# Changes to Envelope Requirements in ANSI/ASHRAE/IES Standard 90.1-2022

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ANSI/ASHRAE/IES Standard 90.1 regulates the energy efficiency and renewable energy use of buildings except low-rise residential buildings. The 2022 edition of Standard 90.1 incorporates numerous changes to the building envelope, lighting, mechanical, service hot water and renewable energy systems. These changes span both the prescriptive and performance compliance paths and will be described in a series of articles in *ASHRAE Journal* over the next several months. Throughout this series, we will cover the major topic areas, including HVAC, lighting and power, energy credits and energy modeling and performance. This month's article will cover several changes that were introduced to the envelope requirements of Standard 90.1-2022.

## Changes to Envelope Requirements in Standard 90.1-2022

This month and in June, we will look specifically at the updates concerning Section 5, the Building Envelope provisions of Standard 90.1-2022. The major changes to the envelope requirements are as follows:

1. **Thermal bridging:** Specifies new requirements for thermal bridging of various assemblies, including mitigation of various thermal bridges, rules for accounting of thermal bridging in the performance compliance paths and methods for verifying compliance

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with thermal bridging requirements. June's article will further discuss thermal bridging.

**2. Insulated metal panels (IMP):** Adds a definition for IMPs and new requirements specifically for IMPs.

**3. Cold-formed steel-framed roof and wall compliance calculations:** Adds a new method for calculating the U-factor of cold-formed steel roof and wall assemblies using the ANSI/AISI S250 Standard.

**4. Wall solar reflectance:** Adds minimum wall solar reflectance requirements for certain climate zones.

**5. Air leakage:** Revises air leakage requirements in a number of ways, including lower air leakage testing threshold, revised test and measurement requirements and revised performance compliance requirements.

**6. Roof replacements:** Specifies requirements for cases where the existing roof structure does not allow insulation requirements to be met during roof replacements.

**7. Envelope commissioning:** Relocates requirements as described on page 49 for consistent organization throughout the standard.

**8. Envelope backstop:** Limits the amount of envelope performance that can be traded off in performance compliance paths (Section 12 and Appendix G).

> "**Standard 90.1** continues to adapt to the needs of the building industry and provide a cost-effective energy efficiency standard that benefits stakeholders and society as a whole."
>
> *–Don Brundage, Chair of SSPC 90.1, 2020-2023*

### Insulated Metal Panels

Standard 90.1-2022 has added specific requirements for IMPs in several sections of Section 5 and Appendix A. IMPs were not previously recognized by Standard 90.1; therefore, a product definition was added to Section 3, Definitions, of the standard. These changes were introduced in Addendum *cg*, which was approved by the 90.1 SSPC in July 2022.

IMPs are factory-made composite panels formed by bonding two separate metal skins to an insulative core capable of transferring stress between the skins, creating a rigid two-way slab. The metal skins are formed into a variety of joint configurations, allowing use as either a roof or wall panel. In either case, they may be used as exterior cladding or provide a host surface for traditional roof or wall cladding materials. Their rigidity allows them to meet the span requirements for a variety of framing systems and spacing. IMPs are approved for use in exterior roof or wall construction as well as interior partitions through common third-party certification agencies.

Although IMPs have been used in building construction for 40 years, they were not specifically recognized in building codes until recently. While IMPs were originally designed for use in cold-storage facilities, increased stringency of envelope requirements in building energy standards has made them practical in other applications and has resulted in a large growth in the number of manufacturers and gross volume.

Depending on how IMPs are implemented for a given project, they may be viewed as a building material,

## New TPS, New Paths

Along with a brand-new mandatory section, Section 11–Additional Efficiency Requirements (aka Energy Credits), the latest version of the standard integrates nearly 90 new addenda. Notably, the Title, Purpose, and Scope (TPS) of the standard has also been expanded, and now includes "sites." This expands the scope of the standard to include not just the building but also equipment that may be not be directly associated with the building (for example, parking lot lighting not connected to the building electrical service). Under the new TPS, users can achieve more credit for on-site renewable energy production beyond what's directly attached to the building. It also means that energy use associated with the exterior and parking areas of the building must be considered.

The committee has also added four new appendices supporting technical content in the main standard. These are: 1) Appendix I–alternatives to energy cost-based compliance, 2) Appendix J–performance curves for chillers for use in modeling, 3) Appendix K–Informative Figures in support of the thermal bridging criteria and 4) Appendix L–a mechanical system component trade-off method.

