



**BSR/ASHRAE/IES Addendum t  
to ANSI/ASHRAE/IES Standard 90.1-2019**

**Public Review Draft**

# **Proposed Addendum t to Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings**

**Second Public Review (November 2021)  
(Draft Shows Proposed Independent Substantive  
Changes to Previous Public Review Draft)**

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at [www.ashrae.org/standards-research--technology/public-review-drafts](http://www.ashrae.org/standards-research--technology/public-review-drafts) and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at [www.ashrae.org/bookstore](http://www.ashrae.org/bookstore) or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

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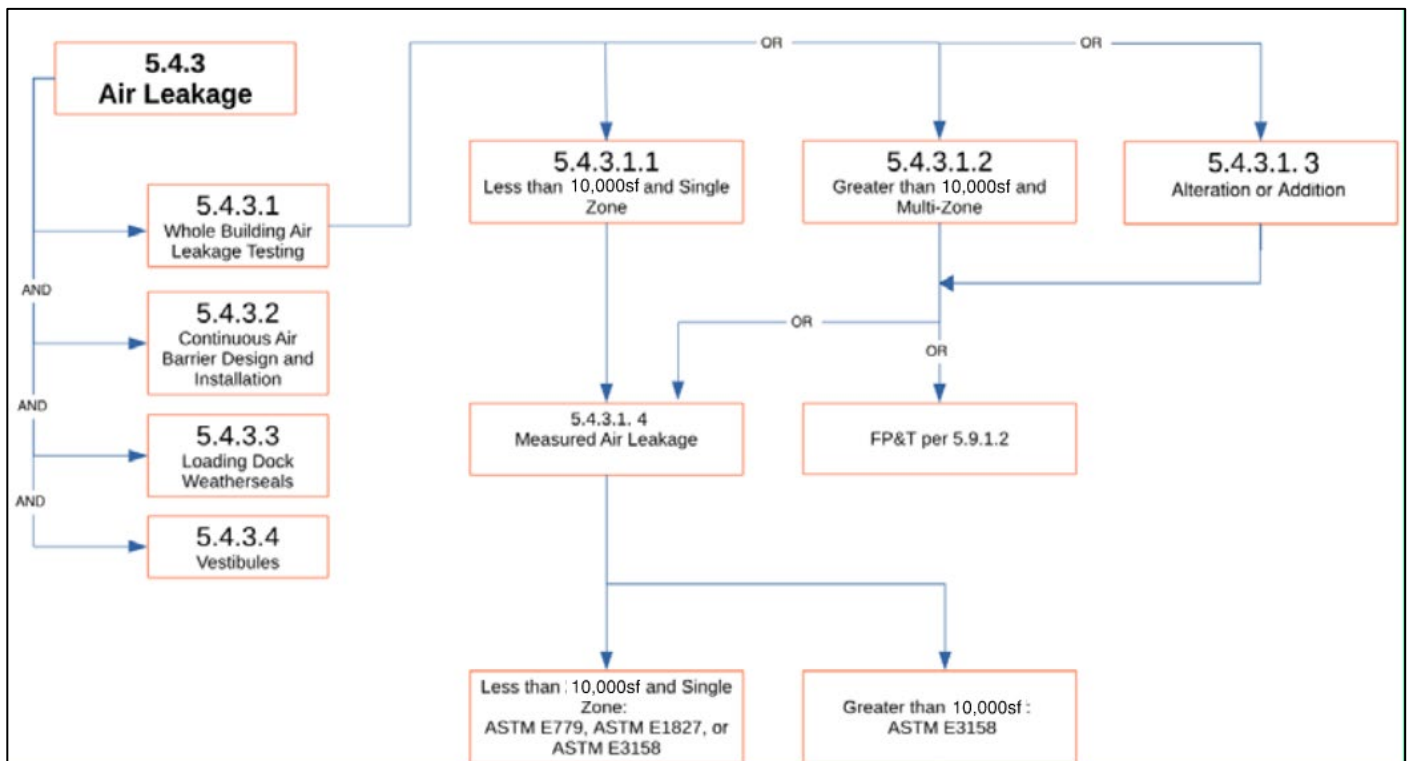
## FOREWORD

### *Air Leakage Terms and Clarifications*

*Forward:*

*This proposal makes the following updates to the Standard:*

- *This Second Public Review includes the following modifications:*
  - *Adjusts the minimum air tightness performance for whole building testing from 0.30 cfm/ft<sup>2</sup> in Public Review Draft #1 to 0.35 cfm/ft<sup>2</sup> in this version.*
  - *Adjusts the new building whole building air tightness testing threshold down from a 25,000 sf building to a 10,000 sf building.*
  - *Corrects the definition of “roof replacement” to italicize defined term “repairing” used in the definition of the previous public review.*
  - *Improved performance related to airtightness requirements in this addenda was reviewed and found to be cost effective.*
  - *Below is a diagram, updated for the Second Public Review, outlining the compliance path and flow air leakage in this proposal:*



*Revise sections as indicated. Portions of sections not shown have not changed.*

### **3.2 Definitions**

***air leakage:*** the uncontrolled air flow through the *building envelope* caused by pressure differences across the *building envelope* due to factors such as wind, inside and outside temperature differences, stack effect, and imbalance between supply and exhaust air *systems*. *Air leakage* can move inward (infiltration) or outward (exfiltration) through the *building envelope*.

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***continuous air barrier:*** the combination of interconnected materials, assemblies, and sealed joints and components of the *building envelope* that minimize *air leakage* into or out of the *building envelope*.

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***replacement air:*** *outdoor air* that is used to replace air removed from a *building* through an exhaust *system*. *Replacement air* may be derived from one or more of the following: *makeup air*, supply air, and *transfer air*.

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***roof replacement:*** The process of removing the existing *roof covering*, including ~~*repairing*~~ *repairing* or replacing any damaged materials down to the roof deck, and installing a new *roof covering*.

### **4.2.5 Verification, Testing and Commissioning**

Building *systems*, controls, and the *building envelope* shall comply with Sections 4.2.5.1, 4.2.5.2 and 4.2.5.3.

***Informative Note:*** There are additional requirements within specific sections of this Standard regarding documentation, procedures, independence of providers, and reporting. Requirements in individual sections are in addition to the general requirements provided in 4.2.5.

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### 5.1.3 Envelope Alterations

*Alterations to the building envelope* shall comply with the requirements of Section 5 for insulation, *air leakage*, and *fenestration* applicable to those specific portions of the *building* that are being altered.

#### Exceptions to 5.1.3

The following *alterations* need not comply with these requirements, provided such *alterations* will not increase the *energy* use of the *building*:

1. Installation of storm windows or glazing panels over existing glazing, provided the storm window or glazing panel contains a low-emissivity coating. However, a low-emissivity coating is not required where the existing glazing already has a low-emissivity coating. Installation is permitted to be either on the inside or outside of the existing glazing.
2. Replacement of glazing in existing sash and frame, provided the *U-factor* and *SHGC* will be equal to or lower than before the glass replacement.
3. *Alterations to roof, wall, or floor* cavities that are insulated to full depth with insulation having a minimum nominal value of R-3.0/in.
4. *Alterations to walls and floors*, where the existing structure is without framing cavities and no new framing cavities are created.
5. *Roof recovering*.
6. Removal and replacement of a *roof* membrane where there is existing *roof* insulation integral to or below the *roof* deck.
7. *Roof replacement*, provided the area of the replacement *roof covering* complies with the opaque element requirements for *roofs* in Tables 5.5-0 through 5.5-8 and Section 5.5.3.1.1.
8. Replacement of existing doors that separate a conditioned space from the exterior shall not require the installation of a vestibule or revolving door, provided that an existing vestibule that separates a conditioned space from the exterior shall not be removed.
9. Replacement of existing fenestration, provided that the area of the replacement fenestration does not exceed 25% of the total fenestration area of an existing building and that the U-factor and SHGC will be equal to or lower than before the fenestration replacement.

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### 5.4.3 Air Leakage

- a. *Air leakage* control for the *building envelope* shall comply with this section. Materials and assemblies that are part of the *continuous air barrier* and *fenestration* and *doors* shall comply with Section 5.8.3.
- b. The *exterior building envelope* and the *semiexterior building envelope* shall have a *continuous air barrier* complying with Sections 5.4.3.1. and 5.4.3.2.

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#### Exceptions to 5.4.3.1

1. *Semiheated spaces* in Climate Zones 0 through 6, except as required to complete the *continuous air barrier* of an adjacent *conditioned space*.
  2. Single wythe concrete masonry *buildings* in Climate Zone 2B.
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### 5.4.3.1 Whole-Building Air Leakage

**5.4.3.1.1** New *Buildings* less than 10,000 ft<sup>2</sup> (930 m<sup>2</sup>) ~~25,000 ft<sup>2</sup> (2,300 m<sup>2</sup>)~~ of *gross conditioned floor area* shall comply with measured *air leakage* requirements in Section 5.4.3.1.4.

**5.4.3.1.2** New *Buildings* not less than 10,000 ft<sup>2</sup> (930 m<sup>2</sup>) ~~25,000 ft<sup>2</sup> (2,300 m<sup>2</sup>)~~ of *gross conditioned floor area* shall comply with one of the following:

- a. Measured *air leakage* requirements in Section 5.4.3.1.4.
- b. A *continuous air barrier* design and installation verification program performed in accordance with Section 5.9.1.2.

**5.4.3.1.3** *Alterations* and *additions* to an *existing building* where portions of the *continuous air barrier* are impacted, those portions shall be installed or reinstalled and comply with one of the following:

- a. Measured *air leakage* requirements in Section 5.4.3.1.4.
- b. A *continuous air barrier* design and installation verification program performed in accordance with Section 5.9.1.2.

**5.4.3.1.4 Measured air leakage.** Where measured *air leakage* is used for compliance, the rate of *air leakage* of the *building envelope* shall not exceed 0.35 cfm/ft<sup>2</sup> (1.7 L/s·m<sup>2</sup>) ~~0.30 cfm/ft<sup>2</sup> (1.5 L/s·m<sup>2</sup>)~~ under a pressure differential of 75 Pa (0.30 in. of water) (**75 Pa**), with this *air leakage* rate normalized by the sum of the above-grade and below-grade *building envelope* areas of the *conditioned* and *semiheated space*, and in accordance with this section.

- a. Whole-building pressurization testing shall be conducted in accordance with ASTM E3158. For buildings less than 10,000 ft<sup>2</sup> (930 m<sup>2</sup>) ~~25,000 ft<sup>2</sup> (2,300 m<sup>2</sup>)~~ of *gross conditioned floor area* and that contain no more than one *single-zone* system, *air leakage* testing may be conducted in accordance with ASTM E779, ASTM E1827, or ASTM E3158. Testing shall be conducted excluding HVAC related elements and be performed by an independent third party *V&T provider* in accordance with 4.2.5.1.
- b. Where a building contains both *conditioned space* and *semiheated space*, compliance shall be shown using one of the following as applicable:
  1. separately for the *conditioned space* and for the *semiheated space*, with the *air leakage* rate for the *conditioned space* normalized by the *exterior building envelope* area of the *conditioned space* and the *air leakage* rate for the *semiheated space* normalized by the *semiexterior building envelope* area of the *semiheated space*; or
  2. for the *conditioned space* and for the *semiheated space* together, with the *air leakage* rate for the overall *space* normalized by the sum of the *exterior building envelope* area and the *semiexterior building envelope* area minus the *semiexterior building envelope* area that separates the *conditioned space* from the *semiheated space*.

- c. Where the measured *air leakage* rate exceeds ~~0.35 cfm/ft<sup>2</sup> (1.7 L/s·m<sup>2</sup>)~~ ~~0.30 cfm/ft<sup>2</sup> (1.5 L/s·m<sup>2</sup>)~~ but does not exceed 0.45 cfm/ft<sup>2</sup> (2.2 L/s·m<sup>2</sup>), a diagnostic evaluation, such as a smoke tracer or infrared imaging shall be conducted while the *building* is pressurized, and any leaks noted shall be sealed if such sealing can be made without destruction of *existing building* components. In addition, a visual inspection of the air barrier shall be conducted, and any leaks noted shall be sealed if such sealing can be made without destruction of *existing building* components. An additional report identifying the corrective actions taken to seal leaks shall be submitted to the *code official* and the *building* owner and shall be deemed to satisfy the requirements of this section.
- d. Where the measured *air leakage* rate exceeds 0.45 cfm/ft<sup>2</sup> (2.2 L/s·m<sup>2</sup>), corrective actions must be made to the *envelope* and an additional test completed where results are 0.45 cfm/ft<sup>2</sup> (2.2 L/s·m<sup>2</sup>) or less in order to demonstrate compliance.
- e. Reporting shall be in compliance with Section 4.2.5.1.2.

#### 5.4.3.2 Continuous Air Barrier Design and Installation

The *continuous air barrier* shall be designed and installed in the following manner:

- a. Components designed to provide the continuous air barrier and the component's position within of each building envelope assemblies shall be clearly identified on construction documents.
- b. The joints, interconnections, and penetrations of the continuous air barrier components shall be detailed in the construction documents.
- c. The *continuous air barrier* shall extend over all surfaces of the *building envelope* and be identified in the *construction documents* to be continuous across the components of the below-grade areas, *walls, fenestration, doors, and roofs*.
- d. The continuous air barrier shall be designed to resist positive and negative pressures from wind, stack effect, and mechanical ventilation and allow for anticipated movements.
- e. The following areas of the continuous air barrier in the building envelope shall be wrapped, sealed, caulked, gasketed, or taped in an approved manner to minimize *air leakage*:
  - 1. Joints around fenestration and door frames.
  - 2. Junctions between *walls* and *floors*, between *walls* at *building* corners, between *walls* and *roofs* including parapets and copings, and *walls* at foundations.
  - 3. Penetrations through the continuous air barrier in building envelope roofs, walls, and floors.
  - 4. Building assemblies used as ducts or plenums.
  - 5. Joints, seams, connections between planes, and other changes in continuous air barrier materials.
  - 6. *Building* and *service* components projecting through or attached through the *continuous air barrier*.
  - 7. Junctions of the *continuous air barrier* that separate *conditioned spaces* from *unconditioned spaces, semiheated spaces*, and areas that are not *enclosed spaces*.

#### 5.4.3.3 Loading Dock Weatherseals

In Climate Zones 0 and 4 through 8, cargo *doors* and loading dock *doors* shall be equipped with weatherseals to restrict *air leakage* when vehicles are parked in the doorway.

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#### 5.4.3.4 Vestibules and Revolving Doors

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### 5.7 Submittals

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#### 5.7.2 Permit Application Documentation

Application documents shall include, at a minimum, the type and *rated R-value of insulation* for each product; *opaque door* schedule showing the *U-factor* for each *opaque door* product as determined in accordance with Section 5.8.2; *fenestration* schedule showing the manufacturer, model number, orientation, area, *U-factor*, *SHGC*, and *VT* for each *fenestration* product, as determined in accordance with Section 5.8.2; and *air leakage*

details in accordance with Section 5.4.3. In addition:

- a. Labeling of Space-Conditioning Categories: For buildings that contain spaces that will be only semiheated space or unconditioned space, and compliance is sought using the semiheated space building envelope criteria, such spaces shall be clearly indicated on the floor plans.
- b. Labeling of Daylight Areas: Daylighting documentation shall identify daylight areas on floor plans, including the primary sidelighted areas, secondary sidelighted areas, daylight area under skylights, and daylight area under roof monitor.
- c. Identify *Air Leakage Compliance*: *Continuous air barrier* compliance with whole-building pressurization testing in accordance with Section 5.4.3.1.4 or verification in accordance with Section 5.9.1.2 shall be clearly indicated on the *construction documents*.

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#### **5.7.3.1 Record Documents**

*Construction documents* shall require that, within 90 days after the date of *building envelope* acceptance, *record documents* be provided to the *building owner* or the designated representative of the *building owner*. *Record documents* shall include, as a minimum, those items listed in Section 5.7.2, and the following:

- a. A report complying with Section 4.2.5.1.2 providing the results of *continuous air barrier* compliance with whole-building pressurization testing in accordance with Section 5.4.3.1.4 or verification of the *building envelope* in accordance with Section 5.9.1.2.
- b. Insulation documentation in accordance with 5.8.1.11.

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## **5.8 Product Information and Installation Requirements**

### **5.8.1 Insulation**

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#### **5.8.1.6 Recessed Equipment**

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In all cases, *air leakage* through or around the recessed *equipment* to the *conditioned space* shall be limited in accordance with Section 5.4.3.

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### **5.8.2 Fenestration and Doors**

#### **5.8.2.1 Rating of Fenestration Products**

The *U-factor*, *SHGC*, *VT*, and *air leakage* rate for all manufactured *fenestration* products shall be determined by a laboratory accredited by a nationally recognized accreditation organization, such as the National Fenestration Rating Council.

#### **5.8.2.2 Labeling of Fenestration and Door Products**

All manufactured and site-built *fenestration* and *door* products shall be *labeled*, or a signed and dated certificate shall be provided, by the *manufacturer*, listing the *U-factor*, *SHGC*, *VT*, and *air leakage* rate.

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### **5.8.3 Air Leakage**

#### **5.8.3.1 Testing, Acceptable Materials, and Assemblies**

*Air leakage* for materials or assemblies used as components of the *continuous air barrier* shall be determined in accordance with the test method and minimum air pressure specified in Table 5.8.3.1 and shall not exceed the maximum *air leakage* specified in Table 5.8.3.1 when complying with the *continuous air barrier* design and installation verification program in accordance with Section 5.9.1.2. *Air leakage* shall be determined by a laboratory accredited by a nationally recognized accreditation organization.

### **5.8.3.2 Fenestration and Doors**

*Air leakage* for *fenestration* and *doors* shall be determined in accordance with the test method and minimum air pressure specified in Table 5.8.3.2 and shall not exceed the maximum *air leakage* specified in Table 5.8.3.2 when complying with the *continuous air barrier* design and installation verification program in accordance with Section 5.9.1.2. *Air leakage* shall be determined by a laboratory accredited by a nationally recognized accreditation organization and shall be *labeled* and certified by the *manufacturer*.

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#### **Exceptions to 5.8.3.2**

1. *Field-fabricated fenestration* and *doors*.
2. Metal coiling *doors* in *semiheated spaces* in Climate Zone 0 through 6 shall have an *air leakage* not exceeding 1.0 cfm/ft<sup>2</sup> when tested at a pressure of at least 1.57 psf in accordance with ANSI/DASMA 105, NFRC 400, or ASTM E283.
3. Products in *buildings* that are tested and shown to comply with a whole *building air leakage* in accordance with Section 5.4.3.1.4.

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## 5.9 Verification, Testing, Commissioning, and Inspection

### 5.9.1 Verification and Testing

#### 5.9.1.1 Building Envelope Performance Verification

The *energy* performance of the *building envelope* shall be verified in accordance with this section and Section 4.2.5.1.

#### 5.9.1.2 Verification of the Design and Installation of the Continuous Air Barrier

Where verification of the design and installation of the *continuous air barrier* is used for compliance in Section 5.4.3.1, it shall be determined in accordance with the following:

- a. Requirements for a field inspection plan shall be included in the *construction documents* and shall include as a minimum the following:
  1. Schedule for periodic inspection(s),
  2. *Continuous air barrier* scope of work,
  3. List of critical inspection items,
  4. Inspection document requirements, and
  5. Provisions for corrective actions when needed.
- b. An independent third party *V&T provider* in accordance with 4.2.5.1 shall conduct reviews and inspections as follows:
  1. A design review shall be conducted to verify and document compliance with the requirements in Sections 5.4.3 and 5.8.3.2.
  2. Periodic field inspection of the *continuous air barrier* materials and assemblies shall be conducted during *construction* while the *continuous air barrier* is still accessible for inspection and *repair* to verify and document compliance with the requirements of Sections 5.4.3.2 and 5.8.3 and the field inspection plan.
  3. Reporting shall comply with Section 4.2.5.1.2 and the field inspection plan.

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### 5.9.3 Inspections

#### 5.9.3.1 Inspection of Fenestration and Door Requirements

*Fenestration* and *doors* shall be inspected to verify compliance with the requirements of Sections 5.4.3.3, 5.8.2.1, 5.8.2.2, and 5.8.2.3. Where testing is required to demonstrate compliance with the *air leakage* requirements, it shall be conducted by an independent third party.

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#### 6.4.4.2.1 Duct Sealing

*Ductwork* and all plenums with pressure class ratings shall be constructed to *Seal Class A*. Openings for rotating shafts shall be sealed with bushings or other devices that seal off leaking air. Pressure-sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory, and the tape is used in accordance with that certification. All connections shall be sealed, including but not limited to spin-ins, taps, other branch connections, access *doors*, access panels, and duct connections to *equipment*. Sealing that would void product listings is not required. Spiral lock seams need not be sealed. All duct pressure class ratings shall be designated in the design documents.

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#### 6.4.5 Walk-In Coolers and Walk-In Freezers

Site-assembled or site-constructed *walk-in coolers* and *walk-in freezers* shall conform to the following requirements:

- a. ...
- b. Doorways shall have strip *doors* (curtains), spring-hinged *doors*, or other method of minimizing infiltration when *doors* are open.

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#### 6.5.1 Economizers

Each cooling system shall include either an air economizer or fluid economizer meeting the requirements of Sections 6.5.1.1 through 6.5.1.5.

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##### Exceptions to 6.5.1

Economizers are not required for the following *systems*:

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7. *Systems* that serve *spaces* whose sensible cooling load at *design conditions*, excluding transmission less than or equal to transmission losses at an outdoor temperature of 60°F.

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## Chapter 11

### 5. Building Envelope

All components of the *building envelope* in the *proposed design* shall be modeled as shown on architectural drawings or as built for *existing building envelopes*. All uninsulated assemblies and *linear thermal bridges* and *point thermal bridges* as identified in Section 5.5.5.1 thru 5.5.5.5 (e.g., projecting balconies, perimeter edges of intermediate floor slabs, concrete floor beams over parking garages, *roof* parapet) shall be modeled using either of the following techniques:

- a. Separate model of each of these assemblies within the *energy simulation model*.
- b. When present, uninsulated assemblies and *linear thermal bridges* or *point thermal bridges* as identified in Section 5.5.5.1 thru 5.5.5.5 shall be modeled by adjusting the *U-factor* in accordance with Appendix A10.

**Exceptions:** The following *building elements* are permitted to differ from architectural drawings.

1. Any *building envelope* assembly that covers less than 5% of the total area of that assembly type (e.g., *exterior walls*) need not be separately described. If not separately described, the area of a *building envelope* assembly must be added to the area of the adjacent assembly of that same type.
  2. Exterior surfaces whose azimuth *orientation* and tilt differ by less than 45 degrees and are otherwise the same shall be described as either a single surface or by using multipliers.
  3. The exterior *roof* surface shall be modeled using the aged solar *reflectance* and thermal *emittance* determined in accordance with Section 5.5.3.1.1(a). Where aged test data are unavailable, the *roof* surface shall be modeled with a solar *reflectance* of 0.30 and a thermal *emittance* of 0.90
  4. Manually operated *fenestration* shading devices, such as blinds or shades, shall not be modeled. Permanent shading devices, such as fins, overhang, and lightshelves, shall be modeled.
- c. To simulate *air leakage*, infiltration shall be modeled using the same methodology and adjustments for weather and *building operation* in both the *proposed design* and the *budget building design*. These adjustments shall be made for each simulation time step and must account for but not be limited to weather conditions, and HVAC *system operation*, including strategies that are intended to positively pressurize the *building*. The *air leakage rate* of the *building envelope* shall be in accordance with one of the following:

1. When whole-building pressurization testing is required or specified during design and completed in accordance with Section 5.4.3.1.4, the measured *air leakage rate* of the *building envelope* (175Pa) at a fixed building pressure differential of 75 Pa (0.30 in. of water ) (75 Pa) shall be modeled for purposes of demonstrating compliance with this Standard, or
2. For buildings providing verification in accordance with Section 5.9.1.2, the *air leakage rate* of the *building envelope* (175Pa) at a fixed building pressure differential of 75 Pa (0.30 in. of water ) (75 Pa) shall be 0.45 cfm/ft<sup>2</sup> (2.2 L/s·m<sup>2</sup>).

The *air leakage rate* of the *building envelope* shall be converted to appropriate units for the simulation program using one of the methods in Section 11.5.3.

The *budget building design* shall have identical *conditioned floor area* and identical exterior dimensions and orientations as the *proposed design*, except as follows:

- a. *Opaque assemblies*, such as *roof*, *floors*, *doors*, and *walls*, shall be modeled as having the same *heat capacity* as the *proposed design* but with the minimum *U-factor* required in Section 5.5 for new *buildings* or additions and Section 5.1.3 for *alterations*.
- b. Where *linear thermal bridges* and *point thermal bridges* as identified in Section 5.5.5.1 through 5.5.5.5 are modeled in the *proposed design*, they shall be represented as modified *U-factors* by adjusting the *U-factor* in accordance with the default values in Appendix A10. If the proposed design does not have *linear thermal bridges* and *point thermal bridges*, as identified in Sections 5.5.5.1 through 5.5.5.5, they shall not be modeled in the *budget building design*.  
If the balcony length in the *proposed design* exceeds the maximum allowed by Section 5.5.5.2, Exception 2(c)(i), the area shall be reduced proportionally for each balcony until the limit set in Section 5.5.5.2, Exception 2(c)(i) is met.
- c. The exterior *roof* surfaces shall be modeled with a solar *reflectance* and thermal *emittance* as required in Section 5.5.3.1.1(a). All other *roofs*, including *roofs* exempted from the requirements in Section 5.5.3.1.1, shall be modeled the same as the *proposed design*.
- d. No shading projections are to be modeled; *fenestration* shall be assumed to be flush with the *wall* or *roof*. If the *fenestration area* for new *buildings* or additions exceeds the maximum allowed by Section 5.5.4.2, the area shall be reduced proportionally along each exposure until the limit set in Section 5.5.4.2 is met. If the *vertical fenestration area* facing west or east of the *proposed design* exceeds the area limit set in Section 5.5.4.5 then the *energy cost budget* shall be generated by simulating the *budget building design* with its actual *orientation* and again after rotating the entire *budget building design* 90, 180, 270 degrees and then averaging the results. *Fenestration U-factor* shall be equal to the criteria from Tables 5.5-0 through 5.5-8 for the appropriate climate, and the *SHGC* shall be equal to the criteria from Tables 5.5-0 through 5.5-8 for the appropriate climate. For portions of those tables where there are no *SHGC* requirements, the *SHGC* shall be equal to that determined in accordance with Section C3.6(c). The *V<sub>T</sub>* shall be equal to that determined in accordance with Section C3.6(c). The *fenestration model* for *building envelope alterations* shall reflect the limitations on area, *U-factor*, and *SHGC* as described in Section 5.1.3.
- e. *Skylights* shall be included in each *thermal block* when required by Section 5.5.4.2.3.

**Exceptions:** When trade-offs are made between an addition and an *existing building*, as described in the exception to Section 4.2.1.2, the *building envelope* assumptions for the *existing building* in the *budget building design* shall reflect existing conditions prior to any revisions that are part of this permit.

- f. The *air leakage rate* of the *building envelope* (175Pa) at a pressure differential of 75 Pa (0.30 of water) (75 Pa) shall be  $0.35 \text{ cfm/ft}^2$  ( $1.7 \text{ L/s}\cdot\text{m}^2$ ) ~~0.30 cfm/ft<sup>2</sup> (1.5 L/s·m<sup>2</sup>)~~ of *building envelope area* and shall be converted to appropriate units for the simulation software using the same method as the *proposed design*.

### 11.5.3 Modeling Building Envelope Air Leakage

The *air leakage rate of the building envelope* ( $I_{75Pa}$ ) at a pressure differential of 75 Pa (0.30 in. of water) (75 Pa) shall be converted to appropriate units for the *simulation program* using one of the following formulas:

For methods describing *air leakage* as a function of *floor area*.

$$I_{FLR} = 0.112 \times I_{75Pa} \times S/A_{FLR}$$

For methods describing *air leakage* as a function of the area of *above-grade walls* that separate *conditioned spaces* and *semiheated spaces* from the exterior,

$$I_{AGW} = 0.112 \times I_{75Pa} \times S/A_{AGW}$$

When using the measured *air leakage rate of the building envelope* at a pressure differential of 75 Pa (0.30 in. of water) (75 Pa) for the *proposed design*, the *air leakage rate* shall be calculated as follows:

$$I_{75Pa} = Q/S$$

where

$I_{75Pa}$	=	<i>air leakage rate of the building envelope</i> cfm/ft <sup>2</sup> ( $L/s \cdot m^2$ ) at a fixed <i>building</i> pressure differential of 75 Pa (0.30 in. of water) (75 Pa)
$Q$	=	Volume of air in cfm ( $L/s$ ) flowing through the <i>building envelope</i> when subjected to a pressure differential of 75 Pa (0.30 in. of water) (75 Pa), in accordance with ASTM E779, ASTM E1827, or ASTM E3158.
$S$	=	total area of the <i>building envelope</i> ft <sup>2</sup> ( $m^2$ ), including the lowest <i>floor</i> , any <i>below-grade walls</i> or <i>above-grade walls</i> , and <i>roof</i> (including <i>vertical fenestration</i> and <i>skylights</i> )
$I_{FLR}$	=	adjusted <i>air leakage rate of the building envelope</i> cfm/ft <sup>2</sup> ( $L/s \cdot m^2$ ) at a reference wind speed of 10 mph (4.47 m/s) and relative to the <i>gross floor area</i>
$A_{FLR}$	=	<i>gross floor area</i> , ft <sup>2</sup> ( $m^2$ )
$I_{AGW}$	=	adjusted <i>air leakage rate of the building envelope</i> cfm/ft <sup>2</sup> ( $L/s \cdot m^2$ ) at a reference wind speed of 10 mph (4.47 m/s) and relative to the area of the <i>above-grade walls</i> of the <i>building envelope</i>
$A_{AGW}$	=	total area of <i>above-grade walls</i> of the <i>building envelope</i> , ft <sup>2</sup> ( $m^2$ )

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#### Exception to 11.5.3

A multizone airflow model alternative method to modeling *building envelope air leakage* may be used, provided the following criteria are met:

1. Where the calculations are made independently of the *energy simulation program*, the proposed method must comply with Section 11.4.5.
  2. The method for converting the *air leakage rate of the building envelope* at 75 Pa (0.30 in. of water) (75 Pa), to the appropriate units for the *simulation program* is fully documented and submitted to the *rating authority* for approval.
-

## 12 NORMATIVE REFERENCES

Reference	Title
...	...
ASTM E3158 – 18	Standard Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building
...	...

### C1.5 For Continuous Air Barriers

The method of compliance used for *continuous air barriers*, either whole building pressurization testing or verification shall be specified.

...

#### C3.5.5.3 Air Leakage

The *air leakage* rate of the *building envelope* ( $I_{75Pa}$ ) at a pressure differential of 75 Pa (0.30 in. of water) (**75 Pa**) shall be ~~0.35 cfm/ft<sup>2</sup> (1.7 L/s·m<sup>2</sup>)~~ ~~0.30 cfm/ft<sup>2</sup> (1.5 L/s·m<sup>2</sup>)~~ of *building envelope* area when *air leakage* compliance is based on whole-building pressurization testing and shall be 0.45 cfm/ft<sup>2</sup> (**2.2 L/s·m<sup>2</sup>**) of *building envelope* area when *air leakage* compliance is based on verification. The *air leakage* of the *building envelope* shall be converted to the appropriate units to describe the ~~air leakage~~ *air leakage* as a function of the area of *walls* that separate *conditioned spaces* and *semiheated spaces* from the exterior as follows:

$$I_{AGW} = 0.112 \times I_{75Pa} \times S/A_{AGW}$$

where

$I_{75Pa}$  = *air leakage* rate of the *building envelope* (cfm/ft<sup>2</sup>) at a fixed *building* pressure differential of 75 Pa (0.30 in. of water) (**75 Pa**)

$S$  = total area of the *building envelope* (ft<sup>2</sup>) including the lowest *floor*, any *below-grade walls* or *above-grade walls*, and *roof* (including *vertical fenestration* and *skylights*)

$I_{AGW}$  = adjusted *air leakage* rate of the *building envelope* (cfm/ft<sup>2</sup>) at a reference wind speed of 10 mph and relative to the area of the *above-grade walls*

$A_{AGW}$  = the total area of *above-grade walls* that comprise the *building envelope*, ft<sup>2</sup>

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#### E C3.5.5.3

If the *simulation program* cannot simulate *air leakage* as a function of the area of *walls* that separate *conditioned spaces* and *semiheated spaces* from the exterior, the *air leakage* of the *building envelope* shall be converted to the appropriate units to describe the *air leakage* as a function of *gross floor area* as follows:

$$I_{FLR} = 0.112 \times I_{75Pa} \times S/A_{FLR}$$

where

$I_{FLR}$  = adjusted *air leakage* rate of the *building envelope* (cfm/ft<sup>2</sup>) (**L/s·m<sup>2</sup>**) at a reference wind speed of 10 mph and relative to the *gross floor area*

$A_{FLR}$  = *gross floor area*, ft<sup>2</sup>

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\*Schedules and internal loads by *building* area type are found at <http://sspc901.ashraepcs.org/documents.php>.

...

#### C3.5.5.3.1 Air Leakage Schedule

To simulate *air leakage* as described in Section 5.4.3, infiltration shall be adjusted in accordance with the infiltration schedule in the *building envelope trade-off schedules and loads* for the applicable *building* area type.

...

### C3.6 Calculation of Base Envelope Performance Factor

The simulation model for calculating the base envelope performance factor shall modify the simulation model for calculating the proposed envelope performance factor as follows:

...

f. The *air leakage* rate of the *building envelope* ( $I_{75Pa}$ ) at a fixed building pressure differential of 75 Pa (0.30 in. of water) (**75 Pa**) shall be ~~0.35 cfm/ft<sup>2</sup> (1.7 L/s·m<sup>2</sup>)~~ ~~0.30 cfm/ft<sup>2</sup> (1.5 L/s·m<sup>2</sup>)~~ and shall be converted to units for the energy model using the same method as the proposed envelope performance factor.

#### G3.1.1.4 Modeling Building Envelope Air Leakage

The *air leakage* rate of the *building envelope* ( $I_{75Pa}$ ) at a pressure differential of 75 Pa (0.30 in. of water) (75 Pa) shall be converted to appropriate units for the *simulation program* using one of the following formulas:

...

$$I_{75Pa} = \text{air leakage rate of the building envelope (cfm/ft}^2\text{) at a fixed building pressure differential of 75 Pa (0.30 in. of water) (75 Pa)}$$
$$Q = \text{volume of air in cfm flowing through the building envelope when subjected to a pressure differential of 75 Pa (0.30 in. of water) (75 Pa), in accordance with ASTM E 779, ASTM E1827, or ASTM E3158.}$$

...

**Table G3.1 Model Requirements for Calculating Proposed and Building Performance (continued)  
Proposed Building Performance, 5 Building Envelope**

...

b To simulate *air leakage*, infiltration shall be modeled using the same methodology and adjustments for weather and *building* operation in both the *proposed design* and the *baseline building design*. These adjustments shall be made for each simulation time step and must account for but not be limited to weather conditions, and *HVAC* system operation, including strategies that are intended to positively pressurize the *building*. The *air leakage* rate of the *building envelope* shall be converted to appropriate units for the *simulation program* using one of the methods in Section G3.1.1.4.

1. When whole-building pressurization testing is required or specified during design and completed in accordance with Section 5.4.3.1.4, the measured *air leakage* rate of the *building envelope* ( $I_{75Pa}$ ) at a fixed *building* pressure differential of 75 Pa (0.30 in. of water) (75 Pa) shall be modeled for purposes of demonstrating compliance with this Standard.

**Informative Note:** Before the start of pressurization testing, the maximum *air leakage* rate of the *building envelope* ( $I_{75Pa}$ ) specified in Section 5.4.3.1.4 or as specified in design documents may be simulated to estimate the energy impact of *building envelope air leakage*. The final measured value shall be used for compliance, therefore care should be taken when using estimated *air leakage* as a trade-off for performance-based code compliance.

2. For buildings providing verification in accordance with Section 5.9.1.2, the *air leakage* rate of the *building envelope* ( $I_{75Pa}$ ) at a fixed *building* pressure differential of 75 Pa (0.30 in. of water) (75 Pa) shall be 0.45 cfm/ft<sup>2</sup> (2.2 L/s·m<sup>2</sup>).

## Informative Appendix H

Table H-3 Standard 90.1 Items to Verify

Subsection	Subsection Title	Standard 90.1 Items to Verify for Proper Operation or Inclusion	Status
5.4.1	Insulation	Design details maintain continuity of thermal barrier.	
5.4.3.1	Continuous Air Barrier	Air barriers meet the following: <ul style="list-style-type: none"> <li>• Air barrier design and installation per Section 5.4.3.2 and either:                             <ul style="list-style-type: none"> <li>○ Whole building <i>air leakage</i> testing per Section 5.4.3.1, or</li> <li>○ Design and installation verification program performed in accordance with Section 5.4.3.1 and Section 5.9.1.2.</li> </ul> </li> </ul>	
5.8.3.1	Testing, acceptable materials and assemblies	Continuous air barrier materials and assemblies comply with specific manufacturer requirements or are tested for leakage resistance.	
5.8.3.2	Fenestration and doors	<i>Fenestration</i> and <i>doors</i> have manufacturer documentation that <i>air leakage</i> does not exceed allowable leakage rates.	
5.5.4.2	Fenestration and doors	<i>Fenestration</i> to wall ratio and <i>skylight</i> to <i>roof</i> ratio meet either the prescriptive requirements or the proposed design in the performance path, depending on the compliance path used.	
5.8.1	Insulation installation	Insulation material meets design specifications and is continuous.	
5.9	Inspection and verification	Envelope assemblies and <i>fenestration</i> comply with requirements. <i>Building envelope</i> performance is tested or verified.	

### FOR REFERENCE ONLY

*In-progress Addendum bi proposes a new definition for roof replacement. If both Addendum t and Addendum bi complete publication, the definition found in Addendum bi will take precedence. This definition has been reproduced below for information purposes only.*

**roof replacement:** an *alteration* that includes the removal of all existing layers of the *roof* assembly materials down to the *roof* deck and installing a new *roof* assembly above the *roof* deck.