ENERGY COMPLETE MONOGRAPH

Revised 12/14/2021

2021 PUBLIC INPUT TO THE 2021 IECC, IRC CH. 11 AND ICCPC CH.15

ICC
INTERNATIONAL CODE COUNCIL®

Second Printing

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TABLE OF CONTENTS
(2021 Public Input)

PAGE

INTRODUCTION

Following an extensive review and feedback process, on March 4, 2021 the Code Council Board (Board) released a new framework to address energy efficiency. This new framework includes a revised process for the development of the energy provisions with a new scope and intent and optional requirements aimed at achieving net zero energy buildings presently and by 2030. This framework includes using the Code Council's American National Standards Institute (ANSI) approved standards process to update the energy provisions contained in the IECC, Chapter 11 of the IRC and Chapter 15 of the International Code Council Performance Code (ICC PC). The results of this process will be the publication of the energy provisions in the 2024 IECC, IRC and ICC PC as part of the family of I-Codes in the fall of 2023.

The following has occurred since the March 4th release:

- June 22nd: Board appoints two new committees: Commercial Energy Code Consensus Committee and Residential Energy Code Consensus Committee following a Call for Committee members on March 19th and an application deadline of April 23rd.
- July 16th: cdpACCESS opened for Public Input code change submissions, with a deadline of October 12th.

As noted previously, the update process will follow the Code Council's standards development procedures entitled the "ICC Consensus Procedures" (ICC CP). The current version was approved by ANSI on August 2, 2021. Further to this process and in accordance with Section 3.1(c) of the ICC CP, the Board has adopted the "IECC Committee Procedures" for the development of the energy provisions of the 2024 editions and future editions. See document links on page iii.

In accordance with Section 8.2 of the ICC CP, the 2021 edition of the energy provisions (with the Board approved scope and intent) was used as the Initial Draft in order to solicit Public Input in the form of code change submittals. Following the deadline of October 12th, the proposed code change submittals were compiled, published and posted. The publication of these changes constitutes neither endorsement nor question of them but is in accordance with established procedures so that any interested individuals may make their views known to the relevant Subcommittee, Consensus Committee and others similarly interested. In furtherance of this purpose, the Subcommittees and Consensus Committees will hold open virtual meetings as noted below for the purpose of receiving comments and arguments for or against such proposed changes. Those who are interested in speaking on any of the published changes are expected to participate at these meetings.

This compilation of code change proposals is available in electronic form only.

SUBCOMMITTEES AND CONSENSUS COMMITTEES

Subcommittees

In accordance with Section 6 of the ICC Consensus Procedures, Subcommittees have been established and approved by the Consensus Committees following a public notice and application process. The objective of Subcommittees is to provide for broad participation and develop consensus on an issue(s) and report the findings to the Consensus Committee for review and final determination. Voting members are comprised of both Consensus Committee members and interested parties.

Consensus Committees

The Board appointed Consensus Committees will determine the final code content of the energy provisions in accordance with the ICC Consensus Procedures.

All Subcommittee and Consensus Committee meetings are open meetings to all participants (voting and non-voting) with adequate public notice provided in accordance with the ICC Consensus Procedures.

ANTITRUST COMPLIANCE

ICC brings together numerous government officials and industry members to participate in the code and standard development process. ICC provides basic guidance on the antitrust laws that may be applicable to these and other activities sponsored by ICC ("ICC Activities"). Click here to view ICC's policy on Antitrust Compliance.

ANALYSIS STATEMENTS

Code changes may contain an "analysis" that appears after the proponent's reason. These comments do not advocate action by the Subcommittees or Consensus Committees for or against a proposal. The purpose of such comments is to identify pertinent information that is relevant to the consideration of the proposed change by the Subcommittees, Consensus Committees and interested parties. Staff analyses customarily identify such things as: conflicts and duplication within a proposed change and with other proposed changes and/or current code text; deficiencies in proposed text and/or substantiation; text problems such as wording defects and vagueness; background information on the development of current text; and staff's review of proposed new reference standards for compliance with procedures. Lack of an analysis indicates neither support for, nor opposition to a proposal.

NEW REFERENCE STANDARDS

Reference standards provide a very important role in ICC's Codes. As stipulated in Sections C108 and R108 of the IECC and Section R102.4 of the IRC, "….standards referenced in this code……shall be considered as part of the requirements of this code to the prescribed extent of each such reference…".

The I-Code process includes criteria for staff to evaluate the non-technical aspects of the standard, such as mandatory language and a consensus process for development. As an extension of the code, the code change submittal process for proposed new reference standards (a standard not currently referenced in one of the I-Codes) requires that the proponent identify the title and edition of the new standard as well as making the standard available for review. This is typically done in one of three ways:

1. The proponent secures a copy of the standard from the Standards Developing Organization (SDO) and sends it to staff for record retention. The proponent also requests that the SDO execute an ICC "Permission to Post Form", provided by the proponent, that allows ICC to post the standard on a password protected website for both staff and the Consensus Committees.
2. The proponent contacts the SDO and is informed that the standard is available on their website for free download. The download is typically specific only to the individual downloading the standard (in other words it cannot be sent electronically to another person). In addition, ICC administration will obtain a copy of the standard for internal purposes by accessing the SDO's website to download the standard.
3. The SDO tells the proponent the standard is available on their website for free access in a "read-only" format. The proponent provides ICC with the link to access the standard and ICC administration confirms that the standard is available in "read-only" format.

Where necessary, ICC will work with proponents and SDO's to help secure the standard in a reviewable format. It is still the responsibility of the proponent to contact the SDO to determine how the standard can be provided to support its potential inclusion in the code.

Proposed new reference standards must be completed and readily available in a timely fashion in order to facilitate the Consensus Committee approval process. New standards which are approved by the Consensus Committee will be listed in the "Referenced Standard" chapter of the applicable code(s).

REFERENCED STANDARDS UPDATES

Updates to currently referenced energy standards in the 2021 IECC, IRC and ICC PC will be considered by the Administrative Code Development Committee in the 2022 Group B Cycle of the ICC Code Development Process.

In accordance with I-Code procedures, an updated standard to the energy provisions of the IECC, IRC, and ICC PC must be finalized and published by December 1, 2023. If the standard update is not finalized and published by December 1, 2023, the affected energy provisions will be revised to reference the previously listed year edition of the standard and an errata issued.

PROPONENT CONTACT INFORMATION

In accordance with procedures, proponents are under no obligation to provide an email address for their posted proposal. For most of the code change proposals, an email address for the proponent has been provided. In an effort to continue to provide for proponent's privacy and at the same time allow an initial contact between an interested party and the proponent, we will be utilizing cdpACCESS to allow an interested party to initiate contact with the proponent without identifying the proponent's email address. The process is follows:

- Interested party logs into cdpACCESS and searches for the subject code change.
- Interested party locates the button "Contact the Proponent" to request that cdpACCESS contact the proponent, providing the interested party's name and email address.
- cdpACCESS uses the proponent email address on file and sends a notification to the proponent indicating the name of the interested party and their email address and that the interested party would like to discuss the code change.
- The interested party receives an email noting that the cdpACCESS system has sent the request to the proponent.
- It is up to the proponent to determine if they would like to respond and contact the interested party.
- The proponent is under no obligation to respond to the cdpACCESS request for contact or to contact the interested party. The proponent's contact information is not revealed to the interested party as part of this initial contact.

CODE CHANGE SUBMITTALS WITH TABLES

Staff is aware that some of the code change proposals with tables may require additional formatting. In an effort to post these code changes as soon as practical in order to start the discussions at the Subcommittee level, the decision was made to post these proposals now and staff will continue to reformat the tables and re-post when reformatted. All interested parties who have signed up for the email distribution list for notifications (see below) will be notified when the code changes are re-posted.

ICC ENERGY WEBSITES/DOCUMENT POSTINGS

ICC websites are used extensively for access to documents which support the update of ICC's Codes. This current update of the energy provisions is no different. Postings include:

- This code change document
- Code change errata, if any, will be posted
- The "IECC Committee Procedures" previously mentioned will be posted
- Process information such as a flowchart of the key steps currently under development will be posted
- Additional documents/information to support the process will be posted

Links to websites:

- "Leading the Way to Energy Efficiency"
- Commercial: Commercial Energy Consensus Committee
- Residential: Residential Energy Consensus Committee

Users are encouraged to periodically review the websites.

ICC CONSENSUS PROCEDURES

Click here to download the current ICC Consensus Procedures

ICC ENERGY SECRETARIAT/EMAIL DISTRIBUTION LIST

The ICC Secretariat is Kristopher Stenger, AIA, CBO, LEED AP Director of Energy Programs at kstenger@iccsafe.org. Be sure to contact Kris in order to be placed on the email distribution list in order to receive timely meeting information, notices, etc.

TABLE OF CONTENTS

PAGE

2021 PUBLIC INPUT - PROPOSED CHANGES TO THE INTERNATIONAL ENERGY CONSERVATION CODE

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Interest Category
[A] Manufacturer
[B] Builder
[C] Stds Promulgator/Testing Lab
[D] User
[E] Utility
[F] Consumer
[G] Public Segment
[H] Government Regulator
[I] Insurance

CEPI-1-21

IECC®: CHAPTER 2 [CE], SECTION C202, SECTION 202 (New), C402.1.3 (New)

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com)

2021 International Energy Conservation Code

CHAPTER 2 [CE] DEFINITIONS

SECTION C202 GENERAL DEFINITIONS
Add new definition as follows:
PROCESS APPLICATION. A manufacturing, industrial, or commercial procedure or activity where the primary purpose is other than conditioning spaces and maintaining comfort and amenities for the occupants of a building.
PROCESS ENERGY. Energy consumed in support of a *process application.*
Add new text as follows:
C402.1.3 Car wash facilities.
Free-standing and appurtenant manual or automatic car wash, *process application* facilities or portions thereof separated from conditioned spaces by building thermal envelope assemblies complying with C402.1.3 or C402.1.4 or C402.1.5 or C407, shall be exempt from building thermal envelope provisions of Section C402; the interior lighting control provisions of Sections C405.2.1, C405.2.2, C405.2.3; and the interior lighting power provisions of Section C405.3.

Reason Statement:

The code does not intend to regulate the commercial process application of a car wash facility as it does for the conditioning of spaces for the comfort and amenities of building occupants, or the illumination of such a space for the visual acuity of building occupants (to read, work, eat or play). Moreover, the process energy consumed by car washing equipment (applicators, blowers, sprayers, washers, scrubbers and conveyors) utilized for the process application of car washing tend to break down, freeze or fail, prematurely if they are not provided with a minimum level of heat for operational performance of said equipment.

This proposal targets car wash facilities, specifically. The level of space conditioning for a car wash facility is not designed for human comfort heating or cooling, but rather to sustain the commercial enterprise and operational performance of a car wash facility. Vehicle owners do not need the level of illumination necessary to read, work, eat or play during the 2-5 minutes they (in their vehicle) is proceeding through the wash cycle. Hence, there is no pragmatic or feasible reason to require building insulation, window U-factor/SHGC, air-leakage control, interior lighting power, daylight responsive controls, occupancy-vacancy sensing or interior lighting shut-off control for these facilities.

Cost Impact:

The code change proposal will decrease the cost of construction.

There is no cost implication aligned with this proposal. The resulting exclusions would mean the process application energies assigned to car washing equipment would be "excluded" from the scope and applicability of the IECC. No change to stringency is proposed.

CEPI-1-21

CEPI-2-21

IECC®: C101.2, CHAPTER 2 [CE], SECTION C202, SECTION 202 (New), C401.1

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com)

2021 International Energy Conservation Code

C101.2 Scope (Not subject to public input).
This code applies to the design and construction of buildings not covered by the scope of the IECC — Residential Provisions.

CHAPTER 2 [CE] DEFINITIONS

SECTION C202 GENERAL DEFINITIONS
Add new definition as follows:
PROCESS APPLICATION. A manufacturing, industrial, or commercial procedure or activity where the primary purpose is other than conditioning spaces and maintaining comfort and amenities for the occupants of a building
PROCESS ENERGY. Energy consumed in support of a *process application.*
Revise as follows:
C401.1 Scope.
The provisions in this chapter are applicable to commercial *buildings*, ~~and~~ their *building sites*, and new equipment or *building* systems specifically identified by this code that are part of a *process application*. *Process applications* not specifically identified or otherwise not specifically restricted are exempt from this code in total.

Reason Statement:

Without the proposed language, and interpreted literally, the IECC could indeed be read as limiting the amount of energy put into a blast furnace at a foundry, energy dedicated to municipal pumping stations and wastewater treatment facilities keeping our civilian water supply clean, energy to operate fermenting casks at a distillery, energy to run a conveyor at a packaging plant, or even the energy to modulate cabinet temperatures within telecommunication shelters dedicated to switching and signal receiving. However, this is simply not pragmatic and not the case.

Cost Impact:

The code change proposal will decrease the cost of construction.

There is no cost implication aligned with this proposal. Rather, it is an exercise steeped in clarification of the Purpose and Scope for Commercial Energy Efficiency (Chapter 4). The resulting exclusions would mean the process application energies assigned to foundries, coal mining elevator control buildings agricultural and farm-land irrigation pumps, municipal wastewater treatment facilities, distilleries, packaging plants, agricultural growing greenhouses supporting the national food supply and telecommunication shelters would be "excluded" from the scope and applicability of Chapter 4, without the need for explicitly articulating an ever-growing list of exceptions. No change to stringency is proposed.

CEPI-2-21

CEPI-3-21

IECC®: CHAPTER 2 [CE], SECTION C202, SECTION 202 (New), C402.1.3 (New)

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com)

2021 International Energy Conservation Code

CHAPTER 2 [CE] DEFINITIONS

SECTION C202 GENERAL DEFINITIONS
Add new definition as follows:
PROCESS APPLICATION. A manufacturing, industrial, or commercial procedure or activity where the primary purpose is other than conditioning spaces and maintaining comfort and amenities for the occupants of a building.
PROCESS ENERGY. Energy consumed in support of a *process application.*
Add new text as follows:
C402.1.3 Water treatment facilities.
Structures surrounding and covering water storage and *process application* facilities, including water clarification processors, water treatment plants, sewage treatment plants (pumping stations and collector systems) and similar facilities consuming *process energy* shall be exempt from *building thermal envelope* provisions of Section C402.

Reason Statement:

The code does not intend to regulate facilities harboring the commercial process application of municipal water treatment as it does for the conditioning of spaces for the comfort and amenities of building occupants. Moreover, the equipment (tanks, stirrers, clarifiers, blowers, separators, sprayers, filters and conveyors) utilized for the private and public enterprise of municipal water treatment tend to break down, freeze or fail, prematurely if they are not provided with a minimum level of heat for operational performance.

This proposal targets water treatment, pumping and booster facilities, specifically. There is no pragmatic reason to require building insulation, window U-factor/SHGC, air-leakage control, day-lighting for these facilities.

Cost Impact:

The code change proposal will decrease the cost of construction.

There is no cost implication aligned with this proposal. The resulting exclusions would mean the process application energies assigned to municipal water treatment equipment would be "excluded" from the scope and applicability of the IECC. No change to stringency is proposed.

CEPI-3-21

CEPI-4-21

IECC®: C102.1.1

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:
C102.1.1 Above code programs.

The *code official* or other authority having jurisdiction shall be permitted to deem a national, state or local energy efficiency program as exceeding the energy efficiency required by this code. Buildings *approved* in writing by such an energy efficiency program shall be considered to be in compliance with this code. The requirements identified in Table C407.2 shall be met. The *building envelope* U-factors, C-factors, F-factors, and SHGCs shall be no greater than the values in Tables C402.1.4 and C402.4, with the following modifications to values in each table:

1. For the opaque elements, each U-factor, C-factor, and F-factor in Table C402.1.4 shall be permitted to be increased by 15%.
   For vertical fenestration and skylights, each U-factor and SHGC in Table C402.4 shall be permitted to be increased by 15%.
2. **Exception**: The U-factor, C-factor, F-factor, or SHGC shall not be modified where the requirement in the table is “NR” (no requirement).

Reason Statement:

The purpose of this code change proposal is to improve the *IECC* by incorporating a mandatory building thermal envelope trade-off backstop (limiting the user’s ability to trade-off the prescriptive envelope performance levels) for approved above-code programs (similar to the residential version in Section R102.1.1 of the 2021 *IECC*). Although the residential provisions of the *IECC* have included mandatory trade-off limits (backstops) for various compliance paths for several editions now, and these trade-off limits were expanded and improved in the 2021 *IECC*, the commercial code compliance paths do not yet have similar trade-off backstops.

Even though the 2021 *IECC* requires a substantially improved level of efficiency in commercial building envelope components, an effective thermal envelope trade-off backstop for those who comply through above-code programs would provide important benefits for the owners and occupants of these buildings:

- The efficiency of the building envelope is the most important factor in a building’s long-term performance (unlike equipment, the envelope can last a very long time, even for the life of the building), but is the most costly to retrofit after the building is constructed;
- Occupants will be more comfortable and healthier in a building with a reasonably efficient envelope; and
- Well-insulated buildings are more resilient and will provide better protection for occupants and property in long-term power outages.

An effective thermal envelope backstop is crucial to ensure that the building retains reasonable envelope performance similar to the prescriptive path under an alternative compliance path, such as the performance path or an above-code program, etc., and that the envelope is not unduly traded-off for other measures. Trading off envelope and associated occupant comfort can have direct negative impacts on energy usage. For example, if the occupant responds to discomfort from a “cold” or “hot” room due to an inadequate building envelope by adjusting the thermostat, the additional energy use from the adjusted thermostat can be substantial. As a result, backstops can save significant energy and energy costs in buildings.

Because most above-code programs give code users wide latitude to trade efficiency among envelope, mechanical equipment, lighting, and other measures it is even more important that a backstop be included. Building owners may not fully understand the impact of an above-code building’s thermal envelope until years into ownership.

This proposal adds reasonable limits on efficiency trade-offs for opaque elements and fenestration, allowing code users to trade the efficiency of components up to 15% over the prescriptive U-factor, C-factor, F-factor or SHGC. These limits should be very straightforward to apply in any performance compliance software and should be easily understood by design professionals. As green or above-code programs are increasingly used by states and cities to achieve energy efficiency and carbon reduction goals, it is more important than ever that each new building contain adequate insulation and efficient fenestration that will provide energy savings and comfort over the useful life of the building.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not increase the baseline stringency of the prescriptive requirements of the IECC, but merely limits trade-offs under a voluntarily chosen alternate compliance path (in this case, compliance with an above-code program). The mandatory minimum values proposed are 15% less stringent than prescriptive values of the IECC and only apply if an alternative compliance path is chosen. The user can be expected to choose an alternate compliance path, with the mandatory measures, when it produces lower costs than prescriptive compliance). As a result, whether costs of construction increase or decrease ultimately depends on choices made by the code user.

COST-EFFECTIVENESS

This proposal does not increase the stringency of the code or result in increased costs, so a cost-effectiveness analysis does not apply. The ICC Board of Directors set the 2021 *IECC* as the baseline for future IECC development – and by extension made the 2021 *IECC* the basis for cost-effectiveness analyses. This means for purposes of analyzing code proposals, the existing provisions of the 2021 *IECC* are considered cost-effective and reasonable, since they are the starting point for analyses of code changes and no rollbacks are permitted. Establishing trade-off backstops like this code change proposal, which utilizes U-factors and SHGCs 15% less stringent than the prescriptive measures of the 2021 *IECC*, does not increase the stringency of that baseline or impose any additional costs to meet specific measures. In addition, if the prescriptive values are cost-effective, then the backstop values would be cost-effective. Changes to trade-off backstops like the proposal above do not increase the stringency of that baseline or impose any additional costs to meet specific measures. These backstops serve only as a consumer protection against excessive trade-offs, but do not require anything more than what would be required for base code prescriptive compliance. Thus, a cost-effectiveness analysis would be difficult or impossible to apply, and would not be informative for the Committee

CEPI-4-21

CEPI-5-21

IECC®: C103.2, SECTION 202 (New), 405.13 (New), C405.13.1 (New), C405.13.2 (New), C405.13.3 (New), C406.5, CC103.3.2

Proponents:

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2021 International Energy Conservation Code

Revise as follows:
C103.2 Information on construction documents.

Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Economizer description.
8. Equipment and system controls.
9. Fan motor horsepower (hp) and controls.
10. Duct sealing, duct and pipe insulation and location.
11. Lighting fixture schedule with wattage and control narrative.
12. Location of *daylight* zones on floor plans.
13. Air barrier and air sealing details, including the location of the air barrier.

14. Location of pathways for routing of raceways or cable from the on-site renewable energy system to the electrical service panel.

Add new definition as follows:

C202 COMMUNITY RENEWABLE ENERGY FACILITY. A facility that produces energy harvested from *renewable energy resources* and is qualified as a community energy facility under applicable jurisdictional statutes and rules.
C202 FINANCIAL RENEWAWABLE ENERGY POWER PURHASE AGREEMENT (FPPA). A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."
C202 PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (PPPA).

A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

RENEWABLE ENERGY CERTIFICATE (REC). A market-based instrument that represents and conveys the environmental, social, and other non-power attributes of one megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with *renewable energy resources*; also known as "energy attribute" and "energy attribute certificate" (EAC).

Add new text as follows:

405.13 Renewable energy systems.

Each *building site* shall have equipment for on-site renewable energy with a rated capacity of not less than 1.5 W/ft² (16.1 W/m²) multiplied by the sum of the gross conditioned floor area of the three largest floors.

Exception: Where the *building site* cannot meet the requirement, either in part or in full, with an o*n-site renewable energy system*, the *building site* shall procure and be credited for an amount of renewable energy not less than otherwise required by this section with one or more of the following:

1. A *physical renewable energy power purchase agreement.*
2. A *financial renewable energy power purchase agreement.*
3. A *community renewable energy facility.*

The renewable energy shall be delivered or credited to the *building site* under an energy contract with a duration of not less than 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.

C405.13.1 Additional efficiency package options.
The PV capacity required in this section shall not be used for compliance with the on-site renewable energy option of Section C406.5.
C405.13.2 Total building performance.
Where the total building performance of Section C407 is used for compliance, the PV capacity required in this section shall be the same in the *standard reference design* and the *proposed design*.
C405.13.3 Renewable energy certificate documentation.

The property owner or owner's authorized agent shall demonstrate that any RECs or EACs associated with on-site and off-site renewable energy comply with the following:

1. Are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years;
2. Are createdwithin a 12-month period of the use of the REC; and
3. Arefrom a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy.

Revise as follows:

C406.5 On-site renewable energy.

Building~~s~~ *sites* shall comply with Section C405.13.3 and with Section C406.5.1 or C406.5.2.

CC103.3.2 Requirements for all procurement methods.
The following requirements shall apply to all off-site renewable energy procurement methods:

1. The building owner shall sign a legally binding contract to procure qualifying *off-site renewable energy*.
2. The procurement contract shall have duration of not less than 15 years and shall be structured to survive a partial or full transfer of ownership of the property.

3. RECs and other environmental attributes associated with the procured *off-site renewable energy* shall comply with Section C405.13.3 ~~be assigned to the building project for the duration of the contract~~.

4. The *renewable energy* generating source shall include one or more of the following: photovoltaic systems, solar thermal power plants, geothermal power plants and wind turbines.

5. The generation source shall be located where the energy can be delivered to the *building site* by the same utility or distribution entity, the same independent system operator (ISO) or regional transmission organization (RTO), or within integrated ISOs (electric coordination council).

6. The *off-site renewable energy* producer shall maintain transparent accounting that clearly assigns production to the building. Records on power sent to or purchased by the building shall be retained by the building owner and made available for inspection by the code official upon request.

Reason Statement:

In 2020, renewable energy sources were responsible for 21% of U.S. electricity generation. In order to cost-effectively achieve President Biden's goal to create a carbon-free power sector by 2035, it is paramount to begin installing a nominal capacity of renewable energy on-site in all new buildings now. According to a recent study entitled "A New Roadmap for the Lowest Cost Grid", the least expensive grid involves a large amount of centralized renewables and a large amount of distributed renewables located on the building site. More renewables placed onsite can enable the efficient deployment of rapidly expanding utility-scale renewables. It is therefore crucial for new commercial buildings to install renewable energy on-site during new construction so that the U.S. can reach its 100% carbon-free power sector goal in the most cost-effective manner. Installing renewables on site will also allow building owners to economically benefit from the transition towards a low-carbon economy, to prepare their building for expansion of renewable capacity, and to benefit from additional resiliency during disruptions in centrally supplied power.

In addition, this proposal will expand good paying jobs in one of the nation's fastest growing employment sectors. According to the Bureau of Labor Statistics, the two fastest growing occupations in the US in 2019 were solar PV installers and wind turbine service technician. The Interstate Renewable Energy Council estimates that to reach Biden's target of 100% renewable energy by 2035, the industry will need to employ three times the number of workers employed in 2020.

This code proposal change is based on approved ASHRAE addenda by, ck, and cp to Standard 90.1-2019 which will be published in ASHRAE Standard 90.1-2022 and a recent technical brief developed by PNNL in support of further revisions to 90.1. Proposed definitions clarify renewable energy requirements for community renewable energy facility, financial renewable power purchase agreement, physical power purchase agreement and renewable energy credits. The proposal more closely aligns these definitions with language under consideration both in ASHRAE Standard 228P, The Standard Method of Evaluating Zero Energy Building Performance, and in ASHRAE Standard 189.1, which will be the basis of the 2024 IgCC.

The addenda establishes a prescriptive requirement for onsite renewable energy of 1.5W/s.f. of the three largest floors of all commercial buildings. The size of the required on-site renewable energy will supply on average 30% of building energy use. The recent technical brief from PNNL indicates there is enough roof space to meet this requirement for the vast majority of commercial buildings. If there is insufficient roof space or substantial shading, building owners are allowed to be exempted from on-site renewable energy requirements if they procure an equivalent amount of renewable energy off-site from a community renewable energy facility, a physical power purchase agreement or a financial power purchase agreement.

The proposal also requires building owners to retain any renewable energy credits (RECS) so that no other individual or organization can claim or take credit for the production from the system (thus preventing double-counting). REC documentation requirements are based on those currently in R406.7.3 of the 2021 IECC and 701.4.1.1.1 of the 2021 IgCC, and revisions pending for ASHRAE Standard 189.1-2023.

Finally, this proposal includes requirements to illustrate raceways used for the renewable energy system in construction documents and revises section C406.5 to prevent double-counting of the minimum renewable energy requirements in section C405.

Bibliography:

Renewables Became the Second-Most Prevalent U.S. Electricity Source in 2020 , U.S. Energy Information Administration, https://www.eia.gov/todayinenergy/detail.php?id=48896.

Fact Sheet: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies, The White House, 22 Apr. 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/.

Why Local Solar For All Costs Less: A New Roadmap for the Lowest Cost Grid, Vibrant Clean Energy, Dec. 2020, www.vibrantcleanenergy.com/wp-content/uploads/2020/12/ https://irecusa.org/wp-content/uploads/2021/07/National-Solar-Jobs-Census-2020-FINAL.pdf. WhyDERs_ES_Final.pdf.

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Richardson, Jake. *Solar and Wind Tech Are the Fastest Growing Jobs in US*, Red, Green, and Blue, 28 Jan. 2019, http://redgreenandblue.org/2019/01/27/solar-wind-tech-fastest-growing-jobs-us/.

ANSI/ASHRAE/IES Addendum by, ck, and cp to ANSI/ASHRAE/IES Standards 90.1-2019, ASHRAE Standards Committee, 31 July 2020,
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_by

Cost Impact:

The code change proposal will increase the cost of construction.

This proposed code change will increase cost of construction for commercial buildings following the prescriptive pathway of the 2021 IECC. The following table lists the required size of the photovoltaic array and cost effectiveness of that array under this proposed code amendment for a set of prototype commercial buildings following the prescriptive pathway. Analysis of the approximate total installed costs for these photovoltaic system is estimated at $2.20/W based on analysis by NBI and partners. The annual energy cost savings in the first year of production are based on electricity generation from NREL's PVWatts tool in Minneapolis (which has below average solar radiation compared with the majority of the U.S.) and average U.S. electricity rates according to the U.S. EIA. The analysis indicates that this requirement would result in a payback time that is far less than the system lifetime.

Building Type	PV System Size (kW)	PV Cost/s.f.	Energy Savings (kWh)	Annual Energy Cost Savings	Simple Payback Period (yrs)
Small Office (5,500 s.f., 1 floor)	24.8	$9.9	32,958	$3,737	14.6
Medium Office(53,630 s.f., 3 floors)	80.4	$3.3	106,847	$12,116	14.6
Mid-Rise Apartment (33,740 s.f., 4 floors)	38.0	$2.5	50,500	$6,994	11.9
High-Rise Apartment (84,360 s.f., 10 floors)	38.0	$1.0	50,500	$6,994	11.9

CEPI-5-21

CEPI-7-21

IECC®: C103.2, C105.2.5, C405.15 (New), C405.15.1 (New)

Proponents:

Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Amber Wood, representing ACEEE (awood@aceee.org)

2021 International Energy Conservation Code

Revise as follows:
C103.2 Information on construction documents.

Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Economizer description.
8. Equipment and system controls.
9. Fan motor horsepower (hp) and controls.
10. Duct sealing, duct and pipe insulation and location.
11. Lighting fixture schedule with wattage and control narrative.
12. Location of *daylight* zones on floor plans.
13. Air barrier and air sealing details, including the location of the air barrier.

14. Location of pathways for routing of raceways or cable from the renewable energy system to the electrical service panel and electrical energy storage system area.

15. Location and layout of a designated area for electrical energy storage system.

C105.2.5 Electrical system.
Inspections shall verify lighting system controls, components and meters as required by the code, *approved* plans and specifications. Where an electrical energy storage system area is required, inspections shall verify space availability and pathways to electrical service.
Add new text as follows:
C405.15 Energy storage infrastructure.

Each building site shall be provided with a location for on-site energy storage not less than 2 feet (610 mm) in one dimension and 4 feet (1219 mm) in another dimension and located in accordance with Section 1207 of the International Fire Code and Section 110.26 of the NFPA 70.

Exception: Where an onsite electrical energy system storage system is installed.

C405.15.1 Electrical service reserved space.

The main electrical service panel shall have a reserved space to allow installation of a two-pole circuit breaker for future electrical energy storage system installation This space shall be labeled “For Future Electric Storage.” The reserved spaces shall be positioned at the end of the panel that is opposite from the panel supply conductor connection.

Reason Statement:

Energy storage will soon become critical to achieving President Biden’s goal of a carbon-free power sector by 2035. These systems could also bolster economy, present a cost savings opportunity for homeowners and increase resilience to power outages. In 2020, 21% of the United State’s electricity is sourced from renewable energy, primarily wind, an intermittent source of energy. As the U.S. increases the amount of electricity generated from renewables, buildings must be prepared to aid in this transition by storing energy to match grid demands.

Policies to encourage energy storage will improve the U.S. economy. Energy storage is expected to grow by over 40% each year until 2025 and the U.S., because of its manufacturing background and experience in battery-storage technology for cars is becoming a clear leader in this market.

Energy storage will also present a cost-saving opportunity. Battery prices have and will likely continue to fall in the United States, meaning that behind-the-meter storage will likely become more accessible and affordable in the short-term. More and more utilities are moving beyond voluntary programs and are expanding use of time-of-use rates for electricity as a tool for shaping demand. Ensuring buildings are energy-storage ready now will allow them to cost effectively install storage systems in the future and take advantage of these programs.

Finally, energy storage will improve resilience to power outages. In 2020, DOE found that an average household in the United States goes without power for 8 hours in a year. Because of extreme weather events caused by climate change, those outages are increasing. These outages are estimated to cost the U.S. economy between $25 billion to $70 billion annually. Requiring buildings to be storage-ready will ensure communities are more resilient by allowing buildings to cost effectively install storage which can operate for a short-period of time without relying on the electricity grid.

Bibliography:

Renewables Became the Second-Most Prevalent U.S. Electricity Source in 2020 , U.S. Energy Information Administration, https://www.eia.gov/todayinenergy/detail.php?id=48896.

Fact Sheet: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies, The White House, 22 Apr. 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/.

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Campbell, Richard. Weather-Related Power Outages and Electric System Resiliency, 28 Aug. 2012, https://sgp.fas.org/crs/misc/R42696.pdf.

Economic Benefits of Increasing Electric Grid Resilience to Weather Outages, U.S. Department of Energy and President's Council of Economic Advisors, Aug. 2013, https://www.energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Analysis completed by NBI using RSMeans showed no incremental costs for this measure.

CEPI-7-21

CEPI-8-21 Part I

IECC®: SECTION C104, C104.1, C104.2, C104.3 (New), C104.3, C104.4, C104.5

Proponents:

Mike Nugent, representing Building Code Action Committee (bcac@iccsafe.org); David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

SECTION C104 FEES
Revise as follows:
C104.1 Payment of Fees.

A permit shall not be ~~issued~~ valid until the fees prescribed ~~in Section C104.2~~ by law have been paid. ~~, nor~~ Nor shall an amendment to a permit be released until the additional fee, if any, has been paid.

C104.2 Schedule of permit fees.

~~A~~ Where a permit is required, a fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.

Add new text as follows:
C104.3 Permit valuation.

The applicant for a permit shall provide an estimated value of the work for which the permit is being issued at the time of application. Such estimated valuations shall include the total value of the work, including materials and labor. Where, in the opinion of the code official, the valuation is underestimated, the permit shall be denied, unless the applicant can show detailed estimates acceptable to the code official. The final valuation shall be *approved* by the code official.

Revise as follows:
~~C104.3~~ C104.4 Work commencing before permit issuance.
Any person who commences any work before obtaining the necessary permits shall be subject to ~~an additional~~ a fee established by the *code official* that shall be in addition to the required permit fees.
~~C104.4~~ C104.5 Related fees.
The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.
~~C104.5~~ C104.6 Refunds.
The *code official* is authorized to establish a refund policy.
CEPI-8-21 Part I

CEPI-8-21 Part II

IECC®: SECTION R104, R104.1, R104.2, R104.3 (New), R104.3, R104.4, R104.5

Proponents:

Mike Nugent, representing Building Code Action Committee (bcac@iccsafe.org); David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

2021 International Energy Conservation Code

SECTION R104 FEES
Revise as follows:
R104.1 Payment of Fees.
A permit shall not be ~~issued~~ valid until the fees prescribed ~~in Section R104.2~~ by law have been paid. ~~, nor~~ Nor shall an amendment to a permit be released until the additional fee, if any, has been paid.
R104.2 Schedule of permit fees.
Where a permit is required, a fee for each permit shall be paid as required, in accordance with the schedule as established by the applicable governing authority.
Add new text as follows:
R104.3 Permit valuations.
The applicant for a permit shall provide an estimated value of the work for which the permit is being issued at the time of application. Such estimated valuations shall include the total value of the work, including materials and labor. Where, in the opinion of the code official, the valuation is underestimated, the permit shall be denied, unless the applicant can show detailed estimates acceptable to the code official. The final valuation shall be *approved* by the code official.
Revise as follows:
~~R104.3~~ R104.4 Work commencing before permit issuance.
Any person who commences any work before obtaining the necessary permits shall be subject to ~~an additional~~ a fee established by the *code official* that shall be in addition to the required permit fees.
~~R104.4~~ R104.5 Related fees.

The payment of the fee for the construction, *alteration*, removal or demolition of work done in connection to or concurrently with the work or activity authorized by a permit shall not relieve the applicant or holder of the permit from the payment of other fees that are prescribed by law.

~~R104.5~~ R104.6 Refunds.

The *code official* is authorized to establish a refund policy.

Reason Statement:

The intent is consistency in language for ‘Fees’ within the codes.

- Payment of fees – consistent title, always two sentences
- Schedule of permit fees – Not all projects require a fee - Commercial and Residential are currently different in this section.
- Permit valuation: This lets the jurisdiction establish fees for permits.
- Work commencing before permit issuance – remove redundant language
- Refunds – no change

The BCAC is working from the philosophy that ICC is a family of codes, so administrative requirements should be consistent across books. Most administrative and enforcement matters are the same for any code. Those matters unique for a specific code remain unchanged. This is one of a series of proposals being submitted relating to technical, editorial and organizational changes proposed for the Administrative chapters (Chapter 1) in all of the I-Codes.

This proposal is submitted by the ICC Building Code Action Committee (BCAC) and the ICC Sustainable and Energy and High Performance Code Action Committee (SEHPCAC).

BCAC was established by the ICC Board of Directors in July 2011 to pursue opportunities to improve and enhance assigned International Codes or portions thereof. In 2020 and 2021 the BCAC has held several virtual meetings open to any interested party. In addition, there were numerous virtual Working Group meetings for the current code development cycle, which included members of the committee as well as interested parties. Related documents and reports are posted on the ICC website at https://www.iccsafe.org/codes-tech-support/codes/codedevelopment-process/building-code-actioncommittee-bcac.

The SEHPCAC was established by the ICC Board of Directors to pursue opportunities to improve and enhance International Codes with regard to sustainability, energy and high performance as it relates to the built environment included, but not limited to, how these criteria relate to the International Green Construction Code (IgCC) and the International Energy Conservation Code (IECC). In 2018-2019, the SEHPCAC has held five two- or three-day open meetings and numerous workgroup calls, to discuss and debate proposed changes and public comments. Attendees at the meetings and calls included members of the SEHPCAC as well as any interested parties. Related documentation and reports are posted on the SEHPCAC website at http://www.iccsafe.org/cs/SEHPCAC/Pages/default.aspx.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is an administrative allowance for a building department. This will not change any construction requirements.

CEPI-8-21 Part II

CEPI-9-21

IECC®: SECTION 202 (New), C403.7.5

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 DEMAND CONTROL KITCHEN VENTILATION (DCKV). A system that provides automatic, continuous control over exhaust hood and make-up air fan speed in response to temperature, optical, or infrared (IR) sensors that monitor cooking activity or through direct communication with cooking appliances.
Revise as follows:
C403.7.5 Kitchen exhaust systems.

Replacement air introduced directly into the exhaust hood cavity shall not be greater than 10 percent of the hood exhaust airflow rate. Conditioned supply air delivered to any space shall not exceed the greater of the following:

1. The ventilation rate required to meet the space heating or cooling load.
2. The hood exhaust flow minus the available transfer air from adjacent space where available transfer air is considered to be that portion of outdoor ventilation air not required to satisfy other exhaust needs, such as restrooms, and not required to maintain pressurization of adjacent spaces.

Kitchen exhaust hood systems serving Type I exhaust hoods shall be provided with demand control kitchen ventilation (DCKV) controls w~~W~~here a kitchen or kitchen/dining facility has a total Type I kitchen hood exhaust airflow rate ~~is~~ greater than 5,000 cfm (2360 L/s).~~,~~DCKV systems shall be configured to provide a minimum of 50 percent reduction in exhaust and replacement air system airflow rates. Systems shall include controls necessary to modulate exhaust and replacement air system airflows in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle operation. ~~e~~Each hood shall be a factory-built commercial exhaust hood listed by a nationally recognized testing laboratory ~~in compliance with UL 710. Each hood~~ and shall have a maximum exhaust rate as specified in Table C403.7.5. ~~and shall comply with one of the following:~~

~~1. Not less than 50 percent of all replacement air shall be transfer air that would otherwise be exhausted.~~

~~2. Demand ventilation systems on not less than 75 percent of the exhaust air that are configured to provide not less than a 50-percent reduction in exhaust and replacement air system airflow rates, including controls necessary to modulate airflow in response to appliance operation and to maintain full capture and containment of smoke, effluent and combustion products during cooking and idle.~~

~~3. Listed energy recovery devices with a sensible heat recovery effectiveness of not less than 40 percent on not less than 50 percent of the total exhaust airflow.~~

Where a single hood, or hood section, is installed over appliances with different duty ratings, the maximum allowable flow rate for the hood or hood section shall be based on the requirements for the highest appliance duty rating under the hood or hood section.

~~Exception~~ Exceptions: ~~Where not less than 75 percent of all the replacement air is transfer air that would otherwise be exhausted.~~

1. UL 710 listed exhaust hoods that have a design maximum exhaust flow rate no greater than 250 cfm per linear foot of hood that serve kitchen or kitchen/dining facilities with a total kitchen hood exhaust airflow rate less than 5000 cfm (2360 L/s).
2. An energy recovery device is installed on the kitchen exhaust with a sensible heat recovery effectiveness of not less than 40 percent on not less than 50 percent of the total exhaust hood airflow.

Reason Statement:

Demand control kitchen ventilation has been commonplace on make-up air hoods for years and has appeared in the IECC since 2015. This proposal clarifies the section by relocating several nested requirements to the charging language and mandating DCKV on hoods of 5000 cfm or greater unless they have an energy recovery device, or are UL-710 hoods with a maximum 250 cfm/lf flowrate or below the 5,000 cfm threshold.

This cleans up the section to make it clearer that DCKV is required on most kitchen exhaust hoods and moves less common compliance paths (such as heat recovery and UL 710 listed hoods) to exceptions rather than in the charging language making this provision easier to understand. It also removes the transfer air requirement which is not common on systems above this size threshold to utilize in real world applications.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Because the threshold for which this applies remains the same for kitchens with a total exhaust airflow of 5,000 cfm there is no expectation that costs will increase. Prior analysis for adding variable speed fans and associated controls have shown an incremental cost of $11,500 regardless of hood size. The 5,000cfm threshold was chosen as the cost-effective breakpoint given the cost and is not changing as part of this proposal.

CEPI-9-21

CEPI-10-21

IECC®: SECTION 202 (New), C405.13 (New), TABLE C405.13 (New), ANSI Chapter 06 (New)

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 ALTERNATING CURRENT-OUTPUT UNINTERRUPTIBLE POWER SUPPLY (AC-OUTPUT UPS). A combination of convertors switches, and energy storage devices, such as batteries, constituting a power system for maintaining continuity of load power in case of input power failure. Input power failure occurs when voltage and frequency are outside rated steady state and transient tolerance bands or when distortion or interruptions are outside the limits specified for the uninterruptible power supply. An AC-output UPS is an uninterruptible power supply that supplies power with a continuous flow of electric charge that periodically reverses direction.
Add new text as follows:
C405.13 Alternating Current-Output Uninterruptible Power Supplies (AC-output UPS).

AC-output UPS systems serving a *computer room* shall meet or exceed minimum average efficiencies listed in Table C405.13 when tested in accordance with ENERGY STAR Program Requirements for Uninterruptible Power Supplies (UPSs) test method.

Where:

P is the rated output power in watts (W).

E_{MOD} is an allowance of 0.004 for modular UPSs applicable in commercial 1,500-10,000 W range.

In is the natural logarithm

Exception: AC-output UPS that utilizes standardized NEMA 1-15P or NEMA 5-15P input plug, as specified in ANSI/NEMA WD-6-2016.

TABLE C405.13 ALTERNATING CURRENT-OUTPUT UNINTERRUPTIBLE POWER SUPPLY MINIMUM AVERAGE EFFICIENCY

	Voltage and Frequency Dependent	Voltage Independent	Voltage and Frequency Independent
P<350 W	5.71 x 10-5 x P + 0.962	5.71 x 10-5 x P + 0.964	0.011 x In(P) + 0.824
350 W<P<1,500 W	0.982	0.984	0.011 x In(P) + 0.824
1,500 W<P<10,000 W	0.981 - E_{MOD}	0.980 - E_{MOD}	0.0145 x In(P) +0.800 - E_{MOD}
P>10,000 W	0.970	0.940	0.0058 x In(P) + 0.886

Add new standard(s) as follows:
ANSI American National Standards Institute 25 West 43rd Street, 4th Floor New York NY 10036

WD-6-2016	Wiring Devices - Dimensional Specifications Table C405.13

Attached Files

- **ENERGY STAR Uninterruptible Power Supplies Test Method.pdf**
  http://localhost/proposal/66/635/files/download/12/
- **IECC 2024 Proposal Support-UPS.docx**
  http://localhost/proposal/66/635/files/download/11/

Reason Statement:

There are no standards for Uninterruptible Power Supply (UPS) systems in computer rooms like there are for Data Centers. This code proposal introduces minimum UPS efficiency aligned with efficient levels found in the market. This code provision was included in the 2022 Title 24 updates as well as the 2021 Washington State Energy Code (WSEC). A UPS with a NEMA 1-15P or NEMA 5-15P plug are exempt from this requirement because minimum standards for these devices are already covered by DOE.

Bibliography:

ENERGY STAR Program Requirements for Uninterruptible Power Supplies (UPSs) Test Method - Rev. Dec-2017

Cost Impact:

The code change proposal will increase the cost of construction.

Incremental costs were found to be $112/kW for high efficiency UPS systems, and were converted to $/sqft based on a 500sqft room (the threshold for which a computer room does not qualify as a data center). Costs were found to be estimated at $0.22/sqft and detailed cost information obtained through Final CASE report for 2022 Title 24 attached to this proposal and accessed publicly here: https://title24stakeholders.com/wpcontent/uploads/2021/03/NR-Computer-Room-Efficiency-Final-CASE-Report_Statewide-CASE-Team_updated.pdf

CEPI-10-21

CEPI-11-21 Part I

IECC®: CHAPTER 2 [CE], SECTION C202, SECTION 202 (New)

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, National Roofing Contractors Association, representing National Roofing Contractors Association (mgraham@nrca.net)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

CHAPTER 2 [CE] DEFINITIONS

SECTION C202 GENERAL DEFINITIONS
Add new definition as follows:
C202 ATTIC. The space above the ceiling framing of the top story and to the underside of a roof deck having a slope not less than two units vertical in 12 units horizontal (16.6-percent slope).

Reason Statement:

The term "attic" is used in the IECC without a specific definition. NRCA has seen various interpretations of the term in the context of the IECC and is offering this code change proposal to achieve consistent interpretation and implementation in attic-related provisions of the IECC. The definition(s) proposed here is based on those already contained in the IBC and IRC and includes a minimum roof slope for the roof deck that is consistent with provisions for steep-slope roof systems (e.g., asphalt shingles) in the IBC and IRC.

For utility:

[IRC] ROOF DECK. The flat or sloped surface not including its supporting members or vertical supports.

[IBC] ROOF DECK. The flat or sloped surface constructed on top of the exterior walls of a building or other supports for the purpose of enclosing the story below, or sheltering an area, to protect it from the elements, not including its supporting members or vertical supports.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will neither increase nor decrease the cost of construction.

CEPI-11-21 Part I

CEPI-11-21 Part II

IECC®: CHAPTER 2 [RE], SECTION R201, SECTION 202 (New)

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

CHAPTER 2 [RE] DEFINITIONS

SECTION R201 GENERAL
Add new definition as follows:
<u>C202</u> <u>ATTIC</u>. <u>The unfinished space above the ceiling framing of the top story and to the underside of a roof deck having a slope not less than two units vertical in 12 units horizontal (16.6-percent slope).</u>
<u>C202</u> <u>ATTIC, HABITABLE</u>. <u>The finished or unfinished *habitable space* within an *attic*.</u>

Reason Statement:

The term "attic" is used in the IECC without a specific definition. NRCA has seen various interpretations of the term in the context of the IECC and is offering this code change proposal to achieve consistent interpretation and implementation in attic-related provisions of the IECC. The definition(s) proposed here is based on those already contained in the IBC and IRC and includes a minimum roof slope for the roof deck that is consistent with provisions for steep-slope roof systems (e.g., asphalt shingles) in the IBC and IRC.

For utility:

[IRC] ROOF DECK. The flat or sloped surface not including its supporting members or vertical supports.

[IBC] ROOF DECK. The flat or sloped surface constructed on top of the exterior walls of a building or other supports for the purpose of enclosing the story below, or sheltering an area, to protect it from the elements, not including its supporting members or vertical supports.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will neither increase nor decrease the cost of construction.

CEPI-11-21 Part II

CEPI-12-21 Part I

IECC®: SECTION 202, SECTION 202 (New)

Proponents:

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE. SEE THE TENTATIVE HEARING ORDER FOR THESE COMMITTEES.
THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Delete without substitution:
~~IECC2021P1E_CE_Ch02_SecC202_DefBIOMASS BIOMASS~~. ~~Nonfossilized and biodegradable organic material originating from plants, animals and/or microorganisms, including products, by-products, residues and waste from agriculture, forestry and related industries as well as the nonfossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of nonfossilized and biodegradable organic material.~~

Add new definition as follows:
C202 BIOMASS WASTE. Organic non-fossil material of biological origin that is a byproduct or a discarded product. Biomass waste includes municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural crop byproducts, straw, and other biomass solids, liquids, and biogases; but excludes wood and wood-derived fuels (including black liquor), biofuel, feedstock, biodiesel, and fuel ethanol.

Revise as follows:
IECC2021P1E_CE_Ch02_SecC202_DefRENEWABLE_ENERGY_RESOURCES RENEWABLE ENERGY RESOURCES. Energy derived from solar radiation, wind, waves, tides~~, landfill gas, biogas, biomass~~*biomasswaste* or extracted from hot fluid or steam heated within the earth.

Reason Statement:

The existing definition for biomass in the IECC dates to the 2012 IECC. It was proposed by the team of New Buildings Institute, US Department of Energy and American Institute of Architects. It was one clause in a comprehensive overhaul of the 2009 IECC. When it was written in 2010, it was the first time that renewable energy had been defined in an I-code, and it reflected a very early understanding of a much less mature industry. It has not been significantly revised since.

This proposal updates the language by further refining biomass energy sources with terms that were not available at the time it was drafted in 2010. The revision also limits the biomass sources that count as renewable energy resources to those that are specified as waste products. There are many flavors of biomass energy, but this proposal ensures that virgin material of unknown origin does not count as a renewable energy resource, which in the provisions of C406 is a trade-off for energy efficiency features of the building. Without an available standard to cite in the IECC for sustainable biomass, it is critical to ensure that biomass used in compliance with the IECC is derived from waste products or byproducts. The definition of *biomass waste* is from the glossary of the Energy Information Administration. A similar amendment has been submitted to amend the residential IECC to ensure the definition of renewable energy resources is consistent between the two codes.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal clarifies the definition of renewable energy and will have no impact on construction costs.

CEPI-12-21 Part I

CEPI-12-21 Part II

IECC®: SECTION 202 (New), SECTION 202

Proponents:

Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 BIOMASS WASTE.

Organic non-fossil material of biological origin that is a byproduct or a discarded product. Biomass waste includes municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural crop byproducts, straw, and other biomass solids, liquids, and biogases; but excludes wood and wood-derived fuels (including black liquor), biofuel, feedstock, biodiesel, and fuel ethanol.

Revise as follows:
IECC2021P1E_RE_Ch02_SecR202_DefRENEWABLE_ENERGY_RESOURCES RENEWABLE ENERGY RESOURCES. Energy derived from solar radiation, wind, waves, tides~~, landfill gas, biogas, biomass~~*biomass waste* or extracted from hot fluid or steam heated within the earth.

Reason Statement:

There is currently no definition for biomass in the residential IECC even though biomass was recently listed as a potential renewable energy resource. Because there are many flavors of biomass, it is important for the IECC to clarify which forms of biomass energy count towards reducing a residential buildings' ERI score. The revision limits the biomass sources that count as renewable energy resources to those that are specified as waste products and ensures that virgin material of unknown origin does not count as a steady source of renewable energy. Without an available standard to cite in the IECC for sustainable biomass, it is critical to ensure that biomass used in compliance with the IECC is derived from waste products or byproducts. The definition of *biomass waste* is taken from the glossary of the Energy Information Administration. A similar amendment has been submitted to the commercial IECC to ensure the definition of renewable energy resources is consistent between the two codes.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal clarifies the definition of renewable energy and will have no impact on construction costs.

CEPI-12-21 Part II

CEPI-13-21 Part I

IECC®: SECTION 202

Proponents:

Robert DeVries, representing Self (rdevries@nuwool.com)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

IECC2021P1E_CE_Ch02_SecC202_DefCONDITIONED_SPACE CONDITIONED SPACE. An area, room or space that is enclosed within the *building thermal envelope,* <u>but not within</u> and is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.
CEPI-13-21 Part I

CEPI-13-21 Part II

IECC®: SECTION 202

Proponents:

Robert DeVries, representing Self (rdevries@nuwool.com)

2021 International Energy Conservation Code

Revise as follows:
IECC2021P1E_RE_Ch02_SecR202_DefCONDITIONED_SPACE CONDITIONED SPACE. An area, room or space that is enclosed within the *building thermal envelope* but not within and that is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ducts, piping or other sources of heating or cooling.

Reason Statement:

The addition of *not within* removes an ambiguity as to what is considered in the conditioned space. As it is now one could, for example, argue that a duct in an exterior wall is actually IN conditioned space. This change eliminates that.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposal is a clarification only

CEPI-13-21 Part II

CEPI-14-21

IECC®: SECTION 202 (New)

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 DEDICATED OUTDOOR AIR SYSTEM (DOAS).

A ventilation system that supplies 100 percent outdoor air primarily for the purpose of ventilation and that is a separate system from the zone space-conditioning system.

C202 DX-DEDICATED OUTDOOR AIR SYSTEM UNITS (DX-DOAS UNITS). A type of air-cooled, water-cooled or water source factory assembled product that dehumidifies 100 percent outdoor air to a low dew point and includes reheat that is capable of controlling the supply dry-bulb temperature of the dehumidified air to the designated supply air temperature. This conditioned outdoor air is then delivered directly or indirectly to the conditioned spaces. It may precondition outdoor air by containing an enthalpy wheel, sensible wheel, desiccant wheel, plate heat exchanger, heat pipes, or other heat or mass transfer apparatus.

Reason Statement:

Both DOAS and DX-DOAS terms are used in the IECC (in C403 and C406) but do not have definitions explaining what they are. These definitions are added to provide clarity when talking about DOAS and are coped from common definitions used in ASHRAE 90.1, the WA State Energy Code, and Title 24.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

These are simply definitions to clarify DOAS types and do nothing to impact cost.

CEPI-14-21

CEPI-15-21 Part I

IECC®: SECTION 202 (New)

Proponents:

Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

THIS IS A 3 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II AND PART III WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Add new definition as follows:

C202 EMITTANCE. The ratio of the radiant heat flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

CEPI-15-21 Part I

CEPI-15-21 Part II

IECC®: SECTION 202 (New)

Proponents:

Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Add new definition as follows:
R202

EMITTANCE

.

The ratio of the radiant heat flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

CEPI-15-21 Part II

CEPI-15-21 Part III

IRC: N1101.6, SECTION 202 (New)

Proponents:

Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

2021 International Residential Code

N1101.6 Defined terms.
The following words and terms shall, for the purposes of this chapter, have the meanings shown herein.
Add new definition as follows:
[RE] 202 EMITTANCE. The ratio of the radiant heat flux emitted by a specimen to that emitted by a blackbody at the same temperature and under the same conditions.

Reason Statement:

This definition is needed because the term emittance is used in various sections of the code and in the definition for radiant barrier and reflective insulation. It is consistent with the definition found in the 2021 IBC, ASHRAE and ASTM standards. The term emittance is used in numerous sections of this code including for: Building Envelope Requirements, Equipment Buildings, Roof Solar Reflectance and Thermal Emittance, Minimum Roof Reflectance and Emittance Options, Specifications for the Standard Reference and Proposed Designs, Roofs, and for Specifications for the Standard Reference and Proposed Designs, Walls above-grade.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Adding a definition of EMITTANCE will neither increase or decrease construction costs. This is only a definition and is identical to the definition found in the 2021 IBC and existing ASHRAE and ASTM standards.

CEPI-15-21 Part III

CEPI-16-21 Part I

IECC®: SECTION 202, IECC2021P1E_CE_Ch02_SecC202_DefFENESTRATION

Proponents:

David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

IECC2021P1E_CE_Ch02_SecC202_DefFENESTRATION FENESTRATION. Products classified as either skylights or vertical fenestration.

Skylights. Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal, including unit skylights, tubular daylighting devices and glazing materials in solariums, sunrooms, roofs, greenhouses and sloped walls.

Revise as follows:

Vertical fenestration. Windows that are fixed or operable, ~~opaque doors, glazed~~ doors that are more than half glazed, glazed block and combination opaque and glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of not less than 60 degrees (1.05 rad) from horizontal.

CEPI-16-21 Part I

CEPI-16-21 Part II

IECC®: SECTION 202, TABLE R402.1.2, R402.3, R402.5

Proponents:

David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:
IECC2021P1E_RE_Ch02_SecR202_DefFENESTRATION FENESTRATION. Products classified as either *vertical fenestration* or *skylights.*

Skylights. Glass or other transparent or translucent glazing material installed at a slope of less than 60 degrees (1.05 rad) from horizontal including unit skylights, tubular daylighting devices, and glazing materials in solariums, sunrooms, roofs and sloped walls.

Vertical fenestration. Windows that are fixed or ~~operable, opaque doors, glazed~~ doors that are more than half glazed, glazed block and combination opaque/glazed doors composed of glass or other transparent or translucent glazing materials and installed at a slope of not less than 60 degrees (1.05 rad) from horizontal.

TABLE R402.1.2 MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION & OPAQUE DOORS *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]	CEILING *U*-FACTOR	WOOD FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
0	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
1	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.25	0.026	0.084	0.165	0.064	0.360	0.477
3	0.30	0.55	0.25	0.026	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.30	0.55	0.40	0.024	0.045	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.40	0.024	0.045	0.082	0.033	0.050	0.055
6	0.30	0.55	NR	0.024	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	NR	0.024	0.045	0.057	0.028	0.050	0.055

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

f. 1. Above 4,000 feet in elevation above sea level, or

2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

R402.3 Fenestration.

In addition to the requirements of Section R402, fenestration and opaque doors shall comply with Sections R402.3.1 through R402.3.5.

R402.5 Maximum fenestration U-factor and SHGC.

The maximum area-weighted average ~~maximum~~vertical fenestration, skylights, and opaque door *U*-factors permitted in Climate Zones 4 through 8 using tradeoffs from Section R402.1.5 or R405 shall be ~~0.48 in Climate Zones 4 and 5 and 0.40 in Climate Zones 6 through 8 for vertical fenestration, and 0.75 in Climate Zones 4 through 8 for skylights. The area-weighted average maximum fenestration SHGC permitted using tradeoffs from Section R405 in *Climate Zones* 0 through 3 shall be 0.40.~~as follows:

1. 0.48 in Climate Zones 4 and 5 for vertical fenestration and opaque doors.
2. 0.40 in Climate Zones 6 through 8 for vertical fenestration and opaque doors.
3. 0.75 in Climate Zones 4 through 8 for skylights.

Exception: The maximum *U*-factor and solar heat gain coefficient (SHGC) for fenestration shall not be required in storm shelters complying with ICC 500.

Reason Statement:

· **Revise the definition of vertical fenestration** in the IECC to resolve a conflict between the IECC and ASHRAE 90.1. By making this change, only doors that are more than one half glazed will be defined as fenestrations in both the IECC and ASHRAE 90.1. thereby clarifying the application of the IECC by more clearly stating that doors that are more than half glazed are included in the definition of vertical glazing. Having technically synonymous definitions will facilitate consistency of requirements going forward and help avoid confusion for designers who work with both the standard and the code.

· **Revise Sec. R402.3** to clarify that opaque doors (by definition *"A door that is not less than 50-percent opaque in surface area*") must meet the fenestration requirements. Since opaque doors are currently included in the definition of fenestration, this represents no technical change.

· **Re-format Sec. R402.**5 for ease of reading and to clearly state that opaque doors must comply with maximum fenestration U-factor limitations when using weighted averages for envelope compliance. Since opaque doors are currently included in the definition of fenestration, this represents no technical change.

· **Re-title the "fenestration" column of Table R402.1.2** to include opaque doors. Since opaque doors are currently included in the definition of fenestration, this represents no technical change.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

None; no technical change to the requirements is proposed.

CEPI-16-21 Part II

CEPI-17-21 Part I

IECC®: SECTION 202

Proponents:

Marcin Pazera, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org); Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

IECC2021P1E_CE_Ch02_SecC202_DefROOF_REPLACEMENT ROOF REPLACEMENT. ~~The process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.~~An alteration that includes the removal of all existing layers of *roof assembly* materials down to the roof deck and installing replacement materials above the existing roof deck.
CEPI-17-21 Part I

CEPI-17-21 Part II

IECC®: SECTION 202

Proponents:

Marcin Pazera, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org); Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org)

2021 International Energy Conservation Code

Revise as follows:
IECC2021P1E_RE_Ch02_SecR202_DefROOF_REPLACEMENT ROOF REPLACEMENT. ~~The process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.~~ An alteration that includes the removal of all existing layers of *roof assembly* materials down to the roof deck and installing replacement materials above the existing roof deck.

Reason Statement:

This proposal revises the definition for roof replacement to reflect the intent and the scope of the roof replacement activity that takes place, which includes removal of all existing materials installed above the roof deck, removing those materials down to the roof deck, and installing a new roof assembly above the roof deck. The definition more explicitly states that roof replacement is an alteration as indicated in Section C503 of the IECC. The revised language in the definition more appropriately aligns with the requirements in Chapter 15 (Section 1512) of the IBC. The term “roof assembly” is already defined in the IECC and in the IBC (for use in Chapter 15). Furthermore, PIMA will submit a code change proposal for the Group B development cycle to explicitly reflect that existing roof insulation that is in good repair may be reused as part of a roof replacement (Section 1512.4).

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal will have no impact on the cost of construction. The proposal does not impose new requirements.