Standard 90.1-2022 now contains a discipline-specific trade-off compliance path for each of the major building components (envelope, lighting and mechanical). They are contained in Appendix C for envelope, Appendix L for mechanical systems and Section 9.5.2 for lighting. Each of these specialized trade-off methods could be used in the future to establish incentive programs related to industry sectors or to help establish contractual requirements within the architecture, engineering and construction (AEC) industry.

insulation or even an assembly by a Standard 90.1 user. Generally, Standard 90.1 provisions treat structure, cladding, insulation and building materials separately with different requirements for each. Not all requirements apply uniformly to IMPs, depending upon how they are used. This results in multiple potential compliance paths, each with a possibly different determination. Addendum *cg* clarifies this by providing a clear path of compliance, making Standard 90.1-2022 easier for users and building officials to apply.

The specific additions to the language are as follows:

- Section 3 defines an insulated metal panel as "a factory-manufactured panel consisting of metal facings, an insulative core and a panel joint intended for use in an assembly forming an exterior wall, an exterior wall covering or a roof covering of a building envelope."
- Section 5 adds new sections for IMPs on roofs (5.5.3.1.5), walls (5.5.3.2.3), ceilings (5.5.3.4.2), which each clarify that the maximum U-factors of assemblies that use IMPs are determined by the class of construction to which the IMP attaches.
- Appendix A adds Section A9.4.7, which states "U-factors of insulated metal panels shall be determined by two- or three-dimensional finite difference or finite volume computer models or by testing in accordance with Section A9.3.2 and shall include panel side joints."

These additions work together to provide a clear path of compliance for designers and authorities having jurisdiction (AHJs) when employing these assemblies and during compliance verification.

## Cold-Formed Steel Walls Compliance Calculations

Normative Appendix A, Section A3.3 entitled Steel Framed Walls, was modified to allow two methods of determining compliance with the Section 5 Building Envelope U-factor requirements. The first method uses Table A3.3.3.1, which contains a listing of precalculated cold-formed steel walls and the associated U-factors based on different R-values of continuous insulation. Note that this method is limited to steel walls with a framing depth of 3.5 in. or 6 in. (90 mm or 152 mm), spacing of 16 in. or 25 in. (406 mm or 610 mm) and thickness up to 54 mils (0.0538 in./1.37 mm).

The new second method uses ANSI/AISI S250-21, *North American Standard for Thermal Transmittance of Building Envelope With Cold-Formed Steel Framing, 2021 Edition,* for determining compliance with Section 5 Building Envelope requirements. This standard provides an opportunity for the user to calculate the U-factor for cold-formed steel framed wall assemblies using framing spacing from 6 in. to 24 in. (152 mm to 610 mm) on-center, framing members depths from 3.5 in. to 12 in. (90 mm to 305 mm) wide, framing thicknesses from 33 Mils to 64 Mils (e.g., 0.033 in. to 0.064 in. [0.839 mm to 1.63 mm] thick base metal thickness), as well as insulations located in the cavity only, in the cavity and outside the cavity and when outside of the cavity only.

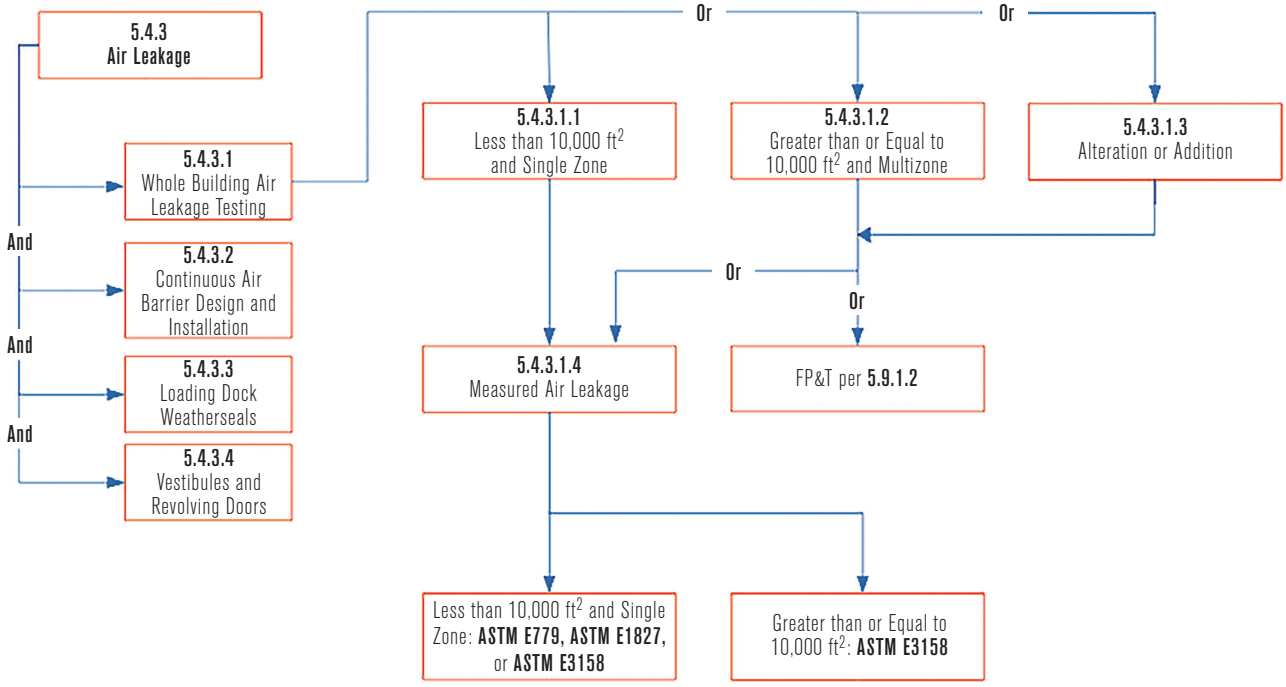
The new option allows the user greater flexibility to experiment with or choose multiple variations of a building envelope design using cold-formed steel framing, which the original Table A3.3.3.1 did not cover. This method also allows the design professional or owner to avoid having to submit a costly and time-consuming alternative means and method request to a jurisdiction for approval to use something other than what is currently listed in Table A3.3.3.1 to demonstrate compliance.

## Wall Solar Reflectance

Several changes were made to the wall solar reflectance requirements. The first is the removal of "reflectance" as a defined term within the standard. The Envelope subcommittee agreed that the previous definition for reflectance was inaccurate and that there is no question about what the term reflectance means. In an effort to simplify the standard, it was decided to remove the definition rather than amend it. The second change was to remove the use of solar reflectance index (SRI) for walls and replace it with the more accurate and relevant term—solar reflectance. (SRI is still used when referring to roofs.) Finally, new requirements were added for south-, east- and west-facing walls to have a minimum solar reflectance of 0.30 in Climate Zone 0.

For solar reflectance, three options have been provided for measurement: (a) ASTM C1549, (b) ASTM E903 or (c) the "G197GT90" output of the Surface Optics 410-Solar-i Hemispherical Reflectometer. For emittance, ASTM C1371 was the simplest and least expensive measurement method, but other options have been provided. Initial reflectance was specified because there isn't a fully developed measurement technique for measuring aged wall reflectance. Preliminary testing shows that walls get much less dirty than roofs because they are vertical surfaces. Finally, planted material as a shading option has

FIGURE 1 The compliance path and flow for air leakage requirements in Standard 90.1-2022.




been removed because plants are not considered durable or guaranteed to last the life of the building.

## Air Leakage

Continuous air barriers have been required in most buildings for a number of Standard 90.1 editions. Air barrier requirements for commercial buildings underwent significant changes in the 2022 edition through addendum *t*. They include clarifications to the Whole Building Performance testing methods, stringency, design phase requirements, material and assembly requirements and on-site installation verification requirements. These updates improved performance related to air tightness requirements and were found to be cost-effective. *Figure 1* outlines the compliance path and flow for air leakage requirements in Standard 90.1-2022.

Whole-building air leakage threshold criteria have been updated in the following ways:

- The air leakage rate for compliance without having to conduct further diagnostics was lowered from 0.40 cfm/ft$^2$ to 0.35 cfm/ft$^2$ (2.0 L/s·m$^2$ to 1.8 L/s·m$^2$).
- The air leakage rate for compliance when further diagnostics are performed was lowered from 0.60 cfm/ft$^2$ to 0.45 cfm/ft$^2$ (3.0 L/s·m$^2$ to 2.2 L/s·m$^2$).
- Whole-building air leakage testing and measurement was required to be performed on buildings with less than 10,000 ft$^2$ (929 m$^2$) of gross conditioned floor area, while for buildings larger than 10,000 ft$^2$ (929 m$^2$), the option remains to test or perform a visual inspection.
- ASTM E3158, *Standard Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building*, was added to the acceptable test list. Its inclusion allowed alternate test methods based on building size and complexity to better align with the scopes of the ASTM standards.
- A clarification was added to Section 11, Normative Appendix C and Normative Appendix G that accommodated performance differences when compliance is achieved through whole-building testing as opposed to the verification without testing option. In addition, the language modifications in Appendix G better describe the path for capturing air leakage improvements when minimum performance requirements are exceeded.

Other improvements to air leakage requirements across Standard 90.1-2022 are as follows:

- Definitions for "air leakage" and "infiltration" and their use in the standard are updated to correspond to the correct requirements of Section 5.
- The SI value of 75 Pascals is the underlying requirement for whole-building air leakage testing and is now reflected in the revised I-P value.

• Clarity is added regarding alteration compliance options with air leakage. As part of this, roof replacement alterations have been defined and the compliance scope clarified.

### Roof Replacements

Addendum *bi* clarifies requirements surrounding the addition of insulation when existing buildings undergo roof replacement. The committee has long believed the time of roof replacement is the lowest cost and best opportunity for existing buildings to be brought up to code or as close to code as possible. However, until now, the standard offered no guidance on how to address existing building roofs with obstacles to installing the minimum insulation required, especially for roofs with insulation entirely above deck. Addendum *bi* clarifies what must be done when existing roof conditions limit full thickness insulation levels.

This new addendum recognizes that existing building roof replacements can be challenging and requires roofing professionals to provide an inspection report identifying obstacles to installing the full thickness of insulation and to describe on construction documents how the proposed design intends to minimize deviation from the insulation requirements.

It further clarifies the definition of roof replacement as an alteration that involves removing all existing materials down to the roof deck and installing a new roof assembly above the roof deck. And it reinforces the standard's requirement that two layers of insulation with staggered joints must be installed in roof replacement designs. This requirement is the same for new roof construction.

### Envelope Commissioning

While inspections, verification and commissioning provisions did not change with this edition, they were moved and section numbering was aligned between all sections. In Standard 90.1-2022, anything related to inspections has been move to Section 4, the Administration and Enforcement section; anything related to verification and/or testing has been moved to a X.9.1 section within each section; everything related to commissioning has been moved to a X.9.2 section.

### Envelope Backstop

A new requirement was added into the performance-based compliance pathways of both Section 12–Energy Cost Budget and Appendix G that limits the trade-off of prescriptive envelope performance. The trade-off limits are based on the envelope performance factors calculated in accordance with the building envelope performance compliance option (Appendix C). For residential building types the proposed envelope performance factor cannot exceed the base envelope performance factor by more than 15%. In nonresidential building types the proposed envelope performance factor cannot exceed the base envelope performance factor by more than 7%. These new trade-off limits recognize the importance of maintaining a robust, well insulated building envelope.

## Summary

In summary, several changes were introduced to the envelope requirements of Standard 90.1-2022. These changes are intended to improve energy efficiency, ease compliance and improve the clarity of the standard. In the next article, we will delve deeper into changes to the thermal bridging requirements, which are completely new in the 2022 edition. Other articles will cover changes to the lighting, mechanical, service water heating, power and other, and performance compliance sections. ■

## Restructuring of the Standard

Within the standard, requirements for New Buildings, Additions and Alterations have also been organized across all the sections. Each Section is organized as follows: X.1.2 outlines the scope for new buildings, X.1.3 has requirements or directions for Additions, and X.1.4 has requirements or directions for Alterations. (Note: this maps to 9.1.1.2, 9.1.1.3, and 9.1.1.4 in the Lighting section).

The last structural change relates to the location of Inspection, Verification and Testing and Commissioning requirements. Inspections have been moved to Section 4, as they are a jurisdictional administrative function or requirement. Verification and Testing (or Functional Performance Testing) provisions have all been located in an X.9.1 section, with the more involved commissioning provisions located in an X.9.2 section within each major section (Sections 5 – 10).

Finally, users should note that, with the introduction of Energy Credits, the Energy Cost Budget Method has moved from Section 11 to Section 12.