vapor permeance of 10 perms or less. This permeance limit is intended to represent a reasonable judgment based on experience and available data.

In addition to references [1,2,3], refer to references [16,20,22,27] in the Reference section for additional information supporting the provisions in Section 3.3.

3.4 Walls with Non-reservoir Claddings in Warm-Humid Climates (Inward Vapor Drive). In the "warm-humid" climate region of Figure 2, the net water vapor permeance of material layers located on the exterior side of wall studs shall not exceed a net water vapor permeance of 20 perms where the permeance of each material layer is based on ASTM E 96 Procedure B (wet cup).

C3.4: *Inward vapor drives are the dominant diffusion wetting mechanism in the warm-humid climate region (see the 'white line' in Figure2), even for walls with claddings that are not reservoir claddings. Therefore, assuring appropriate balance of vapor permeance of the inside and outside of an assembly is beneficial. Having lower- to-moderate vapor permeance on the exterior and higher on the interior should be preferred. This practice together with the limits on interior vapor retarders in*

Exception: The net water vapor permeance of materials to the exterior side of wall studs shall be permitted to exceed 20 perms where spray foam is applied in the wall cavity at an installed thickness as necessary to be non-vapor permeable and air impermeable.

User Note: *While Section 3.3 focused on material layers (and air space) between a reservoir cladding and water sensitive wall materials such as wood-based and gypsum-based sheathing, Section 3.4 focuses on all material layers to the exterior side of the assembly (including the exterior sheathing layer). In this case, it is the net water vapor permeance of all the exterior layers (sheathing, WRB, and unvented claddings) that are required to comply with the 20 perm maximum for net water vapor permeance. Thus, some layers could substantially exceed the 20 perm limit if there is at least one layer that complies with the 20 perm limit. For example, typical wood sheathing materials (e.g., OSB or plywood) have a wet cup water vapor permeance well below 20 perms. Thus, a water-resistive barrier with unlimited water vapor permeance can be used. A means to determine net water vapor permeance of multiple layers is addressed in note 'b' of Table 2(A). Tables 2(A) and 2(B) of Section 3.1, serves to help control inward vapor drives (wetting) during the summer in warm-humid climates just as interior vapor retarders are used to control outward vapor drives (wetting potential) during winter in colder climates. The 20 perm limit is considered to represent reasonable judgment and experience based on available data; refer to Section 3.3 and References.*

The exception provides a means to resist inward vapor drives by cavity insulation that is non-vapor permeable (< 5 perms by code definition) and that is air impermeable (i.e., qualifies as an air barrier material as typically defined in model energy conservation codes; refer also to Section 4). This requirement can be satisfied by closed-cell and open-cell varieties of spray foam insulation; however, a greater thickness will be required for open-cell types. The specific thickness required in each case will depend on the specified spray foam manufacturer's product data.

TABLE 2(A)
MINIMUM NET WATER VAPOR PERMEANCE (WVP)
FOR MATERIAL LAYERS LOCATED ON THE EXTERIOR SIDE OF WALL STUDS [a,b,c]

Climate Zone (Fig. 2)	Interior Vapor Retarder Class		
	Class I	Class II	Class III
1	NP	NP[d]	No minimum
2	NP	NP[d]	No minimum
3	NP	No minimum	No minimum
4	0.5 perm (Marine 4) and otherwise NP	0.5 perm	3 perm
5	0.5 perm	3 perm	5 perm
6	1 perm	5 perm	15 perm
7	1 perm	15 perm	NP
8[e]	1.5 perm	NP	NP

For SI: 1 perm = 57.2 ng/s-m^2-Pa
NP = indicated vapor retarder class is not permitted in the indicated Climate Zone
Table Notes & Commentary:

a. The WVP of materials on the exterior side of the wall studs shall be permitted to be determined using the 'wet-cup' method of ASTM E96 for the purposes of compliance with this table.
b. Where there is more than one layer to the exterior side of wall studs, the net WVP of the layers composing the exterior wall covering assembly, excluding vented claddings, shall be determined using the following equation: Net WVP (perms) = 1/[1/perm1 +1/perm2 + 1/perm3 + etc.], where 'perm#' is the WVP of each individual layer exterior to the wall framing members. Perm ratings for each material layer shall be based on approved test data representative of the actual product, including all component layers of composite products.
c. Where exterior continuous insulation does not satisfy the amount required by Table 2(B), its water vapor permeance shall be considered in accordance with this table and footnote 'b'. The declared water vapor permeance of the specific product shall be used and use of minimum or maximum values associated with a product "type" or "class" shall not be used.
d. In Climate Zones 1 and 2, a Kraft paper vapor retarder or other Class II vapor retarder shall be permitted where the WVP of the vapor retarder is greater than 1.8 perms as measured in accordance with Method B (wet cup) of ASTM E96.
e. The WVP requirement for Climate Zone 8 is based on a maximum 16,200 heating degree days (65°F basis) [9,000 heating degree days (18°C basis)]. Where this heating degree day limit is exceeded, a design shall be required to determine the minimum required net water vapor permeance for materials on the exterior side of the assembly.

TABLE 2(B)
MINIMUM INSULATION RATIO OR CONTINUOUS INSULATION R-VALUE
FOR LIGHT-FRAME WALLS WHERE EXTERIOR CONTINUOUS INSULATION (ci) IS USED [a,b,c,d]

Climate Zone (Fig. 2)	Maximum Heating Degree Days (65F basis)	Interior Vapor Retarder (VR) Class			
		Class I	Class II	Class III	No VR[e]
1	**N/A**	NP	NP[f]	R-2ci minimum	R-2ci minimum
2	**N/A**	NP	NP[f]	R-2ci minimum	R-2ci minimum
3	**3,600**	NP	R-2ci minimum	R-2ci minimum	0.4
4	**5,400**	NP	R-2ci minimum	0.2	0.9
5	**7,200**	0.2	0.2	0.35	1.3
6	**9,000**	0.2	0.2	0.5	1.7
7	**12,600**	0.35	0.35	0.8	2.3
8[g]	**16,200**	0.5	0.5	1.1	2.8

For SI: 1 heating degree day (65°F basis) = 0.56 heating degree days (18°C basis)
NP = indicated vapor retarder class is not permitted in the indicated Climate Zone.

Table Notes & Commentary:

a. Insulation ratio is the exterior continuous insulation R-value (Re) divided by the cavity insulation R-value (Ri). For example, a wall with R20 cavity insulation and R5 continuous insulation (e.g., R20+5ci) has an insulation ratio of 5/20 = 0.25. The R-2ci minimum applies where there is no minimum insulation ratio required and is intended to ensure a minimum level of performance as required for insulating sheathing defined in the locally applicable building code.

b. Interpolation of insulation ratios using a site-specific heating degree day value shall be permitted.

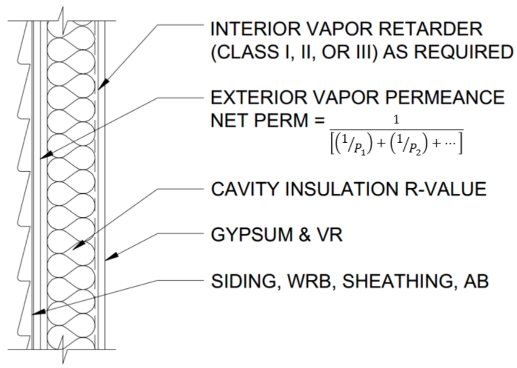
c. For light-frame cold-form steel wall construction, the tabulated minimum insulation ratio shall be increased by adding 0.1.

d. In addition to the vapor retarder, spray foam with a maximum permeance of 1.5 perms at the installed thickness, applied to the interior cavity side of wood structural panels, fiberboard, insulating sheathing or gypsum shall comply with the tabulated insulation ratio or minimum R-value for continuous insulation.

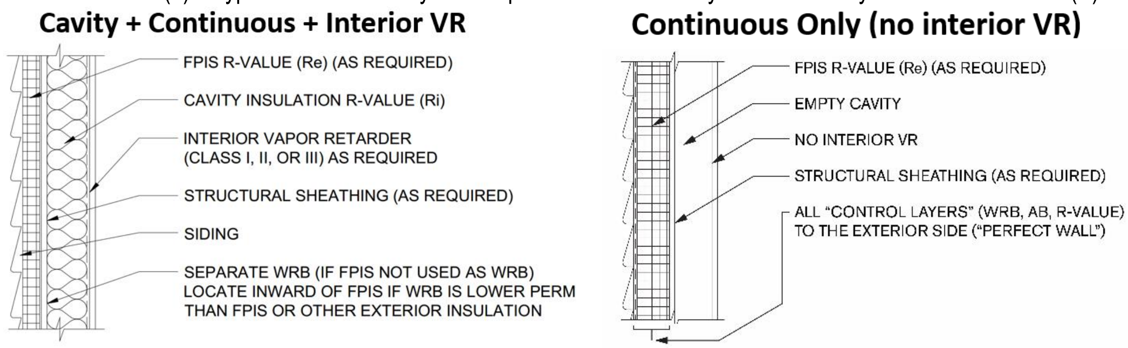
e. "No VR" refers to the case where there is no interior vapor retarder and water vapor control relies entirely on the amount of exterior insulation used to control temperature, humidity, and condensation conditions within the assembly. Where there is no cavity insulation, the R-value of any material layers, air-space, and air-film to the interior side of the exterior continuous insulation shall be used to determine the insulation ratio in accordance with footnote 'a'. In no case shall the value of Ri be taken as less than R-5 in determining the insulation ratio (Re/Ri) for the "No VR" case. The water vapor permeance of the exterior continuous insulation or other material layer located to the interior side of the exterior continuous insulation shall not exceed 1.5 perms.

f. In Climate Zones 1 and 2, a Kraft paper vapor retarder or other Class II vapor retarder shall be permitted where the WVP of the vapor retarder is greater than 1.8 perms as measured in accordance with Method B (wet cup) of ASTM E96.

g. The insulation ratio requirement for Climate Zone 8 is based on a maximum 16,200 heating degree days (65°F basis) [9,000 heating degree days (18°C basis)]. Where this heating degree day limit is exceeded, a design shall be required to determine the insulation ratio.



(a) Typical Wall Assembly with Vapor Permeable Cavity Insulation Only for Use with Table 2(A)



(b) Typical Hybrid Wall Assembly and Exterior Continuous Insulation Only Assembly for Use with Table 2(B)
Note: Arrangement of control layers is material and climate specific.

Figure 3. Typical Wall Assemblies for Use with Tables 2(A) and 2(B).

4.0 Control of Moist Air Movement

4.1 General. Air movement into and through building envelope assemblies shall be controlled in accordance with air barrier material and assembly requirements of the locally applicable energy conservation code. The air-barrier location requirements of Section 4.2 shall be permitted as optional practices where not already required by the locally applicable energy conservation code. Air barrier materials and components shall be installed in accordance with the manufacturer's installation instructions and integrated with other building components and sealed at transitions to maintain a continuous barrier to air leakage.

C4.1: *Detailed application guidance for use of air barriers to achieve adequate air leakage control is beyond the scope of this guide; for additional information refer to various air-barrier documents provided in References [28,29,30]. Air leakage can be a drying mechanism under the right conditions, but under the wrong conditions it can also contribute to significant localized wetting patterns at points along air leakage flow paths within assemblies. Thus, air leakage into assemblies is generally undesirable from a moisture control perspective. It is also undesirable from an energy conservation perspective and, consequently, air leakage control is typically a matter of energy code compliance.*

4.2 Air barrier location. The air-barrier control layer in a wall assembly shall be permitted to be located in accordance with this section unless otherwise required by the locally applicable energy conservation code.

C4.2: *The air-barrier location requirements are provided as optional enhancements to minimum energy code requirements that do not typically specify preferred locations for air-barriers in an assembly based on climate. Regardless of the air barrier location in an assembly, detailing of air barriers requires special care during installation to*

4.2.1 Climate Zones 1 and 2. Locate the air barrier control layer on the exterior side of the wall assembly. Alternatively, use spray-applied cavity insulation of a thickness necessary to qualify as an air barrier material.

4.2.2 Climate Zones 3 and 4. The location of the air barrier control layer shall not be limited.

4.2.3 Climate Zones 5 through 8. Locate the air barrier control layer on the interior and exterior sides of the wall assembly. Alternatively, use spray-applied cavity insulation of a thickness necessary to qualify as an air barrier material.

ensure sealing of various joints, intersections, and penetrations into or through wall assemblies. The locally applicable energy code and the air barrier material manufacturer's installation instructions should be followed in this regard. The water-resistive barrier layer, vapor control layer, some insulation products, and interior or exterior sheathing layers may be installed and detailed to serve as an air barrier layer and the water vapor permeance of the air barrier (if a separate layer) must also comply with Section 3.0. The optional requirement in Section 4.2.3 for a "dual" air-barrier (on both sides of an assembly) is consistent with EPA Energy-Star requirements and provides improved performance of air-permeable cavity insulations (if used) and also provides added protection against moist air infiltration (wetting potential).

Air-barrier material test criteria and test methods can be found in the locally-applicable energy conservation code.

5.0 Control of Initial Construction Moisture

5.1 General. The moisture content of materials at the time of enclosure within exterior wall assemblies shall be controlled to a sufficiently low level to minimize the risk of mold growth or moisture accumulation in sensitive materials as the enclosed materials dry inward or outward by vapor diffusion through the wall enclosure layers (e.g., vapor retarders, interior finishes, exterior sheathing, water-resistive barrier, air-barrier, etc.). The control of initial construction moisture shall comply with Sections 5.2 and 5.3 as applicable.

5.2 Wet-applied insulation materials. Insulation materials that are wet-applied shall be dried to a moisture content of less than 20% (dry mass basis) prior to their enclosure within a wall assembly. Where more stringent, the wet-applied insulation manufacturer's installation instructions shall be followed.

5.3 Wood-based framing and sheathing materials. Prior to enclosure of a wall assembly, wood framing and sheathing materials shall be dried to a moisture content of 16% or less (dry mass basis). Where more stringent, the wood-based framing material producer's installation instructions shall be followed.

C5.1: *The control of initial construction moisture usually involves a few very practical actions. First, construction sequencing is important. The building should be "dried-in" prior to installation of moisture absorbing insulation materials within or on the interior side of walls or roofs. Drying-in involves completion of roofing and, at a minimum, completion of water-resistive barrier, fenestration, and flashing installations on wall assemblies. Second, where materials become wetted during building construction (e.g., exposed wood framing and sheathing) or are installed wet after dry-in of the building (e.g., wet-applied insulation materials such as sprayed cellulose), those materials must be permitted to dry before enclosure. Drying rates will vary based on climate conditions and other factors. Where supplemental drying is needed, dehumidification, dry-air heaters (e.g., electric fan/heaters), or ventilation of low humidity outdoor air are preferred methods. Use of fuel burning heaters, such as torpedo heaters, to assist drying should be avoided as the combustion by-products include significant amounts of water vapor.*

C5.2 and C5.3: *Recommended moisture content targets are based on review of industry practice and also recommendations in the USDA Wood Handbook [31].*

6.0 Corrosion Resistance

6.1 General. Fasteners, connectors, stucco lath, metal flashing, and other metal materials that are exposed to the exterior side of the cladding or the water-resistive barrier material shall be corrosion resistant in accordance with the locally applicable building code and the additional requirements of Sections 6.2 or 6.3 as applicable. Contact of dissimilar metals shall be avoided.

C6.1: *Failure of exterior wall covering components due to corrosion can compromise the water-resistance and structural integrity of exterior wall coverings. Building code provisions for corrosion resistance are generally vague (i.e., "shall be corrosion resistant") and are not associated with variations in corrosive climate hazard.*

6.2 Moderate Corrosion Exposures. Where the annual wind-driven rain receipt in accordance with Figure 2 is greater than 32 inches, corrosion resistance at least equivalent to hot-dipped galvanized carbon steel shall be provided.

6.3 Severe Corrosion Exposures. In areas within 3 miles of coastal salt water bodies, corrosion resistance at least equivalent to stainless steel, copper, anodized aluminum, or other coated or uncoated metals or materials of at least equivalent corrosion resistance shall be used.

C6.2 and C6.3: *While providing a high level of corrosion resistance, smooth shank stainless steel nails have less withdrawal strength than hot-dipped galvanized or uncoated carbon steel nails. Thus, when using corrosion resistant metal fasteners to fasten exterior wall covering materials to wood framing, the use of deformed shanks may be necessary to maintain or improve the intended structural wind load resistance of the installation.*

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Appendix A:
Moisture Control Guideline: Design Check Worksheet

STEP 1: Define Site Climatic Conditions

- Design Wind Speed: ____________________________ (110-180 mph, Figure 1)
- Wind Exposure: ____________________________ (B, C, or D; Table 1, Note 1)
- Climate Zone: ____________________________ (1-8, Figure 2)
- Moisture Region: ____________________________ (A,B or C, Figure 2)
- Warm-Humid Region (y/n): ____________________________ (below white line, Figure 2)
- Wind Driven Rain (in/yr): ____________________________ (WDR contours on Figure 2)

STEP 2: Define Proposed Wall Assembly and Material Data

[Note: This table may be used to record requirements from following subsequent worksheet steps as a means to define parameters for an acceptable design. Alternatively, it can be used to record data for a pre-determined assembly to be evaluated using the subsequent worksheet steps]

Wall Assembly Sketch:	**Wall Component Data**				
	Component[1,2]	**Product Description**	**Perms (dry cup)**	**Perms (wet cup)**	**R-value**
	Siding				**n/a**
	Drainage or Air-space				**n/a**
	WRB				**n/a**
	Cont. Insul. (Re)				
	Str. Shtg				**n/a**
	Cavity Insul. (Ri)				
	Vapor Retarder				**n/a**
	Interior Sheathing				**n/a**
	Interior Paint				**n/a**

TABLE NOTES:

1. Not all wall layers or components indicated are necessary in a given wall design.
2. If an air barrier is included as a separate material layer not identified with one of the components in the table, then its water vapor permeance property must also be documented for compliance checking.
3. Water vapor permeance data may not be required for all or some components of a given wall assembly depending on the design approach used in Section 3.1 (e.g., Table 2(A) or Table 2(B)). Generally, use of Table 2(A) will require consideration of the water vapor permeance of all components on the exterior side of the assembly.
4. R-value data is required for insulation materials only when using the design approach of Table 2(B), but in this case the water vapor permeance data for components on the exterior side of the assembly are not needed. Thus, assessment of the assembly is often simplified.

STEP 3: Determine Design and Specification Requirements for Rain Water Control (Section 2.0)

SECTION	SPECIFICATION OF:	REQUIREMENT:	SOURCE:
Section 2.2.1	WRB Water-Resistance Test Pressure (PSF)	___ psf	Table 1, Figure 1
Section 2.2.1	Fenestration Structural Design Pressure (PSF)	___ psf	Table 1, Figure 1
Section 2.3	Fenestration Pan Flashing and Rough Opening Air Sealing	Yes (if WDR ≥ 16 in/yr) Optional otherwise	Section 2.3, Figure 2
Section 2.4	Drainage Space (options per Section 2.4)	Yes (if WDR ≥ 32 in/yr) Optional otherwise	Section 2.4, Figure 2

STEP 4: Check Wall Assembly for General Water Vapor Control (Section 3.1)

STEP 4A: This step is for the Table 2(A) water vapor control approach in Section 3.1. Table 2(A) applies to walls where the water vapor permeance of materials on the exterior side of the assembly are known and can be checked for compliance. It is generally used for walls without exterior continuous insulation or with an exterior insulation amount (R-value) not satisfying Table 2(B). Otherwise, skip to STEP 4B for compliance check.

SECTION	SPECIFICATION OF:	REQUIREMENT:	SOURCE:
Section 3.1	Interior Vapor Retarder	Vapor Retarder Class ___ (I, II, or III)	Table 2A, Figure 2
Section 3.1	Minimum Net Water Vapor Permeance of Material Layers on Exterior side of Wall Studs	Minimum Required Net Water Vapor Permeance: ___ perms	Table 2A, Figure 2
Section 3.1	Determine Water Vapor Permeance of Each Material Layer on Exterior Side of Wall Studs	Refer to manufacturer data for water vapor permeance per ASTM E 96, Procedure B (wet-cup)	Record data in STEP 2
Section 3.1	Calculate Net Water Vapor Permeance	Net WVP = ____ perms Net WVP = 1/[1/perm1 + 1/perm2 + 1/perm3 + ...]	Use formula in Note 'b' of Table 2(A)
Section 3.1	Material Layers on Exterior Side of Wall Studs	Verify Net WVP ≥ Min. Req'd Net WVP	

If the material layers on the exterior side of wall studs have a net WVP less than required, then:

- Re-specify one or more exterior layers using a material with a greater water vapor permeance,
- Depending on climate, consider use of a lower perm vapor retarder class which will decrease the minimum required net WVP, or
- Consider using the approach of Table 2(B) with exterior continuous insulation.

STEP 4B: This step is for the Table 2(B) water vapor control approach in Section 3.1. Table 2(B) applies to walls where the R-value of continuous insulation on the exterior of the assembly in relation to the R-value of cavity insulation is used to control water vapor by way of an insulation ratio that varies by climate zone and interior vapor retarder class.

SECTION	SPECIFICATION OF:	REQUIREMENT:	SOURCE:
Section 3.1	Interior Vapor Retarder	Vapor Retarder Class ___ (I, II, or III)	Table 2B, Figure 2
Section 3.1	Minimum insulation ratio required	Minimum Req'd Insulation Ratio: ___ (or min. R-2ci as indicated)	Table 2B, Figure 2
Section 3.1	Determine R-value of Continuous (Re) and Cavity (Ri) Insulation Components	Refer to manufacturer data for R-value for insulation type and installed thickness	Record data in STEP 2
Section 3.1	Calculate Insulation Ratio	Insulation Ratio = Re/Ri = ____	
Section 3.1	Insulation Materials	Verify Insulation Ratio ≥ Min. Req'd Insulation Ratio	

If the insulation ratio is less than required, then:

- Increase exterior continuous insulation and/or decrease cavity insulation as required for compliance,
- Depending on climate, consider use of a lower perm interior vapor retarder class,
- Consider using Table 2(A) and note 'c', or
- Consider using closed-cell spray foam cavity insulation in accordance with Note 'd' of Table 2(A) alone or in addition to continuous insulation to achieve the minimum required insulation ratio.

Verify that the final insulation design satisfies the R-value or U-factor requirements of the locally applicable energy conservation code. Note that while closed cell spray foam cavity insulation and continuous insulation can be used together or separately to satisfy the minimum insulation ratio requirement of Table 2(B), cavity insulation components and continuous insulation components must be considered separately (not summed) for energy code compliance checking because cavity insulation materials are interrupted by framing and continuous insulation materials are not.

STEP 5: Determine Drying Potential Requirements (Section 3.2)

If the wind-driven rain amount for the building site (refer to STEP 1), is less than 32 in/yr per Figure 2, then skip to STEP 6. However, the requirements of Section 3.2 may still be optionally applied for increased drying performance.

If the wind-driven rain amount is equal to or greater than 32 in/yr, then verify compliance with one of the following:

- Drying potential to the exterior: Verify net water vapor permeance of material layers on the exterior side of wall studs is greater than 1.5 perms based on ASTM E 96 Procedure B (wet cup) data for those materials. Follow the same procedure in Step 4A to determine net water vapor permeance. This check is usually used with walls designed in accordance with Table 2(A).

- Drying potential to the interior: Verify net water vapor permeance of material layers on the interior side of wall studs is greater than 1.5 perms based on ASTM E 96 Procedure B (wet cup) data for those materials. Generally, use of a Class II (Kraft paper with wet cup permeance of ~1.8 perms) or Class III (latex paint) vapor retarder will satisfy this requirement without calculating the net water vapor permeance. This check is generally used with walls designed in accordance with Table 2(B) which can also allow for no interior vapor retarder (maximal interior drying potential).

STEP 6: Verify control of inward vapor drives with reservoir claddings (Section 3.3)

Skip to STEP 7 if any of the following apply:

- A reservoir cladding is not used
- A reservoir cladding is used, but wood-based sheathing, gypsum-based sheathing, or other moisture sensitive exterior sheathing materials are NOT used.
- The building site is has a wind-driven rain amount of less than 16 in/yr,(see STEP 1 and Figure 2)
- The building site is not located in climate regions A or C (see STEP 1 and Figure 2)

The provisions of Section 3.3 can be optionally applied to any cladding in any climate region or wind-driven rain condition for improved performance.

Where Section 3.3 is applicable, provide a drained and ventilated cladding installation design in accordance with the 2 options or 2 exceptions provided in Section 3.3. Based on results of previous steps one of these solution options or exceptions may be particularly suitable. For example, if higher perm materials are used on the exterior of the building (to the exterior of moisture sensitive sheathings) as typical for compliance with Table 2(A) (see STEP 4A), then the cladding will likely need to be drained and ventilated in accordance with Items 1 or 2 in Section 3.3. However, if the wall design developed in previous steps uses a low perm exterior continuous insulation (e.g., foam plastic insulating sheathing) for general water vapor control in accordance with Table 2(B) (see STEP 4B), then it should easily comply with Exception 1 in Section 3.3 without requiring a ventilated and drained air space. However, if Section 2.4 applies (see STEP 3), then a drainage air space must still be provided (and doesn't need to be ventilated).

STEP 7: Verify control of inward vapor drives with non-reservoir claddings in Warm-Humid Climates (Section 3.4)

Skip to STEP 8 if any of the following apply:

- The cladding material is a reservoir cladding (refer to STEP 6)
- The building site is not in the warm-humid climate region (refer to STEP 1 and Figure 2)

Where Section 3.4 is applicable, the net water vapor permeance of material layers on the exterior side of wall studs (including sheathing materials) are required not to exceed a net water vapor permeance of 20 perms based on ASTM E 96 Procedure B wet cup permeance data for the materials. The checking procedure is identical to STEP 4A. However, in most cases common wood-based sheathing materials will cause the requirement to be met because they typically have a wet cup permeance of less than 20 perms and other material layers, such as the WRB, can have an unlimited water vapor permeance. Alternatively, spray foam cavity insulation can be used in accordance with the Exception and this would allow the exterior layers, including the exterior sheathing, to be of unlimited water vapor permeance.

STEP 8: Check Compliance with Air Barrier Requirements of Section 4.0

In all climate zones, the wall assembly must include at least one designated continuous air barrier layer installed in accordance with Section 4.0. For optional improvements to air barrier performance in controlling moist air movement into an assembly (and also to improve energy performance in colder climates), refer to air barrier location requirements in Section 4.2.

Ensure air barrier installation is complies with the manufacturer's installation instructions and that the installation is detailed and sealed at all joints, intersections, and penetrations to maintain a continuous barrier to air movement into or through the assembly, maintaining continuity with the air barrier layer associated with intersecting assemblies (e.g., roof, foundation, floors).

STEP 9: Check Compliance with Section 5.0 – Initial Construction Moisture

This step must be verified during construction and prior to enclosure of wet materials in wall assemblies. Supplemental drying (ventilation with dry air or use of dehumidifiers or electric fan/heaters) may be necessary depending on conditions during construction. Methods of verification can include moisture meters to sample material moisture contents. For some materials, moisture meters may need to be calibrated appropriately to accurately measure moisture content. Check with the moisture meter manufacturer.

STEP 10: Check Compliance with Section 6.0 – Corrosion Resistance

Verify that specified metal materials (flashing, fasteners, lath, etc.) which are partially or fully exposed to the exterior side of the water-resistive barrier comply with the corrosion resistance specifications of Section 6.0.