CEPI-17-21 Part II

CEPI-18-21

IECC®: SECTION C301, C301.1, FIGURE C301.1, TABLE C301.1, C301.2, C301.3, TABLE C301.3, C301.4

Proponents: Craig Conner, representing self (craig.conner@mac.com)

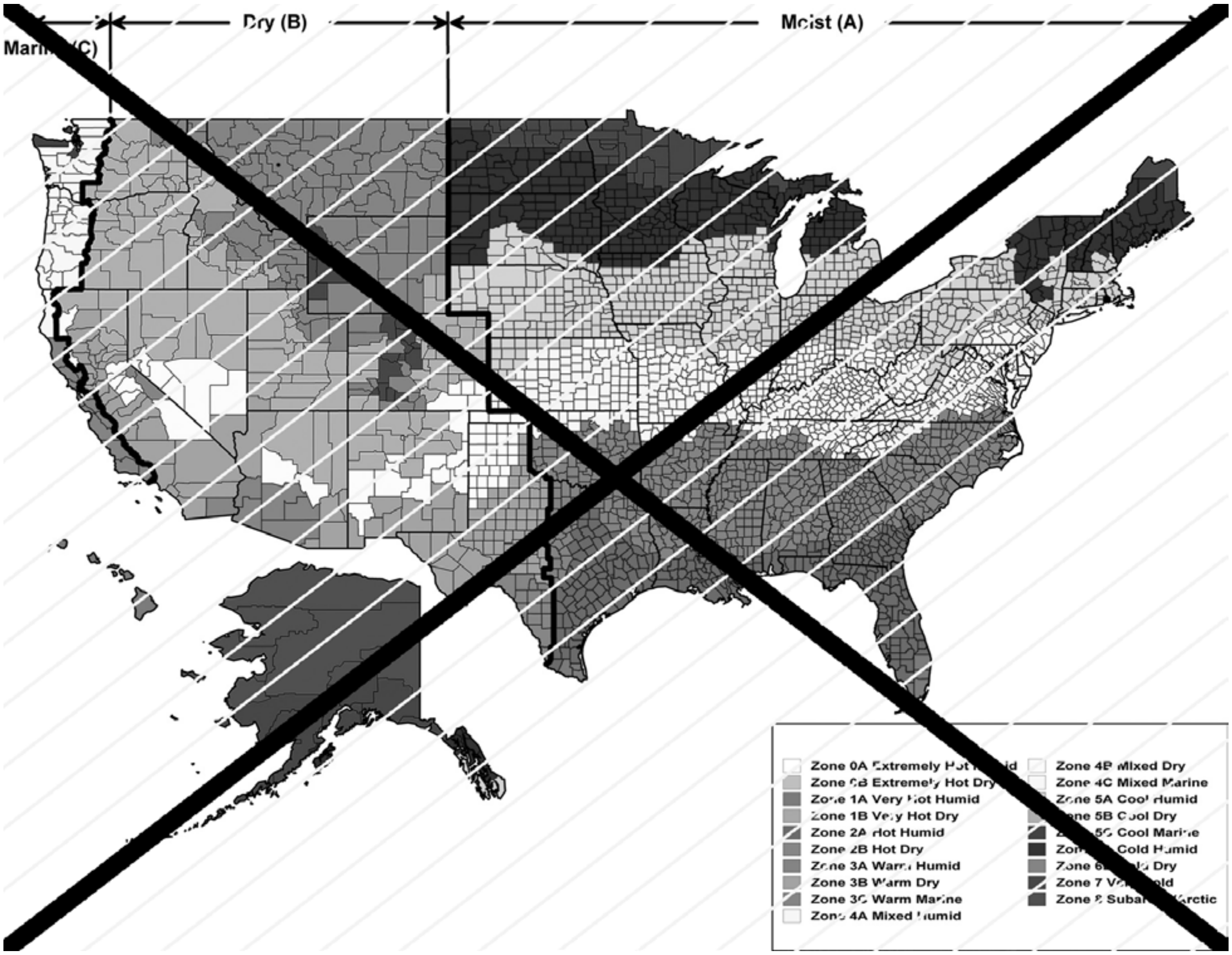
2021 International Energy Conservation Code

Revise as follows:

SECTION C301
CLIMATE ZONES

C301.1 General. *Climate zones shall* be as specified in R301. ~~from Figure C301.1 or Table C301.1 shall be used for determining the applicable requirements from Chapter 4. Locations not indicated in Table C301.1 shall be assigned a *climate zone* in accordance with Section C301.3~~.

Delete without substitution:



~~FIGURE C301.1~~
~~CLIMATE ZONES~~

~~TABLE C301.1~~
~~CLIMATE ZONES, MOISTURE REGIMES, AND WARM HUMID DESIGNATIONS BY STATE, COUNTY AND TERRITORY~~~~[a]~~

~~a. Key: A — Moist, B — Dry, C — Marine. Absence of moisture designation indicates moisture regime is irrelevant. Asterisk (*) indicates a Warm Humid location.~~

Delete without substitution:

~~C301.2 Warm humid counties.~~ ~~In Table C301.1, warm humid counties are identified by an asterisk.~~

~~**C301.3 Climate zone definitions.** To determine the climate zones for locations not listed in this code, use the following information to determine climate zone numbers and letters in accordance with Items 1 through 5.~~

1. ~~Determine the thermal climate zone, 0 through 8, from Table C301.3 using the heating (HDD) and cooling degree-days (CDD) for the location.~~

2. ~~Determine the moisture zone (Marine, Dry or Humid) in accordance with Items 2.1 through 2.3.~~

   ~~2.1. If monthly average temperature and precipitation data are available, use the Marine, Dry and Humid definitions to determine the moisture zone (C, B or A).~~

   ~~2.2. If annual average temperature information (including degree-days) and annual precipitation (i.e., annual mean) are available, use Items 2.2.1 through 2.2.3 to determine the moisture zone. If the moisture zone is not Marine, then use the Dry definition to determine whether Dry or Humid.~~

   ~~2.2.1. If thermal climate zone is 3 and CDD50°F ≤ 4,500 (CDD10°C ≤ 2500), climate zone is Marine (3C).~~

   ~~2.2.2. If thermal climate zone is 4 and CDD50°F ≤ 2,700 (CDD10°C ≤ 1500), climate zone is Marine (4C).~~

   ~~2.2.3. If thermal climate zone is 5 and CDD50°F ≤ 1,800 (CDD10°C ≤ 1000), climate zone is Marine (5C).~~

   ~~2.3. If only degree-day information is available, use Items 2.3.1 through 2.3.3 to determine the moisture zone. If the moisture zone is not Marine, then it is not possible to assign Humid or Dry moisture zone for this location.~~

   ~~2.3.1. If thermal climate zone is 3 and CDD50°F ≤ 4,500 (CDD10°C ≤ 2500), climate zone is Marine (3C).~~

   ~~2.3.2. If thermal climate zone is 4 and CDD50°F ≤ 2,700 (CDD10°C ≤ 1500), climate zone is Marine (4C).~~

   ~~2.3.3. If thermal climate zone is 5 and CDD50°F ≤ 1,800 (CDD10°C ≤ 1000), climate zone is Marine (5C).~~

3. ~~Marine (C) Zone definition: Locations meeting all the criteria in Items 3.1 through 3.4.~~

   ~~3.1. Mean temperature of coldest month between 27°F (-3°C) and 65°F (18°C).~~

   ~~3.2. Warmest month mean < 72°F (22°C).~~

~~3.3. Not fewer than four months with mean temperatures over 50°F (10°C).~~

~~3.4. Dry season in summer. The month with the heaviest precipitation in the cold season has at least three times as much precipitation as the month with the least precipitation in the rest of the year. The cold season is October through March in the Northern Hemisphere and April through September in the Southern Hemisphere.~~

~~4. Dry (B) definition: Locations meeting the criteria in Items 4.1 through 4.4.~~

~~4.1. Not Marine (C).~~

~~4.2. If 70 percent or more of the precipitation, *P*, occurs during the high sun period, defined as April through September in the Northern Hemisphere and October through March in the Southern Hemisphere, then the dry/humid threshold is in accordance with Equation 3-1.~~

$P < 0.44 \times (T - 7)$
$[P < 20.0 \times (T + 14)$ in SI units$]$ **(Equation 3-1)**

where:

~~P~~ = Annual precipitation, inches (mm).
~~T~~ = Annual mean temperature, °F (°C).

~~4.3. If between 30 and 70 percent of the precipitation, *P*, occurs during the high sun period, defined as April through September in the Northern Hemisphere and October through March in the Southern Hemisphere, then the dry/humid threshold is in accordance with Equation 3-2.~~

$P < 0.44 \times (T - 19.5)$
$[P < 20.0 \times (T + 7)$ in SI units$]$ **(Equation 3-2)**

where:

~~P~~ = Annual precipitation, inches (mm).
~~T~~ = Annual mean temperature, °F (°C).

~~4.4. If 30 percent or less of the precipitation, *P*, occurs during the high sun period, defined as April through September in the Northern Hemisphere and October through March in the Southern Hemisphere, then the dry/humid threshold is in accordance with Equation 3-3.~~

$P < 0.44 \times (T - 32)$
$[P < 20.0 \times T$ in SI units$]$ **(Equation 3-3)**

where:

~~*P*~~ = Annual precipitation, inches (mm).
~~*T*~~ = Annual mean temperature, °F (°C).

~~5. Humid (A) definition: Locations that are not Marine (C) or Dry (B).~~

~~TABLE C301.3~~
~~THERMAL CLIMATE ZONE DEFINITIONS~~

~~ZONE NUMBER~~	**~~THERMAL CRITERIA~~**	
	~~IP Units~~	**~~SI Units~~**
~~0~~	~~10,800 < CDD50°F~~	~~6000 < CDD10°C~~
~~1~~	~~9,000 < CDD50°F < 10,800~~	~~5000 < CDD10°C < 6000~~
~~2~~	~~6,300 < CDD50°F ≤ 9,000~~	~~3500 < CDD10°C ≤ 5000~~
~~3~~	~~CDD50°F ≤ 6,300 and HDD65°F ≤ 3,600~~	~~CDD10°C < 3500 and HDD18°C ≤ 2000~~
4	~~CDD50°F ≤ 6,300 and 3600 < HDD65°F ≤ 5,400~~	~~CDD10°C < 3500 and 2000 < HDD18°C ≤ 3000~~
~~5~~	~~CDD50°F < 6,300 and 5,400 < HDD65°F ≤ 7,200~~	~~CDD10°C < 3500 and 3000 < HDD18°C ≤ 4000~~
~~6~~	~~7,200 < HDD65°F ≤ 9,000~~	~~4000 < HDD18°C ≤ 5000~~
~~7~~	~~9,000 < HDD65°F ≤ 12,600~~	~~5000 < HDD18°C ≤ 7000~~
~~8~~	~~12,600 < HDD65°F~~	~~7000 < HDD18°C~~

~~For SI: °C = [(°F) – 32]/1.8.~~

~~C301.4 Tropical climate region.~~ ~~The tropical climate region shall be defined as:~~

~~1. Hawaii, Puerto Rico, Guam, American Samoa, US Virgin Islands, Commonwealth of Northern Mariana Islands; and~~

~~2. Islands in the area between the Tropic of Cancer and the Tropic of Capricorn.~~

Reason: Commercial and Residential climate zones are the same. Creating two large tables with the same values has added unneeded bulk to the code and opens up possibility that the tables will diverge.

Also, the code does not say the residential and commercial tables are the same, which could leave the IECC user to wonder if the two 31 page tables are the same.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

Having one copy of the climate zones in the IECC will not change costs.

CEPI-18-21

CEPI-19-21 Part I

IECC®: C303.1.1, C303.1.2

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

C303.1.1 Building thermal envelope insulation.

An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation 12 inches (305 mm) or greater in width. Alternatively, the insulation installers shall provide a certification listing the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown-in or sprayed fiberglass and cellulose insulation, the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be indicated on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and *R*-value of installed thickness shall be indicated on the certification. For insulated siding, the *R*-value shall be labeled on the product's package and shall be indicated on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

~~**Exception:** For roof insulation installed above the deck, the *R*-value shall be labeled as required by the material standards specified in Table 1508.2 of the *International Building Code*.~~

C303.1.2 Insulation mark installation.

Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection. For insulation materials that are installed without an observable manufacturer's *R*-value mark, such as blown or draped products, an insulation certificate complying with Section C303.1.1 shall be left immediately after installation by the installer, in a conspicuous location within the building, to certify the installed *R*-value of the insulation material.

<u>**Exception:** For roof insulation installed above the deck, the *R-value* shall be labeled as required by the material standards specified in Table 1508.2 of the *International Building Code*.</u>

CEPI-19-21 Part I

CEPI-19-21 Part II

IECC®: R303.1.1, R303.1.2

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:

R303.1.1 Building thermal envelope insulation.

An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation that is 12 inches (305 mm) or greater in width. Alternatively, the insulation installers shall provide a certification that indicates the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown-in or sprayed fiberglass and cellulose insulation, the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be indicated on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and the *R*-value of the installed thickness shall be indicated on the certification. For insulated siding, the *R*-value shall be on a label on the product's package and shall be indicated on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

Exception: For roof insulation installed above the deck, the *R*-value shall be labeled as required by the material standards specified in Table 1508.2 of the *International Building Code* or Table R906.2 of the *International Residential Code*, as applicable.

R303.1.2 Insulation mark installation.

Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable at inspection. For insulation materials that are installed without an observable manufacturer's *R*-value mark, such as blown or draped products, an insulation certificate complying with Section R303.1.1 shall be left immediately after installation by the installer, in a conspicuous location within the building, to certify the installed *R*-value of the insulation material.

Exception: For roof insulation installed above the deck, the *R-value* shall be labeled as required by the material standards specified in Table 1508.2 of the *International Building Code* or Table R906.2 of the *International Residential Code*, as applicable.

Reason Statement:

The National Roofing Contractors Association authored identical exceptions to C303.1.1 and R303.1.1 several cycles ago. Our proposal here, is intent on averting similar confusion relative to field inspection observations. Rigid board insulation intended for above-deck installation is package-labeled. Once the package covering is removed, no permanent marking remains, as these respective sections imply. It is common for inspectors to perform their field inspection duties by collecting or observing unopened or pre-opened packaging materials while on site.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will neither increase nor decrease the cost of construction.

CEPI-19-21 Part II

CEPI-20-21

IECC®: C303.1.3

Proponents:

Helen Sanders, Facade Tectonics Institute/Technoform North America, representing Facade Tectonics Institute

2021 International Energy Conservation Code

Revise as follows:
C303.1.3 Fenestration product rating.

U-factors of fenestration products shall be determined as follows:

1. For windows, doors and skylights, *U*-factor ratings shall be determined in accordance with NFRC 100. <u>For the total performance path, the U-factor modeled in the whole building simulation shall be based on the proposed project size(s) calculated according to NFRC 100. When using the area-weighted average U-factor, U-factors for project specific sizes shall be calculated for all fenestration representing 5% or more of the fenestration area. Physical testing of the project size fenestration to verify U-factor is not required.</u>
2. Where required for garage doors and rolling doors, *U*-factor ratings shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.

U-factors shall be determined by an accredited, independent laboratory, and *labeled* and certified by the manufacturer.

Products lacking such a *labeled U*-factor shall be assigned a default *U*-factor from Table C303.1.3(1) or Table C303.1.3(2). The *solar heat gain coefficient* (SHGC) and *visible transmittance* (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and *labeled* and certified by the manufacturer. Products lacking such a *labeled* SHGC or VT shall be assigned a default SHGC or VT from Table C303.1.3(3). For Tubular Daylighting Devices, VT_{annual} shall be measured and rated in accordance with NFRC 203.

Reason Statement:

The purpose of this submission is to prevent project teams, when using the total performance path (not the prescriptive path), from taking advantage of using U-factors for NFRC standard sizes when using fenestration of smaller size(s) than these NFRC standard sizes in projects. Members of the Façade Tectonics Institute have observed that project teams are already taking advantage of using U-factors calculated for project specific sizes when the fenestration is of a larger size than the NFRC standard size (since this is to their advantage), however, project teams can “play the system” by using U-factors for the NFRC 100 standard size for smaller units.

In addition, the proposed language will help clarify the confusion among design teams on whether to consider NFRC sizes or the project specific size, streamlining the design process. It also clarifies that the project size U-factor shall be calculated according to the NFRC 100 standard and does not require separate physical testing.

The proposal does not change the fact that the NFRC 100 methodology remains the standard, and prescriptive U-factors for fenestration remain based on the standard NFRC size.

Clause C402.4.3.4 Area-weighted U-factor listed below would still allow for using an area-weighted average of the different project size.

We have suggested this section of the code for this clarification to be inserted, but the committee may find a more appropriate place for it. Either way, FTI believes that this loophole should be removed.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal aims to close a loophole and clarifies the way U-factor is defined in the total energy compliance path. There should be no impact in the cost of construction. Some designs may be changed to increase fenestration size (less frame, more glass) in order to improve U-factor to the NFRC 100 value. In the case of curtainwall, some project teams simulate and submit both project size and NFRC size because of lack of clarity, so clarifying this point could actually reduce the cost of the design process.

CEPI-20-21

CEPI-21-21

IECC®: C303.1.4

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:
C303.1.4 Insulation product rating.
The *R-value (thermal resistance)* ~~(*R*-value)~~ of insulation and building materials and envelope assembly *U-factor (thermal transmittance)* shall be determined ~~in accordance with the US Federal Trade Commission *R*-value rule (CFR Title 16, Part 460) in units of h × ft^2 × °F/Btu at a mean temperature of 75°F (24°C)~~a climate-derived *R-value (thermal resistance)* as approved by the *code official*.

Reason Statement:

The Rule does not cover insulation products sold for use in commercial (including industrial) buildings and should be substituted with an appropriate reference.

The R-value Rule. The Federal Trade Commission promulgated the R-value Rule on August 29, 1979, under section 18 of the Federal Trade Commission Act ("FTC Act"), 15 U.S.C. 57a. The Rule became effective on September 30, 1980. The Rule specifies substantiation and disclosure requirements for those who sell thermal insulation products for use in the **residential market**, and prohibits certain claims unless they are true. The primary disclosure required is the insulation product's "R-value." "R-value" is the recognized numerical measure of the ability of an insulation product to restrict the flow of heat and, therefore, to reduce energy costs. R-values may be expressed per unit of thickness (e.g., one inch) or for the total thickness of a particular insulation product or installation. The higher the R-value, the better the product's insulating ability.

Products Covered. The R-value Rule covers all "home insulation products." Under the Rule, "insulation" is any product mainly used to slow down the flow of heat from a warmer area to a cooler area, for example, from the heated interior of a house to the exterior during the winter through exterior walls, attic, floors over crawl spaces, or basement. "Home insulation" includes insulation used in all types of **residential structures**. The Rule automatically covers new types or forms of insulation marketed for use in the **residential market**, whether or not they are specifically referred to in the Rule. The Rule does not cover pipe insulation, or any type of duct insulation except for duct wrap. **The Rule does not cover insulation products sold for use in commercial (including industrial) buildings.** It does not apply to other products with insulating characteristics, such as storm windows or storm doors.

Parties Covered. The Rule applies to home insulation manufacturers, professional installers, retailers who sell insulation to consumers for do-it-yourself installation, and new home sellers (including sellers of manufactured housing). It also applies to testing laboratories that conduct R-value tests for home insulation manufacturers or other sellers who use the test results as the basis for making R-value claims about home insulation products.

Non-residential (Commercial) Insulation. Over the years, comments submitted to the Commission have suggested extending the Rule to cover insulation products used in all buildings, not just residential applications. Although applying the Rule to thermal insulation products used in commercial buildings might provide information to purchasers that could improve the energy efficiency of buildings, and otherwise prove useful, such comments do not demonstrate that sellers of commercial insulations are engaged in unfair or deceptive acts or practices that would justify expanding the Rule. Furthermore, in many instances, thermal insulation purchasing decisions for commercial building applications are made by registered design professionals (i.e., licensed architects or professional engineers). These design professionals may require R-value and other performance information based on circumstances different than the uniform approach the Commission determined was necessary to provide accurate and understandable information to individual consumers to compare competing products and make purchasing decisions.

(**bold-face**, for emphasis)

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will neither increase nor decrease the cost of construction.

CEPI-21-21

CEPI-22-21

IECC®: SECTION 202 (New), C401.2, C404.8.1, C405.5.3, TABLE C406.1(1), TABLE C406.1(2), TABLE C406.1(3), TABLE C406.1(4), TABLE C406.1(5), C406.7.3

Proponents:

Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov)

2021 International Energy Conservation Code

Add new definition as follows:

C202 **ALL-ELECTRIC BUILDING.** A building that contains no combustion equipment, or plumbing for combustion equipment, installed within the building, or building site.

C202 **APPLIANCE.** A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

C202 **COMBUSTION EQUIPMENT.**

Any equipment or appliance used for space heating, service water heating, cooking, clothes drying, or lighting that uses fuel gas or fuel oil.

COMMERCIAL COOKING APPLIANCE. Appliances used in a commercial food service establishment for heating or cooking food and which produce grease vapors, steam, fumes, smoke or odors that are required to be removed through a local exhaust ventilation system. Such appliances include deep fat fryers, upright broilers, griddles, broilers, steam-jacketed kettles, hot-top ranges, under-fired broilers (charbroilers), ovens, barbecues, rotisseries, and similar appliances. For the purpose of this definition, a food service establishment shall include any building or a portion thereof used for the preparation and serving of food.

C202 **EQUIPMENT.** Piping, ducts, vents, control devices and other components of systems other than appliances that are permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.

Revise as follows:

C401.2 Application.

Commercial buildings shall be *all-electric buildings* and comply with Section C401.2.1 or C401.2.2.

C404.8.1 Heaters.

The electric power to all heaters shall be controlled by an on-off switch that is an integral part of the heater, mounted on the exterior of the heater, or external to and within 3 feet (914 mm) of the heater in a location with *ready access*. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas-fired heaters shall not be ~~equipped with continuously burning ignition pilots~~permitted.

C405.5.3 Gas lighting.

Gas-fired lighting appliances shall not be ~~equipped with continuously burning pilot ignition systems~~ permitted.

TABLE C406.1(1)

ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
~~C406.7.3: Efficient fossil fuel water heater~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
C406.7.4: Heat pumpwater heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced air infiltration	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

TABLE C406.1(2)

ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2

C406.2.2: 5% cooling efficiency improvement	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% cooling efficiency improvement	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3: Reduced lighting power	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C406.4: Enhanced digital lighting controls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: On-site renewable energy	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.2: Recovered or renewable water heating	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
~~C406.7.3: Efficient fossil fuel water heater~~	~~5~~	~~5~~	~~6~~	~~6~~	~~8~~	~~7~~	~~8~~	~~8~~	~~8~~	~~9~~	~~9~~	~~9~~	~~10~~	~~10~~	~~9~~	~~10~~	~~11~~
C406.7.4: Heat pump water heater	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Reduced air infiltration	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3
C406.10: Energy monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.11: Fault detection and diagnostics system	1	1	1	1	1	1	NA	1	1	NA	1	1	NA	1	1	1	1

NA = Not Applicable.

TABLE C406.1(3)
ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP E OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	4
C406.2.2: 5% cooling efficiency improvement	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	3	4	3	4	3	4	3	5	7
C406.2.4: 10% cooling efficiency improvement	7	8	7	6	5	4	3	4	3	1	2	2	1	2	2	2	1

C406.3: Reduced lighting power	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
C406.5: On-site renewable energy	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
C406.6: Dedicatedoutdoor air system	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.2: Recoveredor renewable water heating[a]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
~~C406.7.3: Efficient fossil fuel water heater[a]~~	~~NA~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~2~~	~~2~~	~~3~~	~~2~~	~~3~~	~~2~~	~~3~~	~~3~~	~~3~~	~~5~~
C406.7.4: Heat pump water heater[a]	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1	1	1	1
C406.8: Enhanced envelope performance	3	7	3	4	2	4	1	1	3	1	2	3	NA	4	3	6	9
C406.9: Reduced air infiltration	1	1	1	2	NA	NA	NA	NA	NA	NA	1	NA	NA	4	1	4	3
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	2	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2

NA = Not Applicable.

- a.

  For schools with showers or full-service kitchens.

TABLE C406.1(4)
ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP M OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	NA	1	1	2	2	2	2	3	2	3	4
C406.2.2: 5% cooling efficiency improvement	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	4	3	4	5	5	3	6	8
C406.2.4: 10% cooling efficiency improvement	9	12	9	8	6	6	3	4	4	1	2	3	NA	2	2	2	1
C406.3: Reduced lighting power	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12
C406.4: Enhanced digital lighting	3	3	4	3	4	3	4	4	4	3	3	3	3	4	4	3	3

controls																	
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
C406.6: Dedicated outdoor air system	3	4	3	3	3	3	1	3	2	2	2	3	2	4	3	4	4
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
~~C406.7.3: Efficient fossil fuel water heater~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
C406.7.4: Heat pump water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	4	6	3	4	3	3	1	6	4	4	4	5	4	6	5	8	9
C406.9: Reduced air infiltration	1	1	1	2	1	1	NA	3	1	1	3	2	1	7	3	6	3
C406.10: Energy monitoring	4	5	5	5	5	4	4	4	4	3	3	4	3	4	4	4	3
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2

NA = Not Applicable.

TABLE C406.1(5)

ADDITIONAL ENERGY EFFICIENCY CREDITS FOR OTHER[a] OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	3
C406.2.2: 5% cooling efficiency improvement	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	3	3	3	3	4	3	5	5
C406.2.4: 10% cooling efficiency improvement	8	9	8	7	5	5	3	4	4	2	2	3	2	2	2	2	2
C406.3: Reduced lighting power	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	8	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	3	2	5	3	3	5	4	3	7	5	7	6
C406.7.2: Recovered or renewable	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15

water heating [b]																	
~~C406.7.3: Efficient fossil fuel water heater [b]~~	~~5~~	~~5~~	~~6~~	~~6~~	~~8~~	~~7~~	~~8~~	~~8~~	~~8~~	~~9~~	~~9~~	~~9~~	~~10~~	~~10~~	~~9~~	~~10~~	~~11~~
C406.7.4: Heat pump water heater [b]	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	4	3	4	1	5	4	3	5	5	4	7	6	9	10
C406.9: Reduced air infiltration	3	2	2	4	4	2	NA	6	2	2	6	4	1	10	5	7	4
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	3	2	3	2	2	2	3	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

- a.

  Other occupancy groups include all groups except Groups B, E, I, M and R.

- b.

  For occupancy groups listed in Section C406.7.1.

Delete without substitution:

~~C406.7.3 Efficient fossil fuel water heater~~.

~~The combined input-capacity weighted-average equipment rating of all fossil fuel water-heating equipment in the building shall be not less than 95 percent Et or 0.95 EF. This option shall receive only half the listed credits for buildings required to comply with Section C404.2.1.~~

Reason:

In order to meet President Biden's 2050 goal of reducing greenhouse gas emissions in half by 2030 and achieving net zero carbon emissions by 2050, the United States must not only reduce energy use through energy efficiency and move to utility scale and on-site renewable energy, but also transition away from using combustion equipment in buildings that runs on fossil fuels to electric equipment. In 2020, combustion equipment in commercial and residential buildings accounted for 36% of the United States energy-related greenhouse gas emissions. To meet President Biden's goal, it is crucial that new homes built today are all-electric so that emissions from these buildings are not "locked-in" by gas-dependent building infrastructure. Reduced carbon emissions was also recently cited as a priority of energy code development by the ICC in their Leading the Way to Energy Efficiency: A Path Forward on Energy and Sustainability to Confront a Changing Climate in 2021.

This proposed code amendment seeks to address the carbon impact of commercial buildings by requiring all new commercial buildings to be all-electric in Section C401.2. The amendment removes vestigial language that relates to fossil fuel systems related to pool heaters and lighting and clarifies that low-energy buildings must also be all-electric. To clarify the definition of all-electric and combustion equipment, the definition for appliance, equipment, fuel gas, and fuel oil are mirrored from 2021 IMC to be useful in defining combustion equipment.

Requiring all-electric construction as described above will result in new construction that is less expensive to construct than a building constructed with gas appliances and in the long term will result in fewer retrofit costs for building owners to meet future policy goals to eliminate all carbon emissions in the U.S. by 2050. All-electric construction will also result in lower utility costs if high efficiency heat pump technology is used. An Ecotope study of the 2017 Oregon Residential code found that homes heated by electric heat pumps use 40 percent less energy than homes heated with gas (including water heating). Even accounting for reduced efficiency in extreme cold weather, according to a study by RMI, modern air source heat pumps are more than twice as efficient as gas furnaces and can save families up to 9 percent on their utility bills in Climate Zone 6. This is one reason why the U.S. EPA just announced that standards for the most efficient appliances in 2022 certified under the ENERGY STAR program will be all-electric.

All-electric buildings are also healthier. Gas appliances release harmful pollutants like nitrogen dioxide (NO2) and carbon monoxide (CO) either indoors because of gas stoves or outdoors because of space-heating and water heating equipment. A recent study from the Harvard Chang School of Public Health and RMI shows that in 2017, air pollution from burning fuels in buildings led to an estimated 48,000 to 64,000 early deaths and $615 billion in health impact costs. These emissions can particularly affect children. In a meta-analysis analyzing the connections between gas stoves and childhood asthma, children in homes with gas stoves were 42% more likely to experience asthma symptoms, and 32% more likely to being diagnosed with asthma.

Therefore, constructing all-electric buildings is critical to reducing air pollution, protecting public health, reducing utility and construction costs, and meeting climate goals. NBI is submitting this amendment along with amendments that address on-site renewables, electric vehicles, and grid integration techniques. These proposed changes to the 2021 IECC, working together, will put the U.S. on the path to a decarbonized, resilient, and healthier future.

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Nadel, Steven, and Chris Perry. ELECTRIFYING SPACE HEATING IN EXISTING COMMERCIAL BUILDINGS: OPPORTUNITIES AND CHALLENGES, ACEEE, Oct. 2020, www.aceee.org/sites/default/files/pdfs/b2004.pdf.

Cost Impact:

The code change proposal will decrease the cost of construction.

All-electric commercial buildings are less expensive to build than mixed fuel buildings because electric appliances and equipment are typically less expensive than combustion equipment and appliances. In additional developers avoid the cost of installing natural-gas lines and meters. Recent analysis by NBI and partners utilizing data from RS Means indicates that an all-electric 53,000 s.f. office building with a central heat pump water heater and minimum code compliant air source heat pump costs $0.09/s.f. less to build than a mixed-fuel office building of the same size. Additional analyses from a recent CASE study indicate that all-electric high-rise multifamily buildings are also less expensive to build and operate than mixed-fuel buildings. HVAC costs, for example, are on the order of $2,504 to $7,131 lower per dwelling unit depending on the HVAC system installed. Installing electric space heating and water heating equipment instead of natural gas equipment in the majority of California's climate zones also yielded a positive benefit to cost ratio over the 15-year analysis period despite California's high electricity rates.

Another study by ACEEE indicates that assuming energy-efficient construction, electrification incentives, and carbon pricing, space heating in 60% of the existing commercial building stock in the U.S. can be cost effectively retrofitted to electric space-heating with a simple payback of less than 10 years. The percentage of spaces where space-heating is cost effective across the country in new construction is likely higher because no retrofit costs are incurred in new construction and because new construction is already mandated to be energy efficient.

Finally, ensuring commercial buildings are all-electric now will guarantee that those buildings will not have to be retrofitted to be all-electric in the future to meet the nation's goal to be net-zero carbon emissions by 2050.

CEPI-23-21

IECC®: C401.2.1

Proponents:

Gayathri Vijayakumar, Steven Winter Associates, Inc., representing Steven Winter Associates, Inc. (gayathri@swinter.com)

2021 International Energy Conservation Code

Revise as follows:
C401.2.1 International Energy Conservation Code.
Commercial buildings shall comply with one of the following:

1. **Prescriptive Compliance.** The Prescriptive Compliance option requires compliance with Sections C402 through C406 and Section C408. Dwelling units and sleeping units in Group R-2 buildings ~~without systems serving multiple units~~ shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.

2. **Total Building Performance.** The Total Building Performance option requires compliance with Section C407.

Exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

Reason Statement:

In the prior code cycle, there were objections to allowing R406 (ERI) for dwelling / sleeping units in high-rise buildings subject to the Commercial provisions. This was mostly due to a lack of familiarity with the energy rating process and modeling protocols of ANSI/RESNET/ICC 301. As the Chair of the Standards Development Committee that oversees that Standard, it includes calculations that allow shared systems (HVAC and SHW) to be modeled in the energy rating of a dwelling or sleeping unit. A 3 story building with systems that serve multiple units currently is permitted to show compliance using R406 so there is no reason to disallow it for taller buildings.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no specific increase in the cost of construction associated with choosing this compliance path.

For some buildings with systems serving multiple units, R406 may be a less expensive option with respect to the energy modeling costs, but might be more expensive with regard to the specific building systems that would then be needed to meet the current ERI targets. These targets were likely developed with single family homes and low-rise multifamily in mind, without shared systems. The energy rating index uses a baseline where dwelling units and sleeping units have their own HVAC and DHW system. Where the actual design has shared systems, the additional energy associated with distribution is an energy 'penalty' to overcome (which is non-existent in units with their own systems).

CEPI-23-21

CEPI-24-21 Part I

IECC®: SECTION 202, SECTION 202 (New), C401.2.1, SECTION C407, C407.1, C407.2, TABLE C407.2, C407.5.3, C502.2, C505.1

Proponents: Amy Boyce, representing Institute for Market Transformation

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

PROPOSED DESIGN. A description of the proposed building used to estimate annual energy use for determining compliance based on ~~total~~ simulated building performance.

STANDARD REFERENCE DESIGN. A version of the *proposed design* that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on ~~total~~ simulated building performance.

Add new definition as follows:

SIMULATED BUILDING PERFORMANCE. A process in which the proposed building design is compared to a standard reference design for the purposes of estimating relative energy use against a baseline to determine code compliance.

Revise as follows:

C401.2.1 International Energy Conservation Code. Commercial buildings shall comply with one of the following:

1. **Prescriptive Compliance.** The Prescriptive Compliance option requires compliance with Sections C402 through C406 and Section C408. Dwelling units and sleeping units in Group R-2 buildings without systems serving multiple units shall be deemed to be in compliance with this chapter, provided that they comply with Section R406.
2. **~~Total~~ Simulated Building Performance.** The ~~Total~~ Simulated Building Performance option requires compliance with Section C407.

Exception: Additions, alterations, repairs and changes of occupancy to existing buildings complying with Chapter 5.

SECTION C407
~~TOTAL~~ SIMULATED BUILDING PERFORMANCE

C407.1 Scope. This section establishes criteria for compliance using ~~total~~ simulated building performance. The following systems and loads shall be included in determining the ~~total~~ simulated building performance: heating systems, cooling systems, service water heating, fan systems, lighting power, receptacle loads and process loads.

Exception: Energy used to recharge or refuel vehicles that are used for on-road and off-site transportation purposes.

C407.2 Mandatory requirements. Compliance based on ~~total~~ simulated building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to 80 percent of the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

Exception: Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

TABLE C407.2 REQUIREMENTS FOR ~~TOTAL~~ SIMULATED BUILDING PERFORMANCE

SECTION [a]	TITLE
Envelope	
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

C407.5.3 Exceptional calculation methods. Where the simulation program does not model a design, material or device of the *proposed design*, an exceptional calculation method shall be used where approved by the *code official*. Where there are multiple designs, materials or devices that the simulation program does not model, each shall be calculated separately and exceptional savings determined for each. The total exceptional savings shall not constitute more than half of the difference between the baseline simulated building performance and the proposed simulated building performance. Applications for approval of an exceptional method shall include all of the following:

1. Step-by-step documentation of the exceptional calculation method performed, detailed enough to reproduce the results.
2. Copies of all spreadsheets used to perform the calculations.
3. A sensitivity analysis of energy consumption where each of the input parameters is varied from half to double the value assumed.
4. The calculations shall be performed on a time step basis consistent with the simulation program used.
5. The performance rating calculated with and without the exceptional calculation method.

C502.2 Change in space conditioning. Any nonconditioned or low-energy space that is altered to become *conditioned space* shall be required to comply with Section C502.

Exceptions:

1. Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.
2. Where the ~~total~~ simulated building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall be not greater than 110 percent of the annual energy cost otherwise permitted by Section C407.2.

C505.1 General. Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code. Where the use in a space changes from one use in Table C405.3.2(1) or C405.3.2(2) to another use in Table C405.3.2(1) or C405.3.2(2), the installed lighting wattage shall comply with Section C405.3. Where the space undergoing a change in occupancy or use is in a building with a fenestration area that exceeds the limitations of Section C402.4.1, the space is exempt from Section C402.4.1 provided that there is not an increase in fenestration area.

Exceptions:

1. Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall not be greater than 110 percent of the target UA.
2. Where the ~~total~~ simulated building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall not be greater than 110 percent of the annual energy cost otherwise permitted by Section C407.3.

ZERO ENERGY PERFORMANCE INDEX (ZEPIPB,EE). The ratio of the proposed simulated building EUI without renewables to the baseline simulated building EUI, expressed as a percentage.

Reason: The “Total Building Performance” path, as prescribed by the IECC, uses simulation software to compare elements of the *proposed building* with that of a *baseline building*. In this simulation, many building elements are simulated using default values, as those elements do not affect the results of the comparison. The path title leads many to the false conclusion that the results of this building simulation will align with the actual building energy use – its performance – once it is built and occupied; however, that is not the intent of the simulation in this case.
While generally confusing in the past, this misconception is more critical now with the adoption of Building Performance Standards (BPS) in many jurisdictions. While BPS govern existing buildings, they will apply to newly constructed buildings once those structures have been occupied for a set number of years. The misunderstanding of the purpose and the results of the code-required proposed building model may lead owners and operators to assume that a building was designed to meet the future BPS requirements and that that design intent is backed up by the model results. Changing the language to clarify that the results of the code-required proposed building model are not necessarily aligned with future building performance will adjust expectations and potentially minimize future legal concerns.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change affects the language only.

Cost Effectiveness: While the change itself will neither increase nor decrease costs, bringing awareness to the limitations of the current total building performance path will aid owners and designers in the conversation about predicted building performance and potentially reduce costs associated with changes made later on in the process.

CEPI-24-21 Part II

IECC®: SECTION 202, SECTION 202 (New), R401.2.2, R403.3.3.1, SECTION R405, R405.1, R405.2, TABLE R405.2, R405.3, R405.3.2.2, R405.4, R502.2, R505.1

Proponents: Amy Boyce, representing Institute for Market Transformation

2021 International Energy Conservation Code

Revise as follows:

PROPOSED DESIGN. A description of the proposed *building* used to estimate annual energy use for determining compliance based on ~~total~~ simulated building performance.

STANDARD REFERENCE DESIGN. A version of the *proposed design* that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on ~~total~~ simulated building performance.

Add new definition as follows:

SIMULATED BUILDING PERFORMANCE. A process in which the proposed building design is compared to a standard reference design for the purposes of estimating relative energy use against a baseline to determine code compliance.

Revise as follows:

R401.2.2 ~~Total~~ Simulated Building Performance Option. The ~~Total~~ Simulated Building Performance Option requires compliance with Section R405.

R403.3.3.1 Effective R-value of deeply buried ducts. Where using the ~~Total~~ Building Simulated Performance Compliance Option in accordance with Section R401.2.2 , sections of ducts that are installed in accordance with Section R403.3.3, located directly on or within 5.5 inches (140 mm) of the ceiling, surrounded with blown-in attic insulation having an *R*-value of R-30 or greater and located such that the top of the duct is not less than 3.5 inches (89 mm) below the top of the insulation, shall be considered as having an effective duct insulation *R*-value of R-25.

SECTION R405
~~TOTAL~~ SIMULATED BUILDING PERFORMANCE

R405.1 Scope. This section establishes criteria for compliance using ~~total~~ simulated building performance analysis. Such analysis shall include heating, cooling, mechanical ventilation and service water-heating energy only.

R405.2 Simulated p~~P~~erformance-based compliance. Compliance based on ~~total~~ simulated building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table R405.2.
2. The building thermal envelope shall be greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 *International Energy Conservation Code*.
3. An annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations.

    Exception: The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

TABLE R405.2 REQUIREMENTS FOR ~~TOTAL~~ SIMULATED BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration U-factor and SHGC
Mechanical	
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls

a. Reference to a code section includes all the relative subsections except as indicated in the table.

R405.3 Documentation. Documentation of the software used for the ~~performance~~ proposed design and the parameters for the baseline *building* shall be in accordance with Sections R405.3.2.1 through R405.3.2.2.

R405.3.2.2 Compliance report for certificate of occupancy. A compliance report submitted for obtaining the certificate of occupancy shall include the following:

1. Building street address, or other building site identification.
2. Declaration of the ~~total~~ simulated building performance path on the title page of the energy report and the title page of the building plans.
3. A statement, bearing the name of the individual performing the analysis and generating the report, indicating that the as-built building complies with Section R405.3.
4. The name and version of the compliance software tool.
5. A site-specific energy analysis report that is in compliance with Section R405.3.
6. A final confirmed certificate indicating compliance based on inspection, and a statement indicating that the confirmed rated design of the built home complies with Section R405.3. The certificate shall report the energy features that were confirmed to be in the home, including component level insulation *R*-values or *U*-factors; results from any required duct system and building envelope air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical ventilation and service water-heating equipment installed.
7. Where on-site renewable energy systems have been installed, the certificate shall report the type and production size of the installed system.

R405.4 Calculation procedure. Calculations of the ~~performance~~ proposed design shall be in accordance with Sections R405.4.1 and R405.4.2.

R502.2 Change in space conditioning. Any unconditioned or low-energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with this code.

Exceptions:

1. Where the simulated building performance option in Section R405 is used to comply with this section, the annual energy cost of the *proposed design* is permitted to be 110 percent of the annual energy cost otherwise allowed by Section R405.2.
2. Where the Total UA, as determined in Section R402.1.5, of the existing building and the *addition*, and any *alterations* that are part of the project, is less than or equal to the Total UA generated for the existing *building*.
3. Where complying in accordance with Section R405 and the annual energy cost or energy use of the *addition* and the existing *building*, and any *alterations* that are part of the project, is less than or equal to the annual energy cost of the existing *building*. The *addition* and any *alterations* that are part of the project shall comply with Section R405 in its entirety.

R505.1 General. Any space that is converted to a dwelling unit or portion thereof from another use or occupancy shall comply with this code.

Exception: Where the simulated building performance option in Section R405 is used to comply with this section, the annual energy cost of the *proposed design* is permitted to be 110 percent of the annual energy cost allowed by Section R405.2.

Reason: The "Total Building Performance" path, as prescribed by the IECC, uses simulation software to compare elements of the *proposed building* with that of a *baseline building*. In this simulation, many building elements are simulated using default values, as those elements do not affect the results of the comparison. The path title leads many to the false conclusion that the results of this building simulation will align with the actual building energy use – its performance – once it is built and occupied; however, that is not the intent of the simulation in this case.
While generally confusing in the past, this misconception is more critical now with the adoption of Building Performance Standards (BPS) in many jurisdictions. While BPS govern existing buildings, they will apply to newly constructed buildings once those structures have been occupied for a set number of years. The misunderstanding of the purpose and the results of the code-required proposed building model may lead owners and operators to assume that a building was designed to meet the future BPS requirements and that that design intent is backed up by the model results. Changing the language to clarify that the results of the code-required proposed building model are not necessarily aligned with future building performance will adjust expectations and potentially minimize future legal concerns.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change affects the language only.

Cost Effectiveness: While the change itself will neither increase nor decrease costs, bringing awareness to the limitations of the current total building performance path will aid owners and designers in the conversation about predicted building performance and potentially reduce costs associated with changes made later on in the process.

CEPI-25-21

IECC®: SECTION 202 (New), C401.2.3 (New), ASHRAE Chapter 06 (New)

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 DATA CENTER. A room or building, or portions thereof, including *computer rooms* being served by *data center* systems, serving a total information technology equipment load greater than 10 kiloWatts and 20 Watts/ft (215 Watts/m) of *conditioned floor area.*
Add new text as follows:
C401.2.3 Application to Data Centers..
Data centers shall be allowed to comply with the requirements of ANSI/ASHRAE 90.4.
Add new standard(s) as follows:
ASHRAE ASHRAE 180 Technology Parkway NW Peachtree Corners GA 30092
ANSI/ASHRAE 90.4-2019 Energy Standard for Data Centers

Reason Statement:

ASHRAE Standard 90.4, Energy Standard for Data Centers, was originally published in 2016 and updated with higher efficiency requirements in 2019. It is on continuous maintenance and will be updated again within the next 2 years.
It establishes the minimum energy efficiency requirements of data centers for design and construction and for creation of a plan for operation and maintenance, and for utilization of on-site or off-site renewable energy resources.

Data center applications are unlike their commercial building counterparts in two significant ways. First, they include significantly higher plug loads (e.g., computer servers and UPS equipment). Second, they employ rapidly changing technology for the IT equipment and associated power/cooling approaches.

There is also a recognition that current industry modeling tools do not possess all the necessary mathematical models to accurately and appropriately model data center HVAC and electrical equipment design. As a result, demonstrating compliance to the 90.1 Chapter 11 or energy cost budget (ECB) approaches is usually impractical.

Along with ASHRAE 90.1, designers and owners of data centers should have the option to use ANSI/ASHRAE 90.4 as a compliance path.

Bibliography:

American Society of Heating, Refrigeration, and Air Conditioning Engineers, *Energy Standard for Data Centers*, November 2019, Atlanta GA https://www.techstreet.com/standards/ashrae-90-4-2019?product_id=2092750

Cost Impact:

The code change proposal will increase the cost of construction.

This will increase the cost of construction of data centers due to higher efficiency requirements.

Many of the increased requirements will have simple paybacks that are less than 5 years or 10 years (depending on the climate zone and incremental costs of specific technologies and estimated energy costs).

CEPI-25-21

CEPI-26-21

IECC®: SECTION 202 (New), C401.4 (New), C401.4.1 (New), TABLE C401.4.1 (New), TABLE C401.4.2 (New), C401.4.2 (New), C401.4.3 (New)

Proponents:

Emily Kelly, representing ChargePoint (emily.kelly@chargepoint.com)

2021 International Energy Conservation Code

Add new definition as follows:
C202 ELECTRIC VEHICLE. An automotive-type vehicle for on-road use primarily powered by an electric motor that draws current from an onboard battery charged through a building electrical service, Electric Vehicle Supply Equipment (EVSE), or another source of electric current.
C202 ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The apparatus installed specifically for the purpose of transferring energy between the premises wiring and the Electric Vehicle.
C202 ELECTRIC VEHICLE ENERGY MANAGEMENT SYSTEMS. A system to control electric vehicle supply equipment electrical loads comprised of monitor(s), communications equipment, controller(s), timer(s) and other applicable devices.
C202 EV-READY SPACE. A designated parking space that features an electrical branch circuit terminating in a junction box or receptacle for Level 2 Electric Vehicle Supply Equipment located in close proximity to the proposed location of the EV parking space.
C202 LEVEL 2 ELECTRIC VEHICLE SUPPLY EQUIPMENT. Electric Vehicle Supply Equipment capable of providing AC Level 2 EV charging, as defined by the standard SAE J1772.
Add new text as follows:
C401.4 Electric vehicle ready parking.

Where parking is provided, new construction shall provide *EVSE-installed* spaces and facilitate future installation and use of EVSE through the provision of *EV-Ready Spaces* provided in compliance with Sections C401.4.1 through C401.4.3. Where more than one parking facility is provided on a site, *EV-Ready Spaces* shall be calculated separately for each parking facility.

C401.4.1 New multifamily and commercial buildings.

All residential parking in multifamily buildings areas shall be EVSE-Installed or EV-Ready Spaces.

EVSE-installedor EV-Ready Spaces shall be provided in accordance with Table C401.4.1 for Commercial buildings. Where the calculation of percent served results in a fractional parking space, it shall be rounded up to the next whole number.

TABLE C401.4.1 EVSE-INSTALLED AND EV-READY SPACE REQUIREMENTS FOR NEW COMMERCIAL BUILDINGS

Occupancy Classification	Minimum percentage of EVSE-Installed or EV-Ready Spaces	EV Charging Performance Requirements
Group B Occupancies	20%	See Table C401.4.2
Group M Occupancies	10%	See Table C401.4.2
All Other Occupancies	10%	See Table C401.4.2

TABLE C401.4.2 EVSE-INSTALLED AND EV-READY PERFORMANCE REQUIREMENTS

Occupancy Classification	Circuit Breaker Amperage	Maximum Number of *EV Ready* or *EVSE-Installed* Parking Spaces that May Share a Branch Circuit
Group B, Group R and all other Occupancies	20A	1
	30A	1
	40A	3
	50A	4
	60A	5
	70A	6
	80A	8
	90A	9
	100A	10
	125A	12

Group M Occupancies	20A	0 – N/A
	30A	0 – N/A
	40A	1
	50A	1
	60A	2
	70A	2
	80A	2
	90A	3
	100A	4
	125A	5

C401.4.2 EV Charging Performance Requirements.

Electric Vehicle Energy Management Systems may be used to control electric vehicle loads for EV-Ready or EVSE-Installed Spaces, subject to the performance requirements in Table C401.4.2

C401.4.3 Identification.

Construction documents shall indicate the branch circuit termination point and proposed location of future EV spaces and EVSE. Construction documents shall also provide information on amperage of future EVSE, raceway methods, wiring schematics, Electric Vehicle Energy Management Systems, and electrical load calculations to verify that the electrical panel service capacity and electrical system, including any on-site distribution transformers, have sufficient capacity to simultaneously charge all EVs at all required EV spaces.

Staff Note: Proponent unable to provide required copies prior to printing of monograph.

Reason Statement:

The U.S. transportation sector accounted for 29 percent of the nation's greenhouse gas (GHG) emissions in 2019. As a signatory to the Paris Climate Agreement, the USA has adopted the goal of limiting global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. Achieving this goal will require that the overwhelming majority of passenger vehicles be zero emissions electric vehicles by the 2040s, well within the lifetime of buildings that will be constructed to the 2024 IECC – see e.g. (Princeton University, 2020). In August of this year, the U.S administration released an Executive Order that one-half of all new vehicles sold in 2030 to be zero-emissions vehicles, including battery electric and plug-in hybrid electric vehicles (EVs); many states are pursuing yet more aggressive targets. EV battery prices are declining rapidly, and passenger EVs are expected to reach first cost parity (without subsidies) with traditional internal combustion engine vehicles (ICEVs) by the mid-2020s, and decline below ICEVs thereafter (International Council on Clean Transportation, 2019).

To facilitate adoption of EVs, it is critical that drivers have access to convenient, cost-effective EV charging. More than 80% of EV charging in the USA currently occurs at home, and it is projected that into the future, the most convenient, cost-effective means of providing charging will be household's home assigned parking space (if households have access to onsite parking at their residence), or at work. Additionally, some drivers will make use of publicly accessible EV charging infrastructure located at amenities they regularly visit (e.g. retail, assembly uses, etc.) – see e.g. (International Council on Clean Transportation, 2021).

It is very costly and complicated to renovate EV charging infrastructure into existing multifamily buildings. Therefore, new construction should be future-proofed for the near-universal EV adoption necessary in the coming decades. If parking is provided as part of new residential developments, the greatest societal value can be realized by ensuring each households' onsite parking space is "EV Ready" (I.e. parking that features an adjacent electrical outlet at which "AC Level 2" electric vehicle supply equipment [EVSE] can be easily installed in the future). Likewise, significant portions of workplace parking and publicly accessible parking in commercial developments should be made EV Ready.

100% EV Ready residential parking new construction requirements are the best practice in North America. The City of Vancouver and 16 other communities in British Columbia, Canada, have adopted 100% EV Ready requirements for multifamily buildings, as has the City of Toronto, Canada, in "Tier 2" of its Toronto Green Standard Version 4. Similar requirements are being considered by multiple other cities across North America. In 2019, Natural Resources Canada submitted 100% residential EV Ready requirements for inclusion in the model Canadian National Energy Code for Buildings (NECB); changes to appropriate objectives statement in the NECB are currently being pursued to enable these requirements.

High levels of EV Ready parking can be realized cost-effectively in new developments by allowing designs to use of EV energy management systems (EVEMS, i.e. automatic load management systems, systems to monitor and control of EV charging). EVEMS can facilitate load sharing across branch circuits, sharing at the electrical panel level, electrical service monitoring and associated control of EVSE, and other forms of controlling EVSE loads. The Canadian jurisdictions that have adopted 100% EV Ready requirements allow for reasonable levels of load sharing across branch circuits, as well as other EVEMS strategies (e.g. panel sharing, service monitoring, etc.). Allowing for appropriate use of load sharing between EV Ready parking spaces significantly reduces the electrical capacity required to provide for 100% EV Ready parking, and associated costs for new developments. Providing a maximum limit on load sharing across branch circuits ensures that all drivers will receive a reasonable quality of EV charging. Jurisdictions will typically establish performance requirements intended to ensure that drivers receive full overnight charge (residential uses) or full day-time charge (workplace parking) the vast majority of the time. Appropriate performance requirements vary with geography, depending on how far households typically drive, climate, and other factors – for explanation of these factors see: (Chandler, 2020). The charging performance requirements in the proposed Tables R401.4.3 and C401.4.2 are anticipated to be adequate for many suburban geographies. More sharing may be possible in central cities, where on average vehicles travel shortly total distances daily. Conversely, less sharing may be appropriate for areas where vehicles drive relatively far and/or are relatively inefficient/large.

Bibliography:

Chandler, D. (2020). *Capacity to Charge.* AES Engineering. Retrieved from https://static1.squarespace.com/static/59a5b73315d5dbbebf1de0c8/t/5f9361b71d206d227a50d765/1603494346153/Capacity+to+Char

+-+AES+Engineering.pdf

International Council on Clean Transportation. (2019). *Update on electric vehicle costs in the United States through 2030.* Retrieved from https://theicct.org/publications/update-US-2030-electric-vehicle-cost

International Council on Clean Transportation. (2021). *Charging Up America: Assessing the Growing Need for U.S. Charging Infrastructure Through 2030.* Retrieved from https://theicct.org/sites/default/files/publications/charging-up-america-jul2021.pdf

Princeton University. (2020). *Net-Zero America: Potential Pathways, Infrastructure, and Impacts.* Retrieved from https://netzeroamerica.princeton.edu/the-report

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Several costing studies performed for Canadian jurisdictions suggest that the proposed requirements can be achieved for approximately $1000 USD per parking space (ChargePoint and AES Engineering is currently coordinating with these jurisdictions, requesting they provide permission to share the results of these studies). These studies suggest retrofit costs of 3 to 4 times greater per parking space, emphasizing the importance of EV Ready new construction.

CEPI-26-21

CEPI-27-21

IECC®: SECTION C402, C402.1, C402.1.3, C402.1.3.1 (New), C402.1.3.2 (New), C402.1.3.3 (New), C402.1.3.4 (New), C402.1.3.5 (New), C402.1.3.6 (New), C402.1.4, C402.1.4.1, C402.1.4.1 (New), C402.1.4.1.1, C402.1.4.1.2, C402.1.4.1.3, C402.1.4.1.3 (New), C402.1.4.1.4 (New), C402.1.4.2, C402.2, C402.2.1, C402.2.1.1, C402.2.1.2, C402.2.1.3, C402.2.1.4, C402.2.1.5, C402.2.2, C402.2.3, C402.2.4, C402.2.4.1, C402.2.5, C402.2.6

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

SECTION C402 BUILDING ENVELOPE REQUIREMENTS
Revise as follows:
C402.1 General.

Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either ~~the *R*-value-based method of~~ Section C402.1.3; ~~the *U* , *C* and *F*-factor-based method of~~ Section C402.1.4; or ~~the component performance alternative of~~ Section C402.1.5.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of building envelope assemblies shall comply with Section C402.5.
5. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

~~Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.~~

~~Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.~~

C402.1.3 Insulation component R-value-based method.

~~*Building thermal envelope* opaque assemblies shall comply with the requirements of Sections C402.2 and C402.4 based on the *climate zone* specified in Chapter 3.~~ For opaque portions of the *building thermal envelope* intended to comply on an insulation component *R*-value basis, the *R*-values for cavity insulation and continuous insulation shall be not less than that specified in Table C402.1.3. ~~Where cavity insulation is installed in multiple layers, the cavity insulation *R*-values shall be summed to determine compliance with the cavity insulation *R*-value requirements. Where continuous insulation is installed in multiple layers, the continuous insulation *R*-values shall be summed to determine compliance with the continuous insulation *R*-value requirements. Cavity insulation *R*-values shall not be used to determine compliance with the continuous insulation *R*-value requirements in Table C402.1.3.~~ Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *R*-values from the "*Group R*" column of Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *R*-values from the "All other" column of Table C402.1.3.

Add new text as follows:
C402.1.3.1 R-value of multi-layered insulation components..
Where *cavity insulation* is installed in multiple layers, the *cavity insulation R*-values shall be summed to determine compliance with the *cavity insulation R*-value requirements. Where *continuous insulation* is installed in multiple layers, the *continuous insulation R*-values

shall be summed to determine compliance with the *continuous insulation R*-value requirements. *Cavity insulation R*-values shall not be used to determine compliance with the *continuous insulation R*-value requirements in Table C402.1.3.
C402.1.3.2 Area-weighted averaging of R-values.

Area-weighted averaging shall not be permitted for *R*-value compliance.

Exception: For tapered above-deck roof insulation, compliance with the *R*-values required in Table C402.1.3 shall be permitted to be demonstrated by the average *R*-value determined by multiplying the rated *R*-value per inch of the insulation material by the average thickness of the roof insulation. The average thickness of the roof insulation shall equal the total volume of the roof insulation divided by the area of the roof.
C402.1.3.3 Building materials and air spaces.
Building materials that are not insulation components complying with Chapter 3 shall be excluded from demonstrating compliance with the *R*-values of Table C402.1.3. Air spaces used to demonstrate compliance with Table C402.1.3 shall comply with Section C402.2.7.
C402.1.3.4 Assembly construction.
Assembly constructions used for compliance with Table C402.1.3 shall be as described in ANSI/ASHRAE/IESNA 90.1 Appendix A.
C402.1.3.5 Concrete masonry units, integral insulation.
The *R*-value of integral insulation installed in concrete masonry units shall not be used in determining compliance with Table C402.1.3 except as otherwise noted.
C402.1.3.6 Mass walls and floors.

Compliance with required minimum *R*-values for insulation components applied to "mass walls" and "mass floors" in accordance with Table C402.1.3 shall be permitted for assemblies complying with the following:

1. "Mass walls" where used as a component of the *building thermal envelope* shall comply with one of the following:
   1.1. Weigh not less that 35 pounds per square foot (171 kg/m^2) of wall surface area.
   1.2. Weigh not less than 25 pounds per square foot (122 kg/m^2) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m^3).
   1.3. Have a heat capacity exceeding 7 Btu/ft^2-F (144 kJ/m^2-K).
   1.4. Have a heat capacity exceeding 5 Btu/ft^2-F (103 kJ/m^2-K) where the material weight is not more than 120 pcf (1900 kg/m^3).
2. "Mass floors" where used as a component of the *building thermal envelope* shall comply with one of the following weights:
   2.1. 35 pounds per square foot (171 kg/m^2) of floor surface area.
   2.2. 25 pounds per square foot (122 kg/m^2) of floor surface area where the material weight is not more than 120 pcf (1923 kg/m^3).

Revise as follows:
C402.1.4 Assembly U-factor, C-factor or F-factor-based method.

~~*Building thermal envelope* opaque assemblies shall meet the requirements of Sections C402.2 and C402.4 based on the climate zone specified in Chapter 3.~~ *Building thermal envelope* opaque assemblies intended to comply on an assembly *U*-, *C*- or *F*-factor basis shall have a *U*-, *C*- or *F*-factor not greater than that specified in Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *U*-, *C*- or *F*-factor from the "*Group R*" column of Table C402.1.4. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *U*-, *C*- or *F*-factor from the "All other" column of Table C402.1.4.

Delete without substitution:
~~C402.1.4.1 Roof/ceiling assembly.~~
~~The maximum roof/ceiling assembly *U*-factor shall not exceed that specified in Table C402.1.4 based on construction materials used in the roof/ceiling assembly.~~
Add new text as follows:
C402.1.4.1 Methods of determining U-, C-, and F-factors.

U-, C-, and F-factors for proposed building thermal envelope opaque assemblies shall be determined in accordance with pre-calculated values, testing, calculations, or modeling procedures established in ANSI/ASHRAE/IESNA 90.1 Appendix A. The R-value of insulation products used for assembly evaluations shall comply with Section C303.1.4. The thermal resistance of building materials used for assembly evaluations shall comply with values in ANSI/ASHRAE/IESNA 90.1 Appendix A or an approved source based on approved test data. Air spaces used for assembly evaluations shall comply with Section C402.2.7.

Revise as follows:

C402.1.4.1.1 Tapered, above-deck insulation based on thickness.

For tapered, above-deck roof insulation, the area-weighted U-factor of non-uniform insulation thickness shall be determined by accepted engineering practice. ~~Where used as a component of a maximum roof/ceiling assembly *U*-factor calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *U*-factor compliance as prescribed in Section C402.1.4.~~

Exception: The area-weighted U-factor shall be permitted to be determined by using the inverse of the average R-value determined in accordance with the exception to Section C402.1.3.2.

C402.1.4.1.2 Suspended ceilings.

Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly *U*-factor of the roof/ceiling construction.

Delete without substitution:

~~C402.1.4.1.3 Joints staggered~~.

~~Continuous insulation board shall be installed in not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.~~

Add new text as follows:

C402.1.4.1.3 Concrete masonry units, integral insulation.

In determining compliance with Table C402.1.4, the U-factor of concrete masonry units with integral insulation shall be permitted to be used.

C402.1.4.1.4 Mass walls and floors.

Compliance with required maximum U-factors for "mass walls" and "mass floors" in accordance with Table C402.1.4 shall be permitted for assemblies complying with the requirements of Section C402.1.3.6.

Revise as follows:

~~C402.1.4.2~~ C402.1.4.1.5 U-factor ~~Thermal resistance~~ of cold-formed steel walls.

U-factors of walls with cold-formed steel studs shall be permitted to be determined in accordance with Equation 4-1.

$U = 1/[R_s + (ER)]$

(Equation 4-1)

where:

R_s = The cumulative *R*-value of the wall components along the path of heat transfer, excluding the *cavity insulation* and steel studs.

ER = The effective *R*-value of the *cavity insulation* with steel studs as specified in Table C402.1.4.2.

C402.2 Specific ~~building thermal envelope~~ insulation and installation requirements.

Insulation in *building thermal envelope* opaque assemblies shall be installed in accordance ~~comply~~ with Section C303.2 and Sections C402.2.1 through C402.2.7 ~~and Table C402.1.3~~.

C402.2.1 Roof assembly.

~~The minimum thermal resistance (*R*-value) of the insulating material~~ Roof insulation materials shall be installed either between the roof framing or continuously on the roof assembly, or both, and shall comply with Sections C402.2.1.1 through C402.2.1.3 as applicable ~~be as specified in Table C402.1.3, based on construction materials used in the roof assembly~~.

Delete without substitution:

~~C402.2.1.1 Tapered, above-deck insulation based on thickness~~.

~~Where used as a component of a roof/ceiling assembly *R*-value calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *R*-value compliance as prescribed in Section 402.1.3.~~

Revise as follows:

C402.2.1.1 ~~C402.2.1.2~~ Minimum thickness, lowest point.

The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch

(25 mm).

Delete without substitution:
~~C402.2.1.3 Suspended ceilings~~.
~~Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the minimum thermal resistance (*R*-value) of roof insulation in roof/ceiling construction.~~
Revise as follows:
C402.2.1.2 ~~C402.2.1.4~~ Joints staggered.

Continuous insulation board shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

C402.2.1.3 ~~C402.2.1.5~~ Skylight curbs.

Skylight curbs shall be insulated to the level of roofs with insulation entirely above the deck or R-5, whichever is less.

Exception: Unit skylight curbs included as a component of a skylight listed and labeled in accordance with NFRC 100 shall not be required to be insulated.

C402.2.2 Above-grade walls.

Above-grade wall insulation materials shall be installed between the wall framing, integral to the wall assembly, continuous on the wall assembly, or any combination of these insulation methods. Where continuous insulation is layered on the exterior side of a wall assembly, the joints shall be staggered. ~~The minimum thermal resistance (*R*-value) of materials installed in the wall cavity between framing members and continuously on the walls shall be as specified in Table C402.1.3, based on framing type and construction materials used in the wall assembly. The *R*-value of integral insulation installed in concrete masonry units shall not be used in determining compliance with Table C402.1.3 except as otherwise noted in the table. In determining compliance with Table C402.1.4, the use of the *U*-factor of concrete masonry units with integral insulation shall be permitted.~~

~~"Mass walls" where used as a component in the thermal envelope of a building shall comply with one of the following:~~

~~1. Weigh not less than 35 pounds per square foot (171 kg/m^2) of wall surface area.~~

~~2. Weigh not less than 25 pounds per square foot (122 kg/m^2) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m^3).~~

~~3. Have a heat capacity exceeding 7 Btu/ft^2 × °F (144 kJ/m^2 × K).~~

~~4. Have a heat capacity exceeding 5 Btu/ft^2 × °F (103 kJ/m^2 × K), where the material weight is not more than 120 pcf (1900 kg/m^3).~~

C402.2.3 Floors.

For floors over outdoor air or unconditioned space, the floor insulation shall be installed between floor framing, integral to the floor assembly, continuous on the floor assembly, or any combination of these insulation methods. Where continuous insulation is layered on the exterior side of a floor assembly, the joints shall be staggered. ~~The thermal properties (component *R*-values or assembly *U*-, *C*- or *F*-factors) of floor assemblies over outdoor air or unconditioned space shall be as specified in Table C402.1.3 or C402.1.4 based on the construction materials used in the floor assembly.~~ Floor framing *cavity insulation* or structural slab insulation shall be installed to maintain permanent contact with the underside of the subfloor decking or structural slabs.

~~"Mass floors" where used as a component of the thermal envelope of a building shall provide one of the following weights:~~

~~1. 35 pounds per square foot (171 kg/m^2) of floor surface area.~~

~~2. 25 pounds per square foot (122 kg/m^2) of floor surface area where the material weight is not more than 120 pounds per cubic foot (1923 kg/m^3).~~

Exceptions:

1. The floor framing *cavity insulation* or structural slab insulation shall be permitted to be in contact with the top side of sheathing or continuous insulation installed on the bottom side of floor assemblies where combined with insulation that meets or exceeds the minimum *R*-value in Table C402.1.3 for “Metal framed” or “Wood framed and other” values for “Walls, above grade” and extends from the bottom to the top of all perimeter floor framing or floor assembly members.

2. Insulation applied to the underside of concrete floor slabs shall be permitted an airspace of not more than 1 inch (25 mm) where it turns up and is in contact with the underside of the floor under walls associated with the *building thermal envelope*.

Delete without substitution:
~~C402.2.4 Slabs-on-grade~~.

~~The minimum thermal resistance (*R*-value) of the insulation for unheated or heated slab-on-grade floors designed in accordance with the *R*-value method of Section C402.1.3 shall be as specified in Table C402.1.3.~~

Revise as follows:
~~C402.2.4.1~~ C402.2.4 ~~Insulation installation~~ Slabs-on-grade.
Where installed, the slab-on-grade perimeter insulation shall be placed on the outside of the foundation or on the inside of the foundation wall. The perimeter insulation shall extend downward from the top of the slab for the minimum distance shown in the table or to the top of the footing, whichever is less, or downward to not less than the bottom of the slab and then horizontally to the interior or exterior for the total distance shown in the table. Insulation extending away from the building shall be protected by pavement or by not less than 10 inches (254 mm) of soil. Where installed, full slab insulation shall be continuous under the entire area of the slab-on-grade floor, except at structural column locations and service penetrations. Insulation required at the heated slab perimeter shall not be required to extend below the bottom of the heated slab and shall be continuous with the full slab insulation.

Exception: Where the slab-on-grade floor is greater than 24 inches (61 mm) below the finished exterior grade, perimeter insulation is not required.

C402.2.5 Below-grade walls.
Below-grade wall insulation shall be installed between framing members, integral to the wall assembly, continuous on the wall assembly, or any combination of these insulation methods. ~~The *C*-factor for the below-grade exterior walls shall be in accordance with Table C402.1.4. The *R*-value of the insulating material installed continuously within or on the below-grade exterior walls of the building envelope shall be in accordance with Table C402.1.3.~~ The installed insulation ~~*C*-factor or *R*-value required~~ shall extend to a depth of not less than 10 feet (3048 mm) below the outside finished ground level, or to the level of the lowest floor of the conditioned space enclosed by the below-grade wall, whichever is less.
C402.2.6 Insulation of radiant heating systems.

Radiant heating system panels, and their associated components that are installed in interior or exterior assemblies, shall be insulated to an *R*-value of not less than R-3.5 on all surfaces not facing the space being heated. *Radiant heating system* panels that are installed in the *building thermal envelope* shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than the *R*-value of insulation installed in the opaque assembly in which they are installed or the assembly shall comply with Section C402.1.4.

Exception: Heated slabs on grade insulated in accordance with Section C402.2.4 and Section C402.1.

Reason Statement:

Sections C402.1, C402.1.3, C402.1.4, and C402.2 are in need of improvement and better coordination to address redundancies and misplaced requirements related to R-value or U-factor compliance versus basic installation or application requirements. This proposal does not change any requirements, but places requirements in their proper location for clarity and ease of use. In addition, redundant language or restatement of requirements already established are removed.

For example, alternative means for fenestration and skylight compliance mentioned in Section C402.1 are deleted because those requirements are already established in Section C401.2 and are not relevant when choosing to comply with Section C402.1. Requirements in Section C402.2 that are related to complying with R-values (Section C402.1.3) or U/C/F-factors (Section C402.1.4) are moved into those sections respectively. Table footnotes that provide important information for compliance are moved into text of those sections and clarified (such as reference to data and requirements in ASHRAE Appendix A). In some cases, editorial errors are identified and corrected. Finally, Section C402.2 is streamlined to focus on installation and application related matters pertaining to insulation installation and, consequently, R-value and U/C/F-factor compliance requirements are moved into Sections C402.1.3 or C402.1.4.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal is a formatting/clarification change and does not change requirements and should have no cost impacts. However, it could help improve efficiency and consistency of compliance and enforcement.

CEPI-27-21

CEPI-28-21

IECC®: SECTION C402, C402.1, C402.1.3, C402.1.4, TABLE C402.1.3, TABLE C402.1.4

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

SECTION C402 BUILDING ENVELOPE REQUIREMENTS
Revise as follows:
C402.1 General.

Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either ~~the *R*-value-based method of~~ Section C402.1.3; ~~the *U*-, *C*- and *F*-factor-based method of~~ Section C402.1.4; or ~~the component performance alternative of~~ Section C402.1.5.

2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.

3. Fenestration in building envelope assemblies shall comply with Section C402.4.

4. Air leakage of building envelope assemblies shall comply with Section C402.5.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

C402.1.4 ~~C402.1.3~~ Insulation component R-value alternatives ~~-based method~~.
Building thermal envelope opaque assemblies shall comply with the requirements of Sections C402.2 and C402.4 based on the *climate zone* specified in Chapter 3. For opaque portions of the *building thermal envelope* using this section as an alternative to Section C402.1.3 ~~intended to comply on an insulation component *R*-value basis~~, the *R*-values for cavity insulation and continuous insulation shall be not less than that specified in Table C402.1.4 ~~C402.1.3~~. Where cavity insulation is installed in multiple layers, the cavity insulation *R*-values shall be summed to determine compliance with the cavity insulation *R*-value requirements. Where continuous insulation is installed in multiple layers, the continuous insulation *R*-values shall be summed to determine compliance with the continuous insulation *R*-value requirements. Cavity insulation *R*-values shall not be used to determine compliance with the continuous insulation *R*-value requirements in Table C402.1.4 ~~C402.1.3~~. Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *R*-values from the "*Group R*" column of Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *R*-values from the "All other" column of Table C402.1.4 ~~C402.1.3~~.
C402.1.3 ~~C402.1.4~~ Assembly U-factor, C-factor or F-factor-based method.
Building thermal envelope opaque assemblies shall meet the requirements of Sections C402.2 and C402.4 based on the climate zone specified in Chapter 3. *Building thermal envelope* opaque assemblies ~~intended to comply on an assembly *U*-, *C*- or *F*-factor basis~~ shall have a *U*-, *C*- or *F*-factor not greater than that specified in Table C402.1.3 ~~C402.1.4~~. Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *U*-, *C*- or *F*-factor from the "*Group R*" column of Table C402.1.3 ~~C402.1.4~~. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *U*-, *C*- or *F*-factor from the "All other" column of Table C402.1.3 ~~C402.1.4~~.

TABLE C402.1.4 ~~C402.1.3~~ OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-

VALUE ALTERNATIVES ~~METHOD~~[a]

Portions of table not shown remain unchanged.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.3 ~~C402.1.4~~.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. “Mass floors” shall be in accordance with Section C402.2.3.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

TABLE C402.1.3 ~~C402.1.4~~ OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD[a, b]

Portions of table not shown remain unchanged.

Reason Statement:

This proposal places assembly U-factor approach as the primary approach for compliance since it is the basis for prescriptive R-value solutions. The R-value path is retained as an alternative to the U-factor approach and retains the same R-value requirements as before (consistent with the assembly U-factors). This proposal makes no criteria change but clarifies that R-values are to be derived from and be equivalent to the U-factors, C-factors, or F-factors. This proposal also makes the IECC consistent with similar action taken for the 2021 IRC.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not change current criteria.

CEPI-28-21

CEPI-29-21

IECC®: C402.1, C402.1.4.3 (New)

Proponents:

Duncan Brown, New York City Department of Buildings, representing New York City Department of Buildings

2021 International Energy Conservation Code

Revise as follows:
C402.1 General.

Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5. <u>When the total area of the penetrations from the through-the-wall mechanical equipment or equipment listed in Table C403.3.2(4) exceeds 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with the U-, C- and F-factor-based method of Section C402.1.4.</u>
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of building envelope assemblies shall comply with Section C402.5.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

Add new text as follows:
<u>C402.1.4.3</u> <u>Thermal Resistance of mechanical equipment penetrations</u>.

<u>When the total area of penetrations from through-the-wall mechanical equipment or equipment listed in Table C403.3.2(4) exceeds 1 percent of the opaque above-grade wall area, the mechanical equipment penetration area shall be calculated as a separate wall assembly with a default U-factor of 0.5.</u>

<u>**Exception:** Where mechanical equipment has been tested in accordance with testing standards approved by the department, the mechanical equipment penetration area may be calculated as a separate wall assembly with the U-factor as determined by such test.</u>

Attached Files

- **DESIGN OF EXPERIMENT TO EVALUATE THERMAL RESISTANCE OF A PTAC UNIT .pdf**
  http://localhost/proposal/171/646/files/download/94/
- **160106_PTAC Unit R-Value Memo_lk .pdf**
  http://localhost/proposal/171/646/files/download/34/
- **PTAC Envelope Study - SWA - 2016-06-06.pdf**
  http://localhost/proposal/171/646/files/download/33/

Reason Statement:

A tremendous amount of energy is lost with through-wall mechanical equipment penetrations in building envelopes. This proposal, which has been in effect in New York City since 2016, amends the code to require that these areas of lower thermal value are accounted for when demonstrating compliance.

Bibliography:

Design of Experiment to Evaluate Thermal Resistance of a PTAC Unit - Leylegian, Naraghi et al., Proceedings of the 2011 International Mechanical Engineering Congress and Exposition, IMEC2011-65030

Cost Impact:

The code change proposal will increase the cost of construction.

While there is increased construction cost compensating for the areas of lower insulation value, even with dated numbers, there is a simple payback period followed by improved overall performance.

CEPI-29-21

CEPI-30-21

IECC®: SECTION 202 (New), C402.1, C402.1.6 (New), ACI (New)

Proponents:

Martha VanGeem, representing Masonry Alliance for Codes and Standards; Jason Thompson, representing National Concrete Masonry Association (jthompson@ncma.org); Charles Clark Jr, representing Brick Industry Association (cclark@bia.org); Scott Campbell, representing NRMCA (scampbell@nrmca.org); Stephen Szoke, representing American Concrete Institute (steve.szoke@concrete.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 THERMAL BRIDGE. A material or component having a higher thermal conductivity penetrating through a material or component having a lower thermal conductivity. Thermal bridges include concrete and steel penetrating insulation.
Revise as follows:
C402.1 General.

Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5. Thermal bridges in concrete and masonry walls and walls with masonry veneers shall comply with Section C402.1.6.

2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.

3. Fenestration in building envelope assemblies shall comply with Section C402.4.

4. Air leakage of building envelope assemblies shall comply with Section C402.5.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

Add new text as follows:
C402.1.6 Thermal Bridge Mitigation for Concrete and Masonry Walls and Masonry Veneers.

Thermal bridges in concrete and masonry walls and walls with masonry veneers shall comply with ACI Code 122.1.

ACI American Concrete Institute 38800 Country Club Dr. Farmington HIlls MI 48331
ACI American Concrete Institute.

ACI Code 122.1-2021 Thermal Bridge Mitigation for Buildings Having Concrete and Masonry Walls and Masonry Veneer—Code Requirements

Reason Statement:

This proposal adds new thermal bridge mitigation requirements to the IECC commercial for concrete and masonry walls and walls with masonry veneers. The code that is referenced as the requirement is ACI Code 122.1. It includes requirements at slab edges, for parapets, and for shelf angles. The new code includes a prescriptive method, building envelope tradeoff method, and a whole building simulation method. It was developed under the ANSI standards process for a code for the American Concrete Institute (ACI), including a public comment process.

In this proposal, it is inserted in a new section within the insulation section, since thermal bridges are commonly higher thermal conductivity materials such as concrete and steel that penetrate the lower thermal conductivity insulation. However, if other thermal bridge mitigation proposals are submitted, it could be an alternate path to those.

A definition of a thermal bridge is included. ACI 122.1 is also added to the reference section.

It is not unusual for the IECC to have separate criteria for separate kinds of walls systems developed by an industry following ANSI procedures. Section R402.1 has an exception for log homes designed according to ICC 400, Standard on the Design and Construction of Log Structures.

The benefit of this standard is that it provides constructible options, and it is easy to understand and implement. This will lead to better adoption, compliance by industry, and enforcement by code officials.

Cost Impact:

The code change proposal will increase the cost of construction.

This will increase the cost of construction in a cost effective manner. It is anticipated that the committee will receive other thermal bridge mitigation proposals. This standard is most likely more cost effective than those. Other proposals may indicate that they have no increase in cost since the code already requires mitigation of thermal bridges.

CEPI-30-21

CEPI-31-21

IECC®: C402.1, C402.3 (New)

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:
C402.1 General.

Building thermal envelope assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5.

2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.

~~2.~~3. Roof solar reflectance and thermal emittance shall comply with Section ~~C402.3~~C402.4.

~~3.~~4. Fenestration in building envelope assemblies shall comply with Section ~~C402.4~~C402.5.

~~4.~~5. Air leakage of building envelope assemblies shall comply with Section ~~C402.5~~C402.6.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

Add new text as follows:
C402.3 Above Grade Wall Solar Reflectance.

For Climate Zone 0, above-grade east-oriented, south-oriented, and west-oriented walls shall comply with either of the following:

1. A minimum of 75% of the above grade wall area shall have a minimum area-weighted initial solar reflectance of 0.30 when tested in accordance with ASTM C1549 with AM1.5GV output or ASTM E903 with the AM1.5GV output or determined in accordance with generally accepted engineering standards; and a minimum emittance or emissivity of 0.75 when tested in accordance with ASTM C835, C1371, E408, or determined in accordance with *generally accepted engineering standards.* For the portion of the above grade wall that is glass spandrel area, a minimum solar reflectance of 0.29 determined in accordance with NFRC 300 or ISO 9050 shall be permitted. Area-weighting is permitted only between the south-, east-, and west-oriented walls and only between walls of the same occupancy classification.
2. A minimum of 30% of the above-grade wall area shall be shaded through the use of manmade structures, existing buildings, hillsides, permanent building projections, on-site renewable energy systems, or a combination of these. Shade coverage shall be calculated by projecting the shading surface downward on the above grade wall at an angle of 45 degrees.

Exception: Above grade walls of low energy buildings, greenhouses and equipment buildings.

Reason Statement:

The proposal adds requirements for south-, east-, and west-facing walls to have a minimum solar reflectance of 0.30 in Climate Zone 0. Thermal emittance values do not vary much for opaque, nonmetallic surfaces. A minimum value of 0.75 is sufficient and can be demonstrated by published values or testing. The main reason to have 0.75 backstop is to avoid shiny bare metal, which can become hot.

For solar reflectance, three options have been provided for measurement: (1) ASTM C1549 with air mass 1.5 global vertical (AM1.5GV) output (labeled “1.590” for air mass 1.5, 90 degree tilt in an upgrade to the Devices and Services Solar Spectrum Reflectometer v6, available from its manufacturer); (2) ASTM E903, using the AM1.5GV solar spectral irradiance to weight near normal-hemispherical solar spectral reflectance; or (3) the “G197GT90” output of the Surface Optics 410-Solar-i Hemispherical Reflectometer, operated following Appendix 9 of the CRRC-1 Program Manual (https://coolroofs.org/documents/CRRC-1_Program_Manual.pdf). All three options are based on the global solar spectral irradiance for a 90 degree sun-facing tilted surface specified in ASTM G197.

For emittance, ASTM C1371 is the simplest and least expensive measurement method but other options have been provided.

Initial reflectance is specified because there isn't a fully developed measurement technique for measuring aged wall reflectance. Preliminary testing shows that walls become much less dirty than roofs because they are vertical surfaces.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum s.

https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Levinson, R., et. al., “Solar Reflective “Cool” Walls: Benefits, Technologies, and Implementation,” State of California, California Energy Commission, Sacramento, CA, Report CEC-500-2019-040, April 2019.

Cost Impact:

The code change proposal will increase the cost of construction.

For climate zone 0 the cost of construction may increase in the short term as these requirements are new and the availability of products may be limited. For all other climate zones this proposal will have no impact. However, long term the cost impact will most likely be reduced as more manufacturers produce products to meet demand, and as testing and reporting opportunities become available, such as the Cool Roof Rating Council's new program for Cool Wall Rating Program, which is currently under construction.

However, it should be noted that there are many products on the market that currently meet these thresholds.

CEPI-31-21

CEPI-32-21

IECC®: SECTION 202 (New), C402.1, C402.5, C402.5.1, C402.5.1.1, C402.5.1.2, C402.5.1.5, C402.5.3, C402.5.2, C402.5.8, C402.5.11, C406.1, TABLE C406.1(1), TABLE C406.1(2), TABLE C406.1(3), TABLE C406.1(4), TABLE C406.1(5), C406.9

Proponents: Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Add new definition as follows:

AIR LEAKAGE. The uncontrolled air flow through the building thermal envelope caused by pressure differences across the building thermal 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.

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of the *building thermal envelope* ~~building envelope assemblies~~ shall comply with Section C402.5.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

C402.5 Air leakage—thermal envelope. The *building thermal envelope* shall comply with Sections C402.5.1 through Section C402.5.11.1, or the ~~building~~ *building thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9.

C402.5.1 Air barriers. A continuous ~~air barrier~~ *air barrier* shall be provided throughout the *building thermal envelope*. The continuous ~~air barriers~~ *air barrier* shall be located on the inside or outside of the ~~building thermal envelope~~ *building thermal envelope*, located within the assemblies composing the ~~building thermal envelope~~ *building thermal envelope*, or any combination thereof. The ~~air barrier~~ *air barrier* shall comply with Sections C402.5.1.1, and C402.5.1.2.

Exception: ~~Air barriers~~ *Air barriers* are not required in buildings located in *Climate Zone* 2B.

C402.5.1.1 Air barrier construction. The *continuous air barrier* shall be constructed to comply with the following:

1. The ~~air barrier~~ *air barrier* shall be continuous for all assemblies that ~~are~~ comprise the ~~thermal envelope of the building~~ *building thermal envelope* and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Penetrations of the ~~air barrier~~ *air barrier* shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.5.10. Where similar objects are installed that penetrate the ~~air barrier~~ *air barrier*, provisions shall be made to maintain the integrity of the ~~air barrier~~ *air barrier*.

C402.5.1.2 . A continuous ~~air barrier~~ *air barrier* for the ~~opaque building envelope~~ *building thermal envelope* shall comply with the following:

1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.

Exception: Buildings in Climate Zones 2B, 3C and 5C.

2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.

   Exceptions:

   1. Buildings in Climate Zones 2B, 3B, 3C and 5C.
   2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.
   3. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

C402.5.1.5 Building envelope performance verification. The installation of the continuous ~~air barrier~~ *air barrier* shall be verified by the *code official*, a *registered design professional* or *approved* agency in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section C402.5.1.
2. Inspection of continuous ~~air barrier~~ *air barrier* components and assemblies shall be conducted during construction while the ~~air barrier~~ *air barrier* is still accessible for inspection and repair to verify compliance with the requirements of Sections C402.5.1.3 and C402.5.1.4.
3. A final commissioning report shall be provided for inspections completed by the *registered design professional* or *approved* agency. The commissioning report shall be provided to the building owner or owner's authorized agent and the *code official*. The report shall identify deficiencies found during the review of the construction documents and inspection and details of corrective measures taken.

C402.5.3 Building thermal envelope testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured ~~air leakage~~ *air leakage* shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured ~~air leakages~~ *air leakages* shall be area weighted by the surface areas of the ~~building envelope~~ *building thermal envelope* in each portion. The weighted average test results shall not exceed the whole building *air leakage* ~~leakage~~ limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire ~~envelope~~ *building thermal envelope* area of all stories that have any spaces directly under a roof.
2. The entire ~~envelope~~ *building thermal envelope* area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the ~~building~~ *building thermal envelope* totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

Exception: Where the measured ~~air leakage~~ *air leakage* rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the ~~air barrier~~ *air barrier.* Any leaks noted shall be sealed where 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 comply with the requirements of this section.

C402.5.2 Dwelling and sleeping unit enclosure testing. The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured ~~air leakage~~ *air leakage* shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building ~~air leakage~~ *air leakage* shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

C402.5.8 Loading dock weather seals. Cargo door openings and loading door openings shall be equipped with weather seals that restrict ~~infiltration~~ *air leakage* and provide direct contact along the top and sides of vehicles that are parked in the doorway.

C402.5.11 Operable openings interlocking. Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 m^2) in area, such openings shall be interlocked with the heating and cooling system so as to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.

Exceptions:

1. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
2. Warehouses that utilize overhead doors for the function of the occupancy, where approved by the code official.
3. The first entrance doors where located in the exterior wall and are part of a vestibule system.

Revise as follows:

C406.1 Additional energy efficiency credit requirements. New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced ~~air infiltration~~ *air leakage* in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.

TABLE C406.1(1) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pumpwater heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced ~~air infiltration~~ *air leakage*	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

TABLE C406.1(2) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406.2.2: 5% cooling efficiency improvement	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% cooling efficiency improvement	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3: Reduced lighting power	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C406.4: Enhanced digital lighting controls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: On-site renewable energy	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.2: Recovered or renewable water heating	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Reduced ~~air infiltration~~ *air leakage*	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3
C406.10: Energy monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.11: Fault detection and diagnostics system	1	1	1	1	1	1	NA	1	1	NA	1	1	NA	1	1	1	1

NA = Not Applicable.

TABLE C406.1(3) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP E OCCUPANCIES

SECTION	CLIMATE ZONE															
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	4
C406.2.2: 5% cooling efficiency improvement	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	3	4	3	4	3	4	3	5	7
C406.2.4: 10% cooling efficiency improvement	7	8	7	6	5	4	3	4	3	1	2	2	1	2	2	2	1
C406.3: Reduced lighting power	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
C406.5: On-site renewable energy	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
C406.6: Dedicatedoutdoor air system	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.2: Recoveredor renewable water heating[a]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.7.3: Efficient fossil fuel water heater[a]	NA	1	1	1	1	1	1	2	2	3	2	3	2	3	3	3	5
C406.7.4: Heat pump water heater[a]	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1	1	1	1
C406.8: Enhanced envelope performance	3	7	3	4	2	4	1	1	3	1	2	3	NA	4	3	6	9
C406.9: Reduced ~~air infiltration~~ *air leakage*	1	1	1	2	NA	NA	NA	NA	NA	NA	1	NA	NA	4	1	4	3
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	2	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2

NA = Not Applicable.

a. For schools with showers or full-service kitchens.

TABLE C406.1(4) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP M OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	NA	1	1	2	2	2	2	3	2	3	4
C406.2.2: 5% cooling efficiency improvement	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	4	3	4	5	5	3	6	8
C406.2.4: 10% cooling efficiency improvement	9	12	9	8	6	6	3	4	4	1	2	3	NA	2	2	2	1
C406.3: Reduced lighting power	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12
C406.4: Enhanced digital lighting controls	3	3	4	3	4	3	4	4	4	3	3	3	3	4	4	3	3
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
C406.6: Dedicated outdoor air system	3	4	3	3	3	3	1	3	2	2	2	3	2	4	3	4	4
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pump water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	4	6	3	4	3	3	1	6	4	4	4	5	4	6	5	8	9
C406.9: Reduced ~~air infiltration~~ *air leakage*	1	1	1	2	1	1	NA	3	1	1	3	2	1	7	3	6	3
C406.10: Energy monitoring	4	5	5	5	5	4	4	4	4	3	3	4	3	4	4	4	3
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2

NA = Not Applicable.

TABLE C406.1(5) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR OTHER[a] OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	3
C406.2.2: 5% cooling efficiency improvement	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	3	3	3	3	4	3	5	5
C406.2.4: 10% cooling efficiency improvement	8	9	8	7	5	5	3	4	4	2	2	3	2	2	2	2	2
C406.3: Reduced lighting power	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	8	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	3	2	5	3	3	5	4	3	7	5	7	6
C406.7.2: Recovered or renewable water heating [b]	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater [b]	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater [b]	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	4	3	4	1	5	4	3	5	5	4	7	6	9	10
C406.9: Reduced ~~air infiltration~~ *air leakage*	3	2	2	4	4	2	NA	6	2	2	6	4	1	10	5	7	4
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	3	2	3	2	2	2	3	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

a. Other occupancy groups include all groups except Groups B, E, I, M and R.

b. For occupancy groups listed in Section C406.7.1.

C406.9 Reduced ~~air infiltration~~ air leakage. ~~Air infiltration~~ *Air leakage* shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured ~~air leakage rate~~ *air leakage* of the ~~building envelope~~ *building thermal envelope* shall not exceed 0.25 cfm/ft^2 (2.0 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exception: For buildings having over 250,000 square feet (25 000 m^2) of *conditioned floor area*, ~~air leakage~~ *air leakage* testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.

Reason: The purpose of this proposal is to introduce correct terminology and to standardize it throughout the code:

- The current term, *air infiltration*, is replaced with *air leakage*. As noted in the proposed definition air leakage can occur either as infiltration or exfiltration and both directions have energy efficiency implications. Furthermore, the new term, *air leakage* and its definition are consistent with the ASHRAE 90.1 Addendum t and expected to be included in ASHRAE 90.1.Therefore, this terminology change will provide consistency across the key industry documents and will enable clarity of the code.
- Additionally, the code is updated to make sure the already defined terms *building thermal envelope* and *air barrier* are used consistently throughout the document.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed changes are to improve clarity of the code by making the terminology consistent throughout the document and consistent with other industry documents.

CEPI-33-21

IECC®: SECTION 202 (New), C402.1, C402.6 (New), C402.6.1 (New), C402.6.2 (New), C402.6.3 (New), C402.6.4 (New), C402.6.5 (New), TABLE C407.2

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Add new definition as follows:

THERMAL BRIDGE. A building material or element that interrupts the *building thermal envelope* and has a greater thermal conductivity than the *building thermal envelope* insulation.

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the *R*-value-based method of Section C402.1.3; the *U*-, *C*- and *F*-factor-based method of Section C402.1.4; or the component performance alternative of Section C402.1.5.
2. Roof solar reflectance and thermal emittance shall comply with Section C402.3.
3. Fenestration in building envelope assemblies shall comply with Section C402.4.
4. Air leakage of building envelope assemblies shall comply with Section C402.5.
5. *Thermal bridges* in *above-grade walls* shall comply with Section C402.6

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.4, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.11.

Add new text as follows:

C402.6 Thermal bridges in above-grade walls. *Thermal bridges* in above-grade walls shall be mitigated in accordance with this section.

Exceptions:

1. Climate Zones 0 through 3.
2. A *thermal bridge* with a material thermal conductivity of 3.0 Btu-in/hr-ft^2-F or less.
3. An *approved* design to mitigate the t*hermal bridges* covered by this section.

C402.6.1 Balconies, slabs, and decks. Balconies, slabs, and decks shall not penetrate the *building thermal envelope*. Such horizontal assemblies shall be separately supported or shall be supported by designed structural attachments that minimize *thermal bridges*.

Exception: Concrete slabs shall be permitted to fully penetrate the building thermal envelope where:

1. An area-weighted U-factor is used for above-grade wall compliance and includes a *U*-factor of 0.8 Btu/hr-F-ft^2 for the area of the above-grade wall interrupted by the slab penetration, or
2. A minimum R-10 structural thermal break is installed in accordance with the manufacturer's instructions and an *approved* design.

C402.6.2 Cladding supports. Cladding support elements, other than fasteners, shall not continuously penetrate *continuous insulation*. Cladding supports shall be off-set from the structure with attachments that allow the full thickness of *continuous insulation* to pass behind the cladding support element to minimize *thermal bridges*.

Exception: Where the *above-grade wall U*-factor used for compliance accounts for the cladding support system *thermal bridge* by an *approved* design.

C402.6.3 Structural beams and columns. Structural steel and concrete beams and columns that penetrate the *building thermal envelope* shall be encapsulated with a minimum R-5 insulation for a distance of at least 2 feet along the length of the beam or column beyond the interior or exterior surface of the *building thermal envelope* assembly. Alternatively, a structural thermal break shall be installed in accordance with the manufacturer's instructions and an *approved* design.

Exception: Where the *above-grade wall* U-factor used for compliance accounts for the beam or column *thermal bridges* by an *approved* design

Exception: Where the *above-grade wall* U-factor used for compliance accounts for the beam or column *thermal bridges* by an *approved* design.

C402.6.4 Vertical fenestration.. Vertical fenestration shall be installed in the *building thermal envelope* in accordance with one of the following:

1. Where *above-grade walls* include *continuous insulation*, the exterior glazing layer or a fenestration frame thermal break shall be positioned within 2 inches (5.08 cm) of the interior or exterior surface of the continuous insulation.
2. Where *above-grade walls* do not include *continuous insulation*, the exterior glazing layer or a fenestration frame thermal break shall be positioned within the thickness of the integral or *cavity insulation*.
3. The surface of the rough opening not covered by the fenestration frame shall be insulated with a minimum R-3 material or a minimum 1.5-inch-thick (3.81 cm) wood buck shall be permitted as an alternative.
4. An *approved* design where the *above-grade wall* U-factor used for compliance accounts for *thermal bridges* at the perimeter of vertical fenestration rough openings.

C402.6.5 Parapets. Parapets shall comply with one of the following:

1. Where *continuous insulation* is installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the *continuous insulation* shall extend up both sides of the parapet.
2. Where *continuous insulation* is installed on the exterior side of the *above-grade wall* and the roof insulation is below the roof deck, the *continuous insulation* shall extend up the exterior side of the parapet.
3. Where *continuous insulation* is not installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the wall insulation shall be extended into the parapet up to the top of the roof insulation or shall be extended a minimum of 2 feet horizontally inward on the underside of the roof deck.
4. Where *continuous insulation* is not installed on the exterior side of the *above-grade wall* and the roof insulation is below the roof deck, the wall and roof insulation components shall abut at the roof-ceiling-wall intersection.
5. An *approved* design where the *above-grade wall U*-factor used for compliance accounts for the parapet *thermal bridge*.

Revise as follows:

TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

Portions of table not shown remain unchanged.

SECTION [a]	TITLE
Envelope	
C402.5	Air leakage—thermal envelope
C402.6	Thermal bridges in above-grade walls

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Reason: In the 2021 IECC, the definition for above-grade wall (shown below) was changed in a way that creates a need to address thermal bridging at intersections of above-grade walls with floors, roofs, and fenestration.

"WALL, ABOVE-GRADE.

A wall associated with the *building thermal envelope* that is more than 15 percent above grade and is on the exterior of the building or any wall that is associated with the *building thermal envelope* that is not on the exterior of the building**. This includes, but is not limited to, between-floor spandrels, peripheral edges of floors, roof knee walls, dormer walls, gable end walls, walls enclosing a mansard roof and skylight shafts."*[bold added for emphasis]***

In prior and IECC editions, the thermal performance impact of these major thermal bridging conditions have been completely ignored with no guidance provided to mitigate them. Depending on structural material type and quantity of thermal bridging based on structural configuration or detailing, these ignored thermal bridging conditions can decrease the assumed or idealized thermal performance of the opaque building envelope assemblies by as much as 20% to 70% with significant whole building energy use impacts (BC Hydro, 2020).

Now that the above-grade wall definition is updated to bring appropriate attention to these thermal bridging conditions that are effectively part of the above-grade wall (or at least directly affect its actual performance), guidance is needed in the body of the code to support compliance with the new definition for above-grade walls. This guidance will also support other important aspects of building design such as properly understanding building envelope loads such that HVAC equipment can be properly and efficiently sized. Mitigating these thermal bridges also has other benefits than just energy savings, such as helping to control condensation and mold growth in or on building envelope assemblies (which also can help improve structural durability and occupant comfort and health).

The objective of this proposal is straight-forward: develop a simple, prescriptive, effective, and flexible means to begin to address and reasonably mitigate the effects of major thermal bridges now identified in the new definition for above-grade walls. To support this effort, various thermal bridging studies, detailing guides, and provisions developed domestically and internationally were reviewed to help inform and refine this proposal (e.g., BC Hydro, 2020; Morrison-Hershfield, 2011; ISO, 2007; AISC/SEI, 2012; USACE, 2015; Payette/AIA, 2014; etc.).

While there are many and varied thermal bridging conditions to consider (and as many different possible solutions), this proposal focuses only those that have significant impact and which also have practical and available means to effectively mitigate the thermal bridge. Alternative means and methods are permitted with an approved design to avoid any unnecessary restriction or inflexibility. It is felt that this is an appropriately abbreviated and enforceable way to address this topic in the energy code.

Bibliography: BC Hydro, Thermal Bridging Guide, Version 1.5, 2020, https://www.bchydro.com/powersmart/business/programs/new-construction.html#thermal

Morrison Hershfield Ltd. (2011). ASHRAE 1365-RP Thermal Performance of Building Envelope Construction Details for Mid- and High-Rise Buildings. Atlanta, GA: American Society of Heating, Refrigeration and Air-Conditioning Engineers Inc

ISO Standard 14683: 2007, Thermal Bridges in Building Construction – Linear thermal transmittance (simplified methods and default Chi-factors).

AISC/SEI, Thermal Bridging Solutions: Minimizing Structural Steel's Impact on Building Envelope Energy Transfer, A Supplement to Modern Steel Construction, March 2012, American Institute for Steel Construction (AISC) & Structural Engineering Institute (SEI).

USACE, "Development of Thermal Bridging Factors for Use in Energy Models," ERDC/CERL TR-15-10, June 2015, U.S. Army Corp of Engineers, Engineer Research and Development Center, Construction Engineering Research Laboratory.

Payette/AIA, Thermal Performance of Facades, 2012, AIA Upjohn Grant Research Initiative, Payette, Boston, MA, November 2014.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
As much as 20% to 75% of the energy loss through the opaque building envelope is associated with ignored or inadequately mitigated thermal bridges caused by intersections of roofs, floors, and fenestration with the above-grade exterior wall (BC Hydro, 2020). This currently unaccounted heat loss accounts for a significant portion of whole building annual energy use and also results in improperly sized mechanical equipment which impacts energy use and cost, among other things such as moisture control, comfort, and durability of the structure.

This proposal provides provisions needed to comply with and enforce the code (as already required by the above-grade wall definition) and to mitigate significant whole building energy losses that are happening in practice due to thermal bridging. But, the proposal does not go so far as the code currently requires in the definition of “above-grade wall” to make up for energy losses for unmitigated thermal bridges as well as those that are mitigated (yet still increase heat loss of the building thermal envelope). In this proposal, if the thermal bridges are reasonably mitigated (as proposed) the remaining difference will not need to be made up with additional insulation or other trade-offs to compensate for the thermal bridges. In this sense, the proposal may be considered as reducing cost.

CEPI-34-21

IECC®: C402.1.1, C402.1.1.1 (New), C402.1.1.1, TABLE C402.1.1.1, C402.1.2

Proponents: Leonard Sciarra, representing Sciarra Architecture & Planning (leonard.sciarra@gmail.com)

2021 International Energy Conservation Code

Revise as follows:

C402.1.1 Low-energy buildings and greenhouses. The following low-energy buildings, or portions thereof separated from the remainder of the building by *building thermal envelope* assemblies complying with this section, shall be exempt from the *building thermal envelope* provisions of Section C402.

1. ~~Those with a peak design rate of energy usage less than 3.4 Btu/h × ft^2 (10.7 W/m^2) or 1.0 watt per square foot (10.7 W/m^2) of floor area for space conditioning purposes.~~
2. ~~Those that do not contain *conditioned space.*~~

Add new text as follows:

C402.1.1.1 Low-energy buildings. Buildings that comply with either of the following:

1. Those with a peak design rate of energy usage less than 3.4 Btu/h × ft^2 (10.7 W/m^2) or 1.0 watt per square foot (10.7 W/m^2) of floor area for space conditioning purposes.
2. Those that do not contain *conditioned space.*

Revise as follows:

~~**C402.1.1.1**~~ **C402.1.1.2 Greenhouses.** Greenhouse structures or areas that are mechanically heated or cooled and that comply with all of the following shall be exempt from the building envelope requirements of this code:

1. Exterior opaque envelope assemblies comply with Sections C402.2 and C402.4.5.

   Exception: Low energy greenhouses that comply with Section C402.1.1.

2. Interior partition *building thermal envelope* assemblies that separate the greenhouse from *conditioned space* comply with Sections C402.2, C402.4.3 and C402.4.5.
3. Fenestration assemblies that comply with the thermal envelope requirements in Table C402.1.1.1. The *U*-factor for a roof shall be for the roof assembly or a roof that includes the assembly and an *internal curtain system*.

   Exception: Unconditioned greenhouses.

TABLE ~~C402.1.1.1~~ C402.1.1.2 FENESTRATION THERMAL ENVELOPE MAXIMUM REQUIREMENTS

COMPONENT	*U*-FACTOR (BTU/h × ft^2 × °F)
Skylight	0.5
Vertical fenestration	0.7

~~C402.1.2~~ C402.1.3 Equipment buildings. Buildings that comply with the following shall be exempt from the *building thermal envelope* provisions of this code:

1. Are separate buildings with floor area not more than 1,200 square feet (110 m^2).
2. Are intended to house electric equipment with installed equipment power totaling not less than 7 watts per square foot (75 W/m^2) and not intended for human occupancy.
3. Have a heating system capacity not greater than (17,000 Btu/hr) (5 kW) and a heating thermostat setpoint that is restricted to not more than 50°F (10°C).
4. Have an average wall and roof *U*-factor less than 0.200 in *Climate Zones* 1 through 5 and less than 0.120 in *Climate Zones* 6 through 8.
5. Comply with the roof solar reflectance and thermal emittance provisions for *Climate Zone* 1.

Reason: This proposal cleans up the list of buildings that have unique envelope requirements so they all have their unique sections.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
this proposal does not change requirements

CEPI-35-21

IECC®: TABLE C402.1.3

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]

Portions of table not shown remain unchanged.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or more ~~less~~ on center vertically and 48 inches or more ~~less~~ on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. “Mass floors” shall be in accordance with Section C402.2.3.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

Reason Statement:

The spacing of grouted masonry cores should be 32"oc or 48"oc or MORE, not LESS. If less it would allow fully grouted concrete masonry with no cores available for integral insulation as addressed by footnote 'c'. This may be an editorial or inadvertent error from some time ago, but it should be corrected.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is a correction of an obvious editorial error with technical implications. However, in my understanding folks are tending to read or apply the intent of footnote 'c' correctly even though it is written incorrectly.

CEPI-35-21

CEPI-36-21

IECC®: TABLE C402.1.3

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]

Portions of table not shown remain unchanged.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the R-value ~~exterior insulation~~ requirements for above-grade mass walls ~~heated slabs~~.

e. “Mass floors” shall be in accordance with Section C402.2.3.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

Reason Statement:

Footnote ‘d’ in Table C402.1.3 is incorrect and also inconsistent with the same topic addressed in footnote ‘c’ of Table C402.1.4 which reads as follows: "c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls." Therefore, this proposal revises footnote ‘d’ of Table C402.1.4 to align with footnote ‘c’ of Table C402.1.4. The intent is that the below-grade walls be insulated in accordance with the insulation requirements for above-grade mass walls when the below-grade floor is a heated slab.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal makes the two footnotes in the R-value and U-factor tables consistent and in net effect may actually reduce cost for the case of a below-grade heated slab and walls complying with R-value requirements.

CEPI-36-21

CEPI-37-21

IECC®: TABLE C402.1.3

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]

Portions of table not shown remain unchanged.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. “Mass floors” shall be in accordance with Section C402.2.3.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation <u>and full-slab insulation components shall be installed in accordance with Section C402.2.4.1</u> ~~is not required to extend below the bottom of the slab~~.

Reason Statement:

Footnote g includes installation guidance for insulating heated slabs that is incomplete and potentially conflicts with the newly added Section C402.2.4.1. The current footnote misses important information in Section C402.2.4.1 such as the requirement that the under-slab and perimeter slab insulation be continuous. Referencing Section C402.2.4.1 in footnote ‘g’ resolves this disconnect in updating the code last cycle.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This revision is a clarification to coordinate with slab insulation installation provisions revised last code cycle. It does not change requirements.

CEPI-37-21

CEPI-38-21

IECC®: TABLE C402.1.3

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]

Portions of table not shown remain unchanged.

CLIMATE ZONE	**0 AND 1**		**2**		**3**		**4 EXCEPT MARINE**		**5 AND MARINE 4**		**6**		**7**		**8**	
	All other	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**
Walls, above grade																
Metal framed[h]	R-0 + R-10ci or R-13 + R-5ci or R-20 + R-3.8ci	R-0 + R-10ci or R-13 + R-5ci or R-20 + R-3.8ci	R-0 + R-10ci or R-13 + R-5ci or R-20 + R-3.8ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-12.6ci or R-13 + R-7.5ci or R-20 + R-6.3ci	R-0 + R-15.2ci or R-13 + R-10ci or R-20 + R-9ci	R-0 + R-15.2ci or R-13 + R-10ci or R-20 + R-9ci	R-0 + R-17.3ci or R-13 + R-12.5ci or R-20 + R-11ci	R-0 + R-17.3ci or R-13 + R-12.5ci or R-20 + R-11ci	R-0 + R-17.3ci or R-13 + R-12.5ci or R-20 + R-11ci	R-0 + R-21ci or R-13 + R-15.6ci or R-20 + R-14.3ci	R-0 + R-24ci or R-13 + R-18.8ci or R-20 + R-17.5ci	R-0 + R-24ci or R-13 + R-18.8ci or R-20 + R-17.5ci
Wood framed and other[h]	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 +R-12ci or R-13 + R-3.8ci or R-20	R-0 + R-12ci or R-13 + R-3.8ci or R-20	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 +R-16ci or R-13 + R-7.5ci or R20 + R3.8ci or R-27	R-0 + R-27.5ci or R-13 + R-18.8ci or R-20 +	R-0 + R-27.5ci or R-13 + R-18.8ci or R-20 + R-14ci

									ci or R-27						R-14ci	

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. “Mass floors” shall be in accordance with Section C402.2.3.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

h. The first value is cavity insulation; the second value is continuous insulation. Therefore, “R-0+R-12ci” means R-12 continuous insulation and no cavity insulation; “R-13+R-3.8ci” means R-13 cavity insulation and R-3.8 continuous insulation; “R-20” means R-20 cavity insulation and no continuous insulation. R-13, R-20, and R-27 cavity insulation as used in this table apply to a nominal 4-inch, 6-inch, and 8-inch deep wood or cold-formed steel stud cavities, respectively.

Reason: This proposal does not change the stringency of the insulation requirements for walls. It provides additional equivalent prescriptive R-value options for all climate zones that address the three primary insulation strategies or locations on framed assemblies (cavity insulation only, cavity + continuous insulation, and continuous insulation only). For these common strategies for insulation, the user should not be required to do calculations or reference U-factor tables in a separate document, Appendix A of ASHRAE 90.1. Similar action was taken and is now included in 2021 IECC-R for wall R-values. The calculations and assumptions are exactly the same as used for existing values in the table and are available to the committee upon request.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

This proposal merely adds options for user without requiring calculations (which may reduce costs).

CEPI-38-21

CEPI-39-21

IECC®: TABLE C402.1.3

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]

Portions of table not shown remain unchanged.

CLIMATE ZONE
Roofs
Insulation entirely above roof deck
Metal buildings[b]
Attic ~~and other~~
Walls, above grade
Mass[f]
Metal building
Cold-formed steel ~~Metal~~ framed
Wood framed ~~and other~~

Reason Statement:

This proposal does two things to clarify appropriate application of the table:

First, “other” framing or building systems likely have different structural materials and thermal bridging impacts that can only be accounted for in the U-factor path. It is inappropriate to include a broad category for “and other” with the R-values in Table C402.1.3 which presume and are based on specific framing conditions. Such “other” roof or wall assemblies may have completely different structural material properties and structural configurations that depart by uncertain amounts from those assumed in deriving the required R-values. It is only appropriate for these unknown systems to comply using the U-factor approach. Thus, the “wood framed and other” and the “Attic and other” categories are retained only in the U-factor Table C402.1.4.

Second, the R-value solutions in Table C402.1.3 for “metal framed” walls are based on cold-formed steel framing, not other types of metal framing (e.g., stainless steel or aluminum) that may have lower or higher thermal conductivities significantly affecting the thermal bridging through framing which can only be accounted for in the U-factor approach. Thus, “metal framed” is not changed in the U-factor Table C402.1.4 because this is the compliance path that should be used with unlimited metal framing materials (including carbon steel, aluminum, stainless or others).

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal is a clarification of how the provisions are to be applied correctly. It does not change the stringency of the provisions.

CEPI-39-21

CEPI-40-21

IECC®: TABLE C402.1.3, TABLE C402.1.4, C402.6 (New), C402.6.1 (New), C402.6.2 (New), C402.6.3 (New), TABLE C402.6 (New)

Proponents:

Paula Zimin, representing Paula Zimin (pzimin@swinter.com); Gayathri Vijayakumar, representing Steven Winter Associates, Inc. (gvijayakumar@swinter.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.1.3
OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD[a]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	R-20ci	R-25ci	R-25ci	R-25ci	R-25ci	R-25ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-30ci	R-35ci	R-35ci	R-35ci	R-35ci
Metal buildings[b]	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-19 + R-11 LS	R-25 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-30 + R-11 LS	R-25 + R-11 + R-11 LS	R-25 + R-11 + R-11 LS
Attic and other	R-38	R-38	R-38	R-38	R-38	R-38	R-49	R-49	R-49	R-49	R-49	R-49	R-60	R-60	R-60	R-60
Walls, above grade																
Mass[f]	R-5.7	R-5.7	R-5.7	R-7.6	R-7.6	R-9.5	R-9.5	R-11.	R-11.	R-13.	R-13.	R-15.	R-15.	R-15.	R-25c	R-25c

	ci[c]	ci[c]	ci[c]	ci	ci	ci	ci	4ci	4ci	3ci	3ci	2ci	2ci	2ci	i	i
Metal building	R-13 + R-6.5 ci	R-13 + R-6.5 ci	R13 + R-6.5 ci	R-13 + R-13ci	R-13 + R-6.5 ci	R-13 + R-13ci	R-13 + R-13ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-14ci	R-13 + R-17ci	R-13 + R-19.5ci	R-13 + R-19.5ci	R-13 + R-19.5ci
Metal framed	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-5ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci	R-13 + R-7.5 ci	R-13 + R-10ci	R-13 + R-10ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-12.5ci	R-13 + R-15.6ci	R-13 + R-18.8ci	R-13 + R-18.8ci
Wood framed and other	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-3.8 ci or R-20	R-13 + R-7.5 ci or R20 + R3.8ci	R-13 + R-7.5 ci or R-20 + R-3.8 ci	R-13 + R-7.5 ci or R-20 + R-3.8 ci	R-13 + R-7.5 ci or R-20 + R-3.8 ci	R-13 + R-7.5 ci or R-20 + R-3.8 ci	R-13 + R-7.5 ci or R-20 + R-3.8 ci	R-13 + R-18.8ci	R-13 + R-18.8ci
Walls, below grade																
Below-grade wall[d]	NR	NR	NR	NR	NR	NR	R-7.5 ci	R-10ci	R-7.5 ci	R-10ci	R-10ci	R-15ci	R-15ci	R-15ci	R-15ci	R-15ci
Floors																
Mass[e]	NR	NR	R-6.3 ci	R-8.3 ci	R-10ci	R-10ci	R-14.6ci	R-16.7ci	R-14.6ci	R-16.7ci	R-16.7ci	R-16.7ci	R-20.9ci	R-20.9ci	R-23ci	R-23ci
Joist/framing	R-13	R-13	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-30	R-38	R-38	R-38	R-38	R-38	R-38
Slab-on-grade floors																
Unheated slabs	NR	NR	NR	NR	NR	R-10 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-15 for 24″ below	R-20 for 24″ below	R-20 for 24″ below	R-20 for 48″ below	R-20 for 24″ below	R-20 for 48″ below	R-20 for 48″ below	R-25 for 48″ below
Heated	R-7.5	R-7.5	R-7.5	R-7.5	R-10	R-10	R-15	R-15	R-15	R-15	R-15	R-20	R-20	R-20	R-20	R-20

slabs[g]	for 12″ below + R-5 full slab	for 12″ below + R-5 full slab	for 12″ below + R-5 full slab	for 12″ below + R-5 full slab	for 24″ below + R-5 full slab	for 24″ below + R-5 full slab	for 24″ below + R-5 full slab	for 24″ below + R-5 full slab	for 36″ below + R-5 full slab	for 36″ below + R-5 full slab	for 36″ below + R-5 full slab	for 48″ below + R-5 full slab	for 48″ below + R-5 full slab	for 48″ below + R-5 full slab	for 48″ below + R-5 full slab	for 48″ below + R-5 full slab

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A. For above-grade wall assemblies, exclude cladding finish material but include thermal bridge impact of metal cladding structure where interrupting continuous insulation. Refer to definition of continuous insulation in Chapter 2 of this standard. If the building official determines the proposed construction assembly is not adequately represented due to excessive thermal bridging occurrences, the applicant shall determine appropriate values for the assembly using the requirements of ASHRAE 90.1 2019 Section A9.4 Calculation Procedures and Assumptions.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.4.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted at 32 inches or less on center vertically and 48 inches or less on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the exterior insulation requirements for heated slabs.

e. “Mass floors” shall be in accordance with Section C402.2.3.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation is not required to extend below the bottom of the slab.

TABLE C402.1.4 OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD[a, b]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0	U-0.0

entirely above roof deck	48	39	39	39	39	39	32	32	32	32	32	32	28	28	28	28
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass[f]	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.042	U-0.037	U-0.037
Wood framed and other[c]	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.032	U-0.032
Walls, below grade																
Below-grade wall[c]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass[d]	U-0.322[e]	U-0.322[e]	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066[e]	U-0.066[e]	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602

Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door[g]	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing[h]	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

For SI: 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Where assembly *U*-factors, *C*-factors and *F*-factors are established in ANSI/ASHRAE/IESNA 90.1 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding ~~system~~ finish on walls but including thermal bridge impact of cladding structure (see new section C402.X), complies with the appropriate construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A. If the building official determines the proposed construction assembly is not adequately represented due to excessive thermal bridging occurrences, the applicant shall determine appropriate values for the assembly using the requirements of ASHRAE 90.1 2019 Section A9.4 Calculation Procedures and Assumptions.

b. Where *U*-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The *R*-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.

c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls.

d. "Mass floors" shall be in accordance with Section C402.2.3.

e. These *C*-, *F*- and *U*-factors are based on assemblies that are not required to contain insulation.

f. "Mass walls" shall be in accordance with Section C402.2.2.

g. Swinging door *U*-factors shall be determined in accordance with NFRC-100.

h. Garage doors having a single row of fenestration shall have an assembly *U*-factor less than or equal to 0.44 in Climate Zones 0 through 6 and less than or equal to 0.36 in Climate Zones 7 and 8, provided that the fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

Add new text as follows:

C402.6 Thermal Bridges (Mandatory). Applications for construction document approval shall include the following documentation of thermal bridges

C402.6.1 Clear field thermal bridges. Where otherwise not included in pre-calculated assembly U-factors, C-factors, or F-factors outlined in Appendix A of ASHRAE 90.1 2019 (as amended), clear field thermal bridges in a wall, roof, or floor assembly shall be noted as such in the drawings.

C402.6.2 Point thermal bridges. Point thermal bridges greater than or equal in area to 12 sq in (7741 mm^2) and not associated with HVAC or electrical systems shall be noted as thermal bridges in the drawings.

C402.6.3 Linear thermal bridges. Construction documents shall include the following calculation in tabular format for linear thermal bridges listed in Table C402.6:

1. Linear thermal bridge type
2. Related wall assembly key
3. Aggregate length of each type of linear thermal bridge for each unique wall assembly
4. Relevant detail in the construction documents showing a cross-section through the thermal bridge
5. Y-value for each thermal bridge from Table C402.6.
6. Calculated derating of insulation of the assembly.

Exception: Where linear thermal bridges have been tested or modeled using methods approved by the Authority having jurisdiction, alternate values may be used.

TABLE C402.6
AVERAGE THERMAL TRANSMITTANCE FOR UNMITIGATED LINEAR THERMAL BRIDGES

TYPE OF THERMAL BRIDGE	
Balcony	0.30
Fenestration Perimeter Transition[a]	0.15
Parapet	0.15
Cladding Angle / Shelf Angle / Ledge[b]	0.30

a. Fenestration Perimeter Transition is the thermal bridge between any fenestration frame and the typical wall, roof, or floor assembly it abuts or is mounted within.

b. Applies to angles, ledges, furring strips or similar continuous linear fastener installed without thermal bridge mitigation strategy.

Reason: PNNL's energy code models do NOT account for excessive thermal bridging that occurs in reality across the US. Architects and CEOs think they are meeting the intent of energy code, but our assessment of the effectiveness of energy codes is greatly skewed as there is a great gap in the performance of what code intends and what is interpreted as compliant and actually being built. Adding specific language for thermal bridge accounting and awareness will help to align our assessment of energy code effectiveness as well as increase the effectiveness of our heating systems. For this reason, it could be argued the recommended code adjustments should apply to heating dominant climate zones, for example 4-8.

This recommendation also comes from countless studies on the topic demonstrating that "code compliant" wall systems are performing 30-50% worse than intended (see bibliography), and yet code has done little beyond modifying the definition of continuous insulation. There needs to be a simplified path for design applicants to prescriptively derate a wall system due to common assembly conditions which are beyond those field conditions defined in ASHRAE 90.1 Appendix A. While ASHRAE 90.1 Appendix A addresses many common field thermal bridge conditions (like steel stud construction), point thermal bridging and linear thermal bridging are not addressed. Between these two, linear thermal bridging has the greatest impact on the effective thermal conductance of wall assemblies. For this reason, the defined code targets derating wall assemblies based on linear thermal bridges.

Bibliography:

Morrision Hershfield. Thermal Performance of Building Envelope Details for Mid- and High-Rise Buildings (ASHRAE 1365-RP). Atlanta: ASHRAE Technical Committee 4.4, 2011.

ASHRAE. ANSI/ASHRAE/IESNA Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings. Atlanta, GA: ASHRAE, 2019

Payette Associates (Love, Andrea; Klee, Charles). Thermal Bridging: Observed Impacts and Proposed Improvement for Common Conditions. Boston, MA, 2012

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

As written, the code does not increase the cost of construction - arguably, there should be no change in construction cost as this language enforces the intent of code and closes the gap of what is being built today to what code intends to be built.

CEPI-40-21

CEPI-41-21

IECC®: C402.1.4.1, C402.1.4.1.1, C402.1.4.1.2, C402.1.4.1.3

Proponents:

Marcin Pazera, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org); Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org)

2021 International Energy Conservation Code

Revise as follows:

C402.1.4.1 Roof/ceiling assembly.

The maximum roof/ceiling assembly *U*-factor shall not exceed that specified in Table C402.1.4 based on construction materials used in the roof/ceiling assembly. <u>Insulation shall be installed in accordance with the requirements of C402.2.1.2 through C402.2.1.5.</u>

C402.1.4.1.1 Tapered, above-deck insulation based on thickness.

Where used as a component of a maximum roof/ceiling assembly *U*-factor calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *U*-factor compliance as prescribed in Section C402.1.4.

Delete without substitution:

~~C402.1.4.1.2 Suspended ceilings~~.

~~Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly *U*-factor of the roof/ceiling construction.~~

~~C402.1.4.1.3 Joints staggered~~.

~~Continuous insulation board shall be installed in not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.~~

Reason Statement:

The IECC contains installation requirements applicable to roof insulation in various sections of the code. However, the intent of the code is for the installation requirements to be consistent regardless of the selected compliance method (i.e., R-value, U-factor). In previous code development cycles, inconsistencies were inadvertently created in Section C402 between the installation requirements applicable to the R-value method and the U-factor method. This proposal is intended to eliminate these inconsistencies by referencing a single set of installation requirements applicable to roof insulation. The general installation requirements in Section C402.1.4.1 (U-factor) are stricken and replaced with a pointer reference to the general installation requirements that currently appear in Section C402.2.1 (R-value). Including one set of general installation requirements in the IECC for roof insulation eliminates redundancy in code language and will make maintaining the requirements easier going forward while reducing the chance for inconsistencies. Note that the tapered insulation provisions are specific to either the U-factor or R-value compliance method and are not amended by this proposal.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal will have no impact on the cost of construction. The proposal does not impose new requirements.

CEPI-41-21

CEPI-42-21

IECC®: C402.1.4.1.3, C402.2.1.4

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:
C402.1.4.1.3 Joints staggered.

Continuous<u>, above-deck</u> insulation board shall be installed in not less than two layers, and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

C402.2.1.4 Joints staggered.

Continuous<u>, above-deck</u> insulation board shall be installed in not less than two layers and the edge joints between each layer of insulation shall be staggered, except where insulation tapers to the roof deck at a gutter edge, roof drain or scupper.

Reason Statement:

Clarify the intent of these provisions using language already in Table C402.1.3 and Table C402.1.4.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will neither increase nor decrease the cost of construction.

CEPI-42-21

CEPI-43-21

IECC®: C402.1.4.2, TABLE C402.1.4.2, AISI (New)

Proponents:

Jonathan Humble, representing American Iron and Steel Institute (Jhumble@steel.org)

2021 International Energy Conservation Code

Revise as follows:
C402.1.4.2 Thermal resistance of cold-formed steel ~~walls~~ assemblies.

U-factors of walls with cold-formed steel framed ceilings and walls ~~studs~~ shall be permitted to be determined in accordance ~~with Equation 4-1~~ with AISI S250.

~~*U* = 1/[*Rs* + (*ER*)] (Equation 4-1)~~

~~where:~~

~~R_s = The cumulative *R*-value of the wall components along the path of heat transfer, excluding the *cavity insulation* and steel studs.~~

~~*ER* = The effective *R*-value of the *cavity insulation* with steel studs as specified in Table C402.1.4.2.~~

~~TABLE C402.1.4.2 EFFECTIVE R-VALUES FOR STEEL STUD WALL ASSEMBLIES~~

~~NOMINAL STUD DEPTH (inches)~~	~~SPACING OF FRAMING (inches)~~	~~CAVITY *R*-VALUE (insulation)~~	~~CORRECTION FACTOR (F_c)~~	~~EFFECTIVE *R*-VALUE (ER) (Cavity *R*-Value × F_c)~~
~~3 1/2~~	~~16~~	~~13~~	~~0.46~~	~~5.98~~
		~~15~~	~~0.43~~	~~6.45~~
~~3 1/2~~	~~24~~	~~13~~	~~0.55~~	~~7.15~~
		~~15~~	~~0.52~~	~~7.80~~
~~6~~	~~16~~	~~19~~	~~0.37~~	~~7.03~~
		~~21~~	~~0.35~~	~~7.35~~
~~6~~	~~24~~	~~19~~	~~0.45~~	~~8.55~~
		~~21~~	~~0.43~~	~~9.03~~
~~8~~	~~16~~	~~25~~	~~0.31~~	~~7.75~~
	~~24~~	~~25~~	~~0.38~~	~~9.50~~

~~For SI: 1 inch = 25.4 mm.~~

Add new standard(s) as follows:
AISI American Iron and Steel Institute 25 Massachusetts Avenue, NW, Suite 800 Washington DC 20001
AISI American Iron and Steel Institute.

AISI - S250 - 21North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing

Attached Files

- **AISI S250-21&S250-21-C_s.pdf**
  http://localhost/proposal/104/661/files/download/21/
- **AISI_CFSD-Report-RP20-2-Final.pdf**
  http://localhost/proposal/104/661/files/download/17/

Reason Statement:

The purpose of this proposal is to address the issue of having to submit to the code official a request to use the alternative means and methods provisions for cold-formed steel framing designs that are not shown in the IECC. For example, Section C402.1.4.2 addresses only wall framing spacing for 16 and 24 inch on center spacing and is limited to cavity plus continuous insulation options only, whereas, in the market there are many more framing spacing and insulation options used.

This proposal recommends that the Section be modified to recognize the ANSI/AISI/COFS S250 standard. This standard covers cold-formed steel wall framing spacings from 6 inches to 24 inches on center, covers member sizes from 3.5 inches to 12 inches wide, and covers member thicknesses from 0.033 inches thick to 0.064 inches thick. This standard will provide greater latitude for the user of the IECC by mitigating the necessity of having to submit for approval under alternate means and methods provisions. Further, this standard also includes provisions for evaluation of wall assemblies where all the insulation is located outside the wall cavity, which is an option the IECC does not cover.

This standard also contains provisions for calculating ceiling assemblies constructed of cold-formed steel framing with either conventional c-shape framing members, or truss construction with insulation in the attic and with additional continuous insulation below the truss framing. Previous to this proposal we found users applying the 2003 IECC provisions, which contained the calculation procedures, as part of the alternative means and methods submission process to demonstrate compliance. This proposal is intended to mitigate that additional step.

The ANSI/AISI/COFS S250 was approved and published in September 2021.

As part of AISI's effort to make this document user friendly, an excel spread sheet containing all the necessary equations and back-ground data was generated so that users would merely input the basic assembly materials data (e.g. R-values of insulations, sheathings, etc.) and allow the spread sheet to calculate within seconds the result. This excel spread sheet is available at no cost to any potential user (e.g. code official, design professional, building owner, etc.)

The proponent wishes to schedule time to present to the IECC Commercial Committee this proposal, discuss, and to take questions from the Committee.

Bibliography:

AISI, "Development of a U-Factor Calculation Procedure for Cold-Formed Steel C-Shaped Clear Wall Assemblies," American Iron and Steel Institute, Washington, DC. Research Report RP20-2, April 2020.

AISI, "North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing," American Iron and Steel Institute, Washington, DC, AISI S250-21.

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposed change we expect will decease the cost of construction by eliminating the need to prepare an application to the alternative means and methods process. This is because of the standards wider range of envelope assembly options that the user is permitted to calculate in order to demonstrate compliance.

CEPI-43-21

CEPI-44-21

IECC®: C402.1.4.3 (New), TABLE C402.1.4.3 (New)

Proponents:

Duncan Brown, New York City Department of Buildings, representing New York City Department of Buildings

2021 International Energy Conservation Code

Add new text as follows:
C402.1.4.3 Thermal Resistance of Spandrel Panels.

U-factors of opaque assemblies within fenestration framing systems shall be determined in accordance with Table C402.1.4.3

TABLE C402.1.4.3 EFFECTIVE *U*-FACTORS FOR SPANDREL PANELS[a]

Frame Type	Spandrel Panel	Rated R-value of Insulation between Framing Members						
		R-4	R-7	R-10	R-15	R-20	R-25	R-30
Aluminum without Thermal Break[b]	Single glass pane, stone, or metal panel	0.285	0.259	0.247	0.236	0.230	0.226	0.224
	Double glass with no low-e coatings	0.273	0.254	0.244	0.234	0.229	0.226	0.223
	Triple or low-e glass	0.263	0.249	0.241	0.233	0.228	0.225	0.223
Aluminum with Thermal Break[c]	Single glass pane, stone, or metal panel	0.243	0.212	0.197	0.184	0.176	0.172	0.169
	Double glass with no low-e coatings	0.228	0.205	0.193	0.182	0.175	0.171	0.168
	Triple or low-e glass	0.217	0.199	0.189	0.180	0.174	0.170	0.167
Structural Glazing[d]	Single glass pane, stone, or metal panel	0.217	0.180	0.161	0.145	0.136	0.130	0.126
	Double glass with no low-e coatings	0.199	0.172	0.157	0.143	0.135	0.129	0.126
	Triple or low-e glass	0.186	0.165	0.152	0.140	0.133	0.128	0.125
No framing or Insulation is Continuous[e]	Single glass pane, stone, or metal panel	0.160	0.108	0.082	0.058	0.045	0.037	0.031
	Double glass with no low-e coatings	0.147	0.102	0.078	0.056	0.044	0.036	0.030
	Triple or low-e glass	0.139	0.098	0.076	0.055	0.043	0.035	0.030

Opaque assembly U-factors based on designs tested in accordance with ASTM C1363 or NFRC 100 shall be permitted.

a. Interpolation outside of the table shall not be permitted. Spandrel panel assemblies in the table do not include metal backpans.

b. Aluminum frame without a thermal break shall be used for systems where the mullion provides a thermal bridge through the insulation.

c. Aluminum frame with a thermal break shall be used for systems where a urethane or other nonmetallic element separates the metal exposed to the exterior from the metal that is exposed to the interior condition.

d. Structural glazing frame type shall be used for systems that have no exposed mullion on the interior.

e. No framing or insulation that is continuous shall be used for systems where there is no framing or the insulation is continuous and uninterrupted between framing.

Attached Files

- **Table 4.3.8.pdf**
  http://localhost/proposal/282/754/files/download/59/

Reason Statement:

Considerable review time is spent in debating the appropriate classification and thermal properties of spandrel wall types. Not to mention energy lost through the misrepresentation of U-factors. The new table, derived from Title 24 Appendix Table 4.3.8 and, a variant in effect in NYCECC since 2020, provides clear direction as to how the differently insulated types for a proposed design should

Table 4.3.8 – U-factors for Spandrel Panels and Curtain Walls

			Rated R-value of Insulation between Framing Members							
			None	R-4	R-7	R-10	R-15	R-20	R-25	R-30
Frame Type	**Spandrel Panel**			B	C	D	E	F	G	H
Aluminum without Thermal Break	Single glass pane, stone, or metal panel	1	0.[illegible]5	0.285	0.259	0.247	0.236	0.230	0.226	0.224
	Double glass with no low-e coatings	2	0.[illegible]6	0.273	0.254	0.244	0.234	0.229	0.226	0.223
	Triple or low-e glass	3	0.[illegible]3	0.263	0.249	0.241	0.233	0.228	0.225	0.223
Aluminum with Thermal Break	Single glass pane, stone, or metal panel	4	0.[illegible]9	0.243	0.212	0.197	0.184	0.176	0.172	0.169
	Double glass with no low-e coatings		0.[illegible]8	0.228	0.205	0.193	0.182	0.175	0.171	0.168
	Triple or low-e glass		0.[illegible]7	0.217	0.199	0.189	0.180	0.174	0.170	0.167
Structural Glazing	Single glass pane, stone, or metal panel	7	0.[illegible]8	0.217	0.180	0.161	0.145	0.136	0.130	0.126
	Double glass with no low-e coatings		0.[illegible]6	0.199	0.172	0.157	0.143	0.135	0.129	0.126
	Triple or low-e glass	9	0.[illegible]7	0.186	0.165	0.152	0.140	0.133	0.128	0.125
No framing or Insulation is Continuous	Single glass pane, stone, or metal panel	10	0.[illegible]5	0.160	0.108	0.082	0.058	0.045	0.037	0.031
	Double glass with no low-e coatings	11	0.[illegible]6	0.147	0.102	0.078	0.056	0.044	0.036	0.030
	Triple or low-e glass	12	0.[illegible]3	0.139	0.098	0.076	0.055	0.043	0.035	0.030
Frame Type	**Curtain Wall**									
Aluminum without Thermal Break	Single glass pane, stone, or metal panel	13	1.224	0.929	0.427	0.372	0.347	0.326	0.315	0.308
	Double glass with no low-e coatings	14	0.727	0.611	0.400	0.361	0.341	0.323	0.313	0.307
	Triple or low-e glass	15	0.567	0.494	0.380	0.351	0.335	0.320	0.311	0.306
Aluminum with Thermal Break	Single glass pane, stone, or metal panel	16	1.110	0.862	0.339	0.282	0.256	0.234	0.222	0.215
	Double glass with no low-e coatings	17	0.617	0.531	0.311	0.270	0.249	0.230	0.220	0.214
	Triple or low-e glass	18	0.458	0.409	0.290	0.260	0.243	0.227	0.218	0.212
Structural Glazing	Single glass pane, stone, or metal panel	19	1.106	0.859	0.290	0.228	0.199	0.175	0.162	0.154
	Double glass with no low-e coatings	20	0.577	0.502	0.260	0.215	0.192	0.171	0.160	0.152
	Triple or low-e glass	21	0.407	0.368	0.237	0.204	0.185	0.168	0.158	0.151
No framing or Insulation is Continuous	Single glass pane, stone, or metal panel	22	1.224	0.929	0.197	0.124	0.090	0.062	0.047	0.038
	Double glass with no low-e coatings	23	0.727	0.611	0.177	0.116	0.086	0.060	0.046	0.038
	Triple or low-e glass	24	0.567	0.494	0.166	0.111	0.083	0.059	0.045	0.037

This table has U-factors for the spandrel section of glass and other curtain wall systems. Design factors that affect performance are the type of framing, the type of spandrel panel and the R-value of insulation.

Four framing conditions are considered in the table. The first is the common case where standard aluminum mullions are used. Standard mullions provide a thermal bridge through the insulation, reducing its effectiveness. The second case is for metal framing members that have a thermal break. A thermal break frame uses a urethane or other non-metallic element to separate the metal exposed to outside conditions from the metal that is exposed to interior conditions. The third case is for structural glazing or systems where there is no exposed mullion on the interior. The fourth case is for the condition where there is no framing or the insulation is continuous and uninterrupted by framing. The columns in the table can be used for any specified level of insulation between framing members installed in framed curtain walls or spandrel panels.

be entered.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The intent of the proposal is to aid in compliance review and does not affect the cost of construction.

CEPI-44-21

CEPI-45-21

IECC®: SECTION 202 (New), C402.1.4.3 (New), TABLE C402.1.4.3 (New), TABLE C407.4.1(1), ASHRAE Chapter 06 (New)

Proponents:

Helen Sanders, Facade Tectonics Institute/Technoform North America, representing The Facade Tectonics Institute

2021 International Energy Conservation Code

Add new definition as follows:
C202 LINEAR TRANSMITTANCE. Linear transmittance is a measure of additional heat loss at the interfaces between envelope assemblies expressed in (BTU)/(hr ft ˚F). These interfaces include wall to roof, wall to floor, wall to foundation, wall to wall, and wall to fenestration. It may be calculated based on methodology outlined in ASHRAE RP-1365.
Add new text as follows:
C402.1.4.3 Thermal bridging between assemblies.

The maximum linear transmittance between assemblies, including wall to roof, wall to floor, wall to wall, wall to foundation, and wall to fenestration, shall not exceed that specified in Table C402.1.4.3

TABLE C402.1.4.3 Opaque Envelope Assembly Maximum Requirement, Linear Transmittance

Climate Zone	0 and 1	2	3	4 Except marine	5 and Marine 4	6	7	8
Linear Transmittance	0.55	0.50	0.45	0.40	0.35	0.35	0.30	0.25

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Walls, above-grade	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Linear Transmittance: As specified in Table C402.1.4.3	As proposed
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed

Add new standard(s) as follows:
ASHRAE ASHRAE 180 Technology Parkway NW Peachtree Corners GA 30092
RP-1365 Thermal Performance of Building Envelope Details for Mid- and High-Rise Buildings
Staff Note: Proponent unable to provide required copies prior to printing of monograph.

Reason Statement:

Thermal bridging is widely recognized as a thermal performance degrader of building envelopes and is currently not typically accounted for in building energy simulations nor in IECC. As a result, building designs appear to be better than they are, leading to a performance gap between actual and as-designed energy use. The performance gap between as-built and as-designed has been widely recognized globally. There is even a Wikipedia page dedicated to the issue [1]. The ASHRAE 90.1 Committee has been working through the development of an extensive thermal bridging requirement to add to that standard in recognition of the issue.

The Building Envelope Thermal Bridging Guide [2] by BC Housing and the related Thermal Envelope websites [3] (see bibliography) are excellent references that demonstrate the significant degrading impact of thermal bridging at the interfaces of envelope assemblies and with the building structure. Another good resource to understand the thermal bridging issues is the BC Housing Guide to Low Thermal Energy Demand for Large Buildings [4].

The experts at Morrison Hershfield who created the Thermal Bridging Guide have estimated that opaque panel assembly thermal performance can be degraded by over 50% by thermal bridging through non-thermally broken attachment mechanisms [2]. They also found that 13% of the heat loss through a typical steel stud wall with punched opening windows is due to the window to wall transition and found it to be even higher with poorer edge details.

Also, without accounting for known thermal bridging in the base building in the total performance compliance path, improvements in energy performance derived from techniques and solutions which address thermal bridging, can not be recognized. In fact, the "as-proposed" building where linear transmittances are included from improved attachment and interface measures may look worse that the base building where all the interfaces are currently assumed to be "perfect" [5].

ASHRAE Report RP1365 documents procedures for calculating thermal performance and a catalogue of common envelope details for mid and high-rise construction that allows designers access to information to reduce uncertainty in thermal performance of envelope components [6]. It can be used by design teams to calculate the linear transmittances of interfaces.

For simplicity, this proposal proposes requiring the same maximum linear transmittance values for all linear interfaces that represent what is currently feasible from poor performance (0.55 BTU/hr ft ˚F) to relatively good performance (0.25 BTU/hr ft ˚F). To keep it simple, we are proposing one maximum linear transmittance value for all interfaces.

As examples for context, an exposed slab projecting out past an exterior insulated steel stud wall is in the range of 0.45 BTU/hr ft ˚F. A similar assembly without the projecting slab and continuous insulation has a linear transmittance 0.16 at the floor slab. A shelf angle directly against the floor slab in an exterior insulated masonry wall has a linear transmittance of 0.35 BTU/hr ft ˚F. Window interfaces in an exterior insulated EIFS wall has a linear transmittance under 0.2 BTU/hr ft ˚F and Passive House window interfaces are typically less than 0.1 BTU/hr ft ˚F. So far, all values except for that proposed for climate zone 8, are easily achieved, with a lot of options to move to details that will improve the performance. Even in climate zone 8 these buildings are already highly insulated and modifying the interface details to meet the 0.25 BTU/hr ft ˚F linear transmittance is relatively easy to achieve.

This proposal also aims to provide a relatively straightforward method to recognize thermal bridging in the base building when using the total performance path. Since most buildings tend to use the performance path, we have chosen to focus on the U-factor approach for the inclusion of default linear transmittance, since that is typically used in the performance compliance path.

In order to achieve net-zero performance we need to address these significant energy losses through thermal bridges at the envelope and FTI feels like this is a good first step to move envelope performance and to get the design and construction industry thinking about thermal bridges in the design process.

Bibliography:

[1] https://en.wikipedia.org/wiki/Performance gap

[2] Building Envelope Thermal Bridging Guide Building Envelope Thermal Bridging Guide (bchousing.org) (https://www.bchousing.org/research-centre/library/residential-design-construction/building-envelope-thermal-bridging-guide?__hstc=9930858.1b26ce8b438ffbb6f9d783f6c2a00c85.1615278158022.1615420880106.1622832660024.3&__hssc=9930858.1.1633 d307-483f-acb1-5ee6cbc56c8f%7C4f33cb61-1a5d-4c4d-a14a-5e2a4afd3e3d)

[3] Thermal Envelope website: https://thermalenvelope.ca/

[4] BC Housing Guide to Low Thermal Energy Demand for Large Buildings, https://www.bchousing.org/research-centre/library/residential-design-construction/guide-low-energy-demand-large-buildings&sortType=sortByDate

[5] Neil Norris, Thermal Bridging: Ignorance is not Bliss, 2016. https://morrisonhershfield.com/bpa_library/thermal-bridging-ignorance-is-not-bliss/

[6] ASHRAE RP-1365 -- Thermal Performance of Building Envelope Details for Mid- and High-Rise Buildings (techstreet.com)

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

FTI practitioners do not believe that this proposal will increase the cost of initial construction since the values for linear transmittance were chosen to reflect current practices in each climate zone. Where improved details do increase initial construction these will pay-off through energy savings.

CEPI-45-21

CEPI-46-21

IECC®: C402.1.5

Proponents:

Helen Sanders, Facade Tectonics Institute/Technoform North America, representing The Facade Tectonics Institute

2021 International Energy Conservation Code

Revise as follows:
C402.1.5 Component performance alternative.

Building envelope values and fenestration areas determined in accordance with ~~Equation 4-2~~ the following procedure shall be an alternative to compliance with the *U*-, *F*- and *C*-factors in Tables C402.1.4 and C402.4 and the maximum allowable fenestration areas in Section C402.4.1. *Fenestration* shall meet the applicable SHGC requirements of Section C402.4.3. Procedure:

1. Add up areas and UAs for each of the proposed building's wall, roof, and fenestration types. (Proposed U x Proposed A)
2. Apportion total above-grade proposed area from the above to the prescriptive baseline building according to the maximum allowable window-to-wall area and skylight-to-roof area.
3. Calculate UA for the above-grade wall, roof, and fenestration types for the prescriptive baseline building by multiplying the apportioned areas with the prescriptive U-factors. (Prescriptive U x Prescriptive A)
4. Compare the sum of the proposed UAs to the sum of the prescriptive UAs. If the sum of proposed UAs is smaller than the sum of the prescriptive UAs, then the proposed project is compliant.

$$A + B + C + D + E \leq \text{Zero}$$

~~(Equation 4-2)~~

~~where:~~

~~A = Sum of the (UA Dif) values for each distinct assembly type of the *building thermal envelope*, other than slabs on grade and below-grade walls.~~

~~UA Dif = UA Proposed – UA Table.~~

~~UA Proposed = Proposed *U*-value × Area.~~

~~UA Table = (*U*-factor from Table C402.1.3, C402.1.4 or C402.4) × Area.~~

~~B = Sum of the (FL Dif) values for each distinct slab-on-grade perimeter condition of the *building thermal envelope*.~~

~~FL Dif = FL Proposed – FL Table.~~

~~FL Proposed = Proposed *F*-value × Perimeter length.~~

~~FL Table = (*F*-factor specified in Table C402.1.4) × Perimeter length.~~

~~C = Sum of the (CA Dif) values for each distinct *below-grade wall* assembly type of the *building thermal envelope*.~~

~~CA Dif = CA Proposed – CA Table.~~

~~CA Proposed = Proposed *C*-value × Area.~~

~~CA Table = (Maximum allowable *C*-factor specified in Table C402.1.4) × Area.~~

~~Where the proposed vertical glazing area is less than or equal to the maximum vertical glazing area allowed by Section C402.4.1, the value of D (Excess Vertical Glazing Value) shall be zero. Otherwise:~~

~~D = (DA × UV) – (DA × U Wall), but not less than zero.~~

~~DA = (Proposed Vertical Glazing Area) – (Vertical Glazing Area allowed by Section C402.4.1).~~

~~UA Wall = Sum of the (UA Proposed) values for each opaque assembly of the exterior wall.~~

~~U Wall = Area-weighted average *U*-value of all above-grade wall assemblies.~~

~~UAV = Sum of the (UA Proposed) values for each vertical glazing assembly.~~

~~UV = UAV/total vertical glazing area.~~

~~Where the proposed skylight area is less than or equal to the skylight area allowed by Section C402.4.1, the value of E (Excess Skylight Value) shall be zero. Otherwise:~~

~~E = (EA × US) – (EA × U Roof), but not less than zero.~~

~~EA = (Proposed Skylight Area) – (Allowable Skylight Area as specified in Section C402.4.1).~~

~~U Roof = Area-weighted average *U*-value of all roof assemblies.~~

~~UAS = Sum of the (UA Proposed) values for each skylight assembly.~~

~~US = UAS/total skylight area.~~

Reason Statement:

A traditional UA calculation compares the UA of the entire proposed building to the UA of the entire prescriptive code baseline building matches the intent of the code. The above grade window-to-wall ratio for the prescriptive baseline building would be apportioned and fixed at the maximum allowable percentage to allow for trade-off of exterior wall systems against each other in the proposed building. The same applies to skylights and roofs. No trade off of façade systems against better performing building services systems is permitted anymore; the façade shall be code compliant within itself.

Equation 4-2 leads to erroneous results that allowed for excessive fenestration, which is counter to the intent of the compliance approach. This proposal "fixes" the problem created by the existing equation and delivers on the original intent of the section. The proposed procedure accounts for the envisioned penalty for excess fenestration above and beyond the permissible window-to-wall ratio.

We recognize that this may not have exactly the right code language or formatting, but we hope that the committee will review the section and support addressing the problem with equation 4-2.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed code update fixes an error with an equation and will not increase the cost of construction, as it limits excessive use of lower performance fenestration, which means that the building will be more aligned with a prescriptive building.

CEPI-46-21

CEPI-47-21

IECC®: C402.2.1.1, C402.2.1.2

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:

C402.2.1.1 Tapered, above-deck insulation based on thickness.

Where used as a component of a roof/ceiling assembly *R*-value calculation, the sloped roof insulation *R*-value contribution to that calculation shall use the average thickness in inches (mm) along with the material *R*-value-per-inch (per-mm) solely for *R*-value compliance as prescribed in Section 402.1.3. The minimum thickness of tapered, above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

Delete without substitution:

~~C402.2.1.2 Minimum thickness, lowest point~~.

~~The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).~~

Reason Statement:

Provisions for "Minimum thickness, lowest point," apply to tapered, above-deck installations of insulation, as intended.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will neither increase nor decrease the cost of construction.

CEPI-47-21

CEPI-48-21

IECC®: C402.2.7

Proponents:

Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Revise as follows:
C402.2.7 Airspaces.

Where the *R*-value of an airspace is used for compliance in accordance with Section C402.1, the airspace shall be enclosed in an unventilated cavity <u>bounded on all sides by building components and</u> constructed to minimize airflow into and out of the enclosed airspace. ~~Airflow shall be deemed minimized where the enclosed airspace is located on the interior side of the continuous air barrier and is bounded on all sides by building components.~~

~~**Exception:** The thermal resistance of airspaces located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material shall be determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.~~

Reason Statement:

With the current focus by the energy building code bodies to increase energy efficiency every code cycle, it is imperative that code language be technically accurate. Unfortunately in its current state, this section of the code is not.

The current language does not evaluate the realistic stipulations as they relate to air spaces.

1. The first issue is the location of an “enclosed unventilated cavity”.
2. The second, is the specification for a test method for thermal performance of an air space on the exterior of the air barrier.

A masonry wall assembly that is built to the 2021 IBC will typically include an “enclosed airspace that is bounded on all sides by building components". This provides an “unventialled” condition as the “weep holes” provided for drainage do not promote a level of air exchange that would affect the thermal performance of the system.

An air space that is enclosed, unventilated and bounded by building components on all sides performs thermally the same regardless of location. It is not necessary to differentiate a location if the assembly meets these requirements. If an assembly has ventilation, a mechanism or design for free air exchange, then the requirements are not met, and the air space cannot be utilized as a contributor to the thermal performance of the assembly.

Free air exchange in a wall system requires “air in” and an avenue for “air out”. In order to achieve this with a masonry wall, it would require “venting” in the upper and lower half of the wall. A series of weep holes across the lower extreme of the wall do not qualify as venting which is necessary for a system to be ventilated.

The requirements related to ASTM C1363 are completely inappropriate and impossible to actually execute.

“ASTM C1363 Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus” specifies in Paragraph 1.14 “The test method does not permit intentional mass transfer of air or moisture through the specimen during measurements”.

In regard to the specified “air movement rate” of 70 mm/second, this value is arbitrary. Data to substantiate this as a “real world” rate has never been available or offered. This really is a moot point since the introduction of air movement into the apparatus is prohibited, but further exemplifies the faults with this section/exception.

Cost Impact:

The code change proposal will decrease the cost of construction.

This code change simplifies the code and eliminates unnecessary requirements, which will decrease the cost of construction.

CEPI-48-21

CEPI-49-21

IECC®: C402.2.7

Proponents:

Martha VanGeem, representing Masonry Alliance for Codes and Standards; Charles Clark Jr, representing Brick Industry Association (cclark@bia.org); Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Revise as follows:
C402.2.7 Airspaces.

Where the *R*-value of an airspace is used for compliance in accordance with Section C402.1, the airspace shall be enclosed in ~~an unventilated~~ cavity constructed to minimize airflow into and out of the enclosed airspace. ~~Airflow shall be deemed minimized where the enclosed airspace is located on the interior side of the continuous air barrier and is bounded on all sides by building components.~~

~~**Exception:** The thermal resistance of airspaces located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material shall be determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.~~

Reason Statement:

The current requirement is unnecessarily complicated. ASHRAE Research Project Report 1759: “Impact of Air-Flow on Thermal Performance of Airspaces Behind Cladding” shows that the R-value of air spaces is significant. Huygen and Sanders have shown that wall assemblies incorporating anchored clay masonry veneer experience only a 0.2% reduction in thermal performance due to open weep holes. The R-value of an enclosed air space in a wall cavity is based primarily on radiation and not convection. The R-value behind a façade does not appreciably decrease due to a small amount of air circulation in a cavity on the exterior side of the continuous air barrier. The first sentence is the requirement. The term "unventilated" has been removed because it (1) is not defined, (2) is challenging to define with respect to wall construction, and (3) is ambiguous.

The second sentence in the existing code is a deemed to comply statement. This is not necessary because the the air space does not need to be inside the continuous air barrier per the two reports cited above. ASHRAE 90.1 inserted this sentence as a compromise position, not based on data, in a more comprehensive proposal on air spaces, before the referenced reports were published.

The word "enclosed" includes the concept of "bounded on all sides by building components" so that phrase is not needed (although we have no objection to keeping that phrase and placing it in the first sentence if it provides clarity).

The exception in the current code is not really an exception. The exception is an additional requirement for air spaces on the outside of the continuous air barrier. This is not necessary because the the air space does not need to be inside the continuous air barrier per the two reports cited above. In addition, ASTM C1363 is a hot box test for determining heat transfer through assemblies and was not developed as a test method that introduces air flow within a specimen. This modification of the test method is not within the scope of the ASTM C1363 and is challenging to perform correctly. It should not be cited.

Bibliography:

Rahiminejad M., and Khovalyg, D., 2020, ASHRAE Research Project Report 1759: “Impact of Air-Flow on Thermal Performance of Airspaces Behind Cladding”, sponsored by TC 4.4, Building Materials and Building Envelope Performance, ASHRAE, Atlanta, ASHRAE.org

Huygen, N. C., and Sanders, J.P., 2019a, “Air Flow Within a Brick Veneer Cavity Wall,” Thirteenth North American Masonry Conference, ed. P. Dillon and F. Fonseca, The Masonry Society, Longmont, CO. masonrysociety.org

Cost Impact:

The code change proposal will decrease the cost of construction.

This simplifies the code and will decrease the cost of construction.

CEPI-50-21

IECC®: C402.3, TABLE C402.3

Proponents:

Kimberly Cheslak, New Buildings Institute, representing NBI (kim@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:
C402.3 Roof solar reflectance and thermal emittance.

Low-sloped roofs directly above ~~cooled~~ conditioned spaces ~~in *Climate Zones* 0 through 3~~ shall comply with one or more of the options in Table C402.3.

Exceptions: The following roofs and portions of roofs are exempt from the requirements of Table C402.3:

1. Portions of the roof that include or are covered by the following:
   - 1.1. Photovoltaic systems or components.
   - 1.2. Solar air or water-heating systems or components.
   - 1.3. Vegetative roofs or landscaped roofs.
   - 1.4. Above-roof decks or walkways.
   - 1.5. Skylights.
   - 1.6. HVAC systems and components, and other opaque objects mounted above the roof.
2. Portions of the roof shaded during the peak sun angle on the summer solstice by permanent features of the building or by permanent features of adjacent buildings.
3. Portions of roofs that are ballasted with a minimum stone ballast of 17 pounds per square foot (74 kg/m^2) or 23 psf (117 kg/m^2) pavers.
4. Roofs where not less than 75 percent of the roof area complies with one or more of the exceptions to this section.

TABLE C402.3 MINIMUM ROOF REFLECTANCE AND EMITTANCE OPTIONS[a]

Climate Zone	0-3	4-5	6-8
Three-year-aged solar reflectance[b]/3-year aged thermal emittance[c]	~~Three-year-aged solar reflectance index[b] of 55 and 3-year aged thermal emittance[c] of 0.75~~ 0.63/0.75	0.55/0.75	NR
Three-year-aged solar reflectance index[d]	~~Three-year-aged solar reflectance index[d] of 64~~ 75	64	NR

a. The use of area-weighted averages to comply with these requirements shall be permitted. Materials lacking 3-year-aged tested values for either solar reflectance or thermal emittance shall be assigned both a 3-year-aged solar reflectance in accordance with Section C402.3.1 and a 3-year-aged thermal emittance of 0.90.

b. Aged solar reflectance tested in accordance with ASTM C1549, ASTM E903 or ASTM E1918 or CRRC-S100.

c. Aged thermal emittance tested in accordance with ASTM C1371 or ASTM E408 or CRRC-S100.

d. Solar reflectance index (SRI) shall be determined in accordance with ASTM E1980 using a convection coefficient of 2.1 Btu/h × ft^2 × °F (12 W/m^2 × K). Calculation of aged SRI shall be based on aged tested values of solar reflectance and thermal emittance.

Reason Statement:

Installing a cool roof is a relatively inexpensive energy conservation measure to passively reduce cooling load in warmer regions. Cool roofs strongly reflect sunlight and efficiently radiate heat away from the roof surface. Cool roofs are generally light colors like white or grey, but also are available in a variety of traditional colors by using cool-colored pigments. Installing a cool roof reduces the conduction of heat into the building, thus reducing the need for air-conditioning in conditioned spaces. Minimizing the need for air conditioning saves energy and money, and the decreased load helps to moderate peak grid demand during heat waves and very hot summer afternoons, thereby reducing the risk of power outages. Decreasing the convection of heat into the building also offers increased occupant comfort in unconditioned buildings.

Cool roofs also decrease the amount of heat transferred from the roof to the air, thus mitigating the urban heat island effect. Decreased urban temperatures slow the formation of ground-level ozone, which is the primary component of smog – known to aggravate respiratory illness. Extreme heat is the number one weather-related killer in the U.S. In cities, this is a particular concern due to the urban heat island, where temperatures can be 9 to 16 degrees (Fahrenheit) higher than surrounding rural areas. This is due, in part, to the fact that about 60% of urban surfaces are covered by roofs and pavements. Studies have shown that a 10-percentage point increase in urban surface reflectivity would reduce the number of deaths during heat events by an average of 6%. With 80% of the world's population projected to live in an urban area within the next 50 years, and in a warming climate with more extreme heat events, it is likely that even more lives could be saved if cool roofs were more widely installed.

Cool roofs are currently required by 2021 IECC commercial new construction requirements in Climate Zones 0 to 3 per Section C402.3. This proposal would expand cool roof requirements to Climate Zones 4 and 5 and increase the SRI threshold for Climate Zones 0 to 3 to be consistent with cool roof requirements in Title 24. This proposal also corrects an editorial mistake in the code that refers to a solar reflectance index of 55 when it should read as a solar reflectance of requirement 0.55. There are approximately 3,000 roofing products listed with Cool Roof Rating Council (CRRC) and a majority of those are appropriate for both low-sloped and steep-sloped installations. Product types include single-ply membranes, fluid applied coatings and membranes, asphaltic membranes and modified bitumen-based products, and metal products. Within all of these product types, products that meet the 2021 IECC SRI requirements are available. More than one-third of the CRRC-rated products suitable for low-slope installations would still meet the proposed increase in SRI requirement for Climate Zones 0 to 3, across all the product types previously referenced. Recent analysis indicates that these cool roof products can be installed at no additional cost to the consumer.

These cool roof products also consistently save energy. According to modeling completed by LBNL and access via the Cool Surface Savings Explorer, an increase in the SRI of a roof from 16, the average SRI of an aged typical roof product, to the proposed SRI of 64 and the current commercial cool roof requirement for Climate Zones 0 to 3, would result in average annual energy cost savings for commercial buildings of 0.77% in Climate Zone 4A, 2.18% in Climate Zone 4B, 1.02% in Climate Zone 4C, 0.83% in Climate Zone 5A and 0.98% in Climate Zone 5B.

Increasing the SRI requirements in Climate Zones 0 through 3 to an SRI of 75, the current requirement for commercial roofs in Title 24-2019, would also yield additional energy cost savings. Based on the analysis referenced above, the estimated annual energy cost savings of going from an SRI of 64 (IECC 2021 requirement) to 75 are 0.46% in Climate Zone 1A, 0.40% in Climate Zone 2A, 0.51% in Climate Zone 2B, 0.43% in Climate Zone 3A, 0.49% in Climate Zone 3B, and 0.54% in Climate Zone 3C. It should be noted that the study modeled an increase in roof solar reflectance from 0.20 to 0.40 and 0.60. To obtain the SRI values cited here, the thermal emittance was assumed to be 0.85.

The proposed amendment also aligns the climate zone applicability of cool roofs (IECC climate zones 0 to 5) in the commercial IECC with proposed cool roof requirement submitted as an amendment to the residential IECC.

Bibliography:

Kalkstein , Laurence, et al. Assessing the Health Impacts of Urban Heat Island Reduction Strategies in the District of Columbia, Global Cool Cities Alliance, https://www.coolrooftoolkit.org/wp-content/uploads/2013/10/DC-Heat-Mortality-Study-for-DDOE-FINAL.pdf.

Solar-Reflective “Cool” Walls: Benefits, Technologies, and Implementation, California Energy Commission, Apr. 2019, https://www.energy.ca.gov/sites/default/files/2021-06/CEC-500-2019-040.pdf.

Farahmand, Farhad, et al. Title 24 Codes and Standards Local Ordinances: Cost-Effectiveness Study for Cool Roofs FINAL Report for All Climate Zones, PG&E, 30 Mar. 2016,https://localenergycodes.com/download/506/file_path/fieldList/2016%20Cool%20Roofs%20Cost-Eff%20Report.pdf.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Cool roof products save energy in Climate Zones 4 and 5 and can be installed at no additional cost. An increase in SRI values for Climate Zones 0 to 3 can also be done at no incremental cost and will also result in additional energy savings. More details on energy savings are described in the reason statement above.

CEPI-50-21

CEPI-51-21

IECC®: C402.3.1

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Delete without substitution:
~~C402.3.1 Aged roof solar reflectance~~.

~~Where an aged solar reflectance required by Section C402.3 is not available, it shall be determined in accordance with Equation 4-3.~~

$$\cancel{R_{aged} = [0.2 + 0.7(R_{initial} - 0.2)]}$$
~~(Equation 4-3)~~

~~where:~~

~~R_{aged} = The aged solar reflectance.~~

~~$R_{initial}$ = The initial solar reflectance determined in accordance with CRRC S100.~~

Reason Statement:

The provisions of C402.3.1 are now incorporated into CRRC S100-2021 as will be updated via the ICC Referenced Standards procedures for the Consensus Standard.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will neither increase nor decrease the cost of construction.

CEPI-51-21

CEPI-52-21

IECC®: TABLE C402.4

Proponents:

Helen Sanders, Facade Tectonics Institute/Technoform North America, representing The Facade Tectonics Institute

2021 International Energy Conservation Code

Revise as follows:

TABLE C402.4
BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

	0 AND 1		2		3		4 EXCEPT MARINE				6		7		8	
Vertical fenestration																
***U*-factor**																
Fixed fenestration	~~0.50~~ 0.45		~~0.45~~ 0.40		~~0.42~~ 0.38		~~0.36~~ 0.32		~~0.36~~ 0.32		~~0.34~~ 0.31		~~0.29~~ 0.26		~~0.26~~ 0.25	
Operable fenestration	0.62		0.60		0.54		0.45		0.45		0.42		0.36		0.32	
Entrance doors	0.83		0.77		0.68		0.63		0.63		0.63		0.63		0.63	
SHGC																
	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable
PF < 0.2	0.23	0.21	0.25	0.23	0.25	0.23	0.36	0.33	0.38	0.33	0.38	0.34	0.40	0.36	0.40	0.36
0.2 ≤ PF < 0.5	0.28	0.25	0.30	0.28	0.30	0.28	0.43	0.40	0.46	0.40	0.46	0.41	0.48	0.43	0.48	0.43
PF ≥ 0.5	0.37	0.34	0.40	0.37	0.40	0.37	0.58	0.53	0.61	0.53	0.61	0.54	0.64	0.58	0.64	0.58
Skylights																
U-factor	0.70		0.65		0.55		0.50		0.50		0.50		0.44		0.41	

SHGC	0.30		0.30		0.30		0.40		0.40		0.40		NR		NR	

NR = No Requirement, PF = Projection Factor..

Reason:

The members of the Façade Tectonics Institute (FTI) recognize that in order to reach net zero goals by 2030, the IECC needs to ratchet down envelope energy efficiency quickly over the next two or three code revisions to achieve that goal. The Department of Energy identified a “net zero energy” window as having a U-factor of 0.10 BTU/^{o}F.hr.ft^2 (Reference [1]) and they identified that fenestration with U-factors of 0.15 BTU/^{o}f.hr.ft^2 could save 1 Quadrillion BTUs annually over the current (2006) building stock (0.71 Quads from heating and 0.31 Quads from cooling) if implemented in all US buildings. This report also demonstrates the importance of U-factor in cooling climates based on the cooling energy reduction, as does a paper from the FTI World Congress in 2020 which is included in the bibliography [2].

According to Steve Selkowitz from LBNL, the results of several of their studies indicate that fenestration U-factors between 0.10 to 0.20 Btu/^{o}f.hr.ft^2 are likely to be appropriate to get to net zero across most climate zones, with variation also depending on window area (more area needing lower U-factor). Whether 0.20 or 0.10 or somewhere in between is considered the net-zero target, the IECC window performance change from cycle to cycle is not on a track to achieving close to net zero window performance by 2030. Even if we assume 0.15 BTU/of.hr.ft2 is the target to meet, and we consider the current 0.29 in climate zone 8, the 2024, 2027 and 2030 values would need to be 0.24, 0.19 and 0.15 respectively. And we are proposing 0.25 and 0.26 for climate zones 7 and 8 respectively. The lower climate zones need to have larger changes. For climate zone 6, to get to 0.15 BTU/of.hr.ft2 in 2030, the values in 2024 and 2027 if changed linearly would need to be 0.28 and 0.21 respectively. If the target is 0.20, the reduction would be 0.29 and 0.24 in 2024 and 2027. This represents a more aggressive path than we have proposed here.

Currently, though, U=0.20 Btu/^{o}f.hr.ft^2 aluminum commercial windows are available from several north American fabricators [3] and better performance is possible with even better glass packages. This performance is typical of business-as-usual construction in northern Europe due to tighter code requirements which have been in place there over the last two or more decades. A series of articles in Intelligent Glass Solutions [4-6] provides a review of the adoption of fenestration technologies and correlations to energy codes around the globe. Where energy codes are tighter, higher performance fenestration has become business-as-usual, and economies of scale help achieve cost-effectiveness. The fenestration industry easily supplies this performance, and the technology is readily available [4]. It is just waiting for wider adoption to drive economies of scale in the U.S. The glazing and facade industry is increasing global, so solutions available in some parts of the world can be adapted and made available in others as needed.

The challenge for adoption in the U.S. is related more to economies of scale which impacts cost than a technology readiness issue – technologies are available (warm-edge spacer, complex polyamide thermal barriers, high-performance low-e coatings, room side low-e coatings, triple pane insulating glass), often with a long track record. Indeed, Canadian fenestration requirements are moving more rapidly than in the U.S. and are driving fabricators who provide products to both markets to deliver higher performance fenestration, accelerating adoption of technologies already standard in Europe, and is supporting the achievement of economies of scale, and thus lower cost.

FTI is proposing that the fixed fenestration U-factors be reduced by 10% across all climate zones (except for climate zone 8 where the recommended reduction is less than 10%). While the specifics vary with current U-factor requirement in each zone, and details of the fenestration system under consideration, the technology for better insulating glass performance and for higher-performance thermally broken frames exists in the US and more broadly globally. This is especially true in the middle and southern climate zones where the fenestration U-factor performance being proposed is already required in the more northern zones, and thus has already been shown to be both available and cost-effective in those climate zones. Moving the requirements to more southern climate zones should not lead to barriers in availability, and will only help with driving economies of scale.

When considering cost-effectiveness, bigger thermal improvements can allow other disruptive changes in designs. For example, a change of a curtain wall to wider thermal barrier and triple glazing can eliminate the perimeter heating system that is typically used to address comfort - a big cost savings that can pay for the triple glazing and better frames.

Envelope first – Positioning for resilience: While improving the resilience of a building to acute weather events doesn't have a payback on energy cost, and may cost more in upfront investment, there is a payback on human health and economic productivity. Atelier 10 carried out a study for Urban Green simulating the impact of buildings with different envelope performance on human survivability in a summer power outage and a winter power outage [7]. It clearly demonstrated that current code performance is not sufficient to support occupants for extended periods in these conditions, yet a high-performance envelope with higher than code thermal performance requirements can provide a survivable environment in both extremes of hot or cold.

Efficiency first - **Positioning for decarbonization:** There is a big push on the grid side to electrify and decarbonize buildings to get to net zero carbon. This involves a switch from gas heating/boilers to electric heat pumps, both in new construction and retrofit. DOE has a program – GEB or Grid Interactive Efficient Buildings. In new construction, an aggressive envelope performance should mean not only lower energy bills, but lower peak loads, lower costs for HVAC systems and lower cost for PV/storage and grid upgrades. In retrofit and new construction, at scale, the utilities will have massive new heating loads that occur 6AM in winter (electric heating), when photovoltaics are useless. Heating loads need to be minimized, and better facades will be needed to minimize those loads.

According to Steve Selkowitz of LBNL, there have been a few studies and jurisdictions (New York and British Columbia) that have started to explore this issue of peak load shifting with electrification and decarbonization of the grid and include them in their building strategies [8,9]. All have identified a high-performance building envelope as a necessity.

Below is a more specific discussion for each climate zone.

Climate zones 0 and 1

For climate zones 0 and 1, we are proposing a U-factor of 0.45 BTU/^{o}F.hr.ft^2 which at a minimum means that frames must have at least a small thermal barrier (perhaps only thermally improved) and can be achieved by standard "business-as-usual" curtainwall systems, an air filled IGU with a standard low-e coating and aluminum spacer. This level of performance is easy to achieve (some might say trivial to achieve) with current business as usual components, and has lower performance than the business-as-usual fenestration currently required in the mixed climate zones. Given the data that supports the impact of thermal performance in cooling dominated climate zones, FTI believes that increasing the performance level required in climate zones 0 and 1 to achieve at least a minimum level of thermal performance is indicated. Indeed, it may warrant being more aggressive. A recent article reviewing the status of thermal performance regulations in very hot climates around the globe indicate that countries in the middle east have more stringent U-factor requirements than colder parts of the U.S. [10]. The UAE has a fenestration U-factor requirement of between 1.9 to 2.1 W/m^{2}K (either EN or NFRC method) which is 0.33-0.37 BTU/^{o}f.hr.ft^2 [10]. This is much lower than we are proposing here, and which is being proposed in climate zones 2 and 3 either. The lower end of the range required in UAE is similar to the proposal for climate zones 4-6 which are much cooler climates than that of the Middle East.

Climate zone 2

Fenestration with a U-factor of 0.45 BTU/^{o}f.hr.ft^2 is currently trivial for the industry to provide. Moving from a U-factor of 0.45 to 0.40 BTU/^{o}F.hr.ft^2 in climate zone 2 can be often achieved with the addition of argon gas to the insulating glass unit – which often comes with no or minimum additional cost. Some fabricators offer argon for no upcharge currently as it is easier to keep production consistent and for other technical reasons associated with the IG edge seal system. There are other ways that the U-factor can be achieved, such as by employing a wider thermal barrier, room-side low-e coating or warm-edge spacer. Moving to a 0.40 BTU/ºF.hr.ft^2 seems an obvious, easy, progression. The technology is readily available at scale and the incremental cost is marginal. Reducing the U-factor of the frame and edge of glass will also support lowering solar heat gain coefficient since the solar heat gain coefficient of the frame is directly proportional to its U-factor.

Climate zone 3

Moving from a U-factor of 0.42 to 0.38 BTU/ºF.hr.ft^2 is also straightforward. A standard frame with a small thermal barrier can achieve 0.38 BTU/ºF.hr.ft^2. The industry is also set up to provide this level of performance with a simple frame with small thermal barrier and simple low-e coated insulating glass unit plus gas filling, a second low-e, a warm-edge spacer or wider thermal barrier in the frame.

Climate zones 4-6

U-factors of 0.31-0.32 BTU/ºf.hr.ft^2 can be achieved with dual pane IGUs in a high-performance window (with wide thermal barriers) using argon-filling, warm-edge spacer and possibly a second low-e coating, and relatively more easily in a 2 or 4 sided-structurally glazed curtainwall where there is no exterior metal to cause thermal bridging. There appear to be plenty of curtainwall systems at 0.30 and above in the NFRC certified product database, although triple pane may be needed for some framing systems, depending on their thermal performance.

It should also be noted that a fixed fenestration U-factor of 0.30 BTU/ºF.hr.ft^2 is currently required currently by New York City (climate zone 5) energy code for metal fixed fenestration installed under 95 ft and 0.36 for metal fixed fenestration above 95ft (presumably because of increased structural requirements above 95 ft). How common is it for designers to change fenestration type/performance in tall buildings at the 95ft point (~7-9 stories)?

Climate zones 7-8

The current requirements for these zones require triple pane systems. We are proposing moving the current requirement for zone 8 to zone 7, and slightly reducing the requirement for zone 8 to support incremental improvement. We believe we need to continue to take steps to get to the net zero target of between 0.10 to 0.20 btu/ºf.hr.ft^2, and it requires conditioning the market to provide these products so that they can then be adopted in the lower climate zones in subsequent code revisions.

Making the changes in the more southern climate zones (1-6) are more important to driving down carbon emissions since they constitute a much larger proportion of the building stock compared to climate zones 7 and 8. However, changes in climate zones 7 and 8 are important for conditioning the market such that it is ready to supply this performance and scale for the more populous climate zones.

Bibliography:

[1] LBNL 60049: Zero Energy Windows; https://eta-publications.lbl.gov/sites/default/files/60049.pdf

[2] H. Sanders, U-factor matters in hot climates, Façade Tectonics World Congress 2020. https://www.facadetectonics.org/papers/u-factor-matters-in-hot-climates

[3] Links to examples of commercially available R5 windows in the U.S.:

http://www.wausauwindow.com/index.cfm?pid=44&pageTitle=Product%20Detail&prID=15

https://www.schueco.com/us/architects/products/windows

https://www.kawneer.com/kawneer/north_america/en/product_related_doc.asp?prod_id=4306&doc_id=114

[4] Part 1 - Global connections: The correlation between code stringency and energy-saving technology adoption. https://igsmag.com/market-trends/environmental/global-connections-the-correlation-between-code-stringency-and-energy-saving-technology-adoption-part-1/

[5] Part 2 – Global connections: The correlation between code stringency and energy-saving technology adoption. https://igsmag.com/market-trends/environmental/part-2-global-connections-the-correlation-between-code-stringency-and-energy-saving-technology-adoption/

[6] Part 3 – Global connections: The correlation between code stringency and energy-saving technology adoption. https://igsmag.com/market-trends/environmental/part-3-global-connections-the-correlation-between-code-stringency-and-energy-saving-technology-adoption/

[7] Baby it's cold inside, Atelier 10 for Urban Green. https://www.urbangreencouncil.org/babyitscoldinside

[8] New York State New York State Activities Advancing Building Decarbonization presentation to the California Energy Commission, TN# 237957, link to docket: https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-IEPR-06

[9] British Columbia's Clean Buildings Strategy Presentation to CEC. TN# 237958. Link to docket: https://efiling.energy.ca.gov/Lists/DocketLog.aspx?docketnumber=21-IEPR-06

[10] Hot Climates: Give us a Break, IGS 2021. https://igsmag.com/features/hot-climates-give-us-a-break/

Cost Impact:

The code change proposal will increase the cost of construction.

Decreasing the U-factor requirements will increase the cost of construction. By how much depends on the climate zone. In some cases, where the addition of argon gas fill may only be needed, this comes at no to marginal additional first cost. Based on the discussions above, cost-effectiveness assessments of improving fenestration thermal performance therefore need to consider more than just simplistic assessments of upfront capital cost and payback on cost of energy. The social cost of carbon – the economic costs of future impacts of climate change caused by emissions today – needs to be factored into the cost of energy. And the impact of improving a building's resilience on preserving human health. Plus the benefit to the renewable electrical grid of being able to reduce peak heating loads in the mornings and reduce electric cooling loads. Also, if we continue to only make U-factor stringency improvements when it can product a short-term payback on current energy costs which don't include the cost of carbon, we are not going to reach net zero by 2030.

We are currently working with FTI contractor members to gather more up to date cost data on the impact of incrementally reducing fenestration U-factor. We will follow up and provide this to the committee as soon as it is completed.

CEPI-52-21

CEPI-53-21

IECC®: SECTION 202 (New), TABLE C402.4, C402.4.3, C405.1.1

Proponents: Kimberly Newcomer, representing NBI (kim@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:

CURTAIN WALL. An external non-bearing wall intended to separate the exterior nonconditioned and interior conditioned spaces consisting of any combination of framing materials, fixed glazing, opaque glazing, operable windows, or other in-fill materials.

Revise as follows:

TABLE C402.4 BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
Vertical fenestration																
***U*-factor**																
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Fixed fenestration	0.50	0.40	0.45	0.30	0.42	0.27	0.36	0.25	0.36	0.25	0.34	0.25	0.29	0.25	0.26	0.25
Operable fenestration	0.62	0.40	0.60	0.30	0.54	0.27	0.45	0.25	0.45	0.25	0.42	0.25	0.36	0.25	0.32	0.25
Entrance doors	0.83		0.77		0.68		0.63		0.63		0.63		0.63		0.63	
SHGC																
	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable
$PF < 0.2$	0.23	0.21	0.25	0.23	0.25	0.23	0.36	0.33	0.38	0.33	0.38	0.34	0.40	0.36	0.40	0.36
$0.2 \le PF < 0.5$	0.28	0.25	0.30	0.28	0.30	0.28	0.43	0.40	0.46	0.40	0.46	0.41	0.48	0.43	0.48	0.43
$PF \ge 0.5$	0.37	0.34	0.40	0.37	0.40	0.37	0.58	0.53	0.61	0.53	0.61	0.54	0.64	0.58	0.64	0.58
Skylights																
U-factor	0.70		0.65		0.55		0.50		0.50		0.50		0.44		0.41	
SHGC	0.30		0.30		0.30		0.40		0.40		0.40		NR		NR	

NR = No Requirement, PF = Projection Factor.

C402.4.3 Maximum U-factor and SHGC. The maximum *U*-factor and solar heat gain coefficient (SHGC) for fenestration shall be as specified in Table C402.4.

> **Exception:** Curtain wall fenestration and fenestration products certified to meet the North American Fenestration Standard/Specification for an Architectural Window (AW) in Group R occupancies shall be permitted to use the U-factors for All Other.

The window projection factor shall be determined in accordance with Equation 4-5.

$$PF = A/B \qquad \textbf{(Equation 4-5)}$$

where:

PF = Projection factor (decimal).

A = Distance measured horizontally from the farthest continuous extremity of any overhang, eave or permanently attached shading device to the vertical surface of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave or permanently attached shading device.

Where different windows or glass doors have different *PF* values, they shall each be evaluated separately.

C405.1.1 Lighting for dwelling units. ~~No less than 90 percent of the p~~ Permanently installed lighting serving dwelling units, excluding kitchen appliance lighting, shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W~~, or~~

~~shall comply with Sections C405.2.4 and C405.3~~.

Exception: Lighting that complies with Sections C405.2.4 and C405.3.

Reason: This combination of proposals seeks to align the requirements of multifamily dwelling units across the two sides of the code. Currently there are large discrepancies in terms of system design, control and stringency between a 3-story MF building and a 4-story MF building. This leads to market confusion, enforcement inconsistencies, and large potential untapped energy savings. This revision and its companion seek to close these gaps and create a common set of requirements for multifamily buildings.
The 2022 version of Title 24 has created a new section to regulate MF buildings - similar to a more "omnibus" proposal submitted by NBI previously. Based on feedback from that submission to not create a new section, this proposal instead works to align the sections that currently exist.

Bibliography: https://newbuildings.org/resource/multifamily-building-guide/
https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
For commercial buildings, these changes match current market availability of products and should not change the cost of construction.

CEPI-54-21

IECC®: C402.4.3 (New)

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new text as follows:
C402.4.3 Fenestration Orientation.

The vertical fenestration shall comply with either equation C402.4.3.1 or C402.4.3.2 forClimate Zones 0 through 3. The vertical fenetration shall comply with either equation C402.4.3.1 or C402.4.3.3 forClimate Zones 4 through 8.

Aw ≤ (At)/4 and Ae ≤ (At)/4 (equation C402.4.3.1)

A_W x $SHGC_W$ ≤ (A_T x $SHGC_C$)/4 and A_Ex $SHGC_E$ ≤ (A_T x $SHGC_C$)/4 (equation C402.4.3.2)

A_W x $SHGC_W$ ≤ (A_T x $SHGC_C$)/5 and A_Ex $SHGC_E$ ≤ (A_T x $SHGC_C$)/5 (equation C402.4.3.3)

where:

A_W = west-oriented vertical fenestration area

A_E = east-oriented vertical fenestration area

A_T = total vertical fenestration area

$SHGC_C$ = SHGC criteria in Tables C402.4

$SHGC_E$ = SHGC for east-oriented fenestration

$SHGC_W$ = SHGC for west-oriented fenestration

Exceptions:

1. Buildings with shade on more than 75 percent of the east- and west-oriented vertical fenestration areas from permanent projections, existing buildings, existing permanent infrastructure, or topography at 9 a.m. and 3 p.m., respectively, on the summer solstice (June 21 in the northern hemisphere.)
2. Buildings where the west-oriented and east-oriented vertical fenestration area does not exceed 20% of the gross wall area for each of those façades.
3. Buildings in Climate Zone 8.

Reason Statement:

Orientation is one of the least expensive and most impactful energy conservation strategies available to the design community. It has been proven historically for centuries that a good orientation can increase passive winter heating and control for solar gain in cooling.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal has no cost impact as we are not requiring any physical material changes or increase in insulation values or fenestration technology improvements that would impact a projects first cost.

CEPI-54-21

CEPI-55-21

IECC®: C402.5, C402.5.1, C402.5.1.1, C402.5.1.2, C402.5.1.5, C402.5.2, C402.5.2 (New), C402.5.2.1 (New), C402.5.2.2 (New), C402.5.3, C402.5.3 (New), C402.5.3.1 (New), C402.5.4 (New), C402.5.1.3, C402.5.1.4, C402.5.4, C402.5.5, C402.5.6, C402.5.7, C402.5.8, C402.5.9, C402.5.10, C402.5.11, C402.5.11.1

Proponents:

Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
C402.5 Air leakage—thermal envelope.
~~The~~ *Air leakage* control for the *building thermal envelope* shall comply with SectionsC402.5.1 and Sections C402.5.6 through Section C402.4.12. ~~C402.5.11.1, or the building *thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9.~~
C402.5.1 Air barriers.

A continuous air barrier shall be provided throughout the *building thermal envelope*. The continuous air barriers shall be located on the inside or outside of the building thermal envelope, located within the assemblies composing the building thermal envelope, or any combination thereof. The air barrier shall comply with Sections C402.5.1.1, and C402.5.1.2.

Exception: Air barriers are not required in buildings located in *Climate Zone* 2B.

C402.5.1.1 Air barrier construction.

The *continuous air barrier* shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.5.10. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

Revise as follows:
C402.5.1.2 Air barrier compliance..

A continuous air barrier for the opaque building envelope shall comply with ~~the following:~~the provisions of Section C402.5.2.

Exception: The following buildings or portions of buildings that meet the provisions of Section C402.5.4:
1. Buildings or Group R and I occupancy in *Climate Zones* 3C and 5C, or
2. Buildings of other than Group R and I occupancy in *Climate Zones* 3B, 3C and 5C.

3. Buildings of other than Group R and I occupancy larger than 5,000 square feet (464.5 m^2) floor area in *Climate Zones* 0B, 1, 2A, 4B and 4C.
4. Buildings of other than Group R and I occupancy between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.

~~1.~~ ~~Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.~~

~~**Exception:** Buildings in Climate Zones 2B, 3C and 5C.~~

~~2.~~ ~~Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.~~

~~**Exceptions:**~~

~~1. Buildings in Climate Zones 2B, 3B, 3C and 5C.~~

~~2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.~~

~~3. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.~~

~~3.~~ ~~Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.~~

Delete without substitution:

~~C402.5.1.5 Building envelope performance verification~~.

~~The installation of the continuous air barrier shall be verified by the *code official*, a *registered design professional* or *approved* agency in accordance with the following:~~

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section C402.5.1.

2. Inspection of continuous air barrier components and assemblies shall be conducted during construction while the air barrier is still accessible for inspection and repair to verify compliance with the requirements of Sections C402.5.1.3 and C402.5.1.4.

3. A final commissioning report shall be provided for inspections completed by the *registered design professional* or *approved* agency. The commissioning report shall be provided to the building owner or owner's authorized agent and the *code official*. The report shall identify deficiencies found during the review of the construction documents and inspection and details of corrective measures taken.

~~C402.5.2 Dwelling and sleeping unit enclosure testing~~.

~~The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft² (1.5 L/s m²) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:~~

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.

2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

Add new text as follows:

C402.5.2 Building Thermal Envelope Testing.

Buildings or portions of building shall comply with Section C402.5.2.1.

Exception: Buildings with Group R and I occupancies that have been tested in accordance with C402.5.3.

C402.5.2.1 Building thermal envelope air leakage.

The measured air leakage shall not exceed 0.40 cfm/ft2 (2.0 L/s × m2) of the building thermal envelope area at a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with C402.5.2.2.

Exception: Where the measured air leakage rate exceeds 0.40 cfm/ft2 (2.0 L/s × m2) but does not exceed 0.60 cfm/ft2 (3.0 L/s × m2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where 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 comply with the requirements of this section.

C402.5.2.2 Building thermal envelope testing criteria.

The building thermal envelope shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.
   The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.3.
2. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

Delete without substitution:

~~C402.5.3 Building thermal envelope testing.~~

~~The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:~~

1. The entire envelope area of all stories that have any spaces directly under a roof.
2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

~~**Exception:** Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where 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 comply with the requirements of this section.~~

Add new text as follows:

C402.5.3 Dwelling and sleeping unit enclosure testing.

The measured air leakage of the building thermal envelope shall not exceed 0.30 cfm/ft2 (1.5 L/s m2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa) when tested in accordance with C402.5.2.1.

C402.5.3.1 Testing criteria.

The building thermal envelope shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827, ASTM E3158 or an equivalent method approved by the code official. Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one building thermal envelope, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

C402.5.4 Building envelope design and construction verification.

Materials and assemblies that are part of the continuous air barrier shall comply with Sections C402.5.4.1 and C402.5.4.2, respectively. Fenestration shall comply with C402.5.5. The installation of the continuous air barrier shall be verified by the code official, a registered design professional or approved agency in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section C402.5.1.
2. Inspection of continuous air barrier components and assemblies shall be conducted during construction while the air barrier is still accessible for inspection and repair to verify compliance with the requirements of Sections C402.5.1.3 and C402.5.1.4.
3. A final commissioning report shall be provided for inspections completed by the registered design professional or approved agency. The commissioning report shall be provided to the building owner or owner's authorized agent and the code official. The report shall identify deficiencies found during the review of the construction documents and inspection and details of corrective measures taken.

Revise as follows:

~~C402.5.1.3~~ C402.5.4.1 Materials.

Materials with an air permeability not greater than 0.004 cfm/ft^2 (0.02 L/s × m^2) under a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall comply with this section. Materials in Items 1 through 16 shall be deemed to comply with this section, provided that joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than $^3/_8$ inch (10 mm).
2. Oriented strand board having a thickness of not less than $^3/_8$ inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).
5. Closed-cell spray foam having a minimum density of 1.5 pcf (2.4 kg/m^3) and having a thickness of not less than 1$^1/_2$ inches (38 mm).
6. Open-cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m^3) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than $^1/_2$ inch (12.7 mm).
8. Cement board having a thickness of not less than $^1/_2$ inch (12.7 mm).
9. Built-up roofing membrane.

10. Modified bituminous roof membrane.

11. Single-ply roof membrane.

12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than $^5/_8$ inch (15.9 mm).

13. Cast-in-place and precast concrete.

14. Fully grouted concrete block masonry.

15. Sheet steel or aluminum.

16. Solid or hollow masonry constructed of clay or shale masonry units.

~~C402.5.1.4~~ C402.5.4.2 Assemblies.

Assemblies of materials and components with an average air leakage not greater than 0.04 cfm/ft^2 (0.2 L/s × m^2) under a pressure differential of 0.3 inch of water gauge (w.g.)(75 Pa) when tested in accordance with ASTM E2357, ASTM E1677 , ASTM D8052 or ASTM E283 shall comply with this section. Assemblies listed in Items 1 through 3 shall be deemed to comply, provided that joints are sealed and the requirements of Section C402.5.1.1 are met.

1. Concrete masonry walls coated with either one application of block filler or two applications of a paint or sealer coating.

2. Masonry walls constructed of clay or shale masonry units with a nominal width of 4 inches (102 mm) or more.

3. A Portland cement/sand parge, stucco or plaster not less than $^1/_2$ inch (12.7 mm) in thickness.

~~C402.5.4~~ C402.5.5 Air leakage of fenestration.

The air leakage of fenestration assemblies shall meet the provisions of Table C402.5.4. Testing shall be in accordance with the applicable reference test standard in Table C402.5.4 by an accredited, independent testing laboratory and *labeled* by the manufacturer.

~~Exceptions~~ Exception:

~~1.~~ Field-fabricated fenestration assemblies that are sealed in accordance with Section C402.5.1.

~~2.~~ ~~Fenestration in buildings that comply with the testing alternative of Section C402.5 are not required to meet the air leakage requirements in Table C402.5.4.~~

~~C402.5.5~~C402.5.6 Rooms containing fuel-burning appliances.

In *Climate Zones* 3 through 8, where combustion air is supplied through openings in an exterior wall to a room or space containing a space-conditioning fuel-burning appliance, one of the following shall apply:

1. The room or space containing the appliance shall be located outside of the *building thermal envelope*.

   The room or space containing the appliance shall be enclosed and isolated from conditioned spaces inside the *building thermal envelope*. Such rooms shall comply with all of the following:

2.1. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be insulated to be not less than equivalent to the insulation requirement of below-grade walls as specified in Table C402.1.3 or Table C402.1.4.

2.2. The walls, floors and ceilings that separate the enclosed room or space from conditioned spaces shall be sealed in accordance with Section C402.5.1.1.

2.

2.3. The doors into the enclosed room or space shall be shall be fully gasketed.

2.4. Water lines and ducts in the enclosed room or space shall be insulated in accordance with Section C403.

2.5. Where an air duct supplying combustion air to the enclosed room or space passes through *conditioned space*, the duct shall be insulated to an *R*-value of not less than R-8.

Exception: Fireplaces and stoves complying with Sections 901 through 905 of the International Mechanical Code, and Section 2111.14 of the International Building Code.

~~C402.5.6~~ C402.5.7 Doors and access openings to shafts, chutes, stairways and elevator lobbies.

Doors and *access* openings from conditioned space to shafts, chutes stairways and elevator lobbies not within the scope of the fenestration assemblies covered by Section ~~C402.5.4~~ C402.5.5 shall be gasketed, weather-stripped or sealed.

Exceptions:

1. Door openings required to comply with Section 716 of the International Building Code.

2. Doors and door openings required to comply with UL 1784 by the *International Building Code*.

~~C402.5.7~~ C402.5.8 Air intakes, exhaust openings, stairways and shafts.

Stairway enclosures, elevator shaft vents and other outdoor air intakes and exhaust openings integral to the building envelope shall be provided with dampers in accordance with Section C403.7.7.

~~C402.5.8~~ C402.5.9 Loading dock weather seals.

Cargo door openings and loading door openings shall be equipped with weather seals that restrict infiltration and provide direct contact along the top and sides of vehicles that are parked in the doorway.

~~C402.5.9~~ C402.5.10 Vestibules.

Building entrances shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the *building entrance* shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors.

Exceptions: Vestibules are not required for the following:

1. Buildings in *Climate Zones* 0 through 2.

2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.

3. Doors opening directly from a *sleeping unit* or dwelling unit.

4. Doors that open directly from a space less than 3,000 square feet (298 m^2) in area.

5. Revolving doors.

6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.

7. Doors that have an air curtain with a velocity of not less than 6.56 feet per second (2 m/s) at the floor that have been tested in accordance with ANSI/AMCA 220 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that will operate the air curtain with the opening and closing of the door. Air curtains and their controls shall comply with Section C408.2.3.

~~C402.5.10~~ C402.5.11 Recessed lighting.

Recessed luminaires installed in the *building thermal envelope* shall be all of the following:

1. IC-rated.

2. Labeled as having an air leakage rate of not more 2.0 cfm (0.944 L/s) when tested in accordance with ASTM E283 at a 1.57 psf (75 Pa) pressure differential.

3. Sealed with a gasket or caulk between the housing and interior wall or ceiling covering.

~~C402.5.11~~ C402.5.12 Operable openings interlocking.

Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 m^2) in area, such openings shall be interlocked with the heating and cooling system so as to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.

Exceptions:

1. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.

2. Warehouses that utilize overhead doors for the function of the occupancy, where approved by the code official.

3. The first entrance doors where located in the exterior wall and are part of a vestibule system.

~~C402.5.11.1~~ C402.5.12.1 Operable controls.

Controls shall comply with Section C403.14.

Reason Statement:

This proposal restructures the existing code for clarity, reduces redundancy and possible contradiction between sections. Section C402.5 is currently one of the most intricate and potentially confusing sections of the code, and this proposal seeks to simplify it by improving the flow of the text. No technical requirements are intended to be changed by this proposal.

The restructuring separates sections specifying the air leakage maximum values from sections specifying the methods by which these values are tested and verified. This will allow an easier revision of the code as new technology and/or test methods are deployed in the industry.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is a restructuring of the section, but does not change technical requirements.

CEPI-55-21

CEPI-56-21

IECC®: C402.5, C402.5.3, C402.5.2, C402.5.1, C402.5.1.1, C402.5.1.2, C402.5.1.3, C402.5.1.4, C402.5.1.5

Proponents:

David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:

C402.5 Air leakage—thermal envelope.

The *building thermal envelope* shall comply with ~~Sections C402.5.1 through Section C402.5.11.1, or the building *thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9.~~Sections C402.5.4 through C402.5.11 and be tested in accordance with Section C402.5.1 or C402.5.2. Where buildings are exempted from testing by C402.5.1 and C402.5.2 they shall comply with Section C402.5.3.

~~C402.5.3~~ C402.5.1 ~~Building thermal envelope testing~~Whole building thermal envelope testing..

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent *approved* method ~~approved by the code official~~. ~~The measured air leakage shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa).~~ Alternatively, portions of the building shall be tested and the measured air leakages shall be ~~area~~ weighted by area by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. ~~In the alternative approach,~~Where using weighted averages for compliance, the following portions of the building shall be tested:

1. The entire thermal envelope area of all stories that have any spaces directly under a roof.
2. The entire envelope area of all stories that have a building entrance, ~~exposed floor,~~ or a floor above unconditioned area, ~~or~~ a loading dock, or are below grade.
3. ~~Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.~~Portions of the building totaling not less than 25 percent of the wall area enclosing the conditioned space not otherwise required to be tested.

The measured air leakage shall not exceed 0.40 cfm/ft^2 (2.0 L/s x m^2) of the building thermal envelope area at a pressure differential of 0.3 inch water gauge (75 Pa).

~~Exception~~ Exceptions:

1. Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where 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 comply with the requirements of this section.
2. Buildings in Climate Zones 2B, 3B, 3C, and 5C.
3. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.
4. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor are in Climate Zones 0A, 3A and 5B.

C402.5.2 Dwelling and sleeping unit enclosure testing.

~~The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:~~Group R and I Occupancy buildings or portions of buildings where dwelling and sleeping units shall be tested in accordance with this section or with C402.5.1. The building thermal envelope shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent approved method. Where multiple dwelling units or sleeping units are contained within one building thermal envelope, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all unit tests. Weighting shall be by each unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, ~~the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.~~not less than seven units or 20 percent of the building's testing units, whichever is greater, shall be tested. A top floor unit, a ground floor unit and the unit with the largest enclosure area shall be tested. For each tested unit that exceeds the maximum air leakage rate, two additional units shall be tested. The measured air leakage shall not exceed 0.30 cfm/ft2 (1.5 L/s m2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa).

   Exceptions:
   1. Buildings complying with Section C402.5.1
   2. Buildings in Climate Zones 2B, 3C, and 5C.

~~C402.5.1~~C402.5.3 ~~Air Barriers~~ .

A continuous air barrier shall be provided throughout the *building thermal envelope*. The continuous air barriers shall be located on the inside or outside of the building thermal envelope, located within the assemblies composing the building thermal envelope, or any combination thereof. The air barrier shall comply with Sections ~~C402.5.1.1, and C402.5.1.2.~~C402.5.3.1 and C402.5.3.2.

Exception: Air barriers are not required in buildings located in *Climate Zone* 2B.

~~C402.5.1.1~~C402.5.3.1. Air barrier construction.

The *continuous air barrier* shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.5.10. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

~~C402.5.1.2~~C402.5.3.2 Air barrier compliance..

~~A continuous air barrier for the opaque building envelope shall comply with the following:~~Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.3.5 and either Section C402.5.3.3 or C402.5.3.4.

~~1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.~~

~~**Exception:** Buildings in Climate Zones 2B, 3C and 5C.~~

~~Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.~~

~~**Exceptions:**~~

~~2.~~ ~~1. Buildings in Climate Zones 2B, 3B, 3C and 5C.~~

~~2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.~~

~~3. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.~~

~~3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.~~

~~C402.5.1.3~~C402.5.3.3 Materials.

Materials with an air permeability not greater than 0.004 cfm/ft^2 (0.02 L/s × m^2) under a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall comply with this section. Materials in Items 1 through 16 shall be deemed to comply with this section, provided that joints are sealed and materials are installed as air barriers in accordance with the manufacturer's instructions.

1. Plywood with a thickness of not less than $^3/_8$ inch (10 mm).
2. Oriented strand board having a thickness of not less than $^3/_8$ inch (10 mm).
3. Extruded polystyrene insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).
4. Foil-back polyisocyanurate insulation board having a thickness of not less than $^1/_2$ inch (12.7 mm).
5. Closed-cell spray foam having a minimum density of 1.5 pcf (2.4 kg/m^3) and having a thickness of not less than 1$^1/_2$ inches (38 mm).
6. Open-cell spray foam with a density between 0.4 and 1.5 pcf (0.6 and 2.4 kg/m^3) and having a thickness of not less than 4.5 inches (113 mm).
7. Exterior or interior gypsum board having a thickness of not less than $^1/_2$ inch (12.7 mm).
8. Cement board having a thickness of not less than $^1/_2$ inch (12.7 mm).
9. Built-up roofing membrane.
10. Modified bituminous roof membrane.

11. Single-ply roof membrane.

12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than $^5/_8$ inch (15.9 mm).

13. Cast-in-place and precast concrete.

14. Fully grouted concrete block masonry.

15. Sheet steel or aluminum.

16. Solid or hollow masonry constructed of clay or shale masonry units.

~~C402.5.1.4~~C402.5.3.4 Assemblies.

Assemblies of materials and components with an average air leakage not greater than 0.04 cfm/ft^2 (0.2 L/s × m^2) under a pressure differential of 0.3 inch of water gauge (w.g.)(75 Pa) when tested in accordance with ASTM E2357, ASTM E1677 , ASTM D8052 or ASTM E283 shall comply with this section. Assemblies listed in Items 1 through 3 shall be deemed to comply, provided that joints are sealed and the requirements of Section ~~C402.5.1.1~~C402.5.3.1 are met.

1. Concrete masonry walls coated with either one application of block filler or two applications of a paint or sealer coating.

2. Masonry walls constructed of clay or shale masonry units with a nominal width of 4 inches (102 mm) or more.

3. A Portland cement/sand parge, stucco or plaster not less than $^1/_2$ inch (12.7 mm) in thickness.

~~C402.5.1.5~~C402.5.3.5 Building envelope performance verification.
The installation of the continuous air barrier shall be verified by the *code official*, a *registered design professional* or *approved* agency in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section ~~C402.5.1.~~C402.5.3.

2. Inspection of continuous air barrier components and assemblies shall be conducted during construction while the air barrier is still accessible for inspection and repair to verify compliance with the requirements of Sections ~~C402.5.1.3~~C402.5.3.3 and ~~C402.5.1.4.~~C402.5.3.4.

3. A final commissioning report shall be provided for inspections completed by the *registered design professional* or *approved* agency. The commissioning report shall be provided to the building owner or owner's authorized agent and the *code official*. The report shall identify deficiencies found during the review of the construction documents and inspection and details of corrective measures taken.

Reason Statement:

There were several approved code change proposals of the air leakage provisions in the last code development cycle. The combination of those proposals has resulted in a section in dire need of a reorganization for clarity and ease of use. This proposal does not change provisions but does restructure the entirety of Section C405 and subsections to clarify the requirements and make it easier for users to understand. This includes:

· Moving testing sections up and air barrier section behind them as the air barrier section is used only when testing is not required via exception stated in the testing sections. Renumbering as appropriate.

· Adding a clarification that the Group R & I sleeping and dwelling unit testing is optional. Group R & I buildings are permitted to use whole building testing. This section further clarifies that if these buildings do not test per the sleeping and dwelling unit testing requirements, they shall test per the whole building test section.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no cost impact associated with the reorganization of this code language.

CEPI-56-21

CEPI-57-21

IECC®: SECTION 202 (New), C402.5, C402.5.1.2, C402.5.2, C402.5.3 (New), C402.5.3.1 (New), C402.5.3.2 (New), C402.5.3, C406.1, TABLE C406.1(1), TABLE C406.1(2), TABLE C406.1(3), TABLE C406.1(4), TABLE C406.1(5), C406.9

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 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.

Revise as follows:
C402.5 Air leakage—thermal envelope.

The *building thermal envelope* of all buildings less than 10,000 ft^2 (1000 m^2) shall be tested in accordance with Section C402.5.2 or C402.5.3 and shall also comply with Sections C402.5.7, C402.5.8, and C402.5.9.~~shall comply with Sections C402.5.1 through Section C402.5.11.1, or the building *thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3.~~ The building thermal envelope of all other buildings shall comply with Sections C402.5.1 through C402.5.11.1, or the building thermal envelope shall be tested in accordance with Section 402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9.

Delete and substitute as follows:
~~C402.5.1.2~~ .

~~A continuous air barrier for the opaque building envelope shall comply with the following:~~

1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.

   Exception: Buildings in Climate Zones 2B, 3C and 5C.

2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.

   Exceptions:

   1. Buildings in Climate Zones 2B, 3B, 3C and 5C.
   2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.
   3. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

C402.5.1.2 Documentation requirements.

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

1. 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.

2. The joints, interconnections, and penetrations of the continuous air barrier components shall be detailed in the construction documents.

3. 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*.

4. 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.

5. 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*:
   5.1. Joints around fenestration and door frames.
   5.2. Junctions between *walls* and *floors*, between *walls* at *building* corners, between *walls* and *roofs* including parapets and copings, and *walls* at foundations.
   5.3. Penetrations through the continuous air barrier in building envelope roofs, walls, and floors.
   5.4. Building assemblies used as ducts or plenums.
   5.5. Joints, seams, connections between planes, and other changes in continuous air barrier materials.
   5.6. *Building* and *service* components projecting through or attached through the *continuous air barrier.*
   5.7. Junctions of the *continuous air barrier* that separate *conditioned spaces* from *unconditioned spaces*, *semiheated spaces,* and areas that are not *enclosed spaces*.

Revise as follows:

C402.5.2 Dwelling and sleeping unit enclosure testing.

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. Testing shall be performed by an independent third party. The measured air leakage shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of ~~0.2~~ 0.3 inch water gauge (~~50~~75 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.

2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

Add new text as follows:

C402.5.3 Building thermal envelope testing.

Testing shall be conducted excluding HVAC related elements in the *building thermal envelope* and be performed by an independent third party.

C402.5.3.1 Whole-building pressurization method.

The *building thermal envelope* shall be tested in accordance with ASTME3158or and equivalent method approved by the code official.

C402.5.3.2 Whole-building pressurization methods for small buildings, dwellings, and sleeping units.

For buildings less than 10,000 ft^2 (1000 m^2) or buildings or portions of buildings with Group R and I occupancies the *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC380, ASTM E3158 or ASTM E1827 or and equivalent method approved by the code official.

Revise as follows:

~~C402.5.3~~C402.5.3.3 ~~Building thermal envelope testing~~Whole-building testing - measured air leakage.

~~The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827~~

~~or an equivalent method approved by the code official.~~ The measured air leakage shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). ~~Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:~~

~~1. The entire envelope area of all stories that have any spaces directly under a roof.~~

~~2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.~~

~~3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.~~

Exception: Where the measured air leakage rate exceeds ~~0.40~~<u>0.35</u> cfm/ft^2 (2.0 L/s × m^2) but does not exceed ~~0.60~~<u>0.45</u> cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where 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 comply with the requirements of this section. <u>Where the measured *air leakage* rate exceeds 0.45 cfm/ft^2 (2.2 L/s·m^2), corrective actions must be made to the *envelope* and an additional test completed where results are 0.45 cfm/ft^2 (2.2 L/s·m^2) or less in order to demonstrate compliance.</u>

C406.1 Additional energy efficiency credit requirements.

New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced ~~air infiltration~~<u>*air leakage*</u> in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.

11. Efficient kitchen equipment in accordance with Section C406.12.

TABLE C406.1(1) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

SECTION	CLIMATE ZONE 0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pumpwater heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced air ~~infiltration~~leakage	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

TABLE C406.1(2) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

SECTION	CLIMATE ZONE 0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406.2.2: 5% cooling efficiency improvement	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% cooling efficiency improvement	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3: Reduced lighting power	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C406.4: Enhanced digital lighting controls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: On-site renewable energy	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.2: Recovered or renewable water heating	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Reduced air ~~infiltration~~leakage	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3
C406.10: Energy monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.11: Fault detection and diagnostics system	1	1	1	1	1	1	NA	1	1	NA	1	1	NA	1	1	1	1

NA = Not Applicable.

TABLE C406.1(3) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP E OCCUPANCIES

SECTION	CLIMATE ZONE 0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8

C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	4
C406.2.2: 5% cooling efficiency improvement	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	3	4	3	4	3	4	3	5	7
C406.2.4: 10% cooling efficiency improvement	7	8	7	6	5	4	3	4	3	1	2	2	1	2	2	2	1
C406.3: Reduced lighting power	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
C406.5: On-site renewable energy	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
C406.6: Dedicatedoutdoor air system	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.2: Recoveredor renewable water heating[a]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.7.3: Efficient fossil fuel water heater[a]	NA	1	1	1	1	1	1	2	2	3	2	3	2	3	3	3	5
C406.7.4: Heat pump water heater[a]	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1	1	1	1
C406.8: Enhanced envelope performance	3	7	3	4	2	4	1	1	3	1	2	3	NA	4	3	6	9
C406.9: Reduced air ~~infiltration~~leakage	1	1	1	2	NA	NA	NA	NA	NA	NA	1	NA	NA	4	1	4	3
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	2	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2

NA = Not Applicable.

a. For schools with showers or full-service kitchens.

TABLE C406.1(4) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP M OCCUPANCIES

SECTION	**CLIMATE ZONE**																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	NA	1	1	2	2	2	2	3	2	3	4
C406.2.2: 5% cooling efficiency improvement	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	4	3	4	5	5	3	6	8
C406.2.4: 10% cooling efficiency improvement	9	12	9	8	6	6	3	4	4	1	2	3	NA	2	2	2	1
C406.3: Reduced lighting power	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12
C406.4: Enhanced digital lighting controls	3	3	4	3	4	3	4	4	4	3	3	3	3	4	4	3	3
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
C406.6: Dedicated outdoor air system	3	4	3	3	3	3	1	3	2	2	2	3	2	4	3	4	4
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pump water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	4	6	3	4	3	3	1	6	4	4	4	5	4	6	5	8	9
C406.9: Reduced air ~~infiltration~~leakage	1	1	1	2	1	1	NA	3	1	1	3	2	1	7	3	6	3
C406.10: Energy monitoring	4	5	5	5	5	4	4	4	4	3	3	4	3	4	4	4	3
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2

NA = Not Applicable.

TABLE C406.1(5) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR OTHER[a] OCCUPANCIES

SECTION	**CLIMATE ZONE**																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	3
C406.2.2: 5% cooling efficiency improvement	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	3	3	3	3	4	3	5	5

C406.2.4: 10% cooling efficiency improvement	8	9	8	7	5	5	3	4	4	2	2	3	2	2	2	2	2
C406.3: Reduced lighting power	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	8	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	3	2	5	3	3	5	4	3	7	5	7	6
C406.7.2: Recovered or renewable water heating [b]	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater [b]	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater [b]	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	4	3	4	1	5	4	3	5	5	4	7	6	9	10
C406.9: Reduced air ~~infiltration~~leakage	3	2	2	4	4	2	NA	6	2	2	6	4	1	10	5	7	4
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	3	2	3	2	2	2	3	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

a. Other occupancy groups include all groups except Groups B, E, I, M and R.

b. For occupancy groups listed in Section C406.7.1.

C406.9 Reduced ~~air infiltration~~*air leakage*.

~~Air infiltration~~*Air leakage* shall be verified by whole-building pressurization testing conducted in accordance with Section C402.5.3.1. ~~ASTM E779 or ASTM E1827 by an independent third party.~~ The measured ~~air leakage rate~~*air leakage* of the ~~building envelope~~building thermal envelope shall not exceed 0.25 cfm/ft^2 (2.0 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

~~**Exception:** For buildings having over 250,000 square feet (25 000 m^2) of *conditioned floor area*, air leakage testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.~~

Reason Statement:

This proposal brings the IECC 2021 into alignment with an ongoing addendum to ASHRAE 90.1-2019. It does three things:

1. It updates the required pressure differential that is more typically used in commercial buildings (75 Pa).
2. It updates the target air leakage rate for commercial buildings to match what was proven to be cost effective in the 90.1 deliberations.
3. It adds a requirement for testing of all buildings less than 10,000 square feet.
4. Restructures the whole building air tightness testing language clarify and simplify the complaince path. Revoves overlapping exceptions, repeated testing references, and utilizes the new ASTM E3158 to eliminate the need for IECC prescribed modifications to the standard testing methodoligies. The new ASTM E3158 provides guidance and clarifications for large multizone buildings, whereas the previous references lacked the clarity.

Cost Impact:

The code change proposal will increase the cost of construction.

These proposed changes were considered to be cost effective in the ASHRAE 90.1 committee which resulted in the public review draft - addendum t. The 90.1 process uses an approximately 40-year life to perform a life cycle cost assessment. The analysis includes an incremental increase in construction costs, national electric and gas rates, and resulted in a positive a Net Present Value.

CEPI-57-21

CEPI-58-21

IECC®: C402.5, C402.5.1.2, C402.5.2, C402.5.3, C406.9

Proponents:

Mark Lyles, representing New Buildings Institute (markl@newbuildings.org); Gayathri Vijayakumar, representing Steven Winter Associates, Inc. (gvijayakumar@swinter.com); Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:

C402.5 Air leakage—thermal envelope.

The *building thermal envelope* shall comply with Sections C402.5.1 through Section C402.5.11.1~~, or the building *thermal envelope* shall be tested in accordance with Section C402.5.2 or C402.5.3. Where compliance is based on such testing, the building shall also comply with Sections C402.5.7, C402.5.8 and C402.5.9~~.

C402.5.1.2 .

A continuous air barrier for the opaque building envelope shall ~~comply with the following:~~meet the provisions of Section 402.5.3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

Exception:

Group R and Group I occupancies that meet the provisions of Section C402.5.2. Portions of buildings containing Group R or Group I occupancies that are not tested shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

~~1.~~ ~~Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.~~

~~**Exception:** Buildings in Climate Zones 2B, 3C and 5C.~~

~~2.~~ ~~Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.~~

~~**Exceptions:**~~

~~1. Buildings in Climate Zones 2B, 3B, 3C and 5C.~~

~~2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.~~

~~3. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.~~

~~3.~~ ~~Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.~~

C402.5.2 Dwelling and sleeping unit enclosure testing.

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed ~~0.30 cfm/ft^2 (1.5 L/s m^2)~~ 0.20 cfm/ft^2 (1.0 L/s m^2) of the dwelling or sleeping ~~testing~~ unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units ~~or other occupiable conditioned spaces~~ are contained within one *building thermal envelope*, ~~each unit shall be considered an individual testing unit, and~~ the building air leakage shall be the weighted average of all tes~~ting unit~~ results, area weighted by the enclosure area of each ~~testing~~ tested unit~~'s enclosure area~~. Units shall be tested without simultaneously testing adjacent units and shall be separately ~~with an unguarded blower door test~~ tested as follows:

1. Where buildings have fewer than eight total dwelling or sleeping ~~testing~~ units, each ~~testing~~ unit shall be tested.
2. For buildings with eight or more dwelling or sleeping ~~testing~~ units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest ~~testing unit~~ enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of ~~testing~~ unit types and locations.

C402.5.3 Building thermal envelope testing.
The *building thermal envelope* shall be tested in accordance with ASTM E779, ~~ANSI/RESNET/ICC 380~~, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed ~~0.40 cfm/ft^2 (2.0 L/s × m^2)~~ 0.25 cfm/ft^2 (1.25 L/s m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). ~~Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:~~

Exceptions:

1. ~~The entire envelope area of all stories that have any spaces directly under a roof.~~ For buildings larger than 50,000 ft^2 (4,645 m^2), portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. The following portions of the building shall be tested.
   1.1. The entire envelope area of all stories that have any spaces directly under a roof.
   1.2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
   1.3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.
   1.4. Portions of buildings containing Group R or Group I occupancies that are not tested shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.
2. ~~The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.~~ For buildings larger than 250,000 ft^2 (25,000 m^2), that do not include Group R or Group I occupancies, where an approved agency verifies the design and installation of the continuous air barrier in accordance with Section C402.5.1.5.
3. ~~Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.~~

~~**Exception:** Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where 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 comply with the requirements of this section.~~

C406.9 Reduced air infiltration.

Air infiltration shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air-leakage rate of the building envelope shall not exceed ~~0.25 cfm/ft^2 (2.0 L/s × m^2)~~ 0.17 cfm/ft^2 (0.85 L/s x m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exceptions:

1. For buildings having over 250,000 square feet (25 000 m^2) of *conditioned floor area*~~, air leakage testing need not be conducted on the whole building where~~ testing ~~is~~ shall be conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.
2. For buildings or portions of buildings containing Group R or Group I occupancies, where testing is conducted in accordance with C402.5.2 and the weighted average of all testing unit results does not exceed 0.13 cfm/ft^2 (0.65 L/s m^2) under a pressure differential of 0.2 inches water column (50 Pa).

Reason Statement:

Reason Statement:

Air leakage can be a significant source of energy waste in buildings, contributing to higher heating and cooling costs for building owners and occupants, and increasing risk related to comfort and durability. Air tightness testing can result in more attention to envelope assembly air barrier sealing and significantly reduced building leakage. Adequate control over air leakage can provide many benefits, including reduced HVAC equipment sizing, better building pressurization, and energy savings due to reduced heating and cooling of infiltrated outside air. In moist climates, ensuring lower air leakage through whole-building testing can also result in better humidity control and reduced risk of durability issues. While it is important that the materials and assemblies have limited leakage, that alone does not guarantee a low leakage building. Recent research shows that 40% of buildings constructed without an envelope consultant have air leakage exceeding the currently optional test standard requirements, while buildings with envelope consultants all had leakage below 0.25 cfm/ft (Wiss J. 2014).

Testing is the most reliable means of ensuring that the intent of this code section—limiting unintended energy waste in buildings due to air infiltration—will be achieved. Durston and Heron's review (2012) of the 0.25cfm/ft^2 requirement by the U.S. Department of Defense (DOD) shows that without testing, the range of building leakage can exceed the requirement by more than double (0.9 cfm/ft). However, with testing included as part of the construction process, the average leakage of buildings was determined to be below the 0.25 cfm/ft limit and in many cases lower leakage levels in the range of 0.15 cfm/ft^2 can be achieved (Durston and Heron 2012). Therefore, a test limit of 0.25 cfm/ft is considered to be both a realistic and achievable goal.

This amendment proposes exempting whole building leakage testing for buildings larger than 250,000 ft^2 because of the technical and practical issues with testing these large buildings. This amendment also proposes different test thresholds for multifamily structures (Group R and I occupancies) that align with current industry practice in blower door testing for the multifamily market. The original air leakage testing threshold for residential buildings of 0.30 cfm/square foot tested at 50 Pascals was lowered to 0.20 cfm/square foot to align with the requirements in ASHRAE 62.2.

Additioanlly, as a result of these previous changes, the air leakage rate in Section C406.9 was reduced from 0.25 cfm/ft2 to 0.17 cfm/ft2 at 75 Pa and the specific requirements for Group R and Group I buildings were added as an exception.

Bibliography:

Wiss J. 2014. *ASHRAE 1478-RP Measuring Airtightness of Mid- and High-Rise Non-Residential Buildings*. Elstner Associates, Inc. for ASHRAE. https://www.ashrae.org/resources--publications/periodicals/enewsletters/esociety/2014-12-10-articles/completed-research-december-2014.

Durston JL and M Heron. 2012. *Summary and Analysis of Large Building Air Leakage Testing for the U.S. Department of Defense*. Atlanta, GA. https://cdn.ymaws.com/www.nibs.org/resource/resmgr/BEST/best3_durston.2.9.pdf.

Cost Impact:

The code change proposal will increase the cost of construction.

This measure will increase the cost of construction of new commercial buildings as whole building air leakage testing will be required except for primarily residential buildings (Group R and I building occupancies). Based on a survey of professional commercial building air barrier testing companies, it was determined that the cost of air leakage testing fell into three ranges:

- $350 or $0.12 to $0.07 per square foot for buildings up to 5000 square feet
- $0.50 to $0.15 per square foot for buildings between 5000 and 50,000 square feet
- $0.15 to $0.09 per square foot for buildings between 50,000 and 100,000 square feet, with decreasing costs for larger buildings.

As demand for air leakage testing in commercial buildings increases, more companies will enter the market to provide these services. Therefore, a gradual decrease in cost is expected as more companies are available to do the testing.

CEPI-58-21

CEPI-59-21

IECC®: C402.5.1.1

Proponents:

Bill McHugh, representing Chicago Roofing Contractors Association (bill@mc-hugh.us)

2021 International Energy Conservation Code

Revise as follows:
C402.5.1.1 Air barrier construction.

The *continuous air barrier* shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. <u>Paths for air leakage from the building to the space between the roof deck and roof covering used as an air barrier, shall be caulked, gasketed or otherwise covered with a moisture vapor-permeable material.</u> Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.5.10. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

Reason Statement:

This proposal clarifies the situation where the air barrier is the roof membrane, but there are roof components below that could be affected by moisture in the space below the roof. The purpose of this proposal is to provide protection for the insulation and underside of the roof membrane - to prevent moisture build up. When insulation or its facer gets wet or damp - there can be mildew and issues with water based adhesives, possible wind uplift issues. System energy performance can be compromised. This proposal seeks to keep the space between the roof deck and roof membrane dry, so it performs as intended saving energy and protecting the structure.

Cost Impact:

The code change proposal will increase the cost of construction.

While this will increase the cost of construction slightly, the need to protect the insulation investment is as important as the insulation itself. If the insulation gets wet, it's almost worthless.

CEPI-59-21

CEPI-60-21

IECC®: C402.5.1.1, C402.5.12 (New)

Proponents:

Megan Hayes, representing NEMA (Megan.Hayes@nema.org); Harold Jepsen, representing NEMA (harold.jepsen@legrand.us)

2021 International Energy Conservation Code

Revise as follows:
C402.5.1.1 Air barrier construction.

The *continuous air barrier* shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that are the thermal envelope of the building and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation.
3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration. Joints and seams associated with penetrations shall be sealed in the same manner or taped. Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the penetrations' ability to resist positive and negative pressure from wind, stack effect and mechanical ventilation. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.5.10. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.
5. <u>Electrical and communication boxes shall comply with C405.5.12. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.</u>

Add new text as follows:
<u>C402.5.12</u> <u>Electrical and communication boxes</u>.
<u>Electrical and communication boxes installed in the *building thermal envelope* shall meet one of the following:</u>

1. Boxes that penetrates the *building thermal envelope* shall be air sealed to the subfloor, wall covering, or ceiling penetrated by the box. Spaces behind boxes penetrating the thermal envelope shall have insulation cut or blown to fit or that readily conforms to the space around the box.
2. Boxes that penetrate the *building thermal envelope* shall be the air-sealed type. Air-sealed boxes shall be tested in accordance with NEMA OS 4, Requirements for
Air-Sealed Boxes for Electrical and Communication Applications, and shall have an air leakage rate of not greater than 2.0 cfm (0.944 L/s) at a pressure differential of 1.57 psf (75 Pa). Air-sealed boxes shall be marked "NEMA OS 4" or "OS4" in accordance with NEMA OS 4. Air-Sealed boxes shall be installed per the manufacturer's instructions and with any supplied components required to achieve compliance with NEMA OS 4.

Reason Statement:

It is clear that C402.5 currently requires all building and system components that penetrate the thermal envelope to be sealed to create an air barrier and prevent air leakage. However, additional guidance is needed on how what options are available to achieve the objectives outlined in C402.5 when it comes to electrical and communication outlet boxes. This proposal corrects this gap in the code by offering a prescriptive option for conventional outlet boxes and a performance option utilizing tested air-sealed boxes. Approval of this proposal aligns the IECC-C with the IECC-R that already includes similar provisions for outlet boxes in Table R402.1.1 and R402.4.6.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no increase or decrease cost in construction as this proposal simply adds language specific to electrical and communication outlet boxes that penetrate the thermal envelope and already intended to be sealed against air leakage in C402.5 by mirroring the requirement in C402.5.1.1.4 and C402.5.10 for recessed lighting.

CEPI-60-21

CEPI-61-21

IECC®: C402.5.1.2

Proponents:

Helen Sanders, Facade Tectonics Institute/Technoform North America, representing Facade Tectonics Institute

2021 International Energy Conservation Code

Revise as follows:
C402.5.1.2 .

A continuous air barrier for the opaque building envelope shall comply with the following:

1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.

   ~~**Exception:** Buildings in Climate Zones 2B, 3C and 5C.~~

2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.

   ~~**Exceptions:**~~

   ~~1. Buildings in Climate Zones 2B, 3B, 3C and 5C.~~

   ~~2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.~~

   ~~3. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.~~

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

Reason Statement:

The members of the Façade Tectonics Institute (FTI) believe that the IECC has been moving in the right direction in terms of mandating whole building air leakage testing to improve building energy efficiency. The current 2021 version restricts the requirements to a select few climate zones though – mostly those that are heating dominated. Actual air leakage testing assures the quality of construction of the building envelope in this critical performance area. And air leakage is an energy efficiency degrader in all climate zones, whether heating dominated, mixed or cooling dominated (see references in bibliography).

In cooling dominated climate zones, air-leakage through the building envelope impacts the load on the air conditioning system (cooling of hot air infiltration), and even more so in humid climate zones where water also needs to be removed. This puts additional load on the electrical grid. As we move towards net zero buildings, and 100% electrification for decarbonization, it is becoming even more critical not just to reduce energy usage, but to free up electrical grid capacity, and manage peak demand (timing and amount) because of the increased use of renewables. This further supports the need to focus on more southern climate zones for verifying airtightness performance to reduce grid loads.

In order to achieve net zero energy and carbon emissions in buildings by 2030, the design and construction practitioners of the Façade Tectonics Institute believe we need to eliminate the exceptions to air leakage requirements so that they cover the majority of buildings as soon as possible. Previous studies have shown energy cost savings from air barriers of 2% to 36% (Emmerich et al. 2005) across all climate zones. If air-barriers are required for energy efficiency, they should be verified by testing to ensure the appropriate energy savings are captured. Verification and commissioning of building envelope systems are key tools in closing the performance gap between as-designed and as-built in building assemblies and systems.

Washington State's energy code (see reference for link) is a successful demonstration of the implementation of mandatory air-leakage testing in climate zone 4 (Maritime). Note that based on IECC 2021, only buildings less than 5,000 sq.ft. are required to do air leakage testing in this climate zone. As a result of the introduction of air leakage testing requirement, the state's construction industry has built up testing infrastructure to support meeting the requirements. The cost of fabricating an air-tight barrier is no more expensive than making a poorer one – it just requires high quality installation and quality control. Meeting the standard doesn't cost anything more, the additional cost is in the testing of the barrier's performance. Since testing is considered cost-effective in climate zone 4 (Maritime), it should be cost-effective elsewhere.

Washington's example illustrates that if air barrier testing is required, the industry will set up to do it. The fact that IECC 2021 already requires air-barrier testing in some climate zones supports the further development of testing infrastructure, as the standard is adopted by states. Expanding the climate zones in which air barrier testing is required in IECC 2024, will build on the momentum of what is already required by the 2021 version, and there should be plenty of testing capacity developed to leverage.

FTI strongly recommends removing all exceptions to air leakage testing as soon as possible, since the building envelopes constructed in the near term will be with us for the next fifty years, contributing to carbon emissions. However, an intermediate step could be to require testing for climate zones 3 and higher in the 2024 version, moving to no exceptions in 2027.

Bibliography:

Steven J Emmerich et al., Investigation of the Impact of Commercial Building Envelope Airtightness on HVAC Energy Use, NIST, 2005 https://www.govinfo.gov/content/pkg/GOVPUB-C13-db70d72cbf88472707ae51276ee7e599/pdf/GOVPUB-C13-db70d72cbf88472707ae51276ee7e599.pdf

S. Emmerich and A. Persily, The air tightness of commercial buildings in the U.S. https://www.nist.gov/publications/airtightness-commercial-buildings-united-states

Washington State Energy Code 2018, https://sbcc.wa.gov/sites/default/files/2020-04/2018%20WSEC_C%202nd%20print.pdf

Cost Impact:

The code change proposal will increase the cost of construction.

As mentioned in the reason statement, Washington State has been successful at introducing air leakage testing and an ecosystem of suppliers has been developed and is considered cost-effective in climate zone 4 Maritime. IECC 2021 also requires air leakage testing in some climate zones already and so has been considered cost-effective. Adoption of this 2021 revision should also support further development of testing infrastructure. It should not cost more to install an air barrier well, and to meet the already established standard than to install it poorly – no change in materials or process are needed. The only additional cost is the testing.

Whole building air leakage testing can run the gamut from $10k to $60k+ depending on the size and complexity of the building. The larger the building the more fans are required. The more separate zones within a building, the more individual tests are required. The more compartmentalized the interior the more extensive the required prep-work. As a result, large multi-residential projects tend to be the more expensive buildings to test. That said, even in this range of $10K to $60K, the cost of the test is a very small portion of a typical building project budget, so the fractional incremental cost is low. Blower door testing of single family residential is typically less than $1,000 (typically less than 1% of the cost of construction).

CEPI-61-21

CEPI-62-21

IECC®: C402.5.1.2

Proponents:

Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
C402.5.1.2 .

A continuous air barrier for the opaque building envelope shall comply with the following:

1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.

   ~~**Exception:** Buildings in Climate Zones 2B, 3C and 5C.~~

2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.

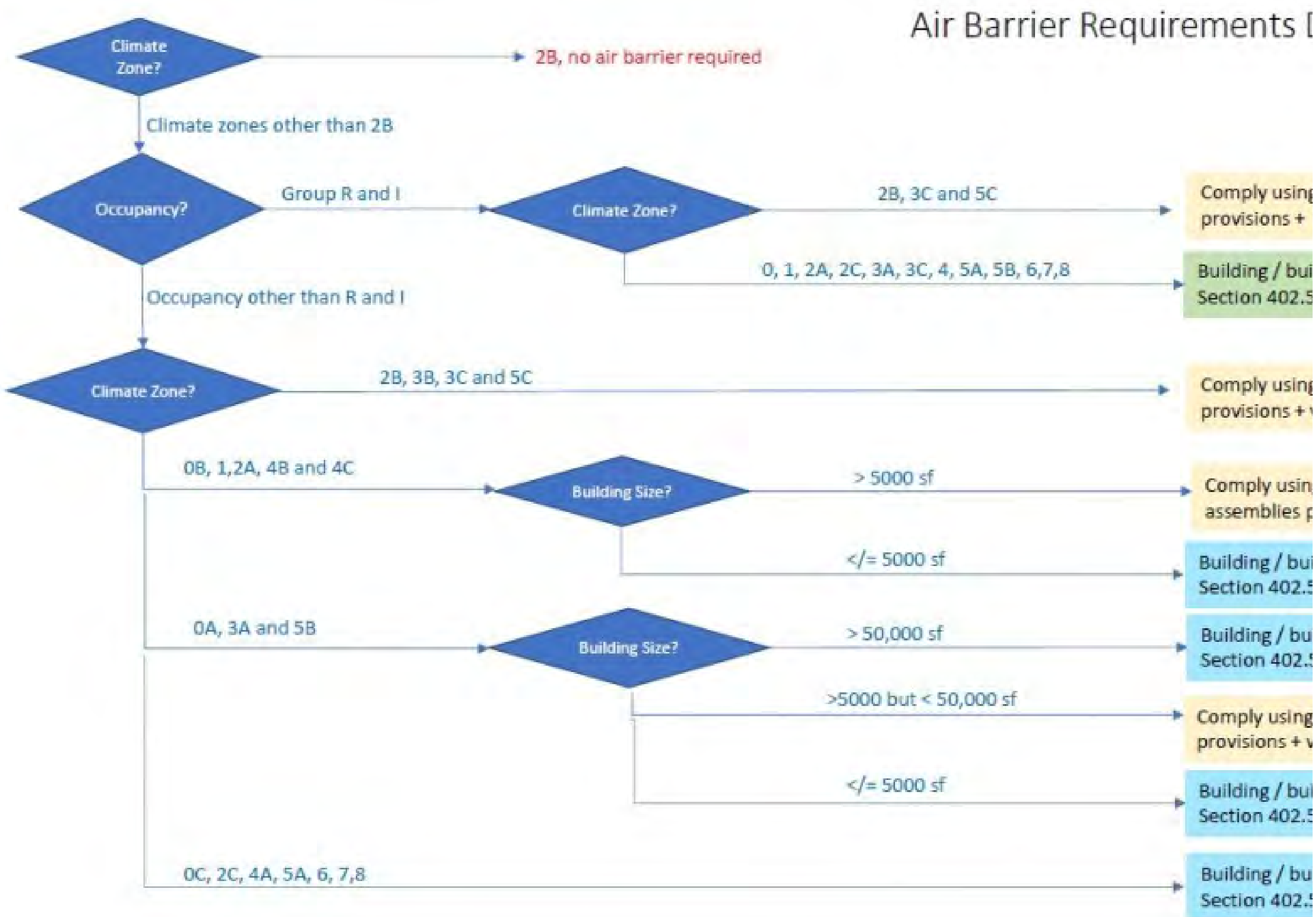
   Exceptions:

   1. ~~Buildings in Climate Zones 2B, 3B, 3C and 5C.~~
   2. Buildings larger than ~~5,000~~ 25,000 square feet (~~464.5~~ 2300 m^2) floor area ~~in Climate Zones 0B, 1, 2A, 4B and 4C.~~
   3. ~~Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.~~

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4 in addition to Section C402.5.1.5.

Reason Statement:

This proposal simplifies under what conditions building thermal envelope air leakage testing is required. Currently the code requires building thermal envelope testing based a complicated combination of climate zone, building size and building occupancy. The requirements are shown in the flowchart schematic below.



The proposal replaces this complicated required schematic with a simple building size requirement for occupancies other than Group R & I occupancies. For Group R& I occupancies, testing is always required, as it is in the IECC-R to bridge the requirements for multi-family buildings. Having uniform testing requirements across the country will allow for all climate zones to experience the learning the curve that will result in improved implementation of air leakage control technologies. Experience with the localities such as Seattle, Washington State and Fort Collins, CO as well as the experience of buildings built under the US Army Corp of Engineers protocols show the value of the learning curve in achieving air leakage control requirements.[1-4] All climate zones should be allowed to benefit from the experience of required testing.

Bibliography:

1. J. Estrada, "Building Air Leakage Testing in Seattle, Washington: What We've Learned and Where We Go from Here," in *Whole Building Air Leakage: Testing and Building Performance Impacts*, ed. T. Weston, K. Nelson, and K. Wissink (West Conshohocken, PA: ASTM International, 2019), 1-19. https://doi.org/10.1520/STP161520180018

2. D. Jonlin, "Rookie Mistakes: Lessons from a Decade of Mandatory Air Barrier Testing," in *Whole Building Air Leakage: Testing and Building Performance Impacts*, ed. T. Weston, K. Nelson, and K. Wissink (West Conshohocken, PA: ASTM International, 2019), 20-37. https://doi.org/10.1520/STP161520180025
3. K. Knight, C. Carson, and G. Proskiw, "Target Airtightness Rates for Large Buildings, What Is Possible, What Is Probable, and What Is Prophetic," in *Whole Building Air Leakage: Testing and Building Performance Impacts*, ed. T. Weston, K. Nelson, and K. Wissink (West Conshohocken, PA: ASTM International, 2019), 291-300. https://doi.org/10.1520/STP161520180121
4. Diana Hun, Mahabir Bhandari, Melissa Lapsa, Som Shrestha, and Simon PallinAirtightness of Commercial Building Envelopes: Where are we and where could we go? , Oak Ridge National Laboratory Caroline Hazard,

CSRA https://www.osti.gov/servlets/purl/1559734

Cost Impact:

The code change proposal will increase the cost of construction.

But the code change proposal will not increase the cost of construction uniformly and may indeed reduce the cost of construction in some cases. Conservatively, the cost impact was indicated as increasing, but the increase in cost will depend on climate zone, as the current code contains climate zone dependent testing and verification requirements. The same level of maximum air leakage is required across climate zones, but the verification method varies. In some case the change proposed may result in a cost savings. According to a market survey a whole building test of a 25,000 sq ft building with leakage of .40 cfm/ft^2 at a pressure differential of 0.3 water gauge had a mean cost of $3792. As verification is required when whole building testing is not conducted, the cost of testing needs to be balanced against the cost of verification audits. According to ABAA (http://www.airbarrier.org/qap/qap-calculator/) verification costs are $2000/audit, with the number of audits determined by the number of square feet of air barrier material being installed. Cost effectiveness will be dependent on the building envelope / floor area ratio, as well as the climate zone. For example, a 25,000 sq ft building with an envelope /floor area ratio of 2.0 would require 3 audits at a cost of $6000. Therefore, there may actually be a cost savings. Additionally, the effect of cost reductions due to learning curve effects need to be considered.

CEPI-62-21

CEPI-63-21 Part I

IECC®: C402.5.1.2, C402.5.2, C402.5.3

Proponents:

Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:
C402.5.1.2 Air barrier compliance.

A continuous air barrier for the opaque building envelope shall comply with the following:

~~1.~~ ~~Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.~~

~~**Exception:** Buildings in Climate Zones 2B, 3C and 5C.~~

Buildings or portions of buildings ~~other than Group R and I occupancies~~ shall meet the provisions of Section ~~C402.5.3~~C402.5.2.

Exceptions:

1. Buildings in Climate Zones 2B, 3B, 3C and 5C.
2. Buildings larger than 5,000 square feet (464.5 m^2) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.
3. Buildings between 5,000 square feet (464.5 m^2) and 50,000 square feet (4645 m^2) floor area in Climate Zones 0A, 3A and 5B.

1~~2~~.

2. Buildings or portions of buildings with dwelling or sleeping units accessed from the outdoors shall meet the provisions of Section C402.5.3.

Exception: Buildings in Climate Zones 2B, 3C and 5C.

3. Buildings or portions of buildings that do not complete air barrier testing shall meet the provisions of Section C402.5.1.3 or C402.5.1.4, in addition to Section C402.5.1.5.

~~C402.5.2~~ C402.5.3 Enclosure testing for dwelling ~~and~~or sleeping units accessed directly from the outdoors ~~enclosure testing~~. For dwelling or sleeping units accessed directly from the outdoors, the *building thermal envelope* shall be tested for air leakage in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage under any approved test method shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit thermal enclosure area at a pressure differential of 0.2 inch water gauge (50 Pascals). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*and are accessed directly from the outdoors, each unit shall be considered an individual testing unit. ~~and~~ The building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.

For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be

2. tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

~~C402.5.3~~ C402.5.2 Building thermal envelope testing.
The *building thermal envelope* shall be tested for air leakage in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage under any approved test method shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pascals). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.

2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.

3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.
Exception: Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where 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 comply with the requirements of this section.

CEPI-63-21 Part I

CEPI-63-21 Part II

IECC®: R402.4.1.2

Proponents:

Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.2 Testing.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

~~Exception~~ Exceptions:

1. When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

   ~~1~~ 1.1. Attached single-family and multiple-family building *dwelling units*.

~~2~~ 1.2. Buildings or *dwelling units* that are 1,500 square feet (139.4 m^2) or smaller.
2. Multiple family buildings with dwelling units accessed directly from the outdoors, that comply with Section C402.5.3

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

Reason Statement:

Purpose of proposed changes is to clarify code intent.

In Section C402.5.1.2, compliance options are reorganized so the compliance option that applies to most buildings is listed first. The second requirement clarifies that it only applies to building occupancies with dwelling or sleeping units.

In Sections C402.5.2 and C402.5.3, additional language is added to provide better code intent clarity and metric units are corrected.

In Section R402.4.1.2, an exception is added that allows low-rise multifamily buildings to comply with the same testing criteria as mid-rise multifamily. This is consistent with the language in the original Exception 1, but in clearer terms.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The intent of this proposal is to improve code language clarity only.

CEPI-63-21 Part II

CEPI-64-21

IECC®: C402.5.11

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Revise as follows:

C402.5.11 Operable openings interlocking.

Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 m^2) in area, such openings shall be interlocked with the heating and cooling system so as to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.

Exceptions:

1. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
2. Warehouses that utilize overhead doors for the function of the occupancy, where approved by the code official.
3. The first entrance doors where located in the exterior wall and are part of a vestibule system.
4. Systems utilizing evaporative cooling do not need to reset the cooling setpoint and are allowed to operate using evaporative cooling only. Other forms of mechanical cooling are not allowed when operable openings are open.

Reason Statement:

As evaporative cooling is 100% OA the space will be positively pressurized and will prevent the infiltration of unconditioned OA when operable openings are open. This allows the space to continue to operate in a normal cooling mode and maintains healthier indoor space conditions for all occupants. This gives the owner/occupant an option to be energy efficient as well as have the choice to have doors and windows open.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Improved air quality for a healthy indoor space and reduced energy consumption while not impacting the cost of construction.

The cost may increase or decrease the cost of construction depending on the building. If an additional system is needed the cost will go up, however the energy cost will decrease by using only evaporative cooling.

CEPI-64-21

CEPI-65-21

IECC®: C402.5.11, C402.5.11.1, C403.14

Proponents:

Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

C402.5.11 Operable openings interlocking.

~~Where occupancies utilize~~Operable openings ~~to the outdoors~~ that are larger than 40 square feet (3.7 m^2) in area~~, such openings~~ that open to the outdoors from a conditioned space shall be interlocked with the heating and cooling systemin accordance with C403.4.1.6.~~so as to raise the cooling setpoint to 90°F (32°C) and lower the heating setpoint to 55°F (13°C) whenever the operable opening is open. The change in heating and cooling setpoints shall occur within 10 minutes of opening the operable opening.~~

Exceptions:

1. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the HVAC loads of a restaurant or similar type of occupancy.
2. Warehouses that utilize overhead doors for the function of the occupancy, where approved by the code official.
3. The first entrance doors where located in the exterior wall and are part of a vestibule system.

Delete without substitution:

~~C402.5.11.1 Operable controls~~.

~~Controls shall comply with Section C403.14.~~

Revise as follows:

~~C403.14~~ C403.4.1.6 Operable opening ~~interlocking controls~~ switches for HVAC system thermostatic control.

~~The heating and cooling systems shall have controls that will interlock these mechanical systems to the set temperatures of 90ºF (32ºC) for cooling and 55ºF (12.7ºC) for heating when the conditions of Section C402.5.11 exist. The controls shall configure to shut off the systems entirely when the outdoor temperatures are below 90ºF (32ºC) or above 55ºF (12.7ºC).~~

Operable openings shall have control switches interlocked with the heating and cooling system. Controls shall be configured to do the following once the operable openings have been open for 5 minutes:

1. Disable mechanical heating to the zone or reset the space heating temperature set point to 55°F (12.7°C) or less within 5 minutes of the door open enable signal.
2. Disable mechanical cooling to the zone or reset the space cooling temperature set point to 90°F (32°F) or more within 5 minutes of the door open enable signal.

Exception: Hydronic radiant heating and cooling systems.

Reason Statement:

Remove duplication, improve description of code intent and relocate mechanical controls provision to the appropriate location within the code.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The intent of this proposal is to improve code language clarity only.

CEPI-65-21

CEPI-66-21 Part I

IECC®: C402.5.2

Proponents:

Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

C402.5.2 Dwelling and sleeping unit enclosure testing.

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed ~~0.30~~ 0.40 cfm/ft^2 (~~1.5~~ 2.0 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.3 ~~0.2~~ inch water gauge (~~50~~ 75 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

CEPI-66-21 Part I

CEPI-66-21 Part II

IECC®: R402.4.1.2

Proponents:

Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.2 Testing.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 m^3/(s × m^2)] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

Exception: When testing individual *dwelling units*, an air leakage rate not exceeding ~~0.30~~ <u>0.40</u> cubic feet per minute per square foot [~~0.008 m3/(s × m2)~~ <u>2.0 L/s x m^2</u>] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (~~50~~ <u>75</u> Pa), shall be permitted in all climate zones for:

1. Attached single-family and multiple-family building *dwelling units*.
2. Buildings or *dwelling units* that are 1.500 square feet (139.4 m^2) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

Reason Statement:

This proposal aligns the pressure difference at which air leakage cubic feet per minute is reported between the whole building thermal envelope and dwelling unit testing. It is provided to prevent the possible confusion and improve uniform enforcement of the code. The proposal also aligns the IECC-R exception allowing for air leakage to be reported in cfm with the IECC-C reporting metrics. As multi-family construction bridges the IECC-C and the IECC-R, it is desirable to have consistency across the two code in the reported metrics for testing.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not change the required performance of the code. It seeks to align the metrics in which values are reported, but all proposed required values were adjusted to preserve current requirements.

CEPI-66-21 Part II

CEPI-68-21

IECC®: C402.5.2

Proponents:

Aaron Gary, representing Seft (aaron.gary@texenergy.org)

2021 International Energy Conservation Code

Revise as follows:
C402.5.2 Dwelling and sleeping unit enclosure testing.
The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a middle floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional ~~two~~three units shall be tested, including a mixture of testing unit types and locations.

Reason Statement:

This amendment brings this section into closer alignment with the updated RESNET sampling guidelines for the testing of multifamily buildings.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This change will only result in a change to the cost of verification if testing failures occur.

CEPI-68-21

CEPI-69-21

IECC®: C402.5.2, C402.5.3, ASTM Chapter 06 (New)

Proponents:

Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
C402.5.2 Dwelling and sleeping unit enclosure testing.
The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). <u>Testing shall be conducted by an *approved* third party.</u> Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

C402.5.3 Building thermal envelope testing.
The *building thermal envelope* shall be tested <u>by an *approved* third party</u> in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.
2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

Exception: Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), <u>an *approved* third party shall perform</u> a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier <u>in accordance with ASTM E1186.</u> Any leaks noted shall be sealed where 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 comply with the requirements of this section.

Add new standard(s) as follows:
ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

<u>E1186 - 17</u>	<u>Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems</u>

Reason Statement:

This proposal seeks to ensure that whole building air leakage and diagnostic test is conducted by an independent & qualified entity that is acceptable to the code official. Additionally, the proposal adds a new reference standard which provides consensus procedures for conducting the diagnostic testing specified in the code. The new reference, ASTM E1186, has the following scope:

"1. Scope

1.1 These practices cover standardized techniques for locating air leakage sites in building envelopes and air barrier systems.

1.2 These practices offer a choice of means for determining the location of air leakage sites with each offering certain advantages for specific applications.

1.3 Some of the practices require a knowledge of infrared scanning, building and test chamber pressurization and depressurization, smoke and fog generation techniques, sound generation and detection, and tracer gas concentration measurement techniques.

1.4 The practices described are of a qualitative nature in determining the air leakage sites rather than determining quantitative leakage rates.

1.5 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use. For specific hazard statements, see Section 6.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee."*

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not change the technical requirements for building thermal envelope. But rather it seeks to ensure that the current code requirements are verified by qualified practitioners and in accordance with industry standard methods.

CEPI-69-21

CEPI-70-21

IECC®: C402.5.2 (New), C402.5.2, C402.5.3 (New), C402.5.3, C406.9

Proponents:

Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Add new text as follows:
C402.5.2 Dwelling and sleeping unit enclosure testing.

The measured air leakage of the building thermal envelope shall not exceed 0.30 cfm/ft2 (1.5 L/sm2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa) when tested in accordance with C402.5.2.1.

Revise as follows:
~~C402.5.2~~ C402.5.2.1 ~~Dwelling and sleeping unit enclosure testing~~ Testing Criteria.

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827, ASTM E3158 or an equivalent method approved by the *code official*. ~~The measured air leakage shall not exceed 0.30 cfm/ft^2 (1.5 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa).~~ Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

Add new text as follows:
C402.5.3 Building thermal envelope testing.
The measured air leakage shall not exceed 0.40 cfm/ft2 (2.0 L/s × m2) of the building thermal envelope area at a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with C402.5.3.1.
Exception: Where the measured air leakage rate exceeds 0.40 cfm/ft2 (2.0 L/s × m2) but does not exceed 0.60 cfm/ft2 (3.0 L/s × m2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where 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 comply with the requirements of this section.
Revise as follows:
~~C402.5.3~~ C402.5.3.1 ~~Building thermal envelope testing~~ Testing Criteria.

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. ~~The measured air leakage shall not exceed 0.40 cfm/ft^2 (2.0 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa).~~ Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.

2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.

3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

~~**Exception:** Where the measured air leakage rate exceeds 0.40 cfm/ft^2 (2.0 L/s × m^2) but does not exceed 0.60 cfm/ft^2 (3.0 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where 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 comply with the requirements of this section.~~

C406.9 Reduced air infiltration.

Air infiltration shall be verified by ~~whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827~~ *building thermal envelope* testing conducted in accordance with Section C402.5.2.1 or C402.5.3.1, as applicable to the building occupancy, by an independent third party. The measured air-leakage rate of the building envelope shall not exceed 0.25 cfm/ft^2 (2.0 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

~~**Exception:** For buildings having over 250,000 square feet (25 000 m^2) of *conditioned floor area*, air leakage testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.~~

Reason Statement:

This proposal seeks to separate the air leakage control requirement from the testing criteria. This allows for the enhanced air leakage option in Section C406 to be tested by the same by the same test method as the basic requirements in Section C402.5. This will enable consistency between the two sections and reduce divergence as the code is developed in future code cycles.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposal does not change technical requirement, and only restructures existing requirements.

CEPI-70-21

CEPI-71-21

IECC®: C402.5.2, C402.5.3, C406.9

Proponents:

Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Revise as follows:

C402.5.2 Dwelling and sleeping unit enclosure testing.

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent method approved by the *code official*. The measured air leakage shall not exceed ~~0.30~~ 0.23 cfm/ft^2 (~~1.5~~ 1.1 L/s m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa). Where multiple dwelling units or sleeping units or other occupiable conditioned spaces are contained within one *building thermal envelope*, each unit shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all testing unit results, weighted by each testing unit's enclosure area. Units shall be tested separately with an unguarded blower door test as follows:

1. Where buildings have fewer than eight testing units, each testing unit shall be tested.
2. For buildings with eight or more testing units, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional two units shall be tested, including a mixture of testing unit types and locations.

C402.5.3 Building thermal envelope testing.

The *building thermal envelope* shall be tested in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E3158 or ASTM E1827 or an equivalent method approved by the code official. The measured air leakage shall not exceed ~~0.40~~ 0.30 cfm/ft^2 (~~2.0~~ 1.5 L/s × m^2) of the *building thermal envelope* area at a pressure differential of 0.3 inch water gauge (75 Pa). Alternatively, portions of the building shall be tested and the measured air leakages shall be area weighted by the surface areas of the building envelope in each portion. The weighted average test results shall not exceed the whole building leakage limit. In the alternative approach, the following portions of the building shall be tested:

1. The entire envelope area of all stories that have any spaces directly under a roof.
2. The entire envelope area of all stories that have a building entrance, exposed floor, or loading dock, or are below grade.
3. Representative above-grade sections of the building totaling at least 25 percent of the wall area enclosing the remaining conditioned space.

Exception: Where the measured air leakage rate exceeds ~~0.40~~ 0.30 cfm/ft^2 (~~2.0~~ 1.5 L/s × m^2) but does not exceed ~~0.60~~ 0.45 cfm/ft^2 (~~3.0~~ 2.2 L/s × m^2), a diagnostic evaluation using smoke tracer or infrared imaging shall be conducted while the building is pressurized along with a visual inspection of the air barrier. Any leaks noted shall be sealed where 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 comply with the requirements of this section.

C406.9 Reduced air infiltration.

Air infiltration shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air-leakage rate of the building envelope shall not exceed ~~0.25~~ 0.20 cfm/ft^2 (~~2.0~~ 1.0 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exception: For buildings having over 250,000 square feet (25 000 m^2) of *conditioned floor area*, air leakage testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.

Reason Statement:

Reducing the measured air leakage from 0.40 to 0.30 cfm/ft^2 at a pressure differential of 0.3 inch water gauge (75 Pa) recognizes the advances the industry has made in air leakage control technology and methods since whole building air leakage tested was introduced in the IECC-C in 2012 (about a decade ago). The advancement of air leakage control technology (including both materials and installation practices) during the last decade has led to increased building performance. Experiences with the air leakage testing and building performance have been recorded industry literature, some of which are listed in the bibliography.[1,2,3]

This change in the maximum air leakage requirement is consistent with industry practices and specifications which have been instituted in the industry, including:

- Seattle Energy Code 2015: .30 cfm/ft^2
- US Army Corps of Engineers (2012): .25 cfm/ft^2 (Demonstrated achievable [5])
- IgCC/ASHRAE 189.1:   .25 cfm/ft^2
- Seattle Energy Code 2018: .25 cfm/ft^2
- PHIUS+ 2015: .08 cfm/ft^2 (included in incentive and tax credit programs in multiple states)

It has long been understood, deficient airtightness has negative consequences, the most important of which are:

- increased energy use
- reduced thermal comfort
- reduced air quality
- moisture damages.[6,7]

Only one of these consequences, energy use, is considered directly in the development of the IECC, but all are experienced by the building occupants.

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Cost Impact:

The code change proposal will increase the cost of construction.

The level of air leakage control is the same as that balloted under ASHRAE 90.1 Addendum t First Public Review Draft (March 2021).

In that draft it is stated "improved performance related to airtightness requirements was reviewed and found to be cost effective". The 90.1 process uses an approximately 40 year life to perform a life cycle cost assessment.

CEPI-71-21

CEPI-72-21

IECC®: SECTION 202, C402.5.9, C403.4.1.4, AMCA Chapter 06, ISO Chapter 06 (New)

Proponents:

Amanda Hickman, representing Air Movement and Control Association (AMCA) (amanda@thehickmangroup.com); Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:
IECC2021P1E_CE_Ch02_SecC202_DefAIR_CURTAIN AIR CURTAIN UNIT. A device, installed at the *building entrance* , that generates and discharges a laminar air stream intended to prevent the infiltration of external, unconditioned air into the conditioned spaces, or the loss of interior, conditioned air to the outside.
C402.5.9 Vestibules.

Building entrances shall be protected with an enclosed vestibule, with all doors opening into and out of the vestibule equipped with self-closing devices. Vestibules shall be designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time. The installation of one or more revolving doors in the *building entrance* shall not eliminate the requirement that a vestibule be provided on any doors adjacent to revolving doors.

Exceptions: Vestibules are not required for the following:

1. Buildings in *Climate Zones* 0 through 2.
2. Doors not intended to be used by the public, such as doors to mechanical or electrical equipment rooms, or intended solely for employee use.
3. Doors opening directly from a *sleeping unit* or dwelling unit.
4. Doors that open directly from a space less than 3,000 square feet (298 m^2) in area.
5. Revolving doors.
6. Doors used primarily to facilitate vehicular movement or material handling and adjacent personnel doors.
7. Doors that have an air curtain unit with a ~~velocity~~ jet speed of not less than 6.56 feet per second (2 m/s) at 6.0 inches (15 cm) above the floor that ~~have~~ has been tested in accordance with ANSI/AMCA 220 or ISO 27327-1 and installed in accordance with the manufacturer's instructions. Manual or automatic controls shall be provided that will operate the air curtain unit with the opening and closing of the door and comply with Section C403.4.1.4. Air curtain~~s~~ units and their controls shall comply with Section C408.2.3.

C403.4.1.4 Heated or cooled vestibules or air curtain units with integral heating.

The heating systems for heated vestibules and air curtain~~s~~ units with integral heating shall be provided with controls configured to shut off the source of heating when the outdoor air temperature is greater than 45°F (7°C). Vestibule heating and cooling systems shall be controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 60°F (16°C) and cooling to a temperature not less than 85°F (29°C).

Exception: Control of heating or cooling provided by site-recovered energy or transfer air that would otherwise be exhausted.

AMCA Air Movement and Control Association International 30 West University Drive Arlington Heights IL 60004-1806

220—~~05~~21	Laboratory Methods of Testing Air Curtain Units for Aerodynamic Performance Rating

Add new standard(s) as follows:

ISO International Organization for Standardization Chemin de Blandonnet 8, CP 401, 1214 Vernier Geneva Switzerland

ISO 27327-1(2009) Air Curtain Units – Laboratory Methods of Testing for Aerodynamic Performance Rating

Reason Statement:

The primary reason for this proposal is to make clarifications regarding air curtain unit requirements, consistent with provisions for air curtain units in a parallel proposal for ASHRAE 90.1-2022 that has undergone public review without comments (ASHRAE 90.1-2019 addendum ao).

There are a few places in this proposal that add the word “unit” where appropriate to “air curtain” (including the definition), which help to clarify the difference between the air curtain (the stream of air) and the air curtain unit (the product creating the air curtain).

Under Exception 7 to Section C402.5.9, there are a few clarifications related to the use of air curtain units. Adding ISO 27327-1 as an optional test standard adds flexibility as to which standard the product can be tested to. The pointer for compliance of controls with Section C403.4.1.4 is intended to help instruct the code user with the requirements for air curtain units that have integral heating. The change to the title of Section C403.4.1.4 is intended to have the same effect.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal adds clarity to the sections on air curtain units, consistent with the parallel ASHRAE 90.1-2022 proposal mentioned in the reason statement. This proposal does not add any new requirements. Therefore, it will not increase the cost of construction.

CEPI-72-21

CEPI-73-21

IECC®: C403.15 (New), TABLE C403.15 (New)

Proponents:

Megan Hayes, representing NEMA (Megan.Hayes@nema.org)

2021 International Energy Conservation Code

Add new text as follows:
C403.15 Operational Flexibility.

Buildings with more than 100,000 square feet (9290 m^2) of conditioned space shall be equipped with a building management system with the ability to operate building systems in at least four distinct operating modes as defined in Table C403.15. Modes shall be password protected and issue message to facilities manager or other high level manager daily that system is in override.

TABLE C403.15 BUILDING OPERATING MODES

Mode	**Minimum Capabilities**
Normal Operation	Temperature, humidity, and ventilation are satisfied in accordance with pervailing building code requirements.
Indoor Pollutant Mitigation	Threshold for the concentration of pollutants in the occupiable space are adjusted and the mechanical system responds by executing one or more of the following:
	1. Increasing outdoor airflow rate
	2. Overriding supply air filter bypass
	3. Adjusting indoor temperature set points
Outdoor Pollution Emergecy	Mechanical system suspends outdoor airflow and overrides supply air filter bypass to maximize return air filtration.
Grid Demand Response	Building electrical systems are controlled to reduce power usage by executing one or more of the following:
	1. Reduce lighting power
	2. Adjust indoor temperature set points
	3. Shift operational electrical loads
	4. Discharge energy storage systems
	5. Suspend charging of energy storage and electrical vehicales
Reduced Occupancy	Building electrical and thermal systems are controlled to reduce energy usage by setting one or more of the following as a default condition which can be overridden by the occupant:
	1. Non-emergency lighting is turned off
	2. Indoor temperature set points for non-occupancy schedules are held
	3. Ventilation rates are adjusted to minimize outdoor air
	4. Non-critical plug loads are switched off
Other Building System Responsive Mode	Building operating mode shall be capable of optimizing the building performance to mitigate other internal and external conditions as established by the building design team.

Reason Statement:

The purpose of this proposal is to increase building flexibility such that they can adjust operating “modes” in response to internal and external environmental conditions. In normal operating environments, building systems should function as they were designed – to provide occupant comfort and utility as efficiently as possible. However, the COVID-19 pandemic has highlighted the need for building systems to override their designed defaults to keep occupants safe during emergency conditions. An example of this can be seen in increasing ventilation rates beyond ASHRAE Standard 62.1 requirements. From an energy efficiency perspective, it is critical that these “emergency modes” be well defined, optimized to provide the needed utility without wasting energy, and to only be operated when needed. This proposal is the first step in securing this level of operational flexibility, by requiring that building management systems have at least four distinct operating modes that can be toggled by the building operator.

The proponents envision buildings having the flexibility to optimize systems for a wide variety of conditions. The proposal language is formatted in a manner that authorities adopting the code could revise operating modes to meet localized needs, as well as a starting point for building developers in specifying building management requirements.

Technologies that enable compliance with this proposal are available from NEMA and non-NEMA members alike. Building management systems have the capability to set operational parameters by which equipment and systems operate under defined conditions. The proponents expect that the ability to program control sequences together to create distinct operational modes is a common capability among Building Management Systems.

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal is intended to shift the new commercial construction market toward using building management systems that can intelligently shift between building operational “modes” to achieve specific outcomes. Example outcomes are a desire to boost IAQ, reduce energy costs, or reduce carbon emissions, and the BMS would have programmed functional requirements to achieve them. Modes could also be in response to external drivers, such as a periodic grid event or outdoor environmental hazard, which would necessitate changes in building operations to achieve the desired outcomes.

CEPI-73-21

CEPI-74-21

IECC®: SECTION C403, C403.15 (New), TABLE C403.15 (New), C503.3.2 (New)

Proponents:

Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org); Marcin Pazera, representing PIMA (mpazera@pima.org); Jeff Mang, representing Polyisocyanurate Insulation Manufacturers Association (jeff@jcmangconsulting.com)

2021 International Energy Conservation Code

SECTION C403 BUILDING MECHANICAL SYSTEMS
Add new text as follows:
C403.15 Roof mounted mechanical equipment.
For *low-sloped roofs* where the *roof assembly* is part of the *building thermal envelope* and contains insulation entirely above the roof deck, roof mounted mechanical equipment shall be installed with roof curbs that meet or exceed the minimum height requirements of Table C403.15.

TABLE C403.15 ROOF MOUNTED MECHANICAL EQUIPMENT CURB HEIGHTS

CLIMATE ZONE	CURB HIEGHT, MINIMUM[a]
0 and 1	15.0 inches (381 mm)
2 and 3	16.0 inches (406.4 mm)
4, 5 and 6	17.0 inches (431.8 mm)
7 and 8	18.0 inches (457.2 mm)

a. Curb height shall be the distance measured from the top of the curb to the roof deck.

C503.3.2 Replacement of roof mounted mechanical equipment.
For *low-sloped roofs* where the existing *roof assembly* is part of the *building thermal envelope* and contains insulation entirely above the roof deck, curb heights for new roof mounted mechanical equipment that are part of the *alteration* shall comply with Section C403.15.

Reason Statement:

Rooftop mechanical equipment with low curbs can create challenges for reroofing work. This is especially true for roof replacements that are required to increase existing levels of above deck roof insulation in order to comply with the IECC’s opaque thermal envelope requirements. This code change proposal is intended to help mitigate these challenges by requiring, at a relatively low (or no) cost, the installation of higher curbs when rooftop mechanical equipment is replaced even if the replacement work does not occur at the same time as the roof replacement project.

The intent of the IECC is to move existing buildings toward compliance as alterations occur, which results in continual improvements to building energy efficiency. Modifying existing roof curbs during equipment replacement work adds minimal upfront costs and reduces or eliminates cost barriers related to complying with the IECC during future building alterations (i.e., roof replacement).

This proposal creates two complementary provisions in the IECC to address the opportunity created by rooftop equipment replacement work. Section C403.15 is added as an anchor requirement in Section 403 – the section that is most likely referenced by a code user during mechanical equipment work. Section C503.3.2 is added to ensure that code users have a reference to the requirement if using Chapter 5 to understand the IECC’s requirements applicable to existing buildings.

This code change proposal would require the installation of curbs with minimum heights calculated to accommodate the amount of insulation and other roof materials needed for each climate zone. The intent of this approach is to help ensure enforceability, contractor understanding and product availability. The required minimum heights would accommodate: (1) the 10 inches of curb height that is above the roof membrane/covering specified under the AHRI/SMACNA Guideline B-1997, “Guidelines for Roof Mounted Outdoor Air-Conditioner Installations”; (2) the amount of insulation necessary to comply with the prescriptive R-value requirements for each climate zone under the IECC; and (3) other materials that are typically part of the roof assembly, such as cover boards, slip sheets and membranes. While this proposal would require heights of between 15 to 18 inches depending on the specific climate zone, the

Committee may decide to simply require 18 inches as the minimum curb height for all climate zones if that approach makes it easier for purposes of product supply and inventory.

Bibliography:

Guidelines for Roof Mounted Outdoor Air-Conditioner Installations (Guideline B-1997), Air-Conditioning, Heating, and Refrigeration Institute (AHRI) and Sheet Meal and Air-Conditioning Contractors National Association (SMACNA). Available at: https://www.ahrinet.org/App_Content/ahri/files/Guidelines/AHRI_Guideline_B_1997.pdf.

Cost Impact:

The code change proposal will increase the cost of construction.

A small increase in cost related to the purchase and installation of a new curb may be incurred. However, over the service life of the curb and mechanical equipment, this code change proposal is life-cycle cost effective due to decreased compliance costs for future reroofing work that is common for all buildings to undergo during the building service life as well as reduced energy costs resulting from the installation of a future, IECC-compliant replacement roof system.

CEPI-74-21

CEPI-75-21

IECC®: C403.1.2, TABLE C403.1.2(1), TABLE C403.1.2(2), ASHRAE Chapter 06

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

C403.1.2 Data centers.

Data center systems shall comply with Sections 6 and 8 of ASHRAE 90.4. ~~with the following changes:~~

- 1.

  ~~Replace design mechanical load component (MLC) values specified in Table 6.2.1.1 of the ASHRAE 90.4 with the values in Table C403.1.2(1) as applicable in each climate zone.~~

- 2.

  ~~Replace annualized MLC values specified in Table 6.2.1.2 of the ASHRAE 90.4 with the values in Table C403.1.2(2) as applicable in each climate zone.~~

Delete without substitution:

~~TABLE C403.1.2(1) MAXIMUM DESIGN MECHANICAL LOAD COMPONENT (DESIGN MLC)~~

CLIMATE ZONE	DESIGN MLC AT 100% AND AT 50% ITE LOAD
~~0A~~	~~0.24~~
~~OB~~	~~0.26~~
~~1A~~	~~0.23~~
~~2A~~	~~0.24~~
~~3A~~	~~0.23~~
~~4A~~	~~0.23~~
~~5A~~	~~0.22~~
~~6A~~	~~0.22~~
~~1B~~	~~0.28~~
~~2B~~	~~0.27~~
~~3B~~	~~0.26~~
~~4B~~	~~0.23~~
~~5B~~	~~0.23~~
~~6B~~	~~0.21~~
~~3C~~	~~0.19~~

~~4C~~	~~0.21~~
~~5C~~	~~0.19~~
~~7~~	~~0.20~~
~~8~~	~~0.19~~

~~TABLE C403.1.2(2) MAXIMUM ANNUALIZED MECHANICAL LOAD COMPONENT (ANNUALIZED MLC)~~

CLIMATE ZONE	HVAC MAXIMUM ANNUALIZED MLC AT 100% AND AT 50% ITE LOAD
~~0A~~	~~0.19~~
~~0B~~	~~0.20~~
~~1A~~	~~0.18~~
~~2A~~	~~0.19~~
~~3A~~	~~0.18~~
~~4A~~	~~0.17~~
~~5A~~	~~0.17~~
~~6A~~	~~0.17~~
~~1B~~	~~0.16~~
~~2B~~	~~0.18~~
~~3B~~	~~0.18~~
~~4B~~	~~0.18~~
~~5B~~	~~0.16~~
~~6B~~	~~0.17~~
~~3C~~	~~0.16~~
~~4C~~	~~0.16~~
~~5C~~	~~0.16~~
~~7~~	~~0.16~~
~~8~~	~~0.16~~

Revise as follows:

ASHRAE	ASHRAE 180 Technology Parkway NW Peachtree Corners GA 30092
90.4—~~2016~~2019	Energy Standard for Data Centers - (with Addenda a, b, d, e, f)

Reason:

Including references to ASHRAE 90.4-2016 and more stringent MLC values in the 2021 IECC ensured that data center systems were held to equivalent efficiency standards as other building mechanical systems. While the MLC values in ASHRAE 90.4-2016 were egregiously lenient and required individual climate zone modifications, the more recent version of 90.4-2019 corrects this issue and therefore the MLC table modifications in the IECC are no longer required.

Additionally, 90.4-2019 removed the requirement to meet a design MLC value and instead splits annualized MLC values by data centers above and below 300kW. This distinction requires more stringent MLC thresholds for larger data centers and provides more lenient MLC thresholds for smaller data centers. This aligns more closely with the built environment, where smaller data centers are limited in their ability to increase efficiency compared to larger data centers, whereas larger data centers have a variety of methods to meet MLC thresholds.

The changes to the reference section also include adopted ASHRAE Addenda that provide necessary clarifications on how to calculate the MLC value with shared data center systems and how to incorporate heat recovery into the calculations. The transition from 90.4-2016 to 90.4-2019 has made the standard more robust and is important to capture in the IECC updates.

Bibliography:

ANSI/ASHRAE Standard 90.4-2019 - Energy Standard for Data Centers

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The levels specified in ASHRAE 90.1-2019 for >300kW data centers are similar to the adjusted levels published in the IECC using 90.4-2016, especially in climate zones where data centers are commonly located. For less dense data centers (<300kW) ASHRAE determined the updated MLC levels based on achievable technology from real-world projects and the MLC thresholds are more lenient in this size to better track with market practices and available efficiency improvements. Therefore costs to meet 90.4-2019 MLC levels for both data center size classes are not expected to increase on average.

CEPI-76-21

IECC®: SECTION 202 (New), C403.1, C403.1.3 (New), C403.1.3.1 (New), C403.1.3.2 (New), C403.1.3.3 (New), C406.13 (New), TABLE C406.1(1), TABLE C406.1(2), TABLE C406.1(3), TABLE C406.1(4), TABLE C406.1(5), SECTION C409 (New), C409.1 (New), C409.2 (New), C409.3 (New), C409.4 (New), Table C409.4 (New), C409.4.1 (New), C409.5 (New), C409.5.1 (New), C409.5.2 (New), C409.5.3 (New), C409.5.3.1 (New), C409.6 (New), C409.6.1 (New), C409.6.1.1 (New), C409.6.1.1.1 (New), C409.6.1.2 (New), C409.6.1.3 (New), C409.6.1.3.1 (New), C409.6.1.3.2 (New), C409.6.1.4 (New), C409.6.1.4.1 (New), C409.6.1.4.2 (New), C409.6.1.4.3 (New), C409.6.1.4.4 (New), C409.6.1.4.5 (New), C409.6.1.4.6 (New), C409.6.1.4.7 (New), C409.6.1.4.8 (New), C409.6.1.5 (New), C409.6.1.6 (New), C409.6.1.7 (New), C409.6.1.8 (New), C409.6.1.9 (New), C409.6.1.10 (New), C409.6.1.10.1 (New), TABLE C409.6.1.10.1 (New), C409.6.1.10.2 (New), TABLE C409.6.1.10.2(1) (New), TABLE C409.6.1.10.2(2) (New), C409.6.1.10.3 (New), C409.6.2 (New), C409.6.2.1 (New), C409.6.2.2 (New), C409.6.2.3 (New), C409.6.2.4 (New), C409.6.2.5 (New), C409.6.2.6 (New), C409.6.2.7 (New), C409.6.2.8 (New), C409.6.2.9 (New), C409.6.2.10 (New), C409.6.2.11 (New), Table C409.6.2.11(1) (New), Table C409.6.2.11(2) (New), Table C409.6.2.11(3) (New), C409.7 (New), Table C409.7(1) (New), TABLE C409.7(2) (New), TABLE C409.7(3) (New), Appendix CD (New), CD 101 (New), (New)

Proponents: Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Add new definition as follows:

BLOCK. A generic concept used in energy simulation. It can include one or more thermal zones. It represents a whole building or portion of a building with the same use type served by the same HVAC system type.

HVAC TOTAL SYSTEM PERFORMANCE RATIO (HVAC TSPR). The ratio of the sum of a building's annual heating and cooling load in thousands of Btus to the sum of annual site energy consumption of the building HVAC systems in BTU.

STANDARD REFERENCE DESIGN. A version of the proposed design that meets the minimum requirements of this code and is used to determine the maximum annual energy use requirement for compliance based on total building performance and *HVAC total system performance ratio*.

PROPOSED DESIGN. A description of the proposed building used to estimate annual energy use for determining compliance based on total building performance and *HVAC total system performance ratio*.

Revise as follows:

C403.1 General. Mechanical systems and equipment serving the building heating, cooling, ventilating or refrigerating needs shall comply with ~~this section~~ one of the following:

1. Sections C403.1.1 and C403.2 through C403.14
2. Data Centers shall comply with C403.1.1, C403.1.2 and C403.6 through C403.14
3. Section C403.1.3 and Sections within Section C403 that are listed in Table C407.2

~~**Exception:** Data center systems are exempt from the requirements of Sections C403.4 and C403.5.~~

Add new text as follows:

C403.1.3 HVAC total system performance ratio (*HVAC TSPR*).. HVAC systems serving buildings or portions of buildings listed in C403.1.3.1 that are not served by systems listed in C403.1.3.2 shall have an *HVAC total system performance ratio* (*HVAC TSPR*) of the *proposed design* HVAC systems that is greater than or equal to the *HVAC TSPR* of the *standard reference design* divided by the applicable mechanical performance factor (MPF) from Table C409.3.1. *HVAC TSPR* shall be calculated in accordance with Section C409, Calculation of HVAC Total System Performance Ratio. Systems using the HVAC TSPR method shall also meet requirements in C403.1.3.3.

C403.1.3.1 Included Building Types. HVAC systems that serve the following building use types are allowed to use the TSPR Method:

1. office (including medical office) (occupancy group B),
2. retail (occupancy group M), library (occupancy group A-3),
3. education (occupancy group E),
4. hotel/motel occupancies (occupancy group R-1),
5. the *dwelling units* and common areas within occupancy group R-2 multifamily buildings.

C403.1.3.2 Excluded Systems. The following *HVAC systems* are excluded from using the TSPR Method:

1. HVAC Systems using

1.1 district heating water, chilled water or steam

1.2. small duct high velocity air cooled, space constrained air cooled, single package vertical air conditioner, single package vertical heat pump, or

1.3 double-duct air conditioner or double-duct heat pump as defined in subpart F to 10CFR part 431

1.4. packaged terminal air conditioners and packaged terminal heat pumps that have cooling capacity greater than 12,000 Btu/hr 5.(3500 kW)

1.5. a common heating source serving both HVAC and service water heating equipment, or

2. HVAC systems that provide recovered heat for service water heating
3. HVAC systems not included in Table C409.5.2.10.1
4. HVAC systems included in table C409.5.2.10.1 with parameters in Table C409.5.2.10.2, not identified as applicable to that HVAC system type.
5. HVAC systems with chilled water supplied by absorption chillers, heat recovery chillers, water to water heat pumps, air to water heat pumps, or a combination of air and water cooled chillers on the same chilled water loop.
6. HVAC systems served by heating water plants that include air to water or water to water heat pumps.
7. Underfloor air distribution and displacement ventilation HVAC systems.
8. Space conditioning systems that do not include mechanical cooling.
9. HVAC systems serving laundry rooms, elevator rooms, mechanical rooms, electrical rooms, data centers, and computer rooms.
10. Buildings or areas of medical office buildings that comply fully with ASHRAE Standard 170, including but not limited to surgical centers, or that are required by other applicable codes or standards to provide 24/7 air handling unit operation
11. HVAC systems serving laboratories with fume hoods
12. Locker rooms with more than 2 showers
13. Natatoriums and rooms with saunas
14. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h
15. Areas of buildings with commercial refrigeration equipment exceeding 100 kW of power input.
16. Cafeterias and dining rooms

C403.1.3.3 TSPR Method Partial Prescriptive Requirements. HVAC systems using the HVAC Performance Rating Method shall meet relevant prescriptive requirements in Section C403 as follows:

1. Air economizers shall meet the requirements of Section C403.5.3.4 “relief of excess outdoor air” and Section C403.5.5 “Economizer fault detection and diagnostics.”
2. Variable-air-volume system systems shall meet requirements of Sections C403.6.5, C403.6.6, and C403.6.9.
3. Hydronic systems shall meet the requirements of C403.4.4.
4. Plants with multiple chillers or boilers shall meet the requirements of Section C403.4.5.
5. Hydronic (Water Loop) Heat Pumps and Water-Cooled Unitary Air Conditioners shall meet the requirements of Section C403.4.3.3.
6. Cooling tower turndown shall meet requirements of Section C403.10.4.
7. Heating of unenclosed spaces shall meet the requirements of Section C403.13.1.
8. Hot-gas bypass shall meet the requirements of Section C403.3.3.
9. Systems shall meet the door switch control requirements of Section 6.5.10.
10. Refrigeration systems shall meet the requirements of Section C403.11.

C406.13 HVAC Performance (TSPR). For systems allowed to use Section C403.1.3, the *HVAC TSPR* shall exceed the minimum requirement by 5 percent. If improvement is greater, credits in Tables C406.1(1) through C406.1(5) are permitted to be prorated up to a 20 percent improvement using Equation 4-16. Energy credits for C406.13 may not be combined with energy credits from any of the HVAC measures described in Section C406.2.

HVAC TSPR energy credit = base energy credit from Table 406.1 x (TSPR % / 5%) **(Equation 4-14)**
where:
TSPR% = Percentage by which TSPR of proposed design exceeds minimum TSPR requirement. The value of TSPR% cannot exceed 20% for purposes of calculating H01 energy credits.

Revise as follows:

TABLE C406.1(1) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.13: *HVAC TSPR*	8	8	7	7	6	6	4	6	6	4	6	6	4	6	6	6	6

TABLE C406.1(2) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.13: *HVAC TSPR*	8	8	8	7	6	6	5	6	6	4	6	5	4	6	6	6	7

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TABLE C406.1(3) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP E OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.13: *HVAC TSPR*	11	11	10	9	8	8	6	8	7	6	7	7	6	8	7	8	8

NA = Not Applicable.

a. For schools with showers or full-service kitchens.

TABLE C406.1(4) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP M OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.13 *HVAC TSPR*	11	11	10	9	8	8	6	8	8	7	8	8	6	9	8	9	10

NA = Not Applicable.

TABLE C406.1(5) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR OTHER[a] OCCUPANCIES
Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.13: HVAC TSPR	7	8	7	6	6	5	3	6	5	4	7	6	4	8	7	8	8

Add new text as follows:

SECTION C409
CALCULATION OF HVAC TOTAL SYSTEM PERFORMANCE RATIO

C409.1 Purpose. Section 409 establishes criteria for demonstrating compliance with the requirements of C403.1.1, *HVAC total system performance ratio (HVAC TSPR)*

C409.2 Scope. Section C409 applies to new HVAC systems that serve buildings in Section C403.1.3.1 and are not excluded from using *HVAC TSPR* by Section C403.1.3, and

1. serve office (including medical office), retail, library, hotel/motel, and education occupancies, or.
2. serve *dwelling units* and common areas within multifamily buildings.

All applicable HVAC systems shall comply with Section C409.

C409.3 Core & Shell / Initial Build-Out, and Future System Construction Analysis. Where the building permit applies to only a portion of the HVAC system in a building and the remaining components will be designed under a future building permit or were previously installed, the future or previously installed components shall be modeled as follows:

1. Where the HVAC zones that do not include HVAC systems in the current permit will be or are served by independent systems, then the block including those zones shall not be included in the model.
2. Where the HVAC zones that do not include complete HVAC systems in the permit are intended to receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of C403.
3. Where the zone equipment in the permit receives HVAC services from previously installed systems that are not in the permit, the previously installed systems shall be modeled with equipment matching the certified value of what is installed or equipment that meets the requirements of C403.
4. Where the central plant heating and cooling equipment is completely replaced and HVAC zones with existing systems receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of Section C403.

C409.4 HVAC TSPR Compliance. Systems allowed to use *HVAC TSPR* in accordance with C403.1.3 shall comply with all of the following:

1. Systems shall meet the applicable provisions of Section C403.1.3.3 and Sections within Section C403 that are listed in Table C407.2
2 The *HVAC TSPR* of the *proposed design* shall be greater than or equal to the *HVAC TSPR* of the *standard reference design* divided by the mechanical performance factor (MPF)using Equation 4-16.

TSPRp > TSPRr / MPF **(Equation 4-16)**
where:

TSPRp = *HVAC TSPR* of the *proposed design* calculated in accordance with Sections C409.4, C409.5 and C409.6.

TSPRr = *HVAC TSPR* of the *reference building design* calculated in accordance with Sections C409.4, C409.5 and C409.6.

MPF = Mechanical Performance Factor from Table C409.4 based on climate zone and building use type

Where a *building* has multiple *building* use types, MPF shall be area weighted using Equation 4-17

$MPF = (A_1*MPF_1 + A_2* MPF_2+...+A_n*MPF_n)/(A_1+A_2+...+A_n)$ **(Equation 4-17)**
where:

MPF_1, MPF_2 through MPF_n = Mechanical Performance Factors from Table C409.4 based on climate zone and *building* use types 1,2, through n

A_1, A_2 through A_n = Conditioned *floor* areas for *building* use types 1, 2, through n

Table C409.4 Mechanical Performance Factors

Climate Zone: *Building* type	Ocp. Group	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Office (small and medium)[a]	B	0.75	0.75	0.74	0.74	0.72	0.69	0.75	0.70	0.69	0.73	0.70	0.71	0.76	0.72	0.72	0.78	0.75	0.79	0.81
Office (Large)[a]	B	0.91	0.93	0.94	0.93	0.88	0.94	0.80	0.88	0.95	0.77	0.95	0.82	0.82	0.89	0.82	0.81	0.84	0.79	0.77
Retail	M	0.61	0.59	0.52	0.56	0.48	0.47	0.43	0.46	0.62	0.53	0.60	0.73	0.57	0.68	0.75	0.60	0.60	0.57	0.52
Hotel/Motel	R-1	0.62	0.62	0.63	0.63	0.62	0.68	0.61	0.69	0.73	0.59	0.66	0.65	0.55	0.59	0.68	0.51	0.54	0.47	0.40
Multi-Family/ Dormitory	R-2	0.64	0.63	0.67	0.63	0.65	0.64	0.59	0.60	0.54	0.59	0.57	0.52	0.58	0.53	0.48	0.57	0.53	0.55	0.52
School/ Education and Libraries	E (A-3)	0.89	0.89	0.89	0.87	0.83	0.82	0.79	0.80	0.80	0.75	0.85	0.77	0.84	0.83	0.73	0.86	0.82	0.83	0.78

a. Large office (gross conditioned floor area >150,000 ft^2 (14,000 m^2) or > 5 floors); all other offices are small or medium

C409.4.1 HVAC TSPR. *HVAC TSPR* is calculated according to Equation 4-18 .

HVAC TSPR = heating and cooling load / building HVAC system energy **(Equation 4-18)**
where:

building HVAC system energy = sum of the annual site energy consumption for heating, cooling, fans, energy recovery, pumps, and heat rejection in thousands of Btus

heating and cooling load = sum of the annual heating and cooling loads met by the building HVAC system in thousands of Btus

C409.5 General. Projects shall comply with the requirements of this Section when calculating compliance using *HVAC Total System Performance Ratio.*

C409.5.1 Simulation Program. Simulation tools used to calculate HVAC TSPR of the *Standard Reference Design* shall comply with the following:

1. The simulation program shall calculate the *HVAC TSPR* based only on the input for the *proposed design* and the requirements of Section 409. The calculation procedure shall not allow the user to directly modify the building component characteristics of the *standard reference design.*
2. Performance analysis tools meeting the applicable subsections of Section 409 and tested according to ASHRAE Standard 140 shall be permitted to be *approved.* Tools are permitted to be *approved* based on meeting a specified threshold for a jurisdiction. The *code official* shall be permitted to approve tools for a specified application or limited scope.

C409.5.2 Climatic Data. The simulation program shall perform the simulation using hourly values of climatic data, such as temperature and humidity, using TMY3 data for the site as specified here:
https://buildingenergyscore.energy.gov/resources

C409.5.3 Documentation. Documentation conforming to the provisions of this section shall be provided to the *code official.*

C409.5.3.1 Compliance Report. Building permit submittals shall include:

1. A report produced by the simulation software that includes the following:
   - 1.1 Address of the building.
   - 1.2 Name of individual completing the compliance report.
   - 1.3 Name and version of the compliance software tool.
   - 1.4 The dimensions, floor heights and number of floors for each *block*.
   - 1.5 By *block*, the U-factor, C-factor, or F-factor for each simulated opaque envelope component and the U-factor and SHGC for each fenestration component.
   - 1.6 By *block* or by surface for each block, the fenestration area.
   - 1.7 By *block*, a list of the HVAC equipment simulated in the *proposed design* including the equipment type, fuel type, equipment efficiencies and system controls.
   - 1.8 Annual site HVAC energy use by end use for the proposed and baseline building
   - 1.9 Annual sum of heating and cooling loads for the baseline building.
   - 1.10 The HVAC total system performance ratio for both the *standard reference design* and the *proposed design*.

2. A mapping of the actual building HVAC component characteristics and those simulated in the *proposed design* showing how individual pieces of HVAC equipment identified above have been combined into average inputs as required by Section C409.6.1.10 including:
   - 2.1 Fans
   - 2.2 Hydronic pumps
   - 2.3 Air handlers
   - 2.4 Packaged cooling equipment
   - 2.5 Furnaces
   - 2.6 Heat pumps
   - 2.7 Boilers
   - 2.8 Chillers
   - 2.9 Cooling towers
   - 2.10 Electric resistance coils
   - 2.11 Condensing units
   - 2.12 Motors for fans and pumps
   - 2.13 Energy recovery devices

   For each piece of equipment identified above include the following as applicable:

   1. Equipment name or tag consistent with that found on the design documents.
   2. Rated Efficiency level.
   3. Rated Capacity.
   4. Electrical input power for fans and pumps (before any speed or frequency control device) at design condition and calculation of input value (W/cfm or W/gpm)

3. Floor plan of the building identifying:
   - 3.1 How portions of the buildings are assigned to the simulated blocks
   - 3.2 Areas of the building that are not covered under the requirements of Section C403.1.1.

C409.6 Calculation Procedures. Except as specified by this Section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques

C409.6.1 Simulation of the proposed building design. The proposed design shall be configured and analyzed as specified in this section.

C409.6.1.1 Block Geometry. The geometry of buildings shall be configured using one or more *blocks*. Each *block* shall define attributes including *block* dimensions, number of floors, floor to floor height and floor to ceiling height. Simulation software may allow the use of simplified shapes (such as rectangle, L shape, H Shape, U shape or T shape) to represent *blocks*. Where actual building shape does not match these pre-defined shapes, simplifications are permitted providing the following requirements are met:

1. The *conditioned floor area* and volume of each *block* shall match the proposed design within 10 percent.
2. The area of each exterior envelope component from Table C402.1.4 is accounted for within 10 percent of the actual design.
3. The area of vertical fenestration and skylights is accounted for within 10 percent of the actual design.
4. The orientation of each component in 2 and 3 above is accounted for within 45 degrees of the actual design.

The creation of additional *blocks* may be necessary to meet these requirements.

> **Exception:** Portions of the building that are unconditioned or served by systems not covered by the requirements of Section C403.1.1 shall be omitted.

C409.6.1.1.1 Number of Blocks. One or more *blocks* may be required per building based on the following restrictions:

1. Each *block* can have only one occupancy type (multifamily *dwelling unit*, multifamily common area, office, library, education, hotel/motel or retail). Therefore, at least one single *block* shall be created for each unique use type.
2. Each *block* can be served by only one type of HVAC system. Therefore, a single *block* shall be created for each unique HVAC system and use type combination. Multiple HVAC units of the same type may be represented in one *block*. Table D601.10.2 provides directions for

combining multiple HVAC units or components of the same type into a single *block*.

3. Each *block* can have a single definition of floor to floor or floor to ceiling heights. Where floor heights differ by more than two feet, unique *blocks* should be created for the floors with varying heights.
4. Each *block* can include either above grade or below grade floors. For buildings with both above grade and below grade floors, separate *blocks* should be created for each. For buildings with floors partially above grade and partially below grade, if the total wall area of the floor(s) in consideration is greater than or equal to 50 percent above grade, then it should be simulated as a completely above grade *block*, otherwise it should be simulated as a below grade *block*.
5. Each wall on a façade of a *block* shall have similar vertical fenestration. The product of the proposed design U-factor times the area of windows (UA) on each façade of a given floor cannot differ by more than 15 percent of the average UA for that façade in each *block*. The product of the proposed design SHGC times the area of windows (SHGCA) on each façade of a given floor cannot differ by more than 15 percent of the average SHGCA for that façade in each *block*. If either of these conditions are not met, additional *blocks* shall be created consisting of floors with similar fenestration.
6. For a building model with multiple *blocks*, the *blocks* should be configured together to have the same adjacencies as the actual building design.

C409.6.1.2 Thermal Zoning. Each floor in a *block* shall be modeled as a single thermal zone or as five thermal zones consisting of four perimeter zones and a core zone. Below grade floors shall be modeled as a single thermal *block*. If any façade in the *block* is less than 45 feet in length, there shall only be a single thermal zone per floor. Otherwise each floor shall be modeled with five thermal zones. A perimeter zone shall be created extending from each façade to a depth of 15 feet. Where facades intersect, the zone boundary shall be formed by a 45 degree angle with the two facades. The remaining area or each floor shall be modeled as a core zone with no exterior walls.

C409.6.1.3 Occupancy. Building occupancies modeled in the *standard reference design* and the *proposed design* shall comply with the following requirements.

C409.6.1.3.1 Occupancy Type. The occupancy type for each *block* shall be consistent with the building area type as determined in accordance with C405.4.2.1. Portions of the building that are building area types other than multifamily *dwelling unit*, multifamily common area, office, school (education), library, or retail shall not be included in the simulation. Surfaces adjacent to such building portions shall be modeled as adiabatic in the simulation program.

C409.6.1.3.2 Occupancy schedule, density, and heat gain.. The occupant density, heat gain, and schedule shall be for multifamily, office, retail, library, hotel/motel or school as specified by ASHRAE Standard 90.1 Normative Appendix C.

C409.6.1.4 Envelope Components. Building envelope components modeled in the *standard reference design* and the *proposed design* shall comply with the requirements of this Section.

C409.6.1.4.1 Roofs.. Roofs will be modeled with insulation above a steel roof deck. The roof U-factor and area shall be modeled as in the proposed design. If different roof thermal properties are present in a single *block*, an area weighted U-factor shall be used. Roof solar absorptance shall be modeled at 0.70 and emittance at 0.90.

C409.6.1.4.2 Above grade walls. Walls will be modeled as steel frame construction. The U-factor and area of above grade walls shall be modeled as in the proposed design. If different wall constructions exist on the façade of a *block* an area-weighted U-factor shall be used.

C409.6.1.4.3 Below grade walls. The C-factor and area of below grade walls shall be modeled as in the proposed design. If different slab on grade floor constructions exist in a *block*, an area-weighted C- factor shall be used.

C409.6.1.4.4 Above grade exterior floors. Exterior floors shall be modeled as steel frame. The U-factor and area of floors shall be modeled as in the proposed design. If different wall constructions exist in the *block* an area-weighted U-factor shall be used.

C409.6.1.4.5 Slab on grade floors. The F-factor and area of slab on grade floors shall be modeled as in the proposed design. If different below grade wall constructions exist in a *block*, an area-weighted F- factor shall be used.

C409.6.1.4.6 Vertical Fenestration.. The window area and area weighted U-factor and SHGC shall be modeled for each façade based the proposed design. Each exterior surface in a *block* must comply with Section C409.6.1.1.1 item 5. Windows will be combined into a single window centered on each façade based on the area and sill height input by the user. When different U values, SHGC or sill heights exist on a single facade, area weighted average for each shall be input by the user.

C409.6.1.4.7 Skylights.. The skylight area and area weighted U-factor and SHGC shall be modeled for each floor based the proposed design. Skylights will be combined into a single skylight centered on the roof of each zone based on the area input by the user

C409.6.1.4.8 Exterior Shading.. Permanent window overhangs shall be modeled. When windows with and without overhangs or windows with different overhang projection factors exist on a façade, window width weighted projection factors shall be input by the user as follows.

$P_{avg} = (A_1 \times L_{o1} + A2 \times L_{o2} ... + An \times L_{on}) / (Lw_1 + Lw_2 ... + L_{wn})$ **(Equation 4-19)**

where:

P_{avg} = Average overhang projection modeled in the simulation tool

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.

L_o = Length off the overhang

L_w = Length of the window

C409.6.1.5 Lighting.. Interior lighting power density shall be equal to the allowance in Table C405.4.2(1) for multifamily, office, retail, library, or school. The lighting schedule shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of lighting controls is assumed to be captured by the lighting schedule and no explicit controls shall be modeled. Exterior lighting shall not be modeled.

C409.6.1.6 Miscellaneous equipment.. The miscellaneous equipment schedule and power shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of miscellaneous equipment controls is assumed to be captured by the equipment schedule and no explicit controls shall be modeled.

Exceptions:

1. Multifamily dwelling units shall have a miscellaneous load density of 0.42 W/ft^2
2. Multifamily common areas shall have a miscellaneous load density of 0 W/ft^2

C409.6.1.7 Elevators. Elevators shall not be modeled.

C409.6.1.8 Service water heating equipment.. Service water heating shall not be modeled.

C409.6.1.9 On-site renewable energy systems.. On-site Renewable Energy Systems shall not be modeled.

C409.6.1.10 HVAC equipment.. HVAC systems shall meet the requirements of Section C403 Mechanical Systems.

C409.6.1.10.1 Supported HVAC systems.. At a minimum, the HVAC systems shown in Table CD105.2.10.1 shall be supported by the simulation program.

TABLE C409.6.1.10.1 PROPOSED BUILDING HVAC SYSTEMS SUPPORTED BY HVAC TSPR SIMULATION SOFTWARE

System No.	System Name	System Abbreviation
1	Packaged Terminal Air Conditioner	PTAC
2	Packaged Terminal Air Heat Pump	PTHP
3	Packaged Single Zone Gas Furnace	PSZGF
4	Packaged Single Zone Heat Pump (air to air only)	PSZHP
5	Variable Refrigerant Flow (air cooled only)	VRF
6	Four Pipe Fan Coil	FPFC
7	Water Source Heat Pump	WSHP
8	Ground Source Heat Pump	GSHP
9	Packaged Variable Air Volume (DX cooling)	PVAV
10	Variable Air Volume (hydronic cooling)	VAV
11	Variable Air Volume with Fan Powered Terminal Units	VAVFPTU
12	Dedicated Outdoor Air System (in conjunction with systems 1-8)	DOAS

C409.6.1.10.2 Proposed building HVAC system simulation.. The HVAC systems shall be modeled as in the proposed design with clarifications and simplifications as described in Tables C409.6.1.10.2(1) and C409.6.1.10.2(2). System parameters not described in the following sections shall be simulated to meet the minimum requirements of Section C403. All zones within a *block* shall be served by the same HVAC system type as described in Section C409.6.1.1.1 item 2. Heat loss from ducts and pipes shall not be modeled.
For packaged single-zone air conditioners (cooling only), water-loop heat pumps, ground-source heat pumps and packaged rooftop heat pumps, heating COP and cooling COP, exclusive of fan power, shall be determined using the following equations:

For Table C409.6.1.10.1 Systems 4, 7, and 8 heating efficiency

$COP_{nfheating} = 1.48E\text{-}7 \times COP_{47} \times Q + 1.062 \times COP_{47}$ **(Equation 4-20)**

where:

COP shall be at AHRI full load test conditions

Q = AHRI rated cooling capacity in BTU/h. If Q > 760,000BTU/h use 760,000 in the calculation

For Table C409.6.1.10.1 System 3 heating efficiency

$COP_{nfheating} = -0.0296 \times HSPF^2 + 0.7134 \times HSPF$ **(Equation 4-21)**

where:

COP and HSPF shall be at AHRI full load test conditions

For Table C409.6.1.10.1 System 4, 7, 8, and 9 cooling efficiency

$COP_{nfcooling} = 7.84E\text{-}8 \times EER \times Q + 0.338 \times EER$ **(Equation 4-22)**

where:

EER, and COP shall be at AHRI full load test conditions

Q = AHRI rated cooling capacity in BTU/h. If Q > 760,000BTU/h use 760,000 in the calculation

For Table C409.6.1.10.1 System 1 and 2 cooling efficiency

$COP_{nfcooling} = -0.0076 \times SEER^2 + 0.3796 \times SEER$ **(Equation 4-23)**

where:

SEER and COP and HSPF shall be at AHRI full load test conditions.

For Table C409.6.1.10.1 System 1 and 2 cooling efficiency

$COP_{nfcooling} = 0.3322 \times EER - 0.2145$ **(Equation 4-24)**

where:

EER and COP shall be at AHRI full load test conditions

For Table C409.6.1.10.1 System 2 heating efficiency

$COP_{nfheating} = 1.1329 \times COP - 0.214$ **(Equation 4-25)**

where:

COP shall be at AHRI full load test conditions

Note to adopting authority*: The following equations (in italics) are the SI version of Equations 4-20 through 4-25 and shall be used when adopting an SI version of the IECC.*

($COP_{nfheating} = 5.05E\text{-}4 \times COP_{H8.3} \times Q + 1.062 \times COP_{H8.3}$) Equation 4-20 (SI)

($COP_{nfheating} = -0.3446 \times SCOP_H^2 + 2.434 \times SCOP_H$) Equation 4-21(SI)

($COP_{nfcooling} = 9.13E\text{-}4 \times COP_C \times Q + 1.15 \times COP_C$) Equation 4-22(SI)

($COP_{nfcooling} = -0.0885 \times SCOP_C^2 + 1.295 \times SCOP_C$) Equation 4-23(SI)

($COP_{nfcooling} = 9.13E\text{-}4 \times COP_C \times Q + 1.15 \times COP_C$) Equation 4-24(SI)

($COP_{nfheating} = 1.1329 \times COP - 0.214$) Equation 4-25(SI)

Where:EER, SEER, COP and HSPF shall be at AHRI full load test conditions Q = AHRI rated cooling capacity in BTU/h. If Q > 760,000BTU/h use 760,000 in the calculation.

Where multiple system components serve a *block*, average values weighed by the appropriate metric as described in this section shall be used.

1. Where multiple fan systems serve a single block, fan power shall be based on weighted average using the design supply air cfm
2. Where multiple cooling systems serve a single block, COP shall be based on a weighted average using cooling capacity. DX coils shall be entered as multi-stage if more than 50% of coil capacity serving the block is multi-stage with staged controls.
3. Where multiple heating systems serve a single block, thermal efficiency or heating COP shall be based on a weighted average using heating capacity.
4. Where multiple boilers or chillers serve a heating water or chilled water loop, efficiency shall be based on a weighted average for using heating or cooling capacity.
5. When multiple cooling towers serving a condenser water loop are combined, the cooling tower efficiency, cooling tower design approach and design range are based on a weighted average of the design water flow rate through each cooling tower.
6. Where multiple pumps serve a heating water, chilled water or condenser water loop, pump power shall be based on a weighted average for using design water flow rate.
7. When multiple system types with and without economizers are combined, the economizer maximum outside air fraction of the combined system shall be based on weighted average of 100% supply air for systems with economizers and design outdoor air for systems without economizers.
8. Multiple systems with and without ERVs cannot be combined.
9. Systems with and without supply air temperature reset cannot be combined.
10. Systems with different fan control (constant volume, multi-speed or VAV) for supply fans cannot be combined.

TABLE C409.6.1.10.2(1) PROPOSED BUILDING SYSTEM PARAMETERS

Category	**Parameter**	**Fixed or User Defined**	**Required**	**Applicable Systems**
HVAC System Type	System Type	User Defined	Selected from Table C409.6.1.10.1	All
System Sizing	Design Day Information	Fixed	99.6% heating design and 1% dry-bulb and 1% wet-bulb cooling design	All
	Zone Coil Capacity	Fixed	Sizing factors used are 1.25 for heating equipment and 1.15 for cooling equipment	All
	Supply Airflow	Fixed	Based on a supply-air-to-room-air temperature *set-point* difference of 20°F or	1-11
		Fixed	Equal to required outdoor air ventilation	12
Outdoor Ventilation Air	Portion of supply air with proposed Filter ≥MERV 13	User-defined	Percentage of supply air flow subject to higher filtration (Adjusts baseline Fan Power higher. Prorated)	All
	Outdoor Ventilation Air Flow Rate	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, adjusted for proposed DCV control	All
	Outdoor *Ventilation* Supply Air Flow Rate Adjustments	Fixed	Based on ASHRAE Standard 62.1 Section 6.2.4.3 System Ventilation Efficiency (Evs) is 0.75	9-11
		Fixed	System Ventilation Efficiency (Evs) is 1.0	1-8, 12
		Fixed	Basis is 1.0 Zone Air Distribution Effectiveness	All
System Operation	Space temperature Set points	Fixed	As specified in ASHRAE Standard 90.1 Normative Appendix C, except multifamily which shall use 68 deg. F heating and 76 deg. F cooling setpoints	1-11
	Fan Operation – Occupied	User Defined	Runs continuously during occupied hours or cycles to meet load. Multispeed fans reduce airflow related to thermal loads.	1-11
	Fan Operation – Occupied	Fixed	Fan runs continuously during occupied hours	12
	Fan Operation – Night Cycle	Fixed	Fan cycles on to meet setback temperatures	1-11
Packaged Equipment Efficiency	DX Cooling Efficiency	User Defined	Cooling COP without fan energy calculated in accordance with Section C409.6.1.10.2	1, 2, 3, 4, 5,7, 8, 9, 11,12
	DX Coil Number of Stages	User-defined	Single Stage or Multistage	3, 4, 9
	Heat Pump Efficiency	User Defined	Heating COP without fan energy calculated in accordance with Section C409.6.1.10.2	2, 4, 5, 7, 8
	Furnace Efficiency	User Defined	Furnace thermal efficiencyc	3, 11
Heat Pump Supplemental Heat	Control	Fixed	Supplemental electric heat locked out above 40°F. Runs In conjunction with compressor between 40°F and 0°F.	2, 4
System Fan Power and Controls	Part-load Fan Controls	User-defined	Constant volume or two speed	1-8
	Part-load Fan Controls[a]	User-defined	Constant volume or variable air volume	12
	Part-load Fan Controls[a]	Fixed	Variable air volume. VFD with static pressure reset	9-11
	Design Fan Power	User	Input electric power for all fans in required to operate at fan system design conditions	All

	(W/cfm)	User Defiined	divided by the supply airflow rate This is a “wire to air” value including all drive, motor *efficiency* and other losses.	
	Low-speed fan power	User Defined	Low speed input electric power for all fans required to operate at low speed conditions divided by the low speed supply airflow rate. This is a “wire to air” value including all drive, motor *efficiency* and other losses.	1-8
Variable Air Volume Systems	Supply Air Temperature (SAT) Controls	User defined	If not SAT reset then constant at 55°F. Options for reset based on outside air temperature (OAT) or warmest zone. If warmest zone, then the user can specify the minimum and maximum temperatures. If OAT reset, SAT is reset higher to 60°F at outdoor low of 50°F. SAT is 55°F at outdoor high of 70°F.	9, 10, 11
	Minimum Terminal Unit airflow percentage	User Defined	Average minimum terminal unit airflow percentage for *block* weighted by cfm or minimum required for outdoor air ventilation, whichever is higher.	9, 10, 11
	Terminal Unit Heating Source	User Defined	Electric or hydronic	9, 10, 11
	Dual *set point* minimum *VAV* damper position	User-defined	Heating maximum airflow fraction	9,10.
	Fan Powered Terminal Unit (FPTU) Type	User Defined	Series or parallel FPTU	11
	Parallel FPTU Fan	Fixed	Sized for 50% peak primary air at 0.35 W/cfm	11
	Series FPTU Fan	Fixed	Sized for 50% peak primary air at 0.35 W/cfm	11
Economizer	Economizer Presence	User Defined	Yes or No	3, 4, 9, 10,11
	Economizer Control Type	Fixed	Differential dry-bulb	3, 4, 9, 10,11
Energy Recovery	Sensible Effectiveness	User Defined	Heat exchanger sensible effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Latent Effectiveness	User Defined	Heat exchanger latent effectiveness at design heating and cooling conditions	3, 4, 9, 10, 11, 12
	Economizer Bypass	User Defined	If ERV is bypassed during economizer conditions	3, 4, 9, 10, 11, 12
	Bypass SAT Setpoint	User Defined	If bypass, target supply air temperature	3, 4, 9, 10, 11, 12
	Fan Power Reduction during Bypass (W/cfm)	User Defined	If ERV system include bypass, static pressure set point and variable speed fan, fan power can be reduced during economizer conditions	3, 4, 9, 10, 11, 12
Demand Controlled Ventilation	DCV Application	User Defined	Percent of block floor area under DCV control	3, 4, 9, 10, 11, 12
DOAS	DOAS Fan Power W/cfm	User Defined	Fan electrical input power in W/cfm of supply airflowa	12
	DOAS	User	Heating source, cooling source	12

	Supplemental Heating and Cooling	Defined		
	Maximum SAT Set point(Cooling)	User-defined	SAT set point if DOAS includes supplemental cooling	12
	Minimum SAT Set point (Heating)	User-defined	SAT set point if DOAS includes supplemental heating	12
	-	-	-	-
Heating Plant	Boiler Efficiency	User Defined	Boiler thermal efficiency	1, 6, 7, 9, 10, 11, 12
	Heating Water Loop Configuration	User-defined	Constant flow primary only; Variable flow primary only; Constant flow primary – variable flow secondary	1, 6, 7, 9, 10, 11, 12
	Heating Water Primary Pump Power (W/gpm)	User-defined	Heating water primary pump input W/gpm heating water flow	1, 6, 7, 9, 10, 11, 12
	Heating Water Secondary Pump Power (W/gpm)	User-defined	Heating water secondary pump input W/gpm heating water flow (if primary/secondary)	1, 6, 7, 9, 10, 11, 12
	Heating Water Loop Temperature	Fixed	180°F supply, 130°F return	1, 6, 9, 10,11
	Boiler Type	Fixed	Non-condensing boiler where input thermal efficiency is less than 86%; Condensing boiler otherwise	1, 6, 7, 9, 10, 11, 12
Chilled Water Plant	Chiller Compressor Type	User Defined	Screw/Scroll, Centrifugal or Reciprocating	6,1 0, 11, 12
	Chiller Condenser Type	User Defined	Air cooled or water cooled	6, 10, 11, 12
	Chiller Full Load Efficiency	User Defined	Chiller COP	6, 10, 11, 12
	Chilled Water Loop Configuration	User Defined	Variable flow primary only, constant flow primary – variable flow secondary	6, 10, 11,12
	Chilled Water Primary Pump Power (W/gpm)	User-defined	Primary pump input W/gpm chilled water flow	6, 10, 11,12
	Chilled Water Secondary Pump Power (W/gpm)	User-defined	Secondary Pump input W/gpm chilled water flow (if primary/secondary)	6, 10, 11,12
	Chilled Water Temperature Reset Included	User Defined	Yes/No	6, 10, 11,12
Chilled Water Plant (cont.)	Chilled Water Temperature Reset Schedule (if included)	Fixed	Outdoor air reset: CHW supply temperature of 44°F at 80°F outdoor air dry bulb and above, CHW supply temperature of 54°F at 60°F outdoor air dry bulb temperature and below, ramped linearly between	6, 10, 11,12
	Condenser Water Pump Power (W/gpm)	User Defined	Pump input W/gpm condenser water flow	6, 7, 8, ,10, 11, 12
	Condenser Water Pump Control	User Defined	Constant speed or variable speed	6, 7, 8, 10, 11,12
	Cooling Tower Efficiency	User Defined	gpm/hp tower fan	6, 7, 10, 11,12
	Cooling Tower Fan Control	User Defined	Constant or variable speed	6, 7, 10, 11,12

	Cooling Tower Approach and Range	User Defined	Design cooling tower approach and range temperature	6, 7, 10, 11, 12
Heat Pump Loop Flow Control	Loop flow and Heat Pump Control Valve	Fixed	Two position Valve with VFD on Pump. Loop flow at 3 gpm/ton	7, 8
Heat Pump Loop Temperature Control	_	Fixed	Set to maintain temperature between 50°F and 70°F	7
GLHP Well Field	_	Fixed	Bore depth = 250’ Bore length 200’/ton for greater of cooling or heating load Bore spacing = 15’ Bore diameter = 5” ¾” Polyethylene pipe Ground and grout conductivity = 4.8 Btu-in/h-ft2-0F	8

a. Part load fan power and pump power modified in accordance with Table C409.6.1.10.2(2)

TABLE C409.6.1.10.2(2) FAN AND PUMP Power CURVE COEFFICIENTS

Equation Term	**Fan Power Coefficients**	**Pump Power Coefficients**	
-	**VSD + SP reset**	**Ride Pump Curve**	**VSD + DP/valve reset**
b	0.0408	0	0
x	0.088	3.2485	0.0205
x^2	-0.0729	-4.7443	0.4101
x^3	0.9437	2.5295	0.5753

C409.6.1.10.3 Demand Control Ventilation.. Demand Controlled Ventilation (DCV) shall be modeled using a simplified approach that adjusts the design outdoor supply air flow rate based on the area of the building that is covered by DCV.

C409.6.2 Simulation of the standard reference design. The standard reference design shall be configured and analyzed as specified in this section.

C409.6.2.1 Utility Rates. Same as *proposed design.*

C409.6.2.2 Blocks. Same as *proposed design.*

C409.6.2.3 Thermal zoning. Same as *proposed design.*

C409.6.2.4 Occupancy type, schedule, density, and heat gain. Same as *proposed design.*

C409.6.2.5 Envelope components.. Same as *proposed design.*

C409.6.2.6 Lighting. Same as *proposed design.*

C409.6.2.7 Miscellaneous equipment. Same as *proposed design.*

C409.6.2.8 Elevators. Not modeled. Same as *proposed design.*

C409.6.2.9 Service water heating equipment. Not modeled. Same as *proposed design.*

C409.6.2.10 On-site renewable energy systems. Not modeled. Same as *proposed design.*

C409.6.2.11 HVAC equipment. The *reference building design* HVAC equipment consists of separate space conditioning systems as described in Table C409.6.2.11(1) through Table C409.6.2.11(3) for the appropriate building use types. In these tables, ‘Warm’ refers to climate zones 0 to 2 and 3A and ‘Cold’ refers to climate zones 3B, 3C, and 4 to 8.

Table C409.6.2.11(1) Reference Building Design HVAC Complex Systems

Building Type Parameter	**Large Office (warm)**	**Large Office (cold)**	**School (warm)**	**School (cold)**
System Type	*VAV*/ RH Water-cooled Chiller/ Electric Reheat (PIU)	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*	*VAV*/ RH Water-cooled Chiller/ Electric Reheat (PIU)	*VAV*/ RH Water-cooled Chiller/ Gas *Boiler*
Fan control	VSD (No SP Reset)	VSD (No SP Reset)	VSD (No SP Reset)	VSD (No SP Reset)
Main fan power (W/CFM (W·s/L) Proposed ≥ MERV13	1.165 (2.468)	1.165 (2.468)	1.165 (2.468)	1.165 (2.468)
Main fan power (W/CFM (W·s/L) proposed < MERV13	1.066 (2.259)	1.066 (2.259)	1.066 (2.259)	1.066 (2.259)
Zonal fan power (W/CFM (W·s/L))	0.35 (0.75)	NA	0.35 (0.75)	NA
Minimum zone airflow fraction	1.5* Voz	1.5* Voz	1.2* Voz	1.2 * Voz
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Outdoor air economizer	No	Yes except 4A	No	Yes except 4A
Occupied OSA (= proposed)	Sum(Voz)/0.75	Sum(Voz)/0.75	Sum(Voz)/0.65	Sum(Voz)/0.65
Energy recovery ventilator *efficiency* ERR (Enthalpy Recovery Ratio) ERV bypass SAT *set point*	NA	NA	50% No Bypass	50% 60°F except 4A
DCV	No	No	No	No
Cooling Source	(2) Water-cooled Centrifugal Chillers	(2) Water- cooled Centrifugal Chillers	(2) Water- Cooled Screw Chillers	(2) Water- Cooled Screw Chillers
Cooling *COP* (net of fan)	Path B for profile	Path B for profile	Path B for profile	Path B for profile
Heating source (reheat)	*Electric resistance*	Gas *Boiler*	*Electric resistance*	Gas *Boiler*
Furnace or *boiler efficiency*	1.0	75% Et	1.0	80% Et
Condenser heat rejection	Cooling Tower	Cooling Tower	Cooling Tower	Cooling Tower
Cooling tower *efficiency* (gpm/fan-hp (L/s·fan-*kW*))	38.2 (3.23)	38.2 (3.23)	38.2 (3.23)	38.2 (3.23)
Tower turndown (> 300 ton (1060 *kW*))	50%	50%	50%	50%
Pump (constant flow/variable flow)	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range
Tower approach	25.72 – (0.24 x WB), where WB WB is the 0.4% evaporation design wet-bulb temperature (°F)			
Cooling condenser *pump* power (W/gpm (W·s/L))	19 (300)	19 (300)	19 (300)	19 (300)
Cooling primary *pump* power (W/gpm (W·s/L))	9 (142)	9 (142)	9 (142)	9 (142)
Cooling secondary *pump* power (W/gpm (W·s/L))	13 (205)	13 (205)	13 (205)	13 (205)
Cooling coil chilled water delta-T, °F (°C)	12 (6.7)	12 (6.7)	12 (6.7)	12 (6.7)
Design chilled water supply temperature, °F (°C)	44 (6.7)	44 (6.7)	44 (6.7)	44 (6.7)
Chilled water supply temperature (CHWST) reset *set point* vs OAT, °F (°C)	CHWST/OAT: 44-54/ 80-60 (6.7-12.2/ 26.7-15.6)	CHWST/OAT: 44-54/ 80-60 (6.7-12.2/ 26.7-15.6)	CHWST/OAT: 44-54/ 80-60 (6.7-12.2/ 26.7-15.6)	CHWST/OAT: 44-54/ 80-60 (6.7-12.2/ 26.7-15.6)

CHW cooling loop pumping control	2-way Valves & pump VSD	2-way Valves & pump VSD	2-way Valves & pump VSD	2-way Valves & pump VSD
Heating *pump* power (W/gpm (W·s/L))	16.1 (254)	16.1 (254)	19 (254)	19 (254)
Heating oil HW dT. °F (°C)	50 (10)	50 (10)	50 (10)	50 (10)
Design HWST. °F (°C)	180 (82)	180 (82)	180 (82)	180 (82)
HWST reset *set point* vs OAT, °F (°C)	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)
Heat loop *pumping* control	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD

Table C409.6.2.11(2)
TSPR Reference Building Design HVAC Simple Systems

Building Type Parameter	**Medium Office (warm)**	**Medium Office (cold)**	**Small Office (warm)**	**Small Office (cold)**	**Retail (warm)**	**Retail (cold)**
System type	Package *VAV* - Electric Reheat	Package *VAV* - Hydronic Reheat	PSZ-HP	PSZ-AC	PSZ-HP	PSZ-AC
Fan control	VSD (No SP Reset)	VSD (No SP Reset)	Constant Volume	Constant Volume	Constant Volume	Constant Volume
Main fan power (W/CFM (W·s/L)) proposed ≥ MERV13	1.285 (2.723)	1.285 (2.723)	0.916 (1.941)	0.916 (1.941)	0.899 (1.905)	0.899 (1.905)
Main fan power (W/CFM (W·s/L)) proposed < MERV13	1.176 (2.492)	1.176 (2.492)	0.850 (1.808)	0.850 (1.801)	0.835 (1.801)	0.835 (1.801)
Zonal fan power (W/CFM (W·s/L))	0.35 (0.75)	NA	NA	NA	NA	NA
Minimum zone airflow fraction	30%	30%	NA	NA	NA	NA
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	NA	NA	<40°F (<4.4°C) OAT	NA	<40°F (<4.4°C) OAT	NA
Outdoor air economizer	No	Yes except 4A	No	Yes except 4A	No	Yes except 4A
Occupied OSA source	Packaged unit, occupied damper, all *building* use types					
Energy recovery ventilator	No	No	No	No	No	No
DCV	No	No	No	No	No	No
Cooling source	DX, multi-stage	DX, multi-stage	DX, 1 stage (heat pump)	DX, single stage	DX, 1 stage (heat pump)	DX, single stage
Cooling *COP* (net of fan)	3.40	3.40	3.00	3.00	3.40	3.50
Heating source	*Electric resistance*	Gas *Boiler*	Heat Pump	Furnace	Heat Pump	Furnace
Heating *COP* (net of fan) / furnace or *boiler efficiency*	1.0	75% E_t	3.40	80% E_t	3.40	80% E_t

Table C409.6.2.11(3)
TSPR Reference Building Design HVAC Simple Systems

Building Type **Parameter**	**Hotel (warm)**	**Hotel (cold)**	**Multifamily (warm)**	**Multifamily (cold)**
System type	*PTHP*	*PTAC*	*PTHP*	*PTAC*
Fan control	Constant Volume	Constant Volume	Constant Volume	Constant Volume
Main fan power (W/CFM (W·s/L))	0.300 (0.636)	0.300 (0.636)	0.300 (0.636)	0.300 (0.636)
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	<40°F (<4.4°C)	NA	<40°F (<4.4°C)	NA
Outdoor air economizer	No	No	No	No
Occupied OSA source	Packaged unit, occupied damper	Packaged unit, occupied damper	Packaged unit, occupied damper	Packaged unit, occupied damper
Energy recovery ventilator	No	No	No	No
DCV	No	No	No	No
Cooling source	DX, 1stage (heat pump)	DX, 1 stage	DX, 1 stage (heat pump)	DX, 1 stage
Cooling *COP* (net of fan)	3.10	3.20	3.10	3.20
Heating source	*PTHP*	(2) Hydronic *Boiler*	*PTHP*	(2) Hydronic *Boiler*
Heating *COP* (net of fan) / furnace or *boiler efficiency*	3.10	75% E_t	3.10	75% E_t
Heating *pump* power (W/gpm (W·s/L))	NA	19 (300)	NA	19 (300)
Heating coil heating water delta-T, °F (°C)	NA	50 (27.8)	NA	50 (27.8)
Design HWST, °F (°C)	NA	180 (82.2)	NA	180 (82.2)
HWST reset *set point* vs OAT, °F (°C)	NA	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)	NA	HWST/OAT: 180/150 20/50 (82-65.6/ -6.7-10)
Heat loop *pump*ing control	NA	2-way Valves & ride *pump* curve	NA	2-way Valves & ride *pump* curve

C409.7 Target Design HVAC Systems. Target system descriptions described in Tables C409.7(1) through C409.7(3) are provided as reference for Section C403.1.1 Exception 10. The target systems are used for developing MPF values and do not need to be programmed into TSPR software.

Table C409.7(1)
Target Building Design Criteria HVAC Complex Systems

Building Type Parameter	**Large Office (warm)**	**Large Office (cold)**	**School (warm)**	**School (cold)**
System Type	*VAV*/ RH	*VAV*/ RH	*VAV*/ RH	*VAV*/ RH
	Water-cooled Chiller/	Water-cooled Chiller/	Water-cooled Chiller/	Water-cooled Chiller/
	Electric Reheat (PIU)	Gas *Boiler*	Electric Reheat (PIU)	Gas *Boiler*
Fan control	VSD (No SP Reset)	VSD (No SP Reset)	VSD (No SP Reset)	VSD (No SP Reset)
Main fan power (W/CFM (W·s/L) Proposed ≥ MERV13	1.127 (2.388)	1.127 (2.388)	1.127 (2.388)	1.127 (2.388)
Zonal fan power (W/CFM (W·s/L))	0.35 (0.75)	NA	0.35 (0.75)	NA
Minimum zone airflow fraction	1.5* Voz	1.5* Voz	1.2* Voz	1.2 * Voz
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Outdoor air economizer	*Yes except 0-1*	Yes	*Yes except 0-1*	Yes
Occupied OSA (= proposed)	Sum(Voz)/0.75	Sum(Voz)/0.75	Sum(Voz)/0.65	Sum(Voz)/0.65
Energy recovery ventilator *efficiency* ERR	NA	NA	50%	50%
(Enthalpy Recovery Ratio)			No Bypass	60°F except 4A
ERV bypass SAT *set point*			_	_
DCV	Yes	Yes	Yes	Yes
% Area Variable Control	15%	15%	70%	70%
% Area On/Off Control	65%	65%	20%	20%
Cooling Source	(2) Water-cooled Centrif Chillers	(2) Water- cooled Centrif Chillers	(2) Water- Cooled Screw Chillers	(2) Water- Cooled Screw Chillers
Cooling *COP* (net of fan)	Path B for profile	Path B for profile	Path B for profile	Path B for profile
Heating source (reheat)	*Electric resistance*	Gas *Boiler*	*Electric resistance*	Gas *Boiler*
Furnace or *boiler efficiency*	1.0	90% Et	1.0	80% Et
Condenser heat rejection	Cooling Tower	Cooling Tower	Cooling Tower	Cooling Tower
Cooling tower *efficiency* (gpm/hp (L/s·*kW*))—See G3.1.3.11	40.2 (3.40)	40.2 (3.40)	40.2 (3.40)	40.2 (3.40)
Tower turndown (> 300 ton (1060 *kW*))	50%	50%	50%	50%
Pump (constant flow/variable flow)	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range	Constant Flow; 10°F (5.6°C) range
Tower approach	G3.1.3.11	G3.1.3.11	G3.1.3.11	G3.1.3.11
Cooling condenser *pump* power (W/gpm (W·s/L))	19 (300)	19 (300)	19 (300)	19 (300)
Cooling primary *pump* power (W/gpm (W·s/L))	9 (142)	9 (142)	9 (142)	9 (142)
Cooling secondary *pump* power (W/gpm (W·s/L))	13 (205)	13 (205)	13 (205)	13 (205)
Cooling coil chilled water delta-T, °F (°C)	18 (10)	18 (10)	18 (10)	18 (10)
Design chilled water supply temperature, °F (°C)	42 (5.56)	42 (5.56)	42 (5.56)	42 (5.56)
Chilled water supply temperature (CHWST)	CHWST/OAT:	CHWST/OAT:	CHWST/OAT:	CHWST/OAT:
reset *set point* vs OAT, °F (°C)	44-54/ 80-60	44-54/ 80-60 (6.7-12.2/ 26.7-15.6) (see Apx G)	44-54/ 80-60 (6.7-12.2/ 26.7-15.6) (see Apx G)	44-54/ 80-60 (6.7-12.2/ 26.7-15.6) (see Apx G)

-	(6.7-12.2/ 26.7-15.6) (see Apx G)	-	-	-
CHW cooling loop *pump*ing control	2-way Valves & pump VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD
Heating *pump* power (W/gpm (W·s/L))	16.1 (254)	16.1 (254)	19 (254)	19 (254)
Heating HW dT. °F (°C)	50 (27.78)	20 (11.11)	50 (27.78)	20 (11.11)
Design HWST. °F (°C)	180 (82)	140 (60)	180 (82)	140 (60)
HWST reset *set point* vs OAT, °F (°C)	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)
Heat loop *pumping* control	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD	2-way Valves & *pump* VSD

TABLE C409.7(2) Target Building Design Criteria HVAC Simple Systems

Building Type **Parameter**	**Medium Office (warm)**	**Medium Office (cold)**	**Small Office (warm)**	**Small Office (cold)**	**Retail (warm)**	**Retail (cold)**
System type	Package VAV - Electric Reheat	Package VAV - Hydronic Reheat	PSZ-HP	PSZ-AC	PSZ-HP	PSZ-AC
Fan control	VSD (No SP Reset)	VSD (No SP Reset)	Constant Volume	Constant Volume	2-speed	2-speed
Main fan power (W/CFM (W·s/L)) proposed ≥ MERV13	0.634 (1.343)	0.634 (1.343)	0.486 (1.03)	0.486 (1.03)	0.585 (1.245)	0.585 (1.245)
Zonal fan power (W/CFM (W·s/L))	0.35 (5.53)	NA	NA	NA	NA	NA
Minimum zone airflow fraction	1.5* Voz	1.5* Voz	NA	NA	NA	NA
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	NA	NA	<40°F (<4.4°C) OAT	NA	<40°F (<4.4°C) OAT	NA
Outdoor air economizer	Yes except 0-1	Yes	Yes except 0-1	Yes	Yes except 0-1	Yes
Occupied OSA source	Packaged unit, occupied damper, all building use types					
Energy recovery ventilator	No	No	No	No	Yes, in 0A, 1A, 2A, 3A	Yes all A, 6,7,8 CZ
ERR					50%	50%
DCV	Yes	Yes	No	No	Yes	Yes
% Area Variable Control	15%	15%			80%	80%
% Area On/Off Control	65%	65%			0%	0%
Cooling source	DX, multi-stage	DX, multi-stage	DX, 1 stage (heat pump)	DX, single stage	DX, 2 stage (heat pump)	DX, 2 stage
Cooling COP (net of fan)	3.83	3.83	3.82	3.8248	3.765	3.765
Heating source	Electric resistance	Gas Boiler	Heat Pump	Furnace	Heat Pump	Furnace
Heating COP (net of fan) / furnace or boiler efficiency	100%	81% E_t	3.81	81% E_t	3.536	81% E_t
Heating coil HW dT. °F (°C)	NA	20 (11.11)	NA	NA	NA	NA
Design HWST. °F (°C)	NA	140 (60)	NA	NA	NA	NA
HWST reset set point vs OAT, °F (°C)	NA	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)	NA	NA	NA	NA
Heat loop pumping control	NA	2-way Valves & ride pump curve	NA	NA	NA	NA
Heating pump power (W/gpm (W·s/L))	NA	16.1	NA	NA	NA	NA

TABLE C409.7(3) Target Building Design Criteria HVAC Simple Systems

Building Type / **Parameter**	**Hotel (warm)**	**Hotel (cold)**	**Multifamily (warm)**	**Multifamily (cold)**
System type	*PTHP*	*PTAC with Hydronic Boiler*	*Split HP*	*Split AC*
Fan control	Cycling	Cycling	Cycling	Cycling
Main fan power (W/CFM (W·s/L))	0.300 (0.638)	0.300 (0.638)	0.246 (0.523)	0.271 (0.576)
Heat/cool sizing factor	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	<40°F (<4.4°C)	NA	<40°F (<4.4°C)	NA
Outdoor air economizer	Only CZ 2, 3	No	No	No
Occupied OSA source	DOAS	DOAS	DOAS	DOAS except 3C
Energy recovery ventilator	NA	NA	Yes	Yes except 3C
DCV	Yes	Yes	No	No
% Area Variable Control	70%	70%		
% Area On/Off Control	0%	0%		
Cooling source	DX, 1stage (heat pump)	DX, 1 stage	DX, 1 stage (heat pump)	DX, 1 stage
Cooling *COP* (net of fan)	3.83	3.83	3.823	3.6504
Heating source	*Heat Pump*	(2) Hydronic *Boiler*	*Heat Pump*	Furnace
Heating *COP* (net of fan) / furnace or *boiler efficiency*	3.44	81% E_t	3.86	80% AFUE
Heating *pump* power (W/gpm (W·s/L))	NA	16.1	NA	NA
Heating coil heating water delta-T, °F (°C)	NA	20 (11.11)	NA	NA
Design HWST, °F (°C)	NA	140 (60)	NA	NA
HWST reset *set point* vs OAT, °F (°C)	NA	HWST/OAT: 180-150/ 20-50 (82-65.6/ -6.7-10)	NA	NA
Heat loop *pump*ing control	NA	2-way Valves & ride *pump* curve	NA	NA

Appendix CD
REQUIRED HVAC TSPR

CD 101 Required HVAC TSPR. For jurisdictions who wish to adopt a stretch code or HVAC incentive system, make the following changes to Section C403.

Replace Section C403.1 with the following:

C403.1 General. Mechanical systems and equipment serving the building heating, cooling, ventilating, or refrigerating needs shall comply with one of the following:

1. Sections C403.1.1 and C403.2 through C403.14 and also comply with Section C403.1.3
2. Data Centers shall comply with C403.1.1, C403.1.2 and C403.6 through C403.14

Replace Section C403.1.3 with the following.

C403.1.3 HVAC total system performance ratio (*HVAC TSPR*). For systems serving buildings or portions of buildings of the following types :

1. office (including medical office) (occupancy group B),
2. retail (occupancy group M), library (occupancy group A-3),
3. education (occupancy group E), and

4. hotel/motel occupancies (occupancy group R-1) and
5. the *dwelling units* and common areas within occupancy group R-2 multifamily buildings,

The *HVAC total system performance ratio* (*HVACTSPR*) of the *proposed design* HVAC systems shall be greater than or equal to the *HVACTSPR* of the *standard reference design* divided by the applicable mechanical performance factor (MPF) from Table C409.4 . *HVACTSPR* shall be calculated in accordance with Section C409 , Calculation of HVAC Total System Performance Ratio.

Exceptions to C403.1.3

1. Buildings with conditioned floor area less than 5,000 square feet.
2. Alterations to existing buildings that do not substantially replace the entire HVAC system and are not serving initial build-out construction
3. HVAC systems using district heating water, chilled water or steam.
4. Portions of buildings served by systems using:
   - 4.1. small duct high velocity air cooled, space constrained air cooled, single package vertical air conditioner, single package vertical heat pump, or
   - 4.2. double-duct air conditioner or double-duct heat pump as defined in subpart F to 10CFR part 431
   - 4.3. packaged terminal air conditioners and packaged terminal heat pumps that have cooling capacity greater than 12,000 Btu/hr (3500 kW)
   - 4.4. a common heating source serving both HVAC and service water heating equipment
   - 4.5. HVAC systems not included in Table C409.5.2.10.1
   - 4.6. HVAC systems included in table C409.5.2.10.1 with parameters in Table C409.5.2.10.2, not identified as applicable to that HVAC system type.
   - 4.7. Underfloor air distribution and displacement ventilation HVAC systems.
   - 4.8. Space conditioning systems that do not include mechanical cooling.
   - 4.9. HVAC systems that provide recovered heat for service water heating
   - 4.10. HVAC systems with chilled water supplied by absorption chillers, heat recovery chillers, water to water heat pumps, air to water heat pumps, or a combination of air and water cooled chillers on the same chilled water loop.
   - 4.11. HVAC system served by heating water plants that include air to water or water to water heat pumps.
   - 4.12. HVAC systems meeting or exceeding all the requirements of the applicable Target Design HVAC System described in Tables C409.5.4(1) through C409.5.4(3) ,
   - 4.13. HVAC systems serving laundry rooms, elevator rooms, mechanical rooms, electrical rooms, data centers, and computer rooms.
   - 4.14. Buildings or areas of medical office buildings that comply fully with ASHRAE Standard 170, including but not limited to surgical centers, or that are required by other applicable codes or standards to provide 24/7 air handling unit operation
   - 4.15. HVAC systems serving laboratories with fume hoods
   - 4.16. Locker rooms with more than 2 showers
   - 4.17. Natatoriums and rooms with saunas
   - 4.18. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h
   - 4.19. Cafeterias and dining rooms
   - 4.20. Areas of buildings with commercial refrigeration equipment exceeding 100 kW of power input.

Replace Table C409.4 with the following, this provides a 5% reduction in HVAC energy:

	Climate Zone:	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Building type	Ocp. Group																			
Office (small and medium)[a]	B	0.68	0.68	0.67	0.67	0.65	0.62	0.67	0.65	0.61	0.76	0.67	0.74	0.8	0.73	0.76	0.82	0.79	0.83	0.85
Office (Large)[a]	B	0.79	0.79	0.8	0.8	0.75	0.78	0.68	0.77	0.73	0.64	0.72	0.6	0.67	0.68	0.6	0.69	0.67	0.67	0.67
Retail	M	0.57	0.54	0.48	0.52	0.44	0.44	0.41	0.48	0.38	0.43	0.54	0.65	0.44	0.65	0.64	0.48	0.43	0.42	0.36
Hotel/Motel	R-1	0.59	0.59	0.6	0.6	0.59	0.65	0.58	0.67	0.69	0.43	0.56	0.49	0.36	0.45	0.48	0.33	0.36	0.29	0.25
Multi-Family/ Dormitory	R-2	0.61	0.6	0.64	0.6	0.62	0.61	0.56	0.68	0.52	0.5	0.48	0.42	0.51	0.45	0.36	0.52	0.48	0.48	0.45
School/ Education and Libraries	E (A-3)	0.78	0.77	0.76	0.75	0.71	0.68	0.67	0.68	0.64	0.69	0.68	0.65	0.78	0.69	0.58	0.85	0.76	0.79	0.73

a. large office (gross conditioned floor area >150,000 ft^2 (14,000 m^2) or > 5 floors); all other offices are small or medium

Reason: The prescriptive path is traditionally the most widely used approach for commercial code compliance in the United States. Though easy to implement, the prescriptive approach does not discriminate between high-performing and poorly performing heating, ventilation, air conditioning (HVAC) system configurations that are both minimally compliant. For example, a high capacity PTAC is less efficient than a packaged rooftop air conditioner, but either one can be used in the prescriptive path. The packaged rooftop unit is a better design choice, both for energy savings and reduced noise in the space. To meet aggressive energy and carbon reduction goals, energy codes will need to transition from prescriptive to performance-based approaches, a transition that has several challenges.
This proposal includes 3 features:

- An alternative path in Section C403 that can be used optionally for tradeoffs, such as a more efficient system that does not have outside air economizers. This performance path uses minimum efficiency HVAC equipment for all the target systems with a selection of a reasonable and typical system type and related fan and pumping parameters. In this case, mandatory requirements and certain prescriptive requirements are maintained, while most prescriptive requirements can be traded off for improved efficiency in other parts of the system.

- An addition to the energy credits section (C406) of the code that accounts for the total HVAC system performance, not just heating and cooling efficiency.

- An optional appendix that can be adopted for stretch codes and utility incentive certification that requires TSPR analysis where it is applicable and requires a higher level of performance, saving 5% vs. minimum efficiency systems.

HVAC System Performance is a discipline performance path and provides a simpler solution to HVAC system evaluation compared to whole building performance, while keeping tradeoffs limited to specific building systems. The Total System Performance Ratio (TSPR) is a metric for evaluation of overall system efficiency instead of individual component efficiency, a solution that could also eventually facilitate the transition to a 100% performance-based code structure. TSPR is a ratio that compares the annual heating and cooling load of a building to the annual energy consumed by the building's HVAC system.

A web-based calculation tool has been developed for determining a building's TSPR. Already incorporated into the 2018 Washington State Energy Code, this approach has also been evaluated by the ASHRAE Standard 90.1 Project Committee and has the potential to provide a comprehensive performance-based approach for HVAC system evaluation and analysis

For the stretch code option, implementing a base TSPR minimum requirement for HVAC systems in relevant buildings will result in savings when the least efficient systems allowed under the prescriptive path are required to make some change to improve efficiency in line with a reasonably good prescriptive system. Such changes might include efficiency improvements, better duct design that reduces fan power, or the inclusion of options like economizers, demand controlled ventilation, improvement in energy recovery effectiveness or addition of energy recovery that might be excepted for the particular situation. The HVAC System performance path looks at the performance of all the systems in the building, so smaller systems do not necessarily need to meet higher requirements.

Additional Commentary for Section 409.3

1. Examples of *HVAC systems* that are intended to receive HVAC services from *systems* in the permit include future zonal water source heat pumps that will receive loop water that is heated by a *boiler* or cooled by a cooling tower included in the permit, any *system* that will receive outdoor *ventilation* air from a dedicated *outdoor air system* included in the permit, and future zone terminal units that will be connected to a central *VAV system* included in the permit.

2. An initial build-out with heating coils served from a previously installed *system* with a high-*efficiency* condensing *boiler* would use the installed *efficiency* if it exceeded the current requirements. If the installed *boiler* had a lower *efficiency* than the current requirements, the current requirement would be used

3. A partial central plant upgrade (e.g. chiller, but not *boiler* replacement) cannot use this method

Coordination with Proposal CEPI-193-21

Proposal CEPI-193-21 includes the following coordinating language that adds the HVAC TSPR approach as an HVAC energy credit.

1. Section 406.2.2 numbered list items 1 and 7.

2. Section C406.2.2.1,

3. the base energy credits for H01 in Tables C406.1.4(1) through C406.1.4(9).

If this Proposal CEPI-76-21 is not approved for publication in the 2024 IECC then the coordinating language for energy credit H01 in CEPI-193-21 needs to be removed prior to publication.

Bibliography: Goel S., R Hart, M Tillou, M Rosenberg, J Gonzalez, K Devaprasad, and J Lerond. 2021.HVAC System Performance for Energy Codes. PNNL-31571. Richland, WA: Pacific Northwest National Laboratory.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
For the base proposal, there is no cost impact, as TSPR is an optional path that is not required under the prescriptive path.

For the energy credits addition, this is one of many options, and the energy credits show cost effectiveness through one cost effective path that may not include this option. Adding TSPR to energy credits just increases efficiency.

For the stretch code appendix, there may be a cost increase; however, this option is a jurisdictional adoption choice where the jurisdiction may choose to require improved efficiency performance as a matter of policy, rather than focusing on individual building cost savings, including consideration for environmental externalities and societal costs.

CEPI-77-21

IECC®: C403.10 (New), C403.10.1 (New), C403.10.2 (New)

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new text as follows:

C403.10 Buildings with High-Capacity Space-Heating Gas Boiler Systems. Gas hot-water boiler systems for space heating with system input capacity of at least 1,000,000 Btu/h but not more than 10,000,000 Btu/h in new buildings shall comply with Sections C403.10.1 and C403.10.2

Exceptions:

1. Where 25% of the annual space heating requirement is provided by on-site renewable energy, site-recovered energy, or heat recovery chillers.
2. Space heating boilers installed in individual dwelling units.
3. Where 50% or more of the design heating load is served using perimeter convective heating, radiant ceiling panels, or both.
4. Individual gas boilers with input capacity less than 300,000 Btu/h (87 kW) shall not be included in the calculations of the total system input or total system efficiency.

C403.10.1 Boiler Efficiency. Gas hot-water boilers shall have a minimum thermal efficiency (E_t) of 90% when rated in accordance with the test procedures in Table C403.3.2(6). Systems with multiple boilers are allowed to meet this requirement if the space heating input provided by equipment with thermal efficiency (E_t) above and below 90% provides an input capacity-weighted average thermal efficiency of at least 90%. For boilers rated only for combustion efficiency, the calculation for the input capacity-weighted average thermal efficiency shall use the combustion efficiency value.

C403.10.2 Hot-Water Distribution System Design. The hot-water distribution system shall be designed to meet all of the following:

1. Coils and other heat exchangers shall be selected so that at design conditions the hot water return temperature entering the boilers is 120°F or less.
2. Under all operating conditions, the water temperature entering the boiler is 120°F or less, or the flow rate of supply hot water that recirculates directly into the return system, such as by three-way valves or minimum flow bypass controls, shall be no greater than 20% of the design flow of the operating boilers.

Reason: This proposal adds an implementation of condensing boilers for new construction to achieve condensing-level efficiency (i.e., 90% Et) for large boiler systems (i.e., between 1 million and 10 million Btuh), where the proper design considerations are included so that the condensing boilers will operate properly. To ensure condensing occurs, requirements are added to ensure boiler entering water temperature is designed to be low, and able to be maintained low, by minimizing recirculation of hot-water supply into the return.
The introduction of these new requirements is important because boilers represent 40% of the heating in commercial buildings and are especially prevalent in cold climates and current levels specified in Table C403.3.2(6) are not enough to achieve condensing boiler level efficiency. A challenge for condensing boilers for hot-water heating is that they require system design changes and the use of higher delta entering and leaving temperature to maintain condensing operation to ensure they operate efficiently.

The proposed text seen here was approved for publication in 90.1-2019 as addendum bc to 90.1-2016. There is a slight modification to the charging language to clarify that the capacity threshold applies to individual systems and not the total boiler capacity for the building.

This addendum was closely reviewed by designers, manufacturers, and users. The boiler working group held meetings with all stakeholders to ensure that all concerns were addressed.

Bibliography: ANSI/ASHRAE/IES Standard 90.1-2019: Energy Standard for Buildings Except Low-Rise Residential Buildings

Cost Impact: The code change proposal will increase the cost of construction.
First cost was determined from the 2012 GSA Condensing Boiler Study, which estimates $38.50/MBtu for noncondensing and $42.60/MBtu for condensing boilers. In addition, the study estimates an additional average annual maintenance cost of $400 for condensing boilers. Energy savings were found using energy modeling simulations run using USDOE's EnergyPlus. Three prototype buildings were used—large office, hospital, and secondary school—in various U.S. climate zones.

Using the Standard 90.1 scalar ratio, the economic analysis shows an average scalar ratio of 4.2. The maximum scalar ratio is 17.2 for boilers with a life expectancy of 25 years, so this measure is highly cost-effective. Models and estimates show that all prototypes fall within the maximum scalar ratio and are cost-effective.

CEPI-78-21

IECC®: C403.12.1

Proponents:

Anthony Palucci, representing Annexair

2021 International Energy Conservation Code

Revise as follows:
C403.12.1 Duct, Air Handlers and plenum insulation and sealing.

Supply and return air ducts, ~~and~~ plenums, rooftop units and air handlers shall be insulated with not less than R-6 insulation where located in unconditioned spaces and where located outside the building with not less than R-8 insulation in *Climate Zones* 0 through 4 and not less than R-12 insulation in *Climate Zones* 5 through 8. Ducts located underground beneath buildings shall be insulated as required in this section or have an equivalent *thermal distribution efficiency*. Underground ducts utilizing the *thermal distribution efficiency* method shall be *listed* and *labeled* to indicate the *R*-value equivalency. Where located within a building envelope assembly, the duct, plenum, rooftop units and/or air handlers shall be separated from the building exterior or unconditioned or exempt spaces by not less than R-8 insulation in *Climate Zones* 0 through 4 and not less than R-12 insulation in *Climate Zones* 5 through 8.

Exceptions:

1. Where located within equipment.
2. Where the design temperature difference between the interior and exterior of the duct or plenum is not greater than 15°F (8°C).

Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with Section 603.9 of the International Mechanical Code.

Reason Statement:

There is no code requirement for outdoor HVAC equipment in terms of R-value, or insulation requirement. This change is designed to have the outdoor HVAC equipment match the same R-value as the ductwork it is served by. As outdoor HVAC equipment typically has larger surface area, typically designed around 500 FPM, then the duct it is served by, typically around 1200FPM, there is a great opportunity to save energy by improving the R-value of the HVAC equipment casing

Cost Impact:

The code change proposal will increase the cost of construction.

For many products there would be no change in cost, as R-13 is standard for many manufacturers of outdoor equipment. However, some manufacturer models types would require changes to meet this requirement with a potential increase in cost.

CEPI-78-21

CEPI-79-21

IECC®: TABLE C403.12.3

Proponents: Howard Ahern, representing Airex Manufacturing (howard.ahern@airexmfg.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.12.3 MINIMUM PIPE INSULATION THICKNESS (in inches or R Value)[a, c]

Portions of table not shown remain unchanged.

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY			NOMINAL PIPE OR TUBE SIZE (inches)				
	Conductivity Btu × in./(h × ft^2 × °F)[b]	Mean Rating Temperature, °F	Inches R Value	< 1	1 to < 1 $^1/_2$	1 $^1/_2$ to < 4	4 to < 8	> 8
> 350	0.32–0.34	250	Inches	4.5	5.0	5.0	5.0	5.0
			R Value	R32	R36	R34	R26	R21
251–350	0.29–0.32	200	Inches	3.0	4.0	4.5	4.5	4.5
			R Value	R20	R29	R32	R24	R20
201–250	0.27–0.30	150	Inches	2.5	2.5	2.5	3.0	3.0
			R Value	R17	R17	R17	R15	R13
141–200	0.25–0.29	125	Inches	1.5	1.5	2.0	2.0	2.0
			R Value	R9	R9	R11	R10	R9
105–140	0.21–0.28	100	Inches	1.0	1.0	1.5	1.5	1.5
			R Value	R5	R9	R8	R8	R7
40–60	0.21–0.27	75	Inches	0.5	0.5	1.0	1.0	1.0
			R Value	R2	R2	R5	R5	R4
< 40	0.20–0.26	50	Inches	0.5	1.0	1.0	1.0	1.5
			R Value	R 6	R9	R9	R8	R7

For SI: 1 inch = 25.4 mm, °C = [(°F) – 32]/1.8.

a. For piping smaller than 1 $^1/_2$ inches and located in partitions within conditioned spaces, reduction of these thicknesses by 1 inch shall be permitted (before thickness adjustment required in Note b) but not to a thickness less than 1 inch.

b. For insulation outside the stated conductivity range, the minimum thickness (T) shall be determined as follows:

$$T = r\,[(1 + t/r)^{K/k} - 1]$$

where:

T = Minimum insulation thickness.
r = Actual outside radius of pipe.
t = Insulation thickness listed in the table for applicable fluid temperature and pipe size.
K = Conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu × in/h × ft^2 × °F).
k = The upper value of the conductivity range listed in the table for the applicable fluid temperature.

c. For direct-buried heating and hot water system piping, reduction of these thicknesses by 1 $^1/_2$ inches (38 mm) shall be permitted (before thickness adjustment required in Note b but not to thicknesses less than 1 inch.

Reason: All materials having the same R-value, regardless of type; thickness; or weight, are equal in insulating strength. Where a specific R-value is required all insulation materials can be compared equally.
This proposal seeks to harmonize the selection of pipe insulation requirements by allowing either thickness or R Value. The Chart has been changed to set minimum R valves required as an option to pipe insulation thickness . Optional R Values allows for materials with the same or higher R Values but lower thickness. “Since 2010, there have been a number of new mechanical insulation products and systems developed in North America. Some are modifications to previously commercially available materials, and some are completely new. Additionally, ASTM has developed several new specifications and revised a number of others.”*

New materials for Pipe insulation are readily available and comply with the minimum R values required but can have lower thicknesses. This proposal offers the option of using either R values or pipe insulation thickness to achieve desired energy savings.

2021 IECC C102.1General
The provisions of this code are not intended to prevent the installation of any material or to prohibit any design or method of construction not specifically prescribed by this code, provided that any such alternative has been *approved*. The code official shall have the authority to approve an alternative material, design or method of construction upon the written application of the owner or the owner's authorized agent. The *code official* shall first find that the proposed design is satisfactory and complies with the intent of the provisions of this code, and that the material, method or work offered is, for the purpose intended, not less than the equivalent of that prescribed in this code in quality, strength, effectiveness, *fire resistance*, durability, energy conservation and safety.

The code does allow for alternative material in C102.1 however, this would prove to be impractical as the code official would not know the R Value required without having to Calculate each size of piping to find the Pipe Insulations R Value and again would restrict new material that have the same R value required but in a lower thickness.

C303.1.2 already requires Insulating materials shall be installed such that the manufacturer's *R*-value mark is readily observable upon inspection. This also would make it easier to inspect an R Value on the insulation then to view pipe insulation to determine its thickness.

Technical Report on Calculating Pipe Insulation R-Values

Using Dimensions and Thermal Conductivity Values

In the International Energy Code (IEC)

Written by Gordon H. Hart, P.E.

October 12, 2021

Technical Problem

: The International Energy Code (IEC) includes a Table C403.12.3 that specifies minimum pipe insulation thicknesses. These can be broken into rows for different pipe temperature ranges and columns for different pipe diameter ranges. For each pipe temperature range, there is an assumed range of thermal conductivity values from which the pipe insulation thickness is calculated.

There is an inverse relationship between thermal conductivity and R-value; hence, the greater the thermal conductivity, the lower the R-value and vice-versa. The higher thermal conductivity (i.e., value of k) will give the lower R-value for each range, when R-value is calculated. In the attached table, these lower R-values should be calculated using the standard equation that uses input of inner and outer pipe insulation radii and thermal conductivity of pipe insulation, namely:

First, since there is a range of values of k applicable to each temperature range, the higher value of k should be used to calculate the lower R-value. In addition, the inner and outer pipe insulation radii (radius is half the diameter) are not equal to nominal values. Rather, their exact radii values are different and should be taken from the ASTM standard C585. Making these modifications to the input to the above equation for R-value, we arrive at new, somewhat lower R-values for each temperature range and each pipe diameter range, as shown on the attached table (note that these only show the non-residential values):

	Nominal	Actual	Actual	Actual		R-value
105-140	Pipe Dia, NPS	r1 inside	r2 outside	th (inch)	k (max)	(min)
	< 1	0.72	1.72	1	0.28	5
	1 up to 1.5	0.72	2.22	1.5	0.28	9
	1.5 up to 4	1.015	2.515	1.5	0.28	8
	4 up to 8	2.35	3.99	1.64	0.28	8
	> 8	4.41	6.05	1.64	0.28	7
141-200	< 1	0.72	2.22	1.5	0.29	9
	1 up to 1.5	0.72	2.22	1.5	0.29	9
	1.5 up to 4	1.015	3.015	2	0.29	11
	4 up to 8	2.35	4.45	2.1	0.29	10
	> 8	4.41	6.59	2.18	0.29	9
201-250	< 1	0.72	3.31	2.59	0.3	17
	1 up to 1.5	0.72	3.31	2.59	0.3	17
	1.5 up to 4	1.015	3.81	2.795	0.3	17
	4 up to 8	2.35	5.375	3.025	0.3	15
	> 8	4.41	7.5	3.09	0.3	13
251-350	< 1	0.72	3.81	3.09	0.32	20
	1 up to 1.5	0.72	4.81	4.09	0.32	29
	1.5 up to 4	1.015	5.875	4.86	0.32	32
	4 up to 8	2.35	7	4.65	0.32	24
	> 8	4.41	9	4.59	0.32	20
>350	< 1	0.72	5.375	4.655	0.34	32
	1 up to 1.5	0.72	5.875	5.155	0.34	36
	1.5 up to 4	1.015	6.375	5.36	0.34	34
	4 up to 8	2.35	7.5	5.15	0.34	26
21	21	21	21	21	21	21

Temp Ran	Nominal	Actual	Actual	Actual		R-value
<40	Pipe Dia, NPS	r1 inside	r2 outside	th (inch)	k (max)	(min)
	< 1	0.72	1.72	1	0.26	6
	1 up to 1.5	0.72	2.22	1.5	0.26	10
	1.5 up to 4	1.015	2.515	1.5	0.26	9
	4 up to 8	2.35	3.99	1.64	0.26	8
	> 8	4.41	6.05	1.64	0.26	7
40-60	0.5 (non-res)	0.5	0.935	0.435	0.27	2
	1 up to 1.5 (non-res)	0.72	1.22	0.5	0.27	2
	1.5 up to 4	1.015	2.015	1	0.27	5
	4 up to 8	2.35	3.4	1.05	0.27	5
	> 8	4.41	5.5	1.09	0.27	4

Comments

: These minimum R-values, are calculated using the maximum values of k from the appropriate temperature range in the 2021 IECC Table C403.12.3. It's particularly interesting, however, to examine the smallest pipe in the

< 40° F temperature range since that previously required a minimum of .50-inch thickness, which results in a minimum R-value of 6.

Conclusions: The 2021 IECC Table C403.12.3 gives the minimum required thickness for pipe insulation used to insulate both cold and hot pipes. It is proposed that an alternative be to list the minimum required R-value for each pipe temperature range and each pipe size range, using calculated values of R-value. The new R-value calculations have used minimum values of thermal conductivity, k, and nominal dimensions of the pipe insulation. These calculations, as described above and as shown on the attached table, show the minimum R-values.

*Recent Developments in Mechanical Insulation Technolgy_Gordon H. Hart Insulation Outlook Magazine

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Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code proposal does not change the current requirement for pipe insulation thickness thus not increasing cost but allows an option to comply based on R Values or thickness. As new materials can be higher R values and have lower thickness this could decrease labor and materials used.

Attached Files

- **Recent Developments in Mechanical Insulation Technolgy_Gordon H. Hart.pdf**
  https://energy.cdpaccess.com/proposal/34/622/files/download/183/

insulation outlook

Recent Developments in Mechanical Insulation Technology

Gordon H. Hart

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Many engineers and specifiers of mechanical insulation (MI) may not be aware that there have been a large number of changes and developments in standards and products in the past 5 years. When issuing project specifications, it is recommended that specifiers know what these changes and developments are so they can revise their MI specifications accordingly. Failure to do so can result in missed opportunities for improved MI performance, specifying obsolete materials or systems, or citing obsolete industry standards. These recent developments can apply to mechanical insulation, jacket, or accessory materials, to MI systems, to MI standards, and design tools. This article will attempt to capture those changes and developments.

Objectives for Using Mechanical Insulation

First, it is useful to review the objectives for using MI, and then also review other goals. The new products and systems must each meet 1 of the objectives, or help the MI system meet at least 1 objective. These objectives are as follows:

- **Reduction in Energy Use**By limiting the heat flow to or from a pipe, a duct, or an equipment piece, MI reduces energy use at the source (i.e., boiler, furnace, chiller, etc.). It can also reduce overall energy costs.
- **Process Control**By limiting heat flow to or from a surface, MI allows the designer to limit the rate of heat flow to a known value and thereby control the temperature and pressure of the process fluid (either a liquid or gas). This is often critical to proper functioning of the process.
- **Environmental Controls**Increasingly, designers are trying to achieve certain reductions in greenhouse gas (GHG) emissions. This usually follows the reduction in energy use, but it is not necessary equivalent. With concern over climate change, reduction in GHG emissions is increasingly the primary reason for adding MI.
- **Condensation Control**For below-ambient fluids, condensation control is normally at least 1 of the sought objectives for adding MI. Continuous condensation can, in some instances, be a greater concern than either of the 3 previously mentioned objectives for using MI due to its potential to cause severe damage.
- **Personnel Protection**This objective normally refers to designing the insulation system to keep surfaces below a particular temperature so they will not burn a person who comes into physical contact with a surface (usually, but not always, 140°F). In some cases, personnel protection is the major reason for adding MI.
- **Acoustical Performance**Separate from thermal performance, MI can also improve acoustical performance due to its propensity to absorb sound. Noise typically originates from mechanical equipment such as fans, pumps, or compressors. With a good acoustical design, an MI system can reduce that sound below a particular design level.
- **Freeze Protection**There are instances where MI is required to prevent liquids within pipes from freezing due to the ambient temperature dropping below 32°F. In some applications, freeze protection is a more important objective than reduction in energy use or process control.

Other Goals for Mechanical Insulation

Following are some other goals for MI that can be important in material or system selection.

- **Meet Building Codes**

When MI is installed inside occupied buildings, it usually is required to meet the local building code limiting flame spread and smoke-developed indices. Those codes are usually for either 25/450, in non-return air plenum spaces, or 25/50, for return air plenum spaces, per ASTM Test Method E-84.

- **Reduce Installed Cost**

The installed cost is a sum of the material cost, cost of labor to install, contractor overhead, and ancillary costs. Materials can have different costs and some materials can be installed more quickly than others, even when using trained, skilled, and experienced craft labor (which should be the case on all projects). While everyone likes to purchase an MI system with the lowest installed cost, caution should be exercised in not simply "value engineering" the MI system, which may lower costs, but will ultimately lead to the MI not performing adequately over the system's expected life.

- **Control Schedule of MI Installation**

For the general contractor (GC) and, in buildings, for the mechanical contractor, it is critical to control the building schedule. Of course, this impacts the overall cost, but it can also impact the building schedule. Therefore, in cases where the contractors have high confidence in a particular MI system's speed of installation, they may request that the insulation specifier specify that particular system.

- **Minimize CUI and Other Corrosion**

On all MI systems exposed to the ambient, and on MI systems installed on below-ambient surfaces and located in unconditioned spaces, (which could be outdoors or indoors), corrosion under insulation (CUI) can be a major concern of the specifier. The specifier may in some cases be inclined to specify jacketing materials that seal tightly and are water resistant; in other cases he or she may specify non-water absorbing or hydrophobic insulation materials. He or she may also specify MI materials that have a chloride content below some particular value, or which meets one of the thresholds in ASTM C1617. Regardless, the specifier's goal of minimizing CUI can influence his or her selection of MI materials.

- **Aesthetics**While MI is often located inside buildings where it is out of sight, it may sometimes be visible to people in occupied areas or even those passing by a facility outdoors. When this is the case, the specifier may specify jacketing materials of a particular luster, color, or surface finish.
- **Durability and Longevity**Everyone wants their MI system to last forever. While every system has a shelf life, durability and longevity can be engineered into the MI system. For example, thicker aluminum jacketing is going to last longer than thinner aluminum jacketing. Likewise, stainless-steel jacketing will probably last longer than aluminum jacketing. The selection and specification of the materials will impact the overall MI system installed cost. However, an MI system with the highest installed cost may be more durable and hence could have the lowest life-cycle cost over some particular number of years, thus making it the preferred system.
- **Minimize Impact on Other Trades during Installati**onDuring construction of either a commercial building or industrial facility, there are many different trades present. The GC must work with specialty contractors, including the MI contractor, to schedule and coordinate the work so one trade does not negatively impact another. Sometimes this is simply a matter of scheduling the different trades so they are not in each other's way. However, the GC may also require the specifier to specify low thermal conductivity MI materials that allow for greater clearance around, or between, the insulated pipes, ducts, or pieces of equipment.
- **Health and Safety**While all MI materials generally meet health and safety requirements, some specifiers may decide to limit both off-gassing and emissions of thermal decomposition gasses. They may choose materials that are formaldehyde-free or have low VOCs. The GC may also require the specifier to specify low-dust emitting insulation materials if he or she has concerns about the dust negatively impacting other trades—even if the insulators are wearing protective respiratory gear.
- **Recycled Content**There are many building projects today where the designers are trying to achieve a particular level of recycled content.

When that is the case, they will oftentimes specify MI materials with a known percent recycled content (the greater, the better). As long as this does not negatively impact the MI materials' performance or any of the other issues mentioned above, recycled content may be the deciding factor in the selection of a particular material.

New and Revised Standards, Practices, Guides, and Reports

ASTM Revisions

- **Revisions to ASTM C552, Specification for Cellular Glass Pipe and Block Insulation**While ASTM has had a specification for cellular glass pipe and block insulation (C552), it recently made some significant revisions to include new densities of material (differentiated from one another by thermal conductivity and compressive resistance) for both block and pipe configurations. These revisions are contained in C552-15.
- **Revisions to C1126, Specification for Phenolic Insulation**While this document has been available from ASTM for several years, ASTM Committee C16 (C16) recently revised it to include additional densities of material listed as types and grades (and differentiated from one another by thermal conductivity values). It also updated thermal conductivity values to account for new blowing agents. Specifiers should be certain to specify the most recent version: C1126-14.
- **Revisions to C1685, Specification for Pneumatically Applied High-Temperature Fiber Thermal Insulation for Idustrial Applications**Several years ago, C16 developed a new standard, C1685. The fibers from which these materials are made are inorganic and primarily silicates, made from alumna, calcium, and magnesium. The insulation covered by this specification is pneumatically applied using a wet, inorganic binder that subsequently dries after application. This specification includes insulation materials for use up to 3000°F, broken into 3 Types. These can be used at continuous temperatures up to 2000°F (1093°C), 2300°F (1260°C), and 3000°F (1649°C) for Types 1, 2, and 3, respectively. Earlier this year, C16 revised this specification to include acoustical performance and a new type of high-density material, differentiated from the other type by thermal conductivity

and compressive resistance (called "crush strength" for this high-density material).

- **New Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service: ASTM C1695-10**Several years ago, C16 finalized development of a new specification: C1695, Standard Specification for Fabrication of Flexible Removable and Reusable Blanket Insulation for Hot Service. While removable/reusable insulation blankets have been fabricated and installed at industrial facilities for at least 5 decades, this is the first such ASTM specification. It can be referenced by design engineers instead of following the pattern of writing detailed specifications of their own. The insulation blankets covered by this specification may be either shop or on-site fabricated and can be used on hot surfaces up to 1000°F (538°C). There are separate requirements for outdoor and indoor applications.
- **Revisions to ASTM C1696, Guide for Industrial Thermal Insulation Systems**After more than 10 years of development, C16 developed the first version of C1696. While only a guide, this is a complex document, since it includes so many different MI materials. The most recent version is C1696-14ae1.
- **New Specification for Flexible Aerogel Insulation: ASTM C1728**Several years ago, C16 completed development of a new specification, C1728-12, Standard Specification for Flexible Aerogel Insulation (it was subsequently revised in 2013). While this type of insulation was first commercialized a decade ago, there have been changes to the commercially available products. This specification includes insulation materials that can be used in the range of continuous exposure operating temperatures from -321°F (-196°C) up to 1200°F (649°C). These are categorized as 3 different types by maximum-use temperature as Type I: 257°F (125°C); Type II: 390°F (200°C); and Type III: 1200° F (649°C). Type III is only offered by 1 manufacturer, who had made this product by adding an opacifier (i.e., infra-red absorbing material) consisting of titanium oxide particulate. While the product containing titanium oxide is still commercially available, the manufacturer also recently started offering the product with an iron-oxide particulate as the opacifier in place of the titanium dioxide. This type of product, while being flexible, also has the advantage of having very low thermal conductivity values, lower than most other commercially available products.

- **New Specification for Aluminum Jacketing for Use over Thermal Insulation: ASTM C1729**While aluminum jacketing has been used for decades over mechanical insulation, there has not been an ASTM specification for the material. C16 developed this new specification, which provides minimum acceptable performance as well as classification of different types and grades. It has been revised several times, so specifiers should be certain to reference C1729-14a.
- **New Test Method for Water Absorption by Immersion of Thermal Insulation Materials: ASTM C1763**C16 developed this new test method in order to have a single test method that can be referenced by different insulation material standards. It will probably take a few years for different material standards to be revised to reference this new C1763-15 test method.
- **New Specification for Stainless Steel Jacketing for use over Thermal Insulation: ASTM C1767**As with aluminum jacketing, there has not been an ASTM specification for stainless-steel jacketing. Over the past couple of years, the original C1767 has been revised, so be certain to specify the most recent, C1767-14a.
- **New Specification for Laminate Protective Jacket: ASTM C1775** To address increasing use of this type of jacket on outdoor insulated ducts and even pipes, C16 developed a new specification, C1775-14. It includes 3 types of material, depending on strength, and 3 grades of material, depending on surface emittance. There are also 3 classes, depending on the composition of the outer surface (i.e., aluminum foil, polymer film, or polymer coating).
- **New Test Method for Concentration of Pinhole Detections in Moisture Barriers on Metal Jacketing: ASTM** C1789C16 developed this new test method, C1789-14, to address the need to test for pinholes in moisture barriers on aluminum and stainless-steel jacketing.
- **New Mounting Procedure for Testing Vapor Retarder Joints: ASTM C1809**To address the demand for testing sheet and film-type vapor retarder joints for water-vapor permeance, C16 developed a new mounting procedure, C1809-15, using ASTM Test Method E96. Use of this mounting procedure allows for determining any water vapor leakage that might occur on taped joints.

ASHRAE and Other Industry Standards

- **The American Petroleum Institute's (API's) RP583**In 2014, API released a new recommended practice for minimizing CUI, known as RP583 and titled Corrosion Under Insulation and Fireproofing. It is described by API as follows: "This recommended practice (RP) covers the design, maintenance, inspection, and mitigation practices to address external corrosion under insulation (CUI) and corrosion under fireproofing (CUF). The document discusses the external corrosion of carbon and low alloy steels under insulation and fireproofing and the external chloride stress corrosion cracking (ECSCC) of austenitic and duplex stainless steels under insulation. The document does not cover atmospheric corrosion or corrosion at uninsulated pipe supports but does discuss corrosion at insulated pipe supports." It can be purchased from API's website at *http://tinyurl.com/qyn6m2p.*
- **2013 ASHRAE Handbook—Fundamentals, Chapter 23 Revisions**In 2013, ASHRAE made a number of updates to Chapter 23 of ASHRAE Handbook–Fundamentals, including revisions regarding the use of MI on HVAC applications. These revisions include updated ASTM references as well as advice on where best to use certain MI materials and, in some cases, where to exercise caution using certain materials. Rather than list all the additions and changes, the specifier is advised to reference the 2013 version of Chapter 23 rather than the one from the 2009 or 2005 books.
- **2014 ASHRAE Handbook—Refrigeration, Chapter 10 Revisions**In the 2014 edition, Chapter 10 of the ASHRAE Handbook—Refrigeration was revised to provide better guidance on designing MI systems for refrigeration pipes. This includes guidance on avoiding moisture condensation and moisture penetration of the insulation system.
- **IIAR 2014 Ammonia Refrigeration Piping Handbook, Chapter 7 Revisions**In 2014, the International Institute of Ammonia Refrigeration (IIAR) released the updated version of the Ammonia Refrigeration Piping Handbook. Chapter 7 of this version includes updated advice on MI for refrigerant pipe.
- **Revisions to the National Commercial & Industrial Insulation Standards, 7th Edition (MICA Manual)** *The National Commercial & Industrial Insulation Standards*, 7th Edition, more commonly known as the MICA Manual, had a number of new plates added in this updated edition. It was released in 2012 by the Midwest Insulation Contractors Association (MICA). This edition contains numerous drawings, or "plates," as they are termed in the text, which can be copied and pasted into a specification. This edition contains a new

format and, more importantly, additional plates. For example, there are now several plates showing how to specify a vapor stop in below-ambient pipe insulation systems to prevent moisture intrusion longitudinally, in the direction of the pipe axis, should the vapor retarder become breached in one section of pipe insulation. This document may be purchased, as either a hardcopy or electronic from MICA's website at www.micainsulation.org. MICA is also working on their new 8th Edition which should be released soon.

- **Revised NACE Standard Practice SP0198–Control of Corrosion Under Thermal Insulation and Fireproofing Materials–A Systems Approach**CUI is an age-old problem, probably as old as insulated iron pipes. To provide guidance on how to minimize the occurrences of CUI, NACE International wrote and approved Standard Practice SP0198 in 1998. In 2010, NACE updated SP0198 to provide knowledge gained since the original publication; this updated version is referred to as SP0198-2010. This document provides valuable guidance to the specifier as well as to the facility owner/operator and is available for purchase from NACE at *http://tinyurl.com/prwcjly*.

ASHRAE Research Projects

- **ASHRAE Research Project (RP)-1550: ASHRAE Testing of Thermal Insulating Coatings**Thermal insulating coatings (TICs) have been commercially available for a couple of decades. Most consist of paint with ceramic beads added and some have aerogel beads added. After it is spray painted on surfaces, usually in several layers, and allowed to dry and cure, TICs can provide some degree of insulating value. With different manufacturers, there have been different claims about both their thermal effectiveness and their effectiveness at preventing corrosion of the steel surfaces to which they are applied. To address questions about the thermal performance, ASHRAE, through their Technical Committee 1.8—Mechanical Systems Insulation, sponsored a research project in which the contracting laboratory, R&D Services, Inc., tested 3 different commercially available TIC products. The technical report, RP-1550, can be purchased for $30 as a PDF file from the ASHRAE bookstore at www.ashrae.org.

While some thermal resistance was measured, on pipe temperatures up to about 350°F (177°C) using several layers of TIC, none resulted in a heat-loss reduction—compared to the previously bare test pipe—of more than 60% (for comparison, only 1 inch of standard fiberglass pipe insulation will reduce heat loss by about 88% from the same temperature pipe). The TICs were found to have very low thermal-diffusivity values, which give the materials the ability to be effectively used for personnel protection up to their maximum use temperature. However, if heat-loss reduction with large energy savings—comparable to that provided by several inches of conventional MI—is required, it is generally best to use a conventional material rather than TICs. The effectiveness of TICs for corrosion protection was not evaluated as part of ASHRAE RP-1550.

- **ASHRAE RP-1356: ASHRAE Thermal Performance Tests of Chilled-Water Pipe Insulation with Water Absorption**In 2013, ASHRAE issued a report on RP-1356, which developed a new test apparatus and method for testing the thermal performance of chilled-water pipe insulation. The report provides previously unavailable test data on thermal conductivity as a function of water content of the pipe insulation. This report may be purchased from the ASHRAE online bookstore.
- ASHRAE RP-1646: Measurements of Thermal Conductivity of Pipe Insulation Systems at Below-Ambient Temperature and in Wet Condensing Conditions with Moisture Ingress This research project was performed as a follow-up to RP-1356 and has now been completed. The final report has been approved by the Technical Committee 1.8. The test report is now available for purchase from the ASHRAE bookstore and gives the results of testing 6 different chilled-water pipe insulation systems on a cold pipe in a controlled, hot and humid environment over a time span of 2 months. RP-1356 and RP-1646 are the first known test reports of this type.

New Product Developments in the Past Five Years*

*List reflects new products that the author is aware of and may not contain all new product developments within the past 5 years.

- **Aluminum and Stainless-Steel Jacketing with PVdF Film Protection on the Outer Jacketing Surface**Polyvinylidene fluoride (PVdF) coatings and films provide much greater exterior chemical

resistance to metal jacketing. Also, with a high emittance (greater than that
of aluminum or stainless steel), they allow for lower insulation thicknesses when used on below-ambient pipe when surface condensation minimization is a design objective.

- **American-Made Layered Glass-Fiber Felt Pipe and Board Insulation**While previously only made in South Korea, this pipe and board insulation is now fabricated in the United States. This insulation is made from needled glass-fiber felt mat insulation that is spiral wrapped around mandrills, of particular diameters, with a water-based inorganic binder applied to the mat surfaces, including the final outer surface; it is then oven-dried to make it rigid. The pipe insulation is made to ASTM C585 dimensions. It is also made into large boards with particular radii of curvature so as to fit around cylindrical tanks. The final product has fairly low thermal conductivity values, is rigid but not brittle, and has a fairly high compressive resistance. C16 is in the process of writing a specification for this new material.
- **Fiber-Glass Insulation with Bio-Based, Formaldehyde-Free Binder System**While phenolic resin binders have been used for years in fiber glass and mineral wool insulation materials, there has been an increasing demand for formaldehyde-free binders, and even those made from non-petroleum products. While commercially available on various fiber-glass MI products, this change does not affect thermal performance in the many ASTM specifications such as C547 (for pipe), C612 (for board), or C553 (for blankets).
- **Fiber Glass Made with More Than 60% Recycled Content**Due to an increasing demand for recycled content, fiber-glass MI products made from more than 60% recycled glass are now commercially available.
- **Fiber-Glass Pipe Insulation with an ASTM C1775, Type 2 Factory-Applied Jacket**For use outdoors without the need for adding a separate protective jacket, specifiers can now specify fiber-glass pipe insulation with factory-applied laminate protective jacket that meets C1775, Type 2. This jacket can be used on both below- and above-ambient pipes and ducts.
- **Flexible Elastomeric Insulation Made with EPDM Rubber**Ethylene propylene diene monomer (EPDM) rubber has lower thermal conductivity values and greater UV resistance than standard flexible elastomeric insulation. While it has similar mechanical properties such as flexibility and resilience, its superior thermal performance

and UV resistance makes this material worth specifying for particular applications.

- **Flexible Elastomeric Insulation with Overlap Seals on Longitudinal Joints and Butt-Joint Seals with Pressure-Sensitive Adhesives**To allow for better water-vapor sealing and faster installation, flexible elastomeric pipe insulation is now available with overlap seals and butt-joint seals using a pressure-sensitive adhesive. Such seals allow insulators to install the product more quickly, thereby increasing their productivity, and to do so without concern for emission of volatile organic compounds (VOCs). VOCs can be a safety concern both due to flammability and adverse effect on laborers working in the area.
- **Microporous Insulation Available with a 5-mm Thickness**Microporous insulation that meets the requirements of ASTM C1676-14 is now commercially available with a 5-mm thickness. This material is meant to allow for greater flexibility and thus ease of installation on pipe, and it enables its use on small-bore pipe. This makes it more suitable for a variety of industrial applications. Previously, the minimum thickness was 10mm, resulting in a less flexible sheet material.
- **PVC Fitting Covers with Foam Rubber Seals**To reduce field insulator labor when installing fiber glass with all-service jacket (ASJ) systems that typically use polyvinyl chloride (PVC) covers on the fittings, a company has developed PVC fitting covers with foam rubber seals. This product eliminates the need for the application of mastics over the ASJ-PVC joints, a labor-intensive process that has been the standard for many decades. These joints have been tested for water-vapor permeance, per ASTM E96 and C1809, and found to result in about a 25% increase in water-vapor intrusion. This is worth accounting for in a design, but it is not so great as to rule out their use. At this time, to the best of the author's knowledge, there are not any comparable tests on ASJ-PVC or PVC-PVC joints with vapor retarder mastic, which may, when tested, prove to result in a greater than 25% water vapor intrusion.
- **Rubber Jacketing**The particular new product is a flexible polymeric jacketing system. The system is manufactured from chlorosulphonated polyethylene (CSPE) which is resistant to UV, weathering, salt spray, chemicals, and ozone. This product is being specified for off-shore oil platforms and for outdoor insulated pipes on ships, all of which are exposed to weather and ocean salt spray.

- **Two-Piece Aluminum Jackets for Fittings and with Polyfilm Moisture Barriers**These fittings meet the same performance requirements of ASTM C1729-14a for roll material. Their commercial availability allows for a more consistent metal jacket system.
- **UV-Cured, Fiber-Glass Reinforced Plastic (FRP) Jacketing**This new jacket product can be installed over pipe or equipment insulation in a flexible, uncured form, then exposed to sunlight or some artificial source of UV light, which cures the material into a hard, durable, chemically resistant jacket. C16 is currently working on writing a specification for this new jacket product.
- **Water-Resistant ASJ**While ASJ with exposed white Kraft paper on its outer surface has been the standard, there has been an increasing demand for a water-resistant ASJ. Water-resistant ASJ has a fourth layer consisting of a clear plastic film outer layer, which sheds water and thereby protects the Kraft paper from water exposure. To date, no change has been made to specification ASTM C1136 (i.e., the specification for vapor retarders) to account for this new ASJ.

New or Updated Software Design Guides

NIA Resources

- **Mechanical Insulation Education & Awareness E-Learning Series**This free online training course teaches experts and novices about the benefits of MI as well as Design Objectives and Considerations, and Maintenance. NIA has also created tests so that companies can easily incorporate this course into their existing training or educational programs. The course is available at *www.wbdg.org/education/nia01.php*.
- **Mechanical Insulation Design Guide**The Mechanical Insulation Design Guide (MIDG) is part of the Cloud-based Whole Building Design Guide (WBDG). The MIDG is another design tool available at no charge that helps the designer better understand how to design mechanical insulation systems. It can be accessed at *www.wbdg.org/design/midg.php*. The MIDG has several sections. The first is on the Design Objectives, and this section includes calculators for estimating condensation control insulation thicknesses on below-ambient systems, energy savings, financial savings, time for water in an insulated pipe to freeze, personnel protection, insulation thickness, and temperature drops for both air-

handling ducts and hydronic piping. There are also sections on Materials and Systems, Installation, Design Data, Specifications, E-learning Modules, Resources, Case Studies, and a Glossary. Web-based and free to use, the MIDG helps assure that designs are performed by well-informed engineers.

Other Software Programs

- **New Computer Program for Performing Hygroscopic Analyses of Insulated Pipe and Equipment**This software was developed a few years ago by a German company for the modeling of simultaneous heat and moisture transfer in building walls and ceilings.
  The purpose of developing this software was to address moisture problems prevalent in building envelopes that can lead to mold growth and structural wood member deterioration. While developed as either a 1- or 2-dimensional program, this software can be a valuable tool to model below-ambient pipe insulation, such as that on refrigerant piping. Since all refrigerant pipe insulation, including that on cryogenic service, must eventually become full of water or ice (unless it is located in Antarctica or the North Pole), the question invariably becomes, "How long will a particular insulation system last?" Assuming a quality specification, quality workmanship, and knowledge of insulation material and vapor-retarder material properties, one can model a refrigerant pipe in a given geographic location for many years. If the user defines a maximum amount of moisture intrusion into the insulation material that is deemed acceptable (e.g., 50% by weight), then he or she can calculate how long it will take for that intrusion to happen. Thus, the user can predict the expected life of the insulation system. If the user arrives at an unacceptable answer, he or she can select a different insulation material, with a lower water-vapor permeability, and/or a different sheet-type vapor retarder with a lower water-vapor permeance, then re-run the program for that geographic location. Of course, if the user changes the geographic location (i.e., he or she uses weather data for Boston, Massachusetts instead of weather data for Houston, Texas), he or she could find a significantly different life expectancy for a given pipe operating temperature and a given pipe insulation system. This software is call WUFI and is available at *www.wufi.de/en/* for purchase.

Conclusions and Summary

Since 2010, there have been a number of new mechanical insulation products and systems developed in North America. Some are modifications to previously commercially available materials, and some are completely new. Additionally, ASTM has developed several new standards and revised a number of others. It is recommended that these be referenced in all project specifications rather than the older versions. Mechanical insulation guides have also been developed or revised, including the MIDG, certain ASHRAE handbook chapters, the MICA Manual, and the IIAR *Ammonia Refrigeration Piping Handbook* chapter on Refrigerant Piping; these guides can be valuable for the mechanical insulation specifier.

NACE International has also revised its standard practice on corrosion under insulation and API has written a new recommended practice; these documents can also be valuable for the mechanical insulation specifier concerned with reducing incidents of CUI on his or her projects. In summary, a specifier of mechanical insulation systems has numerous new products, systems, specifications, test methods, test reports, guides, and practices at his or her disposal. Ignoring these new developments and failing to take note of advances in mechanical insulation technology puts the quality of his or her work—and thus his or her employer and clients at risk. Using the aforementioned resources and staying abreast of new developments and updates is the best way to ensure the integrity of all projects and systems.

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CEPI-80-21

IECC®: C403.12.3.1

Proponents:

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2021 International Energy Conservation Code

Revise as follows:
C403.12.3.1 Protection of piping insulation.
Piping insulation exposed to the weather shall be protected from damage, including that caused by sunlight, moisture, equipment maintenance and wind. Protection ~~, and~~ shall provide shielding from solar radiation that can cause degradation of the material and shall be removable for the first 6 feet (4876 mm) from the equipment for maintenance. Adhesive tape shall not be permitted.

Reason Statement:

Purpose of code change: This proposal will clarify the intent of Section C403.12.3. The intent of these sections is not only protection of pipe insulation from weather but to insure the insulations thermal conductivity energy savings integrity lasts the life of the mechanical system asper the intent of the code. To remove the opportunity for misunderstanding so that the code has will have its intended result, the term “equipment maintenance” must be clarified that it is for physical damage.

The 2012,2015, & 2018 IECC Code and Commentary both state that Equipment maintenance is to protect from physical damage to the pipe insulation.
“The piping insulation should be protected from sunlight, moisture, wind and solar radiation but also from personal who may step on it, run in to it with equipment, etc. and cause it to be damaged.
“Protective covering must also protect from physical damage so if the protection covering does get damaged from stepping on it, dropping tools on it, birds, lawn trimmers etc.it can be repaired or replaced.
Keeping the insulations thermal conductivity integrity and insuring the insulation system last the life of the mechanical system and avoiding the costly replacement of the insulation. Repairing pipe insulation is done with adhesives and then adhesive seams are left to weather exposure leading to degradation. The seams open sun and moisture damage the insulation system. Removable protection is vital to ensure insulation can retard heat and condensation to provide energy savings and safety.

Pipe insulation is sold in minimum 6 foot sections at Contractor supply Distributors

The proposal states that protection be removable no less than 6 feet from the equipment to allow equipment maintenance without having to destroy the insulation or purchase additional pipe insulation to replace. The intent is in the original 2012 IECC code proposal, the proponent’s reason statement of this requirement EC207-09/10 stated this was to Harmonize the IECC with ASHRAE 90.1 the 2012 code the reason statement also stated -“All AC units require periodic maintenance. The frequency varies with how hard the unit operates, exterior temperature, preventive maintenance program, and many others. On every occasion, every maintenance provides an excuse for the Freon line insulation to be touched and removed.” The intent is clear that the protection be removable and independent of the pipe insulation for maintenance without damaging the pipe insulation. Removing protection without damaging the insulation is stated in EC207-09/10 “Adhesives Tape is not permitted as it will limit maintenance and damage insulations permeability characteristics. Removal of tape damages the integrity of the original insulation into pieces, specially, if the insulation has reached thermo set state. The main reason for pitting and corrosion of the piping in refrigerant lines is moisture intrusion into the pipe insulation from the termination point that are not protected. The gap between the piping and insulation creates a pathway for moisture to run the length and damage the system. It only takes a 1% moisture gain to equal to a 7.5 % loss in thermal efficiency. “The most likely area of intrusion is at the insulation system penetration Points, gauges, attachments etc. If the integrity or exterior of the insulation system is not installed correctly and moisture sources are present, moisture will more than likely penetrate the insulation system. Moisture intrusion can negatively affect all aspects of the insulation system such as thermal values, which can have a direct impact on process control, energy cost, condensation, control, safety, the potential of mold development etc. Not to mention the potential of corrosion under the insulation (CUI).” Insulation, the Forgotten Technology for Energy Conservation 2007 ACEE

Bibliography:

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Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This change will not increase the cost of construction as removable protection has been used before and snice the IECC2012 when protection was required. In fact this will decrease the cost of construction on future equipment replacement and maintenance by nit having to replace pipe insulation.

CEPI-80-21

CEPI-81-21

IECC®: C403.12.4 (New)

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Add new text as follows:
C403.12.4 Equipment curbs and supports shall not act as a plenum.

Exceptions:

1. When the curb plenum is for return air only

2. The curb plenum may be leak tested in accordance with the SMACNA HVAC Air Duct Leakage Test Manual and shown to have a rate of air leakage (CL) less than or equal to 4.0 as determined in accordance with Equation 4-8.

$CL=F/P^{0.65}$
(Equation 4-8)

where:

F = The measured leakage rate in cfm per 100 square feet ($9.3m^2$) of duct surface

P = The static pressure of the test

Documentation shall be furnished demonstrating that representative sections totaling not less than 25 percent of the duct area have been tested and that all tested sections comply with the requirements of this section.

Reason Statement:

Plenum curbs leak a lot of air. When a plenum curb is used for supply airflow there is typically a decent amount of duct static pressure meaning air is more likely to leak out of the plenum curb. Plenum curbs can still be used, but only if a leakage test is performed.

Cost Impact:

The code change proposal will increase the cost of construction.

Duct configurations may require cost impact solutions. If a supply plenum curb is used, a leakage test would add cost as well.

CEPI-81-21

CEPI-82-21 Part I

IECC®: C403.13.2, C403.13.3 (New), C403.13.3

Proponents:

Nick Thompson, City of Aspen, representing Colorado Chapter of the ICC (nick.thompson@cityofaspen.com)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

C403.13.2 Snow- and ice-melt system controls.
Snow- and ice-melting systems shall include automatic controls configured to shut off the system when the pavement temperature is above 50°F (10°C) and precipitation is not falling, and an automatic or manual control that is configured to shut off when the outdoor temperature is above 40°F (4°C).
Add new text as follows:
C403.13.3 Roof and gutter deicing controls.

Roof and gutter deicing systems, including but not limited to self-regulating cable, shall include automatic controls configured to shut off the system when the outdoor temperature is above 40°F (4.8°C) maximum and shall include one of the following:

1. A moisture sensor configured to shut off the system in the absence of moisture, or
2. A programmable timer configured to shut off the system for 8 hours minimum at night.

Revise as follows:
~~C403.13.3~~ C403.13.4 Freeze protection system controls.

Freeze protection systems, such as heat tracing of outdoor piping and heat exchangers, including self-regulating heat tracing, shall include automatic controls configured to shut off the systems when outdoor air temperatures are above 40°F (4°C) or when the conditions of the protected fluid will prevent freezing.

Reason Statement:

Roof and gutter deicing, often in the form of heat tape, is used to prevent ice dams in buildings with inadequate roof insulation, air sealing, and/or attic/roof surface ventilation. These systems use energy and are often left running at times that are unnecessary for ice dam prevention. The intent is to have automatic controls limit the system from running when either of two conditions is present. The first condition is when the outdoor temperature is above 40°F (4.8°C). For the second condition, there is an option to either provide a moisture sensor or a timer. Running heat tape all day and night can lead to melt cavities with an air space that can insulate the ice from the heat tape. Shutting the system off at night or using moisture control helps alleviate this issue. Moisture control works well if done just right but can be problematic in practice on roofs. A timer provides an option to avoid this concern. A daylight sensor option was considered but deemed inappropriate for high latitudes that may be in darkness all day long.

This language applies to both self-regulating type cable and standard cable. Self-regulating cable automatically adjusts the wattage based on temperature; as temperature decreases, the heat output of the cable increases. However, controls are needed as some current will still flow through at temperatures above 40°F (4.8°C) and the moisture/timer condition is needed to avoid air cavities.

Cost Impact:

The code change proposal will increase the cost of construction.

Upfront cost will increase but will be made up for by reducing energy bills over the useful life of the system. Electric resistant heat is very expensive to run when it is not needed. Manual controls require user interaction which is unlikely to be effective. Anecdotally, many people have systems installed without automatic controls and then wonder why their electric bills are so high until they realize their heat tape system has been running all summer long.

CEPI-82-21 Part I

CEPI-82-21 Part II

IECC®: R403.9, R403.10 (New)

Proponents:

Nick Thompson, City of Aspen, representing Colorado Chapter of the ICC (nick.thompson@cityofaspen.com)

2021 International Energy Conservation Code

R403.9 Snow melt and ice system controls .
Snow- and ice-melting systems, supplied through energy service to the building, shall include automatic controls capable of shutting off the system when the pavement temperature is greater than 50°F (10°C) and precipitation is not falling, and an automatic or manual control that will allow shutoff when the outdoor temperature is greater than 40°F (4.8°C).
Add new text as follows:
R403.10 Roof and gutter deicing controls.

Roof and gutter deicing systems, including but not limited to self-regulating cable, shall include automatic controls configured to shut off the system when the outdoor temperature is above 40°F (4.8°C) maximum and shall include one of the following:

1. A moisture sensor configured to shut off the system in the absence of moisture, or
2. A programmable timer configured to shut off the system for 8 hours minimum at night.

Reason Statement:

Roof and gutter deicing, often in the form of heat tape, is used to prevent ice dams in buildings with inadequate roof insulation, air sealing, and/or attic/roof surface ventilation. These systems use energy and are often left running at times that are unnecessary for ice dam prevention. The intent is to have automatic controls limit the system from running when either of two conditions is present. The first condition is when the outdoor temperature is above 40°F (4.8°C). For the second condition, there is an option to either provide a moisture sensor or a timer. Running heat tape all day and night can lead to melt cavities with an air space that can insulate the ice from the heat tape. Shutting the system off at night or using moisture control helps alleviate this issue. Moisture control works well if done just right but can be problematic in practice on roofs. A timer provides an option to avoid this concern. A daylight sensor option was considered but deemed inappropriate for high latitudes that may be in darkness all day long.

This language applies to both self-regulating type cable and standard cable. Self-regulating cable automatically adjusts the wattage based on temperature; as temperature decreases, the heat output of the cable increases. However, controls are needed as some current will still flow through at temperatures above 40°F (4.8°C) and the moisture/timer condition is needed to avoid air cavities.

Cost Impact:

The code change proposal will increase the cost of construction.

Upfront cost will increase but will be made up for by reducing energy bills over the useful life of the system. Electric resistant heat is very expensive to run when it is not needed. Manual controls require user interaction which is unlikely to be effective. Anecdotally, many people have systems installed without automatic controls and then wonder why their electric bills are so high until they realize their heat tape system has been running all summer long.

CEPI-82-21 Part II

CEPI-83-21

IECC®: SECTION 202 (New), C403.15 (New), Table C403.15 (New)

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 BEST EFFICIENCY POINT (BEP). The pump hydraulic power operating point (consisting of both flow and head conditions) that results in the maximum efficiency.
C202 CLEAN WATER PUMP. A device that is designed for use in pumping water with a maximum nonabsorbent free solid content of 0.016 lb/ft^3 (0.256 kg/m^3) and with a maximum dissolved solid content of 3.1 lb/ft^3 (49.66 kg/m^3), provided that the total gas content of the water does not exceed the saturation volume, and disregarding any additives necessary to prevent the water from freezing at a minimum of 14°F (-10°C).
Add new text as follows:
C403.15 Clean water pumps.

Clean water pumps meeting the following criteria shall comply with the requirements shown in Table C403.15:

1. A flow rate of 25 gal/min (1.58 L/s) or greater at its *best efficiency point (BEP)* at full impeller diameter
2. Maximum head of 459 ft at its *BEP* at full impeller diameter and the number of stages required for testing
3. Design temperature range from 14°F (-10°C) to 248°F (120°C)
4. Designed to operate with either:
   4.1. a 2- or 4-pole induction motor, or
   4.2. a non-induction motor with a speed of rotation operating range that includes speeds of rotation between 2880 and 4320 rpm and/or 1440 and 2160 rpm, and
   4.3. in either (1) or (2), the driver and impeller must rotate at the same speed
5. For submersible turbine pumps, a 6 in. (152 mm) or smaller bowl diameter
6. For end-suction close-coupled pumps and end-suction frame-mounted/own bearings pumps, specific speed less than or equal to 5000 rpm when calculated using U.S. customary units

Exceptions: The following pumps are exempt from these requirements:

1. Fire pumps
2. Self-priming pumps
3. Prime-assisted pumps
4. Magnet-driven pumps
5. Pumps designed to be used in a nuclear facility subject to 10 CFR 50, "Domestic Licensing of Production and Utilization Facilities."
6. Pumps meeting the design and construction requirements set forth in U.S. Military Specification MIL-P-17639F, "Pumps, Centrifugal, Miscellaneous Service, Naval Shipboard Use" (as amended); MIL-P-17881D, "Pumps, Centrifugal, Boiler Feed, (Multi-Stage)" (as amended); MIL-P-17840C, "Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)" (as amended); MIL-P-18682D, "Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard" (as amended); MIL-P-18472G, "Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, And Distilling Plant" (as amended).

Table C403.15 MAXIMUM PUMP ENERGY INDEX (PEI)

Pump Type	Nominal Speed of Rotation (RPM)	Operating Mode	Maximum PEI[a]	C-value[b]	Test Procedure
End suction, close coupled	1800	Constant load	1.00	128.47	
End suction, close coupled	3600	Constant load	1.00	130.42	
End suction, close coupled	1800	Variable load	1.00	128.47	
End suction, close coupled	3600	Variable load	1.00	130.42	
End suction, frame	1800	Constant load	1.00	128.85	

mounted					
End suction, frame mounted	3600	Constant load	1.00	130.99	
End suction, frame mounted	1800	Variable load	1.00	128.85	
End suction, frame mounted	3600	Variable load	1.00	130.99	
In-line	1800	Constant load	1.00	129.30	10 CFR Part 431
In-line	3600	Constant load	1.00	133.84	
In-line	1800	Variable load	1.00	129.30	
In-line	3600	Variable load	1.00	133.84	
Radially split, vertical	1800	Constant load	1.00	129.63	
Radially split, vertical	3600	Constant load	1.00	133.20	
Radially split, vertical	1800	Variable load	1.00	129.63	
Radially split, vertical	3600	Variable load	1.00	133.20	
Submersible turbine	1800	Constant load	1.00	138.78	
Submersible turbine	3600	Constant load	1.00	134.85	
Submersible turbine	1800	Variable load	1.00	138.78	
Submersible turbine	3600	Variable load	1.00	134.85	

a. For pumps with the constant load operating mode, the relevant PEI is PEI_{CL}. For pumps with the variable load operating mode, the relevant PEI is PEI_{VL}.

b. The C-values shown in this table shall be used in the equation for PEI_{STD} when calculating PEI_{CL} or PEI_{VL}.

Reason Statement:

As of January 27th, 2020, DOE published new minimum efficiency requirements for clean-water pumps which increased the minimum efficiency requirements for commercial and industrial pumping applications. This requirement applies to all pumps manufactured on or after January 27, 2020.

To rate the energy performance of pumps, the DOE established a new metric, the pump energy index (PEI). A value of PEI greater than 1.00 indicates the pump does not comply with the energy conservation standard, while a value less than 1.00 indicates the pump is more efficient than the standard requires. A pump model is considered compliant if its PEI rating is less than or equal to the adopted standard. The DOE based its final rule on the test methods recommended by the Hydraulic Institute and contained in its “Methods for Rotodynamic Pump Efficiency Testing.” THis PEI rating is now included on pump submittals as manufacturers have had 4 years to comply with the standard.

The methodology, requirements, and exceptions contained in this proposal mirror what is already included in ASHRAE 90.1-2019 and what is required by DOE to demonstrate compliance. Listing them in the IECC will provide designers with the necessary information on how to calculate PEI and which pumping systems are required to comply.

Bibliography:

DEPARTMENT OF ENERGY 10 CFR Parts 429 and 431 [Docket Number EERE–2011–BT–STD–0031] RIN 1904-AC54

https://www.energy.gov/sites/prod/files/2015/12/f28/Pumps%20ECS%20Final%20Rule.pdf

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

As this proposal simply includes the minimum efficiency provisions adopted by DOE for clean water pumps, there it will not increase or decrease the cost of construction.

CEPI-83-21

CEPI-84-21

IECC®: SECTION 202 (New), C403.15 (New), DOE Chapter 06

Proponents:

Diana Burk, New Buildings Institute, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 DESSICANT DEHUMIDIFICATION SYSTEM. A mechanical dehumidification technology that uses a solid or liquid material to remove moisture from the air.
C202 INTEGRATED HVAC SYSTEM.

An HVAC system designed to handle both sensible and latent heat removal. Integrated HVAC systems may include, but are not limited to HVAC systems with a sensible heat ratio of 0.65 or less and the capability of providing cooling, dedicated outdoor air systems, single package air conditioners with at least one refrigerant circuit providing hot gas reheat, and *dehumidifiers* modified to allow external heat rejection.

C202 DEHUMIDIFIER. A self-contained, electrically operated, and mechanically encased product with the sole purpose of dehumidifying the space consisting of:

1. A refrigerated surface (evaporator) that condenses moisture from the atmosphere,
2. A refrigerating system, including an electric motor,
3. An air-circulating fan, and
4. A means for collecting or disposing of the condensate.

A dehumidifier does not include a portable air conditioner, room air conditioner, or packaged terminal air conditioner.

Add new text as follows:
C403.15 Dehumidification in spaces for plant growth and maintenance.

Equipment that dehumidifies building spaces used for plant growth and maintenance shall comply with one of the following:

1. *Dehumidifiers* regulated under federal law in accordance with DOE 10 CFR 430 and tested in accordance with the test procedure listed in DOE 10 CFR 430 and DOE 10 CFR 430, Subpart B, Appendix X or X1 as applicable.
2. *Integrated HVAC system* with on-site heat recovery designed to fulfill at least 75 percent of the annual energy for dehumidification reheat;
3. Chilled water system with on-site heat recovery designed to fulfill at least 75 percent of the annual energy for dehumidification reheat; or
4. Solid or liquid *desiccant dehumidification system* for system designs that require dewpoint of 50°F or less.

Revise as follows:

DOE US Department of Energy c/o Superintendent of Documents 1000 Independence Avenue SW Washington DC 20585

10 CFR, Part 430—2015	Energy Conservation Program for Consumer Products: Test Procedures and Certification and Enforcement Requirement for Plumbing Products; and Certification and Enforcement Requirements for Residential Appliances; Final Rule Table C403.3.2(1), Table C403.3.2(2), Table C403.3.2(5), Table C403.3.2(6), Table C403.3.2(14), Table C404.2, C403.15

Reason Statement:

Indoor agriculture energy usage is projected to grow significantly nationwide in this decade, driven in large part by state legalization of medical and recreational marijuana across the country. In 2017, a total of 20 million square feet of building space was dedicated to growing crops indoors. Energy use by HVAC systems in indoor horticulture facilities can account for 30 to 65% of energy use - primarily because these systems must maintain specific humidity and temperature levels to promote plant growth. Section 403 already requires HVAC systems meet a certain efficiency threshold but does not address the efficiency of dehumidification systems.

The proposed language provides projects with a range of efficient dehumidification strategies. Indoor grow facilities can install dehumidifiers that meet federal minimum efficiency requirements. The proposal also provides options for solid or liquid desiccant dehumidification systems, for utilizing recovered energy in integrated HVAC systems, and for chilled water systems that can meet dehumidification reheat needs.

This proposal is based largely on the requirements listed in Section 120.6(h)1 of Title 24-2022 and is similar to requirements adopted in Denver, CO and being considered for adoption in Washington State, Michigan, and Illinois.

Bibliography:

Energy Savings Potential of SSL in Horticultural Applications. U.S. Department of Energy, Dec. 2017, https://www.energy.gov/sites/prod/files/2017/12/f46/ssl_horticulture_dec2017.pdf.

Schimelpfenig, Gretchen. *Energy Efficiency for Massachusetts Marijuana Cultivators*, Resource Innovation Institute, Sept. 2020, resourceinnovationinstitute.wildapricot.org/RII-REPORTS/.

Final CASE Report: Controlled Environment Horticulture, California Statewide Codes and Standards Enhancement (CASE) Program, Oct. 2020, https://title24stakeholders.com/wp-content/uploads/2020/10/2022-T24-NR-CEH-Final-CASE-Report.pdf.

15-Day Express Terms 2022 Energy Code - Residential and Nonresidential, California Energy Commission, 14 July 2021, https://efiling.energy.ca.gov/GetDocument.aspx?tn=238848.

Cost Impact:

The code change proposal will increase the cost of construction.

The incremental cost of installing more efficient dehumidification systems is around $8.11 per square foot of canopy. This measure results in significant energy savings of between 212 to 255 TDV kBtu/yr per square foot of canopy in Climate Zones 2-4. Every dollar spent to install more efficient equipment resulted in between $2.33 and $2.80 in operating and maintenance cost savings over the life of the system.

CEPI-84-21

CEPI-85-21

IECC®: C403.16 (New)

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new text as follows:
C403.16 Service Water Pressure-Booster Systems.

Service water pressure-booster *systems* shall be designed such that the following apply:

1. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensors shall either be located near the critical fixtures that determine the pressure required, or logic shall be employed that adjusts the set point to simulate operation of remote sensors.
2. No devices shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster *system* pump or booster *system*, except for safety devices.
3. No booster *system* pumps shall operate when there is no service water flow.

Reason Statement:

The IECC does not have any requirements over pressure boost system operation currently. ASHRAE has had these requirements in place since 90.1-2010 and found them to be a cost-effective requirement for new buildings. Many modern pressure boost systems already comply with ASHRAE standards and have the sensor controls on-board, eliminating the need for a field mounted remote pressure sensor. Furthermore, the energy savings from variable speed pressure boost systems can be substantial, ranging from 20%-50% (depending on the type of pressure control method) as shown in the attached whitepaper.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Modern pressure boost systems have software to control logic on the booster pump skid that adjusts the set point to simulate the operation of remote sensor, foregoing the need to install a remote pressure sensor at the critical fixtures.

CEPI-85-21

CEPI-86-21

IECC®: C403.2.3, C406.11

Proponents:

William Fay, representing Energy Efficient Codes Coalition (bill@energyefficientcodes.org); Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:

C403.2.3 Fault detection and diagnostics.

New buildings with ~~an~~ one or more HVAC ~~system~~systems serving a gross conditioned floor area of 100,000 square feet (9290 m^2) or larger and controlled by a direct digital control (DDC) system shall include a fault detection and diagnostics (FDD) system to monitor ~~the~~ HVAC system~~'s~~ performance and automatically identify faults. The FDD system shall:

1. Include permanently installed sensors and devices to monitor ~~the~~ HVAC system~~'s~~ performance.
2. Sample ~~the~~ HVAC system~~'s~~ performance at least once every 15 minutes.
3. Automatically identify and report HVAC system faults.
4. Automatically notify authorized personnel of identified HVAC system faults.
5. Automatically provide prioritized recommendations for repair of identified faults based on analysis of data collected from the sampling of HVAC system performance.
6. Be capable of transmitting the prioritized fault repair recommendations to remotely located authorized personnel.

Exception: R-1 and R-2 occupancies.

C406.11 Fault detection and diagnostics system.

A fault detection and diagnostics system shall be installed to monitor ~~the~~ HVAC system~~'s~~ performance and automatically identify faults. The system shall do all of the following:

1. Include permanently installed sensors and devices to monitor ~~the~~ HVAC system~~'s~~ performance.
2. Sample ~~the~~ HVAC system~~'s~~ performance at least once every 15 minutes.
3. Automatically identify and report HVAC system faults.
4. Automatically notify authorized personnel of identified HVAC system faults.
5. Automatically provide prioritized recommendations for repair of identified faults based on analysis of data collected from the sampling of ~~the~~ HVAC system performance.
6. Be capable of transmitting the prioritized fault repair recommendations to remotely located authorized personnel.

Reason Statement:

The purpose of this proposal is to clarify the code provisions related to Fault Detection and Diagnostics (FDD) systems. This proposal does not change any requirements of the code, but will make compliance and enforcement more straightforward. Since the FDD provisions were added to the 2021 IECC, some code users have questioned whether the existing language could be interpreted in a way that allows buildings with multiple HVAC systems to avoid complying with the requirement, and whether a building with no direct digital control system (DDC) should be required to comply. This code change proposal clarifies the original intent of the proposal, which is to require all new buildings with HVAC systems (whether a single HVAC system or multiple systems) serving at least 100,000 square feet of conditioned floor area--and controlled by a direct digital control (DDC) system--to include an FDD system. If the building does not include a DDC system, the FDD requirement does not apply.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Because this code change proposal does not introduce any new measures into the code, but simply clarifies the intent of the requirement, there is no impact on cost of construction.

COST-EFFECTIVENESS

Because this code change proposal does not change the requirements of the code, a cost-effectiveness analysis does not apply.

CEPI-86-21

CEPI-87-21

IECC®: C403.3.2

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Revise as follows:
C403.3.2 HVAC equipment performance requirements.

Equipment shall meet the minimum efficiency requirements of Tables C403.3.2(1) through C403.3.2(16) when tested and rated in accordance with the applicable test procedure. Plate-type liquid-to-liquid heat exchangers shall meet the minimum requirements of AHRI 400. The efficiency shall be verified through certification under an approved 3rd party certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the manufacturer during performance testing per applicable test procedure. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements. Where components, such as indoor or outdoor coils, from different manufacturers are used, calculations and supporting data shall be furnished by the designer that demonstrates that the combined efficiency of the specified components meets the requirements herein. In addition, equipment manufacturers shall provide to energy modelers site specific unit performance for real world conditions, including performance at actual operating pressures, distribution distances and other real world performance adjustments for full load and part load conditions to aid in the energy modeling of the building.

Reason Statement:

This improves the wording to require all products to be AHRI or other 3rd party tested, to meet a standardized performance metric. In addition, energy modeling is now being required to meet many local codes. Standardized test conditions, are good to compare common pieces of HVAC equipment; but are not good for comparing different system types. By requiring the equipment manufacturers to provide site condition performance, will allow energy modulars to compare different system types, for energy consumption, and system type analysis.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

No Change for AHRI certified products. It will require additional information to be provided on MFG data sheets.

CEPI-87-21

CEPI-88-21

IECC®: TABLE C403.3.2(1)

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.3.2(1) ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS[c, d]

EQUIPMENT TYPE	SIZE CATEGORY	HEADING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air conditioners, air cooled	< 65,000 Btu/h[b]	All	Split system, three phase and applications outside US single phase[b]	~~13.0 SEER before 1/1/2023~~ 13.4 SEER2 ~~after 1/1/2023~~	~~AHRI 210/240—2017 before 1/1/2023~~ AHRI 210/240—2023 ~~after 1/1/2023~~
			Single-package, three phase and applications outside US single phase[b]	~~14.0 SEER before 1/1/2023~~ 13.4 SEER2 ~~after 1/1/2023~~	
Space constrained, air cooled	≤ 30,000 Btu/h[b]	All	Split system, three phase and applications outside US single phase[b]	~~12.0 SEER before 1/1/2023~~ 11.7 SEER2 ~~after 1/1/2023~~	~~AHRI 210/240—2017 before 1/1/2023~~ AHRI 210/240—2023 ~~after 1/1/2023~~
			Single package, three phase and applications outside US single phase[b]	~~12.0 SEER before 1/1/2023~~ 11.7 SEER2 ~~after 1/1/2023~~	
Small duct, high velocity, air cooled	< 65,000 Btu/h[b]	All	Split system, three phase and applications outside US single phase[b]	~~12.0 SEER before 1/1/2023~~ 12.1 SEER2 ~~after 1/1/2023~~	~~AHRI 210/240—2017 before 1/1/2023~~ AHRI 210/240—2023 ~~after 1/1/2023~~
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)		11.2 EER ~~12.9 IEER before 1/1/2023~~ 14.8 IEER ~~after 1/1/2023~~	
		All other		11.0 EER ~~12.7 IEER before 1/1/2023~~ 14.6 IEER ~~after 1/1/2023~~	
			Split systemand single package		AHRI 340/360

Air conditioners, air cooled	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	Split system and single package	11.0 EER ~~12.4 IEER before 1/1/2023~~ 14.2 IEER ~~after 1/1/2023~~	AHRI 340/360
		All other		10.8 EER ~~12.2 IEER before 1/1/2023~~ 14.0 IEER ~~after 1/1/2023~~	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)		10.0 EER ~~11.6 IEER before 1/1/2023~~ 13.2 IEER ~~after 1/1/2023~~	
		All other		9.8 EER ~~11.4 IEER before 1/1/2023~~ 13.0 IEER ~~after 1/1/2023~~	
	≥ 760,000 Btu/h	Electric resistance (or none)		9.7 EER ~~11.2 IEER before 1/1/2023~~ 12.5 IEER~~after 1/1/2023~~	
		All other		9.5 EER ~~11.0 IEER before 1/1/2023~~ 12.3 IEER ~~after 1/1/2023~~	
Air conditioners, water cooled	< 65,000 Btu/h	All	Split systemand single package	12.1 EER 12.3 IEER	AHRI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)		12.1 EER 13.9 IEER	AHRI 340/360
		All other		11.9 EER 13.7 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)		12.5 EER 13.9 IEER	
		All other		12.3 EER 13.7 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)		12.4 EER 13.6 IEER	
		All other		12.2 EER 13.4 IEER	
	≥ 760,000	Electric resistance		12.2 EER 13.5 IEER	

	Btu/h	(or none)			
		All other		12.0 EER 13.3 IEER	
	< 65,000 Btu/h[b]	All		12.1 EER 12.3 IEER	AHRI 210/240
Air conditioners, evaporatively cooled	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split system and single package	12.1 EER 12.3 IEER	AHRI 340/360
		All other		11.9 EER 12.1 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)		12.0 EER 12.2 IEER	
		All other		11.8 EER 12.0 IEER	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Electric resistance (or none)		11.9 EER 12.1 IEER	
		All other		11.7 EER 11.9 IEER	
	≥ 760,000 Btu/h	Electric resistance (or none)		11.7 EER 11.9 IEER	
		All other		11.5 EER 11.7 IEER	
Condensing units, air cooled	≥ 135,000 Btu/h	—	—	10.5 EER 11.8 IEER	AHRI 365
Condensing units, water cooled	≥ 135,000 Btu/h	—	—	13.5 EER 14.0 IEER	AHRI 365
Condensing units, evaporatively cooled	≥ 135,000 Btu/h	—	—	13.5 EER 14.0 IEER	AHRI 365

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Single-phase, US air-cooled air conditioners less than 65,000 Btu/h are regulated as consumer products by the US Department of Energy Code of Federal Regulations DOE 10 CFR 430. SEER and SEER2 values for single-phase products are set by the US Department of Energy.

c. DOE 10 CFR 430 Subpart B Appendix M1 includes the test procedure updates effective 1/1/2023 that have been ~~will be~~ incorporated in AHRI 210/240—2023.

d. This table is a replica of ASHRAE 90.1 Table 6.8.1-1 Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements.

Reason Statement:

The 2024 version of the IECC will be published in the fall of 2023, and this proposed change updates the Table to take out efficiency requirements for equipment installed before January 1, 2023.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The efficiency requirements in this table were already included in the 2021 IECC (and in ASHRAE 90.1-2019), and this change does not change any efficiency requirements that have already been established.

CEPI-88-21

CEPI-89-21

IECC®: TABLE C403.3.2(12)

Proponents: Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.3.2(12) ELECTRICALLY OPERATED DX-DOAS UNITS, SINGLE-PACKAGE AND REMOTE CONDENSER, WITHOUT ENERGY RECOVERY—MINIMUM EFFICIENCYREQUIREMENTS[b]

EQUIPMENT TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (dehumidification mode)	—	4.0 ISMRE	AHRI 920
Air-source heat pumps (dehumidification mode)	—	4.0 ISMRE	AHRI 920
Water cooled (dehumidification mode)	Cooling tower condenser water	4.9 ISMRE	AHRI 920
	Chilled water	6.0 ISMRE	
Air-source heat pump (heating mode)	—	2.7 ISCOP	AHRI 920
Water-source heat pump (dehumidification mode)	Ground source, closed loop	4.8 ISMRE	AHRI 920
	Ground-water source	5.0 ISMRE	
	Water source	4.0 ISMRE	
Water-source heat pump (heating mode)	Ground source, closed loop	2.0 ISCOP	AHRI 920
	Ground-water source	3.2 ISCOP	
	Water source	3.5 ISCOP	

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-13 Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, without Energy Recovery—Minimum Efficiency Requirements.

c. AHRI 920 test procedure is not applicable to projects in climate zones 2B, 3B, 4B, 5B, 6B.

Reason: AHRI 920 and ISMRE is based on moisture removal efficiency. In the dry climate zones referenced in the change, there is no moisture to remove on design day, therefore the code is not applicable.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal only describes an exception and will not change the cost of construction.

CEPI-90-21

IECC®: TABLE C403.3.2(2)

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.3.2(2) ELECTRICALLY OPERATED AIR-COOLED UNITARY HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS[c, d]

EQUIPMENT TYPE	SIZE CATEGORY	HEADING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Air cooled (cooling mode)	< 66,000 Btu/h	All	Split system, three phase and applications outside US single phase[b]	~~14.0 SEER before 1/1/2023~~ 14.3 SEER2 ~~after 1/1/2023~~	~~AHRI 210/240—2017 before 1/1/2023~~ AHRI 210/240—2023 ~~after 1/1/2023~~
			Single package, three phase and applications outside US single phase[b]	~~14.0 SEER before 1/1/2023~~ 13.4 SEER2 ~~after 1/1/2023~~	
Space constrained, air cooled (cooling mode)	≤ 30,000 Btu/h	All	Split system, three phase and applications outside US single phase[b]	~~12.0 SEER before 1/1/2023~~ 11.7 SEER2 ~~after 1/1/2023~~	~~AHRI 210/240—2017 before 1/1/2023~~ AHRI 210/240—2023 ~~after 1/1/2023~~
			Single package, three phase and applications outside US single phase[b]	~~12.0 SEER before 1/1/2023~~ 11.7 SEER2 ~~after 1/1/2023~~	
Single duct, high velocity, air cooled (cooling mode)	< 65,000	All	Split system, three phase and applications outside US single phase[b]	~~12.0 SEER before 1/1/2023~~ 12.0 SEER2 ~~after 1/1/2023~~	~~AHRI 210/240—2017 before 1/1/2023~~ AHRI 210/240—2023 ~~after 1/1/2023~~
Air cooled (cooling mode)	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	Split system and single package	11.0 EER ~~12.2 IEER before 1/1/2023~~ 14.1 IEER ~~after 1/1/2023~~	AHRI 340/360
		All other		10.8 EER ~~12.0 IEER before 1/1/2023~~ 13.9 IEER ~~after 1/1/2023~~	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)		10.6 EER ~~11.6 IEER before 1/1/2023~~ 13.5 IEER ~~after 1/1/2023~~	
		All other		10.4 EER ~~11.4 IEER before 1/1/2023~~ 13.3 IEER ~~after 1/1/2023~~	
	≥ 240,000 Btu/h	Electric resistance (or none)		9.5 EER ~~10.6 IEER before 1/1/2023~~ 12.5 IEER ~~after 1/1/2023~~	
		All other		9.3 EER ~~10.4 IEER before 1/1/2023~~ 12.3 IEER ~~after 1/1/2023~~	
Air cooled (heating mode)	< 65,000 Btu/h	All	Split system, three phase and applications outside US single phase[b]	~~8.2 HSPF before 1/1/2023~~ 7.5 HSPF2 ~~after 1/1/2023~~	~~AHRI 210/240—2017 before 1/1/2023~~ AHRI 210/240—2023 ~~after 1/1/2023~~
			Single package, three phase and applications outside US single phase[b]	~~8.0 HSPF before 1/1/2023~~ 6.7 HSPF2 ~~after 1/1/2023~~	
Space constrained, air cooled	≤ 30,000 Btu/h	All	Split system, three phase and applications outside US single phase[b]	~~7.4 HSPF before 1/1/2023~~ 6.3 HSPF2 ~~after 1/1/2023~~	~~AHRI 210/240—2017 before 1/1/2023~~
			Single package, three phase and	~~7.4 HSPF~~	

(heating mode)			applications outside US single phase[b]	~~before 1/1/2023~~ 6.3 HSPF2 ~~after 1/1/2023~~	AHRI 210/240—2023 ~~after 1/1/2023~~
Small duct, high velocity, air cooled (heating mode)	< 65,000 Btu/h	All	Split system, three phase and applications outside US single phase[b]	~~7.2 HSPF~~ ~~before 1/1/2023~~ 6.1 HSPF2 ~~after 1/1/2023~~	~~AHRI 210/240—2017~~ ~~before 1/1/2023~~ AHRI 210/240—2023 ~~after 1/1/2023~~
Air cooled (heating mode)	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)	All	47° F db/43° F wb outdoor air	~~3.30 COP_H~~ ~~before 1/1/2023~~ 3.40 COP_H ~~after 1/1/2023~~	AHRI 340/360
			17° F db/15° F wb outdoor air	2.25 COP_H	
	≥ 135,000 Btu/h and < 240,000 Btu/h (cooling capacity)		47° F db/43° F wb outdoor air	~~3.20 COP_H~~ ~~before 1/1/2023~~ 3.30 ~~S~~ COP_H ~~after 1/1/2023~~	
			17° F db/15° F wb outdoor air	2.05 COP_H	
	≥ 240,000 Btu/h (cooling capacity)		47° F db/43° F wb outdoor air	3.20 COP_H	
			17° F db/15° F wb outdoor air	2.05 COP_H	

For SI: 1 British thermal unit per hour = 0.2931 W, ° C = [(° F) – 32]/1.8, wb = wet bulb, db = dry bulb.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Single-phase, US air-cooled heat pumps less than 65,000 Btu/h are regulated as consumer products by the US Department of Energy Code of Federal Regulations DOE 10 CFR 430. SEER, SEER2 and HSPF values for single-phase products are set by the US Department of Energy.

c. DOE 10 CFR 430 Subpart B Appendix M1 includes the test procedure updates effective 1/1/2023 that have been ~~will be~~ incorporated in AHRI 210/240—2023.

d. This table is a replica of ASHRAE 90.1 Table 6.8.1-2 Electrically Operated Air-Cooled Unitary Heat Pumps—Minimum Efficiency Requirements.

Reason: This proposal updates table values for the 2024 version of the IECC that will be published in the fall of 2023. It takes out values for new equipment installed prior to 1/1/2023, and makes other editorial corrections.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal makes corrections to the table and does not modify any efficiency values that have been in the code since the 2021 version.

CEPI-91-21

IECC®: TABLE C403.3.2(5)

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.3.2(5) WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS[g]

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
Warm-air furnace, gas fired for application outside the US	< 225,000 Btu/h	Maximum capacity[c]	80% AFUE (nonweathered) or 81% AFUE (weatherized) or 80% E_t[b, d]	DOE 10 CFR 430 Appendix N or Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, gas fired	< 225,000 Btu/h	Maximum capacity[c]	~~80% E_t[b, d] before 1/1/2023~~ 81% E_t[d] ~~after 1/1/2023~~	Section 2.39, Thermal Efficiency, ANSI Z21.47
Warm-air furnace, oil fired for application outside the US	< 225,000 Btu/h	Maximum capacity[c]	83% AFUE (nonweathered) or 78% AFUE (weatherized) or 80% E_t[b, d]	DOE 10 CFR 430 Appendix N or Section 42, Combustion, UL 727
Warm-air furnace, oil fired	< 225,000 Btu/h	Maximum capacity[c]	~~80% E_t before 1/1/2023~~ 82% E_t[d] ~~after 1/1/2023~~	Section 42, Combustion, UL 727
Electric furnaces for applications outside the US	< 225,000 Btu/h	All	96% AFUE	DOE 10 CFR 430 Appendix N
Warm-air duct furnaces, gas fired	All capacities	Maximum capacity[c]	80% E_c[e]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, gas fired	All capacities	Maximum capacity[c]	80% E_c[e, f]	Section 2.10, Efficiency, ANSI Z83.8
Warm-air unit heaters, oil fired	All capacities	Maximum capacity[c]	80% E_c[e, f]	Section 40, Combustion, UL 731

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. Combination units (i.e., furnaces contained within the same cabinet as an air conditioner) not covered by DOE 10 CFR 430 (i.e., three-phase power or with cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating. All other units greater than 225,000 Btu/h sold in the US must meet the AFUE standards for consumer products and test using USDOE's AFUE test procedure at DOE 10 CFR 430, Subpart B, Appendix N.

c. Compliance of multiple firing rate units shall be at the maximum firing rate.

d. E_t = thermal efficiency. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75 percent of the input rating, and have either power venting or a flue damper. A vent damper is an acceptable alternative to a flue damper for those furnaces where combustion air is drawn from the conditioned space.

e. E_c = combustion efficiency (100 percent less flue losses). See test procedure for detailed discussion.

f. Units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.

g. This table is a replica of ASHRAE 90.1 Table 6.8.1-5 Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters—Minimum Efficiency Requirements.

Reason: This proposal updates the table by removing efficiency requirements for equipment installed prior to 1/1/2023. This information will not be needed for the 2024 IECC.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal only updates the table. It does not change the efficiency requirements of the listed equipment, and therefore has no cost impact.

CEPI-92-21

IECC®: TABLE C403.3.2(6)

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.3.2(6) GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS[i]

EQUIPMENT TYPE[b]	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	~~MINIMUM EFFICIENCY~~	MINIMUM EFFICIENCY ~~AS OF 3/2/2022~~	TEST PROCEDURE[a]
Boilers, hot water	Gas fired	< 300,000 Btu/h[g, h] for applications outside US	~~82% AFUE~~	~~82~~ 84% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~80% E_t[d]~~	80% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[b]	~~82% E_c[c]~~	82% E_c[c]	
	Oil fired[f]	< 300,000 Btu/h[g,h] for applications outside US	~~84% AFUE~~	~~84~~ 86% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~82% E_t[d]~~	82% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[b]	~~84% E_c[c]~~	84% E_c[c]	
Boilers, steam	Gas fired	< 300,000 Btu/h[g] for applications outside US	~~80% AFUE~~	~~80~~ 82% AFUE	DOE 10 CFR 430 Appendix N
	Gas fired—all, except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~79% E_t[d]~~	79% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[b]	~~79% E_t[d]~~	79% E_t[d]	
	Gas fired—natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~77% E_t[d]~~	79% E_t[d]	
		> 2,500,000 Btu/h[b]	~~77% E_t[d]~~	79% E_t[d]	
	Oil fired[f]	< 300,000 Btu/h[g] for applications outside US	~~82% AFUE~~	~~82~~ 85% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~81% E_t[d]~~	81% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h[b]	~~81% E_t[d]~~	81% E_t[d]	

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilersand to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.

c. E_c = Combustion efficiency(100 percent less flue losses).

d. E_t = Thermal efficiency.

e. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.

f. Includes oil-fired (residual).

g. Boilersshall not be equipped with a constant burning pilot light.

h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an automatic means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.

i. This table is a replica of ASHRAE 90.1 Table 6.8.1-6 Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements.

Reason: This proposal updates the table for the 2024 IECC, with updates based on US DOE final rulemakings and removing values in effect for equipment installed before 3/2/2022.

Bibliography: *Energy Conservation Standards for Residential Boilers - Final Rule*, US Department of Energy, Washington DC, January 15, 2016 (as published in the US *Federal Register*, 81 *Fed. Reg.* 2320)

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal only updates the values in the tables based on previous ASHRAE / ICC actions and US Department of Energy final rules. These standards have already taken effect.

Staff Note: CEPI-93-21 addresses the same table.

CEPI-93-21

IECC®: TABLE C403.3.2(6)

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.3.2(6) GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS~~[i]~~

EQUIPMENT TYPE[b]	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	~~MINIMUM EFFICIENCY~~	MINIMUM EFFICIENCY ~~AS OF 3/2/2022~~	TEST PROCEDURE[a]
Boilers, hot water	Gas fired	< 300,000 Btu/h[g, h] for applications outside US	~~82% AFUE~~	82% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~80% E_t[d]~~	~~80~~ 84% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h and ≤ 10,000,000 Btu/h[b]	~~82% E_c[c]~~	~~82~~ 85% E_c[c]	
		> 10,000,000 Btu/h[b]		82% E_c[c]	
	Oil fired[f]	< 300,000 Btu/h[g,h] for applications outside US	~~84% AFUE~~	84% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~82% E_t[d]~~	~~82~~ 87% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h and ≤ 10,000,000 Btu/h[b]	~~84% E_c[c]~~	~~84~~ 88% E_c[c]	
		> 10,000,000 Btu/h[b]		84% E_c[c]	
Boilers, steam	Gas fired	< 300,000 Btu/h[g] for applications outside US	~~80% AFUE~~	~~80~~ 81% AFUE	DOE 10 CFR 430 Appendix N
	Gas fired—all, except natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~79% E_t[d]~~	~~79~~ 82% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h and ≤ 10,000,000 Btu/h[b]	~~79% E_t[d]~~	79% E_t[d]	
		> 10,000,000 Btu/h[b]		79% E_t[d]	
	Gas fired—natural draft	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~77% E_t[d]~~	~~79~~ 81% E_t[d]	
		> 2,500,000 Btu/h and ≤ 10,000,000 Btu/h[b]	~~77% E_t[d]~~	~~79~~ 82% E_t[d]	
		> 10,000,000 Btu/h[b]		79% E_t[d]	
	Oil fired[f]	< 300,000 Btu/h[g] for applications outside US	~~82% AFUE~~	82% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~81% E_t[d]~~	~~81~~ 84% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h and ≤ 10,000,000 Btu/h[b]	~~81% E_t[d]~~	~~81~~ 85% E_t[d]	
		> 10,000,000 Btu/h[b]		81% E_t[d]	

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.

c. E_c = Combustion efficiency (100 percent less flue losses).

d. E_t = Thermal efficiency.

e. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.

f. Includes oil-fired (residual).

g. Boilers shall not be equipped with a constant burning pilot light.

h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an automatic means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.

~~i. This table is a replica of ASHRAE 90.1 Table 6.8.1-6 Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements.~~

Reason: On January 10, 2020 DOE published new boiler efficiency requirements for boilers manufacturer after 1/20/2023. This proposal updates the table for the 2024 IECC, with updates based on US DOE final rulemakings and removing values in effect for equipment installed before 3/2/2022. It also removes the reference to ASHRAE table under footnote i which is no longer necessary.

eCFR :: 10 CFR 431.87 -- Energy and water conservation standards and their effective dates.

Displaying title 10, up to date as of 10/07/2021. Title 10 was last amended 10/06/2021.

Title 10

§ 431.87 Energy and water conservation standards and their effective dates.

(a) Each commercial packaged boiler listed in Table 1 to § 431.87 and manufactured on or after March 2, 2012 and prior to January 10, 2023, must meet the applicable energy conservation standard levels as follows:

Table 1 to § 431.87 - Commercial Packaged Boiler Energy Conservations Standards

Equipment	Subcategory	Size category (input)	Efficiency level - effective date: March 2, 2012 *
Hot Water Commercial Packaged Boilers	Gas-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	80.0% E_T.
Hot Water Commercial Packaged Boilers	Gas-fired	>2,500,000 Btu/h	82.0% E_C.
Hot Water Commercial Packaged Boilers	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	82.0% E_T.
Hot Water Commercial Packaged Boilers	Oil-fired	>2,500,000 Btu/h	84.0% E_C.
Steam Commercial Packaged Boilers	Gas-fired - all, except natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	79.0% E_T.
Steam Commercial Packaged Boilers	Gas-fired - all, except natural draft	>2,500,000 Btu/h	79.0% E_T.
Steam Commercial Packaged Boilers	Gas-fired - natural draft	≥300,000 Btu/h and ≤2,500,000 Btu/h	77.0% E_T.
Steam Commercial Packaged Boilers	Gas-fired - natural draft	>2,500,000 Btu/h	77.0% E_T.
Steam Commercial Packaged Boilers	Oil-fired	≥300,000 Btu/h and ≤2,500,000 Btu/h	81.0% E_T.
Steam Commercial Packaged Boilers	Oil-fired	>2,500,000 Btu/h	81.0% E_T.

* Where E_T means "thermal efficiency" and E_C means "combustion efficiency" as defined in 10 CFR 431.82.

eCFR :: 10 CFR 431.87 -- Energy and water conservation standards and their effective dates.

(b) Each commercial packaged boiler listed in Table 2 to § 431.87 and manufactured on or after January 10, 2023, must meet the applicable energy conservation standard levels as follows:

Table 2 to § 431.87 - Commercial Packaged Boiler Energy Conservations Standards

Equipment	Size category (rated input)	Energy conservation standard
Small Gas-Fired Hot Water Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	84.0% E_T.
Large Gas-Fired Hot Water Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_C.
Very Large Gas-Fired Hot Water Commercial Packaged Boilers	>10,000,000 Btu/h	82.0% E_C.
Small Oil-Fired Hot Water Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	87.0% E_T.
Large Oil-Fired Hot Water Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	88.0% E_C.
Very Large Oil-Fired Hot Water Commercial Packaged Boilers	>10,000,000 Btu/h	84.0% E_C.
Small Gas-Fired Steam Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	81.0% E_T.
Large Gas-Fired Steam Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	82.0% E_T.
Very Large Gas-Fired Steam Commercial Packaged Boilers **	>10,000,000 Btu/h	79.0% E_T.
Small Oil-Fired Steam Commercial Packaged Boilers	≥300,000 Btu/h and ≤2,500,000 Btu/h	84.0% E_T.
Large Oil-Fired Steam Commercial Packaged Boilers	>2,500,000 Btu/h and ≤10,000,000 Btu/h	85.0% E_T.
Very Large Oil-Fired Steam Commercial Packaged Boilers	>10,000,000 Btu/h	81.0% E_T.

* Where E_T means "thermal efficiency" and E_C means "combustion efficiency" as defined in 10 CFR 431.82.

** Prior to March 2, 2022, for natural draft very large gas-fired steam commercial packaged boilers, a minimum thermal efficiency level of 77 percent is permitted and meets Federal commercial packaged boiler energy conservation standards.

[85 FR 1681, Jan. 10, 2020]

Bibliography: *Energy Conservation Standards for Residential Boilers - Final Rule*, US Department of Energy, Washington DC, January 10, 2020
https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-E/subject-group-ECFRe1ae92ed608f22e/section-431.87

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This update simply aligns federal requirements with the efficiency tables listed in the IECC so they are up to date. These are DOE minimum efficiency standards and therefore no increase or decrease in cost is expected.

Staff Note: ASHRAE source footnote is in other efficiency tables. CEPI-92-21 addresses the same table

CEPI-94-21

IECC®: TABLE C403.3.2(8), TABLE C403.3.2(9)

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.3.2(8) ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AIR CONDITIONERS—MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRFair conditioners, air cooled	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.2 EER ~~13.1 IEER~~ 15.5 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	11.0 EER ~~12.9 IEER~~ 14.9 IEER	
	≥ 240,000 Btu/h	Electric resistance (or none)	VRF multisplit system	10.0 EER ~~11.6 IEER~~ 13.9 IEER	

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-8 Electrically Operated Variable-Refrigerant-Flow Air Conditioners—Minimum Efficiency Requirements.

TABLE C403.3.2(9) ELECTRICALLY OPERATED VARIABLE-REFRIGERANT-FLOW AND APPLIED HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS[b]

EQUIPMENT TYPE	SIZE CATEGORY	HEATING SECTION TYPE	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY	TEST PROCEDURE[a]
VRFair cooled (cooling mode)	< 65,000 Btu/h	All	VRF multisplit system	13.0 SEER	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h	Electric resistance (or none)		11.0 EER ~~12.9 IEER~~ 14.6 IEER	
			VRF multisplit system with heat recovery	10.8 EER ~~12.7 IEER~~ 14.4 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h		VRF multisplit system	10.6 EER ~~12.3 IEER~~ 13.9 IEER	
			VRF multisplit system with heat recovery	10.4 EER ~~12.1 IEER~~ 13.7 IEER	
	≥ 240,000 Btu/h		VRF multisplit system	9.5 EER ~~11.0 IEER~~ 12.7 IEER	
			VRF multisplit system with heat recovery	9.3 EER ~~10.8 IEER~~ 12.5 IEER	
VRF water source (cooling mode)	< 65,000 Btu/h	All	VRF multisplit systems 86° F entering water	12.0 EER 16.0 IEER	AHRI 1230
			VRF multisplit systems with heat recovery 86° F entering water	11.8 EER 15.8 IEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h		VRF multisplit system 86° F entering water	12.0 EER 16.0 IEER	
			VRF multisplit system with heat recovery 86° F entering water	11.8 EER 15.8 IEER	
	≥ 135,000 Btu/h and < 240,000 Btu/h		VRF multisplit system 86° F entering water	10.0 EER 14.0 IEER	
			VRF multisplit system with heat recovery 86° F entering water	9.8 EER 13.8 IEER	
	≥ 240,000 Btu/h		VRF multisplit system 86° F entering water	~~10.0 EER~~ 12.0 IEER	
			VRF multisplit system with heat recovery 86° F entering water	~~9.8 EER~~ 11.8 IEER	
VRFgroundwater source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system 59° F entering water	16.2 EER	AHRI 1230
			VRF multisplit system with heat recovery 59° F entering water	16.0 EER	
	≥ 135,000 Btu/h		VRF multisplit system 59° F entering water	13.8 EER	
			VRF multisplit system with heat recovery 59° F entering water	13.6 EER	
			VRF multisplit system 77° F entering water	13.4 EER	

VRFground source (cooling mode)	< 135,000 Btu/h	All	VRF multisplit system with heat recovery 77° F entering water	13.2 EER	AHRI 1230
	≥ 135,000 Btu/h		VRF multisplit system 77° F entering water	11.0 EER	
			VRF multisplit system with heat recovery 77° F entering water	10.8 EER	
VRFair cooled (heating mode)	< 65,000 Btu/h (cooling capacity)		VRF multisplit system	7.7 HSPF	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)		VRF multisplit system 47° F db/43° F wb outdoor air	3.3 COP_H	
			17° F db/15° F wb outdoor air	2.25 COP_H	
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 47° F db/43° F wb outdoor air	3.2 COP_H	
			17° F db/15° F wb outdoor air	2.05 COP_H	
VRFwater source (heating mode)	< 65,000 Btu/h (cooling capacity)		VRF multisplit system 68° F entering water	~~4.2 COP$_H$~~ 4.3 COP_H	AHRI 1230
	≥ 65,000 Btu/h and < 135,000 Btu/h (cooling capacity)		VRF multisplit system 68° F entering water	~~4.2 COP$_H$~~ 4.3 COP_H	
	≥ 135,000 Btu/h and < 240,000 Btu/h (cooling capacity)		VRF multisplit system 68° F entering water	~~3.9 COP$_H$~~ 4.0 COP_H	
	≥ 240,000 Btu/h (cooling capacity)		VRF multisplit system 68° F entering water	3.9 COP_H	
VRF groundwater source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 50° F entering water	3.6 COP_H	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 50° F entering water	3.3 COP_H	
VRF ground source (heating mode)	< 135,000 Btu/h (cooling capacity)		VRF multisplit system 32° F entering water	3.1 COP_H	AHRI 1230
	≥ 135,000 Btu/h (cooling capacity)		VRF multisplit system 32° F entering water	2.8 COP_H	

For SI: ° C = [(° F) – 32]/1.8, 1 British thermal unit per hour = 0.2931 W, db = dry bulb temperature, wb = wet bulb temperature.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. This table is a replica of ASHRAE 90.1 Table 6.8.1-9 Electrically Operated Variable-Refrigerant-Flow and Applied Heat Pumps—Minimum Efficiency Requirements.

Reason: This proposal updates the VRF efficiency tables by removing requirements for equipment that was installed before 1/1/2017 or 1/1/2018. These changes are consistent with the requirement shown in ASHRAE 90.1-2019.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not change any efficiency values for VRF equipment. It only updates the tables to remove requirements for equipment installed before 1/1/2018.

CEPI-95-21

IECC®: C403.3.2.3 (New)

Proponents:

Mike Kennedy, Mike D. Kennedy Inc., representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new text as follows:
C403.3.2.3 Package electric heating and cooling equipment.

Package equipment providing both electric heating and cooling with a total cooling capacity greater than 6,000 Btu/h shall be a heat pump. The unit shall have reverse-cycle defrost and operate in heating mode down to 25ºF.

Exceptions:

1. Units installed in *Climate Zones* 0 through 3.
2. Unstaffed equipment shelters or cabinets used solely for wireless service facilities.

Reason Statement:

Package AC with electric resistance is a commonly installed in Group-R occupancies, yet the incremental cost of adding heat pump capabilities is minimal given that the compressor is already present. The proposal requires package AC units with electric resistance heat to have heat pumps if they are installed in climate zones 4 through 8. Many package terminal heat pumps (PTHP) lock out the heat pump below 40°F or whenever the unit comes on or the set point is increased. Many do not have defrost capabilities at all. This is a special concern since the buildings PTHP units are typically installed in, Group R1 and R2, have low balance points and only require heat at cooler temperatures. A number of major and minor manufacturers provide units that comply with these code requirements. Many are developing units based upon mini-split/VRF technology that greatly exceed the proposed requirements. It is time to encourage heat pumps over electric resistance and heat pumps capable of operating below 40 degrees F.

At the same time, 2021 IECC C403.4.1.1 effectively bans PTHP units as currently written without a very generous interpretation of exception 1. There is no way to limit the supplemental electric in most PTHP units. Some consideration should be made to revising that language with an exception for PTHP with defrost.

Cost Impact:

The code change proposal will increase the cost of construction.

Cost data for PTAC and PTHP units from a manufacturer whose units provide defrost complying with the code language were found at https://www.kingersons.com/packageterminalairconditioner.html. The incremental cost was $70 to $100 per unit depending upon the capacity.

CEPI-95-21

CEPI-96-21

IECC®: C403.3.4 (New)

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Add new text as follows:
C403.3.4 Reversing Valve Requirement.

All air cooled electrically operated unitary air conditioners and condensing units in table C403.3.2(1) must be provided with a reversing valve to allow unit to operate as a heat pump in heating mode.

Exception: If it can be proven that heating is not required above 30°F, a reversing valve is not required.

Reason Statement:

Purpose: The purpose of requiring reversing valves on all air cooled unitary air conditioning units is to allow operation with 100% electric source heating. Although supplemental gas heat may be required during peak conditions, this requirement will reduce the overall consumption of energy for heating.

Reasons: The only difference between a heat pump and cooling only is a reversing valve and some piping. Utah Power implemented this as a rebate as they realized the grid is cleaner at mild heating temperatures and the CO2 emission reduction is dramatic. The 30 deg requirement is to recognize that on commercial buildings there may not be a heating requirement until 30 deg or below.

Cost Impact:

The code change proposal will increase the cost of construction.

This measure will result in savings of 50-60% in CO2 emissions due to the increased efficiency of heat pump operation. Adding a reversing valve had minimum impact on overall equipment costs. The typical cost adding a reversing valve is $110 per nominal ton of cooling capacity.

CEPI-96-21

CEPI-97-21

IECC®: SECTION 202 (New), C403.3.4 (New), C403.3.4.1 (New), TABLE C403.3.4.1 (New), C403.3.4, TABLE C403.3.4

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 COMMERCIAL BOILER. A type of boiler with a capacity (rated maximum input) of 300,000 Btu/h or more and serving a space heating or water heating load in a commercial building.
C202 PROCESS BOILER. A type of boiler with a capacity (rated maximum input) of 300,000 Btu/h or more that serves a process load.
Add new text as follows:
C403.3.4 Boilers.

Boiler Systems shall comply with the following:

1. Combustion air positive shut-off shall be provided on all newly installed *boiler systems* as follows:
   - 1.1. All *boiler systems* with an input capacity of 2,500,000 Btu/h and above, in which the boiler is designed to operate with a nonpositive vent static pressure.
   - 1.2. All *boiler systems* where one stack serves two or more boilers with a total combined input capacity per stack of 2,500,000 Btu/h.
2. *Boiler system* combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:
   - 2.1. The fan motor shall be driven by a variable speed drive, or
   - 2.2. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

C403.3.4.1 *Boiler Systems* oxygen concentration controls.

Newly installed *boiler systems* with a steady state full-load combustion efficiency less than 90 percent and an input capacity of 5,000,000 Btu/h and greater shall maintain stack-gas oxygen concentrations at less than or equal to the values specified in table C403.3.4.1 below. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

TABLE C403.3.4.1 BOILER SYSTEMS OXYGEN CONCENTRATIONS

Boiler System Type	Minimum stack-gas oxygen concentration[a]
Commercial Boilers	5%
Process Boilers	3%

a. Concentration levels measured by volume on a dry basis over firing rates of 20 to 100 percent.

Revise as follows:
~~C403.3.4~~ C403.3.4.2 Boiler turndown.

Boiler systems with design input of greater than 1,000,000 Btu/h (293 kW) shall comply with the turndown ratio specified in Table ~~C403.3.4~~ C403.3.4.2.

The system turndown requirement shall be met through the use of multiple single-input boilers, one or more *modulating boilers* or a combination of single-input and *modulating boilers*.

TABLE ~~C403.3.4~~ C403.3.4.2 BOILER TURNDOWN

BOILER SYSTEM DESIGN INPUT (Btu/h)	MINIMUM TURNDOWN RATIO
≥ 1,000,000 and ≤ 5,000,000	3 to 1

> 5,000,000 and ≤ 10,000,000	4 to 1
> 10,000,000	5 to 1

For SI: 1 British thermal unit per hour = 0.2931 W.

Reason Statement:

Boiler oxygen controls, combustion air controls, and variable fan motors have been commonplace in state codes on larger boilers for quite some time. This proposal would align existing requirements in state codes with IECC. The effect will be an improvement in the part-load operation of larger boilers.

Savings are estimated at 2.116 kBtu/sqft and derived from the Title 24 CASE study as follows:

Flue damper – 2.5 mmbtu boiler 229 therms

VFD – 10 hp fan 4080 kWh

O2 trim controls – 5 mmBtu boiler 2746 therms

Based on EnergyPlus modeling of prototype buildings for California CASE study for 2022 Title 24. Savings shown above are an example assuming a large office building in CA Climate Zone 2 which is 13 stories. Provisions shown to be cost-effective for commercial boilers in all modeled scenarios except mixed use and apartment high-rise. Process boilers shown to be cost-effective in all cases due to constant load assumptions.

Final CASE report available here: https://title24stakeholders.com/wp-content/uploads/2020/08/NR-Boilers-and-Water-Heating_Final-CASE-Report.pdf

Bibliography:

Codes and Standards Enhancement (CASE) Initiative 2022 California Energy Code - High Efficiency Boilers and Service Water Heating, 2022-NR-HVAC3-F Final Case Report, August 2020

Cost Impact:

The code change proposal will increase the cost of construction.

Expected cost to implement boiler controls is estimated at $0.098/sqft and derived from the Title 24 CASE study as follows:

Flue damper cost = $1665 ($1500 2013 inflated 11% to 2021) + $166 ($150 2013 inflated 11%) every 10 years
VFD cost = $4716 ($4249 2013 inflated 11% to 2021) + ½ hour per year in maintenance @$100/hr
O2 trim controls cost = $7500 (2022) + 4 hours per year in maintenance @$100/hr

https://title24stakeholders.com/wp-content/uploads/2020/08/NR-Boilers-and-Water-Heating_Final-CASE-Report.pdf

CEPI-97-21

CEPI-98-21

IECC®: C403.3.5 (New), TABLE C403.3.5 (New), C403.3.5.1 (New), C403.3.5.2 (New), C403.7.4, C403.7.4.3 (New), C406.1

Proponents:

Mark Lyles, representing New Buildings Institute (markl@newbuildings.org); Diana Burk, representing New Buildings Institute (diana@newbuildings.org); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new text as follows:
C403.3.5 Dedicated outdoor air systems (DOAS).

Outdoor air shall be provided to each occupied space by a dedicated outdoor air system (DOAS), as required by Table C403.3.5, which delivers 100 percent outdoor air without requiring operation of the heating and cooling system fans for ventilation air delivery. For DOAS having a total fan system motor nameplate hp less than 5 hp, total combined fan power shall not exceed 1 W/cfm of outdoor air. Total fan power limits of Section C403.8.1 shall apply to each outdoor air unit of the DOAS and shall not include the fan power associated with the zonal heating and cooling equipment.

Exceptions:

1. Use groups listed as exempted in Table C403.3.5.
2. Occupied spaces that are solely ventilated by a natural ventilation system in accordance with Section 402 of the International Mechanical Code.
3. Buildings where the cooling and heating equipment exceeds the minimum efficiency requirements listed in the tables in Section C403.3.2 by 10 percent. Where multiple cooling performance requirements are provided, the equipment shall exceed the rating requirement, including IEER, SEER and IPLV as applicable. This exception shall not be used as a substitution for the more efficient HVAC equipment credit option per C406.2.
4. Buildings with underfloor air systems.

TABLE C403.3.5 OCCUPANCY CLASSIFICATIONS REQUIRING DOAS

OCCUPANCY CLASSIFICATIONