DISCUSSION POINTS CONCERNING

BUILDING CODE PROVISIONS AND MOLD PROLIFERATION

Prepared by the
Virginia Department of Housing and Community Development

for the
Virginia Housing Commission

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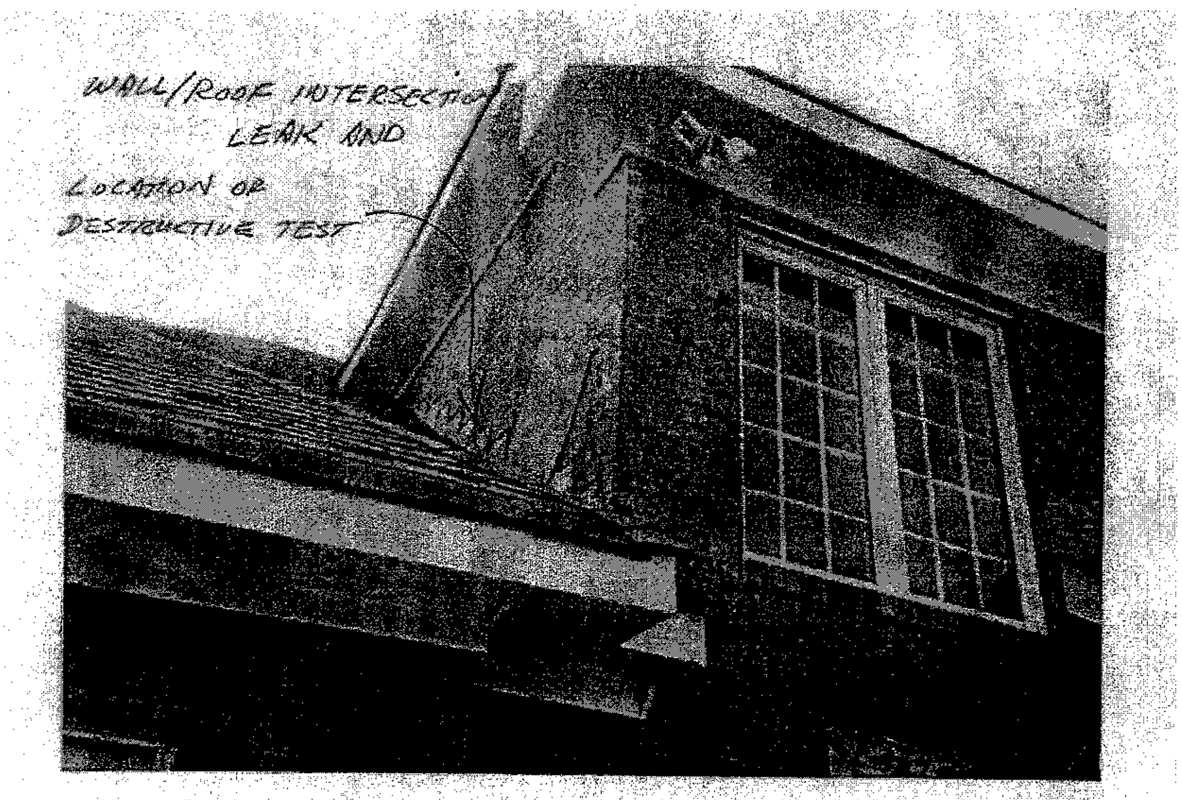
ISSUE #1

Mold and mildew problems caused by improper construction techniques which are also building code violations.

- Case Studies – State Technical Review Board
  - Warwick vs. Schoch and the City of Virginia Beach



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ISSUE #1

Mold and mildew problems caused by improper construction techniques which are also building code violations.

- Case Studies – State Technical Review Board (cont)
    - Demarest vs. Legacy Custom Homes and James City County

ISSUE #1

Mold and mildew problems caused by improper construction techniques which are also building code violations.

- Literature Indicates Bulk of Problems Fall Into This Category
- Remediation of Code Violations
  - State Building Code Appeals Process
    - Voluntary Remediation
    - Criminal Prosecution/Court Ordered Remediation
  - Va. Dept. of Professional and Occupational Regulation
    - Board for Contractors
      - Investigations
      - Recovery Fund
  - Civil Litigation

ISSUE #2

Mold and mildew problems where construction is in compliance with the state building code.

- Terminology
  - Vapor diffusion – movement of water vapor through building components.
  - Air leakage – flow of humid air through cracks or holes in building construction.
  - Dew point temperature – combination of temperature and humidity level at which water vapor will form liquid on surfaces.
    - Example: Inside temperature of 68° F, relative humidity of 70%, water will condense on surfaces below 58° F.
  - Vapor retarder (IBC 2003) – a material ... (specifications for perm rating omitted) such as foil, plastic sheeting, or insulation facing, installed to resist the transmission of water vapor through the exterior envelope.

ISSUE #2

Mold and mildew problems where construction is in compliance with the state building code.

- Pertinent Code Provisions (walls, attics and crawlspaces) (summary only; full provisions with Commentary attached in Appendix)
  - Residential Construction
    - (IRC 2003) R318.1 Moisture Control. In all framed walls, floors and roof/ceilings ... a vapor retarder shall be installed on the warm-in-winter side of the insulation. Exceptions provided for moisture resistant construction techniques and where ventilation of the spaces is provided.
    - (IRC 2003) R408.1 Ventilation. The under-floor space between the bottom of the floor joists and the earth under any building ... shall be provided with ventilation openings ... Exceptions provided for reducing the number of openings when using a vapor retarder material on earth.
    - (IRC 2003) R806.1 Ventilation required. Enclosed attics and enclosed rafter spaces ... shall have cross ventilation ... Exceptions provided to reduce the cross ventilation area when a vapor barrier is installed on the warm side of the ceiling.

ISSUE #2

Mold and mildew problems where construction is in compliance with the state building code.

- Pertinent Code Provisions (walls, attics and crawlspaces) (summary only; full provisions with Commentary attached in Appendix)

    - Commercial Construction

        - (IBC 2003) 1203.2 Attic spaces. (Same as residential)

        - (IBC 2003) 1203.3 Under-floor ventilation. (Same as residential)

        - (IBC 2003) 1403.3 (Exterior walls) Vapor retarder. An approved interior noncorrodible vapor retarder shall be provided. Exceptions provided where other means to avoid condensation and leakage of moisture are provided.

    - Energy Conservation

        - (IECC 2003) (residential) 502.1.1 Moisture control. The design shall not create conditions or accelerated deterioration from moisture condensation. Frame walls, floors and ceilings not ventilated to allow moisture to escape shall be provided with an approved vapor retarder.

        - (ANSI/ASHRAE 90.1 2001) (commercial) 5.1.1 Building envelope scope. Section 5 specifies requirements for the exterior building envelope ... Section 5 does not address moisture control ...

APPENDIX
(Code Provisions with Code Commentaries)

2003 International Residential Code

R318.1 Moisture Control
R408 Under-Floor Space
R806 Roof Ventilation

2003 International Building Code

1203 Ventilation
1403.3 Vapor Retarder (Exterior walls)

2003 International Energy Conservation Code

502.1.1 Moisture Control

2001 ANSI/ASHRAE/IESNA 90.1

5.1.1 Building Envelope Scope

SECTION R318 MOISTURE VAPOR RETARDERS

R318.1 Moisture control. In all framed walls, floors and roof/ceilings comprising elements of the building thermal envelope, a vapor retarder shall be installed on the warm-in-winter side of the insulation.

Exceptions:

1. In construction where moisture or freezing will not damage the materials.
2. Where the framed cavity or space is ventilated to allow moisture to escape.
3. In counties identified with footnote a in Table N1101.2.

❖ This section addresses the use of a vapor retarder for moisture control purposes at the exterior thermal envelope; it is applicable to walls, floors, and roof/ceiling assemblies of frame construction.

Water condensation in an exterior framed element can diminish the insulation value and lead to early structural failure. The code takes steps to eliminate these detrimental effects by requiring a vapor retarder, also referred to as a vapor barrier. As attic and underfloor spaces generally are provided with adequate means of ventilation, the exterior wall cavities are the locations where a vapor retarder is necessary. Water vapor is part of the atmosphere and as such travels with the air flow. However, as does independent gas, it migrates by diffusion through air and materials according to its own pressure differentials. Once inside the wall cavity, the vapor can encounter surfaces that are below its dew point and condense.

The location of the vapor barrier is important, but to understand why we must examine how moisture enters the wall cavity. Moisture can enter in at least two ways, through a hole with direct air migration or by diffusion. Much more moisture can enter and be deposited in a wall cavity through air currents than by diffusion alone. The first step to effective moisture control is construction of a tight envelope.

Assuming a tight envelope is present, moisture flows through a wall by the process of diffusion. Diffusion is driven by the water-vapor pressure differences between indoor air and outdoor air. For most of the year, in a large part of the United States, the vapor pressure is greater indoors than outdoors. Under these conditions, the moisture diffuses through the wall from inside to outside. Hence, the code provides for the vapor barrier on the warm-in-winter side of the wall, as shown in Commentary Figure R318.1.

Moisture migration is more complicated in air-conditioned buildings. A portion of the southern United States (along the Gulf of Mexico and the lower Atlantic

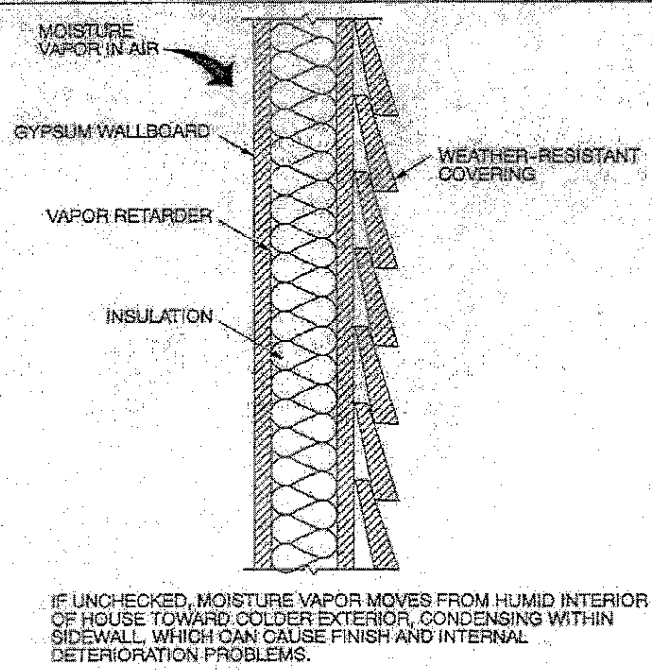


Figure R318.1
TYPICAL WOOD STUD WALL CONSTRUCTION

SECTION R407
COLUMNS

R407.1 Wood column protection. Wood columns shall be protected against decay as set forth in Section R319.

❖ See the commentary for Section R319.

R407.2 Steel column protection. All surfaces (inside and outside) of steel columns shall be given a shop coat of rust-inhibitive paint, except for corrosion-resistant steel and steel treated with coatings to provide corrosion resistance.

❖ The requirements of this section protect steel columns from the adverse affects of corrosion.

R407.3 Structural requirements. The columns shall be restrained to prevent lateral displacement at the bottom end. Wood columns shall not be less in nominal size than 4 inches by 4 inches (102 mm by 102 mm) and steel columns shall not be less than 3-inch-diameter (76 mm) standard pipe or approved equivalent.

Exception: In Seismic Design Categories A, B and C columns no more than 48 inches (1219 mm) in height on a pier or footing are exempt from the bottom end lateral displacement requirement within underfloor areas enclosed by a continuous foundation.

❖ Minimum sizes for wood columns and steel columns are specified to reduce concerns about the structural capacity of slender columns.

To minimize the chance of accidentally displacing columns supporting beams or girders, a means of mechanically anchoring a column is required. Accepted construction details that have performed adequately in the field are typically employed in lieu of a structural analysis and design. See Commentary Figures R407.3(1), R407.3(2), and R407.3(3). If prefabricated metal-wood connectors are used, they should be installed in accordance with the manufacturer's installation instructions.

SECTION R408
UNDER-FLOOR SPACE

R408.1 Ventilation. The under-floor space between the bottom of the floor joists and the earth under any building (except space occupied by a basement or cellar) shall be provided with ventilation openings through foundation walls or exterior walls. The minimum net area of ventilation openings shall not be less than 1 square foot for each 150 square feet (0.67 m^2 for each 100 m^2) of under-floor space area. One such ventilating opening shall be within 3 feet (914 mm) of each corner of said building.

❖ Raised floor construction results in an under-floor space, commonly referred to as a crawl space. To control condensation within crawl space areas and thus reduce the chance of dry rot, natural ventilation of such spaces by reasonably distributed openings through foundation walls or exterior walls is required. Condensation is a function of the geographical location

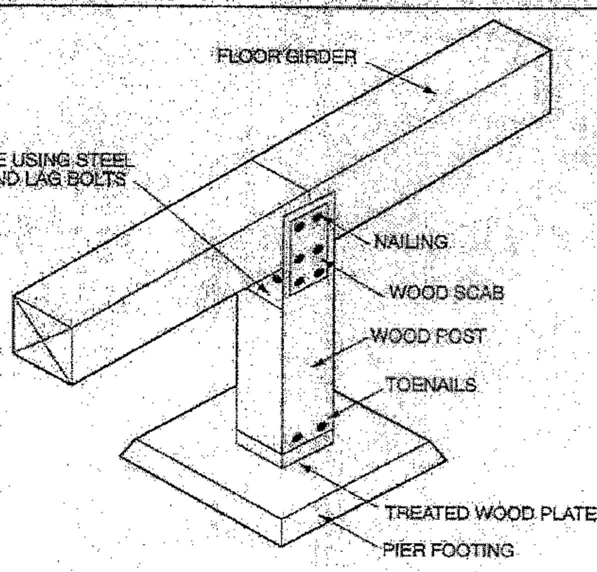


Figure R407.3(1)
COLUMN ANCHORAGE

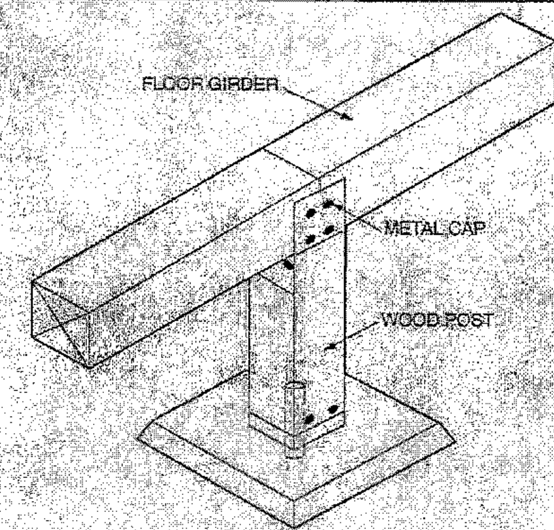


Figure R407.3(2)
COLUMN ANCHORAGE

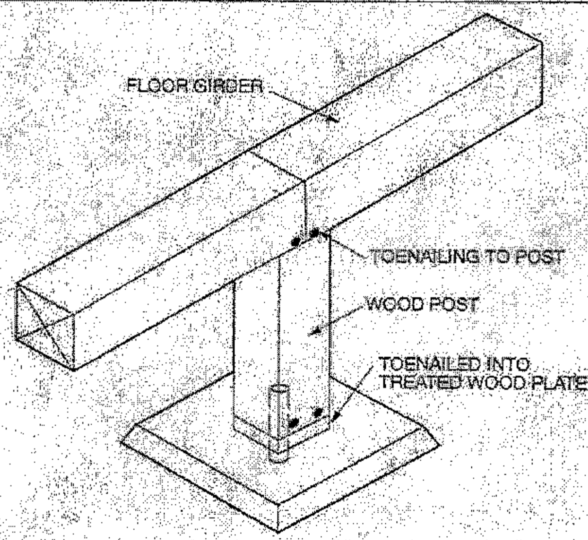
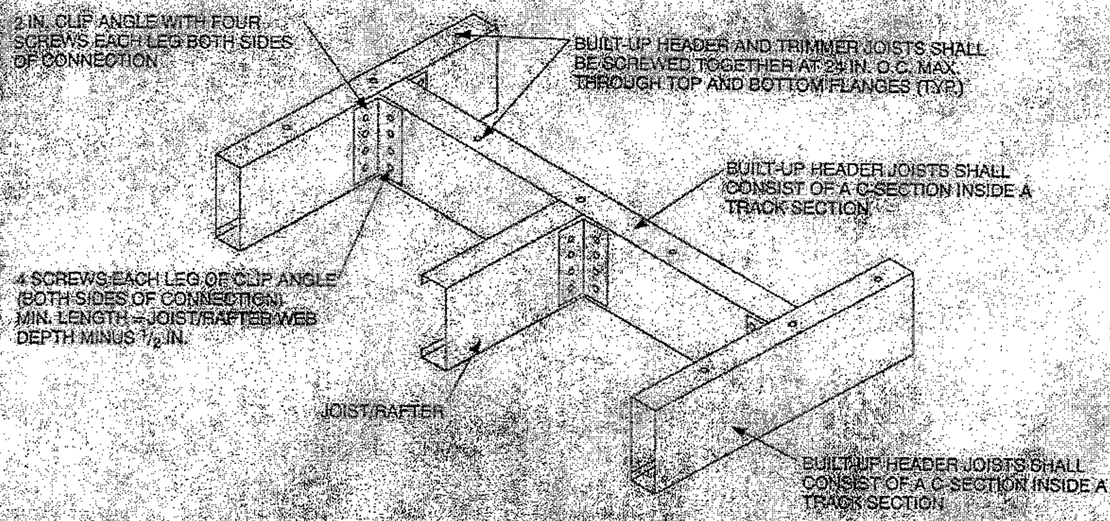


Figure R407.3(3)
COLUMN ANCHORAGE

and the climatic conditions and, thus, the dependence upon ventilating openings through the foundation wall or exterior wall may run counter to energy-conservation measures. Commentary Figure R408.1 illustrates the use of openings through the foundation walls.

R408.2 Openings for under-floor ventilation. The minimum net area of ventilation openings shall not be less than 1 square foot (0.0929 m^2) for each 150 square feet (100 m^2) of under-floorspace area. One such ventilating opening shall be within 3 feet (914 mm) of each corner of the building. Ventilation openings shall be covered for their height and width with any of the



For SI: 1 inch = 25.4 mm.

FIGURE R804.3.10(2)
HEADER TO TRIMMER CONNECTION

❖ See the commentary for Section R804.3.10.

R804.4 Roof tie-down. Roof assemblies subject to wind uplift pressures of 20 pounds per square foot (0.96 kN/m^2) or greater, as established in Table R301.2(2), shall have rafter-to-bearing wall ties provided in accordance with Table R802.11.

❖ Steel-framed roof assemblies require rafter-to-bearing wall ties with a capacity determined in the manner described in Section R802.11.

SECTION R805
CEILING FINISHES

R805.1 Ceiling installation. Ceilings shall be installed in accordance with the requirements for interior wall finishes as provided in Section R702.

❖ This section provides a reference to the ceiling installation requirements found in Section R702.

SECTION R806
ROOF VENTILATION

R806.1 Ventilation required. Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof rafters shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain or snow. Ventilating openings shall be provided with corrosion-resistant wire mesh, with $^1/_8$ inch (3.2 mm) minimum to $^1/_4$ inch (6.4 mm) maximum openings.

❖ Large amounts of water vapor migrate by air movement or diffusion through the building envelope materials because of a vapor pressure difference. The sources of water vapor include cooking, laundering, bathing, and human breathing and perspiration. These can account for an average daily production of 25 pounds of water vapor in a typical family-of-four dwelling. The average can be much higher where appliances such as humidifiers, washers, and dryers are used.

As the vapor moves into the attic, it may reach its dew point, condensing on wood roof components. This wetting and drying action will cause rotting and decay. To avoid this, the attic must be ventilated to prevent the accumulation of water on building components. The installation of a vapor retarder acts to prevent the passage of moisture to the attic, and an effective vapor retarder allows a decrease in ventilation. Vapor retarders are ineffective when openings in the barrier allow moisture to be carried by air into the attic. This is also the reason exhaust fans must terminate outdoors and not in the attic. Care should be exercised to assure that attic vent openings remain unobstructed.

To minimize condensation problems within attic and enclosed rafter spaces, free-flow ventilation of such spaces is required. Ventilation openings must be screened to prevent the entry of animals.

R806.2 Minimum area. The total net free ventilating area shall not be less than 1 to 150 of the area of the space ventilated except that the total area is permitted to be reduced to 1 to 300, provided at least 50 percent and not more than 80 percent of the required ventilating area is provided by ventilators located in

SECTION 1201
GENERAL

1201.1 Scope. The provisions of this chapter shall govern ventilation, temperature control, lighting, yards and courts, sound transmission, room dimensions, surrounding materials and rodent proofing associated with the interior spaces of buildings.

❖ This section identifies the scope of Chapter 12. The requirements of this chapter are intended to govern and regulate the need for light, ventilation, sound transmission control, interior space dimensions and materials surrounding plumbing fixtures in all buildings. It is the intent of the code that the user must comply with these regulations for all newly constructed buildings and structures and for all buildings and structures, or portions thereof, when there is to be a change of occupancy.

SECTION 1202
DEFINITIONS

1202.1 General. The following words and terms shall, for the purposes of this chapter and as used elsewhere in this code, have the meanings shown herein.

❖ Definitions of terms can help in the understanding and application of the code requirements. The purpose for including these definitions within this chapter is to provide more convenient access to them without having to refer back to Chapter 2. For convenience, these terms are also listed in Chapter 2 with a cross reference to this section. The use and application of all defined terms, including those defined herein, are set forth in Section 201.

SUNROOM ADDITION. A one-story addition added to an existing building with a glazing area in excess of 40 percent of the gross area of the structure's exterior walls and roof.

❖ This terminology is added in order to deal with separate requirements for sunroom additions with regard to ventilation of adjoining spaces (see Section 1203.4.1.1).

THERMAL ISOLATION. A separation of conditioned spaces, between a sunroom addition and a dwelling unit, consisting of existing or new wall(s), doors and/or windows.

❖ This terminology is required for the same reason provided in the definition of "Sunroom addition" (see above).

SECTION 1203
VENTILATION

1203.1 General. Buildings shall be provided with natural ventilation in accordance with Section 1203.4, or mechanical ventilation in accordance with the *International Mechanical Code.*

❖ Every room or space must be provided with ventilation. The selection of natural versus mechanical ventilation on a room-by-room or space-by-space basis is the designer's prerogative. Certain conditions require mechanical exhaust even though natural ventilation systems have been selected by the designer. Section 1203.4.2 of the code and Sections 401.7 and 403 of the IMC direct the treatment of those special situations. Existence of these conditions, however, does not compel mechanical ventilation other than to address the condition. Other rooms or spaces not affected by those conditions may be served by natural systems.

1203.2 Attic spaces. Enclosed attics and enclosed rafter spaces formed where ceilings are applied directly to the underside of roof framing members shall have cross ventilation for each separate space by ventilating openings protected against the entrance of rain and snow. Blocking and bridging shall be arranged so as not to interfere with the movement of air. A minimum of 1 inch (25 mm) of airspace shall be provided between the insulation and the roof sheathing. The net free ventilating area shall not be less than 1/150 of the area of the space ventilated, with 50 percent of the required ventilating area provided by ventilators located in the upper portion of the space to be ventilated at least 3 feet (914 mm) above eave or cornice vents with the balance of the required ventilation provided by eave or cornice vents.

> **Exception:** The minimum required net free ventilating area shall be $^{1}/_{300}$ of the area of the space ventilated, provided a vapor retarder having a transmission rate not exceeding 1 perm in accordance with ASTM E 96 is installed on the warm side of the attic insulation and provided 50 percent of the required ventilating area provided by ventilators located in the upper portion of the space to be ventilated at least 3 feet (914 mm) above eave or cornice vents, with the balance of the required ventilation provided by eave or cornice vents.

❖ All attic spaces and each separate space formed between solid roof rafters are required to be cross ventilated where the ceiling is applied directly to the underside of the roof rafters. Care must be taken, however, to provide cross ventilation in a manner that does not introduce moisture to the attic area.

Snow infiltration can occur when the attic ventilation openings are not sufficiently protected against the entrance of snow or rain, or when more than 50 percent of the ventilation openings are located along the ridge or gable wall of the roof rather than at the eave. When the wind blows perpendicular to a roof ridge vent, a negative pressure builds up across the ridge that draws air out of the attic space through the attic vents. Cross flow of air through the attic can be achieved when outside air is drawn into the attic through the eave or cornice and exits through the ridge or gable vents. In order for this to occur, eave or cornice vents must be greater than or equal to the area of the ridge or gable vents.

Vents that permit snow or rain to infiltrate the attic are not permitted. While there is no specific test standard for this performance aspect of vents, snow infiltration through roof vents can be addressed by what is referred to as "balanced" venting. Balanced venting is providing at least 50 percent of the required ventilating area in the upper third of the space being ventilated (e.g., through ridge or gable vents). The balance of the required ventilation is provided by eave or cornice vents that are greater than or equal to the ventilation area provided by the ridge or gable vents. Most ridge vent manufacturers require slightly more ventilation area in the eaves than provided in the ridge vent to help prevent snow infiltration.

If insufficient eave or cornice ventilation is provided, air will be drawn through the ridge or gable vents. Snow-laden air can enter the attic space through a ridge or gable vent; therefore, it is preferable to have both eave and ridge vents, with the eave vent area being greater than or equal to the ridge vent area (i.e., "balanced" venting).

If an adequate amount of ventilation area in the upper portion of the space is not provided and the ventilation area is provided mainly at the eave or cornice vents, then air will enter and leave the attic space at the eave and very little cross flow of air will occur.

A test method that has been devised for ridge vent manufacturers involves the use of a 13-foot, 6-inch-diameter (4115 mm) propeller of a 2,650 horsepower aircraft engine wind generator. Snow is simulated with fine, soft wood sawdust added to the airstream at about 5 pounds (2 kg) per minute. Using this method, the wind speed is varied, because it is not known at what speed the most snow infiltration will occur or the factors that will determine that each wind speed was sustained for a period of 5 minutes. The entire roof system, with all vents, must be installed in the test set-up in order to get a true measure of the potential (or lack thereof) for snow infiltration.

Attic ventilation openings cannot be placed in roof areas subject to snow drifts. These roof areas are subject to greater concentrations of snow, which could increase the chances of snow entering the attic through the ventilation openings. In addition, the ventilation openings are required to be covered with corrosion-resistant mesh or similar material in accordance with Section 1203.2.1.

If roof spaces are not created (e.g., solid concrete roof sections), ventilation is not required, as there is no concealed space for condensation, etc., to accumulate. The amount of area needed for ventilating a roof space is also established in this section. The minimum required ventilating area is reduced in accordance with the exception where the upper ventilation area is provided in the upper portion of the attic space [at least 3 feet (914 mm) above eave or cornice vents] to maximize cross ventilation from the eave or soffit vents. Also required for the reduction of the ventilating area is an approved vapor retarder installed to keep interior moisture from reaching the insulation [see Figure 1203.2(1) for the location of a vapor retarder].

The following example illustrates the calculation of required ventilation areas for an attic space (with only soffit vents) [see Figure 1203.2(2)]:

Note: The area of the attic must include the area of the eave or soffit.

Area of attic	=	1,100 sq. ft.
Eave or soffit vents only	=	$^1/_{150}$ of area
Required ventilating area	=	1,100/150
	=	7.33 sq. ft.
	=	1,056 sq. in.
Minimum required ventilation in upper portion of attic	=	.5 x 1,056 sq. in.
	=	528 sq. in. (Balance to be provided in soffit vents.)

Common methods used to provide soffit ventilation include manufactured units, strips or soffit panels and holes or slots (with screening) that meet the criteria and are approved.

Note: When an approved vapor retarder is provided as noted in Figure 1203.2(1), the ventilation requirements can be reduced to $^1/_{300}$.

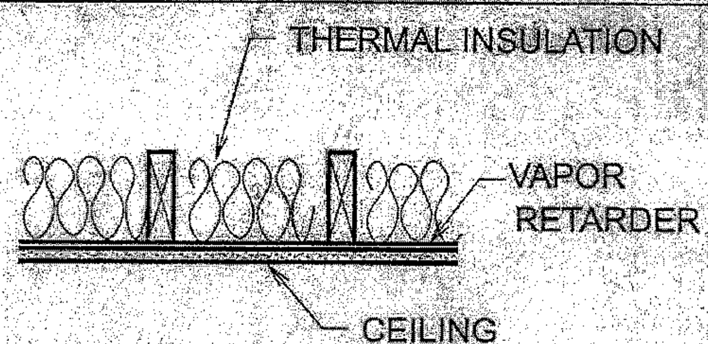


Figure 1203.2(1)
VAPOR RETARDER

The following example illustrates the calculation of required ventilation areas where both ridge and soffit vents are provided [see Figure 1203.2(3)]:

Eave or soffit and ridge or roof vents	= $^1/_{300}$ of area
Required ventilating area	= 1,100/300
	= 3.67 sq. ft.
	= 528 sq. in.
Provide 50% by	= 528 × 0.5 ridge or roof vent = 264 sq. in.
Provide soffit ventilation	= 264 sq.in. total or 264/2(50) = 2.64 sq. in./ft.

It is important to note that the distribution of ventilation openings should be uniform along the length of the soffits and ridge.

Common methods used to provide roof ridge ventilation include manufactured roof units, ridge vents and gable louvers.

Common methods used to provide soffit ventilation include manufactured units, strips or soffit panels and holes or slots (with screening) that meet the criteria and are approved.

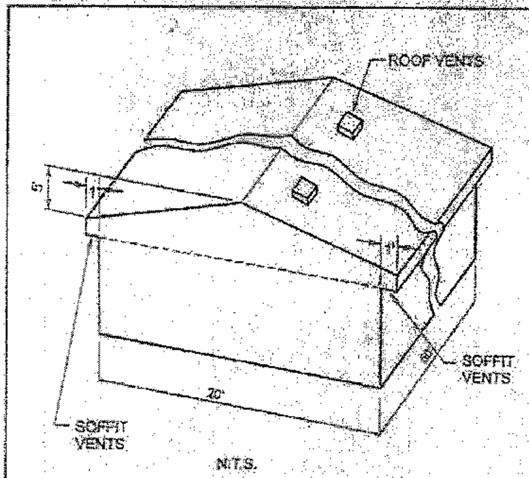
Note that the net-free ventilation area of equipment used for soffit, roof and gable ventilation must be determined. One cannot simply calculate the ventilation area based on the opening created in the roof, wall or soffit. Products vary by manufacturer, and a review of the listing and specifications is necessary to verify actual or net-free ventilation areas.

Where an attic space is not created, but the ceiling membrane is applied directly to the bottom of the solid roof rafters, each rafter space is to be ventilated separately. In this type of installation, it is particularly important that cross ventilation is developed between each rafter space by providing vents at the ridge and eave [see Figure 1203.2(4)].

1203.2.1 Openings into attic. Exterior openings into the attic space of any building intended for human occupancy shall be covered with corrosion-resistant wire cloth screening, hardware cloth, perforated vinyl or similar material that will prevent the entry of birds, squirrels, rodents, snakes and other similar creatures. The openings therein shall be a minimum of $^1/_8$ inch (3.2 mm) and shall not exceed $^1/_4$ inch (6.4 mm). Where combustion air is obtained from an attic area, it shall be in accordance with Chapter 7 of the *International Mechanical Code*.

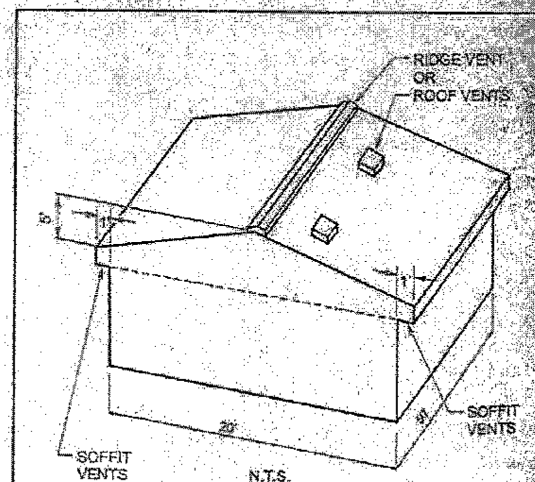
❖ Ventilation openings that would permit the entrance of small animals into the structure must be protected in accordance with this section. Hardware cloth is a particular kind of metal wire cloth screening, and perforated vinyl is a plastic screening or grid with openings of similar dimensions. Metal or vinyl are specified because of their resistance to deterioration over time; therefore whatever material is used, it must be nondeteriorating in addition to having the minimum and maximum opening dimensions of $^1/_8$ and $^1/_4$ inches.

Combustion air is air supplied to the room where a fuel-burning appliance is located, so that combustion of the fuel can take place in a safe and complete manner. Chapter 7 of the IMC permits combustion air to be taken from an attic space that is ventilated by openings to the exterior, under certain conditions. Those conditions are based on the configuration of the attic space and the ventilation openings themselves (see Chapter 7 of the IMC and the IMC commentary for more information).



For SI: 1 foot = 304.8 mm.

Figure 1203.2(2)
EAVE OR SOFFIT VENTS ONLY



For SI: 1 foot = 304.8 mm.

Figure 1203.2(3)
COMBINATION OF SOFFIT AND RIDGE VENTS

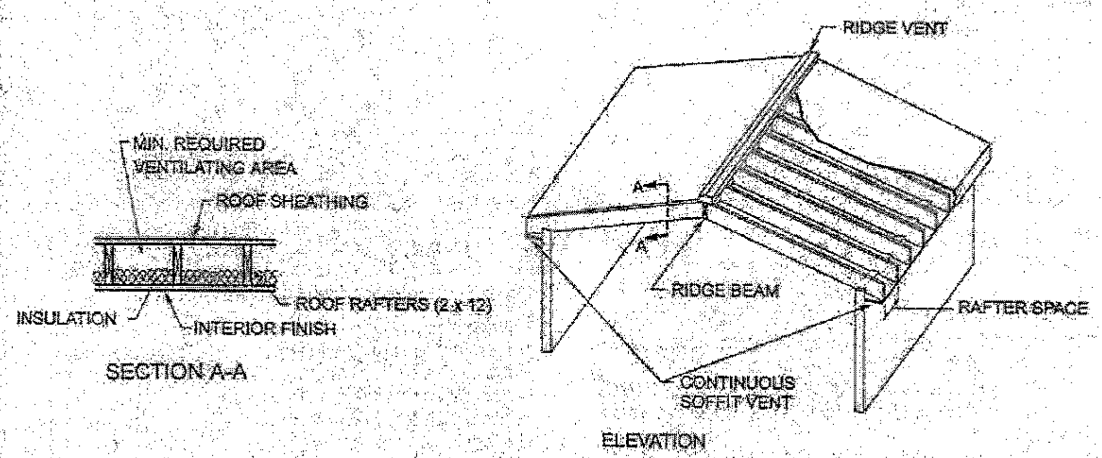


Figure 1203.2(4)
VENTILATION OF RAFTER SPACE

1203.3 Under-floor ventilation. The space between the bottom of the floor joists and the earth under any building except spaces occupied by a basement or cellar shall be provided with ventilation openings through foundation walls or exterior walls. Such openings shall be placed so as to provide cross ventilation of the under-floor space.

❖ The intent of this section is to create an adequate flow of air through crawl spaces to achieve the ventilation goals of controlling temperature, humidity and accumulation of gases. The entire space must be properly ventilated by openings that are distributed to affect cross flow and include corner areas. Although the code does not specify the exact location of openings, an equal distribution of openings on at least three sides of a building, with at least one opening near each corner of the building, is typically sufficient.

Mechanical ventilating devices also can be installed to force air movement and ventilate the space, in which case the location and number of ventilation openings are less critical (see Exception 3 in Section 1203.3.2). The amount of ventilation openings required can be drastically reduced if a vapor retarder is used on the ground surface in the crawl space, in accordance with Exception 2 in Section 1203.3.2. Also, in accordance with Exception 3, when a vapor retarder is used, the installation of operable louvers (to close the openings in the coldest times of the year) is permitted.

1203.3.1 Openings for under-floor ventilation. The minimum net area of ventilation openings shall not be less than 1 square foot for each 150 square feet (0.67 m^2 for each 100 m^2) of crawl-space area. Ventilation openings shall be covered for their height and width with any of the following materials, provided that the least dimension of the covering shall not exceed $^1/_4$ inch (6 mm):

1. Perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick.
2. Expanded sheet metal plates not less than 0.047 inch (1.2 mm) thick.
3. Cast-iron grills or gratings.
4. Extruded load-bearing vents.
5. Hardware cloth of 0.035 inch (0.89 mm) wire or heavier.
6. Corrosion-resistant wire mesh, with the least dimension not exceeding $^1/_8$ inch (3.2 mm).

❖ The following is an example of the area calculation: A rectangular building that is 60 feet (18 288 mm) long and 20 feet (6096 mm) wide has a plan area of 1,200 square feet (111.5 m^2). The amount of ventilation opening required is 1,200/150 = 8 square feet (0.74 m^2) by 144 square inches per square foot = 1,152 square inches (0.74 m^2). This is the total (aggregate) amount of ventilation opening that must be distributed among all the openings.

This required amount of openings may be reduced by a factor of 10 if a vapor retarder is used on the ground surface in accordance with Exception 2 of Section 1203.3.2.

The requirement for covering the openings with perforated plates, corrosion-resistant wire mesh or other covering is to keep small animals out. Six alternatives are given for this covering, and they all must have open-

1403.3 Vapor retarder. An approved vapor retarder shall be provided.

Exceptions:

1. Where other approved means to avoid condensation and leakage of moisture are provided.
2. Plain and reinforced concrete or masonry exterior walls designed and constructed in accordance with Chapter 19 or 21, respectively.

❖ Vapor retarders are intended to prevent the movement of moisture-laden air from the warm side of the wall to the cold side. The IECC requires that a vapor retarder have a maximum rating of 1.0 perm [5 mg/(s · m² · Pa)] when tested in accordance with Procedure A [Desiccant Method at 73.4°F (23°C)] of ASTM E 96. The material used for the vapor retarder must be resistant to degradation from moisture in order for it to be effective over the expected life of the building.

Water vapor flow through interior finish materials into a wall cavity can result from the lack of or improper installation of a vapor retarder on the warm-in-winter side of the insulation. The water vapor can then condense when it comes in contact with a colder surface, resulting in an accumulation of moisture in the wall cavity. The prolonged presence of moisture can eventually lead to the degradation of both the structural and thermal resistance properties of the wall assembly. It must be noted that in some climatic areas, the dynamic of vapor drive is reversed, such as in hot, humid locations. In areas where the wet-bulb temperature is 67°F (19.4°C) or higher for 3,000 or more hours during the warmest six consecutive months of the year or 73°F (22.8°C) or higher for 1,500 or more hours during the warmest six consecutive months of the year, the vapor retarder should not be placed on the interior side of the exterior wall (refer to IECC Sections 502.1.1 and 802.1.2). Under these climatic conditions, the main source of moisture-laden air is the exterior environment, which is driven toward the cooler, drier air in the interior of the building.

1403.4 Structural. Exterior walls, and the associated openings, shall be designed and constructed to resist safely the superimposed loads required by Chapter 16.

❖ Exterior walls and their associated openings are required to resist all structural loads in accordance with the provisions of Chapter 16. This section is a correlative cross reference to emphasize the applicability of Chapter 16.

1403.5 Fire resistance. Exterior walls shall be fire-resistance rated as required by other sections of this code with opening protection as required by Chapter 7.

❖ The required fire-resistance rating of exterior walls is set forth in Tables 601 and 602. Table 602 is applicable to both load-bearing and nonload-bearing walls, since it addresses the prevention of fire spread from one building to an adjacent building. Load-bearing walls must comply with the greater of the requirements in Tables 601 and 602, based on the type of construction of the building. The size of openings in exterior walls is limited to prevent the spread of fire to other buildings. The commentary to Section 704 should also be reviewed when designing exterior walls. Trim on exterior walls is regulated by Section 1406.

The allowable size of openings in exterior walls is listed in Table 704.8. Section 715.3 specifies the required fire protection rating for fire door and fire shutter opening protectives, and Section 715.4 specifies the required rating for windows when a rating is required by Table 704.8. Where fire-resistance rating is not required for the wall and unprotected openings are allowed, the glazing and the sash or frame may be of any material permitted by the code.

1403.6 Flood resistance. For buildings in flood hazard areas as established in Section 1612.3, exterior walls extending below the design flood elevation shall be resistant to water damage. Wood shall be pressure-preservative treated in accordance with AWPA C1, C2, C3, C4, C9, C15, C18, C22, C23, C24, C28, P1, P2 and P3, or decay-resistant heartwood of redwood, black locust or cedar.

❖ Flood-resistant construction of exterior walls requires special consideration. Construction materials used in exterior walls of buildings that are located in flood hazard areas must be resistant to the effects of flooding. Some of the properties these materials must posses include resistance to prolonged contact with water, the ability to be cleaned and disinfected after the water recedes and negligible loss of physical properties after exposure to water. Additionally, systems must possess structural strength to resist the hydrodynamic and impact forces related to flooding. Wood construction materials in locations below the base flood elevation are required to be resistant to decay and exposure to water (see the commentary to Section 2303.1.8 for more discussion on preservative treatment of wood). Appendix G contains requirements specific to construction within areas that are prone to flooding.

1403.7 Flood resistance for high-velocity wave action areas. For buildings in flood hazard areas subject to high-velocity wave action as established in Section 1612.3, electrical, mechanical and plumbing system components shall not be mounted on or penetrate through exterior walls that are designed to break away under flood loads.

❖ ASCE 24 and Section 1612.3 provide for the option to design exterior walls to break away under flood loads. This section prohibits the installation of penetrations for electrical, plumbing or mechanical systems through such exterior walls. The breakaway provisions are a method of protecting the remaining building frame and building system. Installation of penetrations through these walls could serve in part to defeat that purpose or to reduce the ability of the breakaway system to perform as designed.

CHAPTER 5

RESIDENTIAL BUILDING DESIGN BY COMPONENT PERFORMANCE APPROACH

SECTION 501 GENERAL

501.1 Scope. Residential buildings or portions thereof that enclose conditioned space shall be constructed to meet the requirements of this chapter.

SECTION 502 BUILDING ENVELOPE REQUIREMENTS

502.1 General requirements. The building envelope shall comply with the applicable provisions of Sections 502.1.1 through 502.1.5 regardless of the means of demonstrating envelope compliance as set forth in Section 502.2.

502.1.1 Moisture control. The design shall not create conditions of accelerated deterioration from moisture condensation. Frame walls, floors and ceilings not ventilated to allow moisture to escape shall be provided with an approved vapor retarder having a permeance rating of 1 perm (5.7×10^{-11} kg/Pa · s · m²) or less, when tested in accordance with the dessicant method using Procedure A of ASTM E 96. The vapor retarder shall be installed on the warm-in-winter side of the thermal insulation.

Exceptions:

1. In construction where moisture or its freezing will not damage the materials.
2. Where the county in which the building is being constructed is considered a hot and humid climate area and identified as such in Figures 902.1(1) through 902.1(51) in Chapter 9 of this code.
3. Where other approved means to avoid condensation in unventilated framed wall, floor, roof and ceiling cavities are provided.

502.1.2 Masonry veneer. When insulation is placed on the exterior of a foundation supporting a masonry veneer exterior, the horizontal foundation surface supporting the veneer is not required to be insulated to satisfy any foundation insulation requirement.

502.1.3 Recessed lighting fixtures. When installed in the building envelope, recessed lighting fixtures shall meet one of the following requirements:

1. Type IC rated, manufactured with no penetrations between the inside of the recessed fixture and ceiling cavity and sealed or gasketed to prevent air leakage into the unconditioned space.
2. Type IC or non-IC rated, installed inside a sealed box constructed from a minimum 0.5-inch-thick (12.7 mm) gypsum wallboard or constructed from a preformed polymeric vapor barrier, or other air-tight assembly manufactured for this purpose, while maintaining required clearances of not less than 0.5 inch (12.7 mm) from combustible material and not less than 3 inches (76 mm) from insulation material.
3. Type IC rated, in accordance with ASTM E 283 admitting no more than 2.0 cubic feet per minute (cfm) (0.944 L/s) of air movement from the conditioned space to the ceiling cavity. The lighting fixture shall be tested at 1.57 pounds per square foot (psf) (75 Pa) pressure difference and shall be labeled.

502.1.4 Air leakage. Provisions for air leakage shall be in accordance with Sections 502.1.4.1 and 502.1.4.2.

502.1.4.1 Window and door assemblies. Window and door assemblies installed in the building envelope shall comply with the maximum allowable air leakage rates in Table 502.1.4.1.

Exception: Site-constructed windows and doors sealed in accordance with Section 502.1.4.2.

TABLE 502.1.4.1 ALLOWABLE AIR LEAKAGE RATES[a, b]

WINDOWS (cfm per square foot of window area)	DOORS (cfm per square foot of door area)	
	Sliding	Swinging
0.3[c, d]	0.3[c]	0.5[c, d]

For SI: 1 cfm/ft² = 5 L/S · m².

a. When tested in accordance with ASTM E 283.

b. See AAMA/WDMA 101/I.S.2.

c. Requirement based on assembly area.

d. See NFRC 400.

502.1.4.2 Caulking and sealants. Exterior joints, seams or penetrations in the building envelope, that are sources of air leakage, shall be sealed with durable caulking materials, closed with gasketing systems, taped or covered with moisture vapor-permeable housewrap. Sealing materials spanning joints between dissimilar construction materials shall allow for differential expansion and contraction of the construction materials.

This includes sealing around tubs and showers, at the attic and crawl space panels, at recessed lights and around all plumbing and electrical penetrations. These are openings located in the building envelope between conditioned space and unconditioned space or between the conditioned space and the outside.

502.1.5 Fenestration solar heat gain coefficient. In locations with heating degree days (HDD) less than 3,500, the

4.9 Informative Appendices. The informative appendices to this standard and informative notes located within this standard contain additional information and are not mandatory or a part of this standard.

4.10 Validity. If any term, part, provision, section, paragraph, subdivision, table, chart, or referenced standard of this standard shall be held unconstitutional, invalid, or ineffective in whole or in part, such determination shall not be deemed to invalidate any remaining terms, parts, provisions, sections, paragraphs, subdivisions, tables, or charts of this standard.

4.11 Manuals. Operating and maintenance information shall be provided to the building owner. This information shall include, but not be limited to, the information specified in 6.2.5.2 and 8.2.2.2.

4.12 Other Laws. The provisions of this standard shall not be deemed to nullify any provisions of local, state, or federal law. Where there is a conflict between a requirement of this standard and such other law affecting construction of buildings, precedence shall be determined by the *authority having jurisdiction.*

5. Building Envelope

5.1 General

5.1.1 Building Envelope Scope. Section 5 specifies requirements for the *exterior building envelope*, which separates *conditioned space* from the exterior.

Exceptions to 5.1.1: For buildings that contain spaces that will be only semi-heated or unconditioned, and if alternative compliance is sought for such spaces, then Section 5 also specifies requirements for the semi-exterior building envelope, which separates

(a) conditioned space from either semiheated space or unconditioned space,

(b) semiheated space from either unconditioned space or from the exterior.

Section 5 does not address moisture control or provide design guidelines to prevent moisture migration that leads to condensation, mold and mildew, or deterioration to insulation or equipment performance.

5.1.2 Compliance. For the appropriate climate, *space-conditioning category*, and *class of construction*, the *building envelope* shall comply with

(A) 5.1, General,

(B) 5.2, Mandatory Provisions, and

(C) either

(1) 5.3, Prescriptive Building Envelope Option, provided that
(a) the *vertical fenestration area* does not exceed 50% of the *gross wall area* for each *space-conditioning category* and
(b) the *skylight fenestration area* does not exceed 5% of the *gross roof area* for each *space-conditioning category*,

or

(2) 5.4, Building Envelope Trade-Off Option.

5.1.3 Climate. The climate shall be determined based on the *cooling degree-days base 50°F, CDD50*, and *heating degree-days base 65°F, HDD65*.

5.1.3.1 Locations Listed. For those locations listed in Normative Appendix D, use the published climatic data to determine compliance. In the case of cities or urban regions with several climatic data entries, the designer shall select the location within the region or city that best represents the climate of the construction site.

5.1.3.2 Locations Not Listed. For locations not listed in Normative Appendix D, designers shall select the location that best represents the climatic conditions of the construction site being analyzed to determine compliance. If there are recorded historical climatic data available for a construction site, they may be used to determine compliance if approved by the building official.

5.1.4 Envelope Requirements Are Specified by Space-Conditioning Categories. Separate *exterior building envelope* requirements are specified for each of two categories of conditioned space:

(A) nonresidential conditioned space,

(B) residential conditioned space.

Spaces shall be assumed to be *conditioned space* and shall comply with the requirements for *conditioned space* at the time of construction, regardless of whether mechanical or electrical equipment is included in the building permit application or installed at that time.

Exceptions to 5.1.4: For buildings that contain spaces that will be only semi-heated or unconditioned, and if alternative compliance is sought for such spaces, then all semi-heated or unconditioned spaces shall be clearly indicated on the floor plan as such, and the following semi-exterior building envelope requirements apply:

(a) If a space will be only semiheated, the space shall be considered semiheated.

(b) If a space will remain unconditioned, the space shall be considered unconditioned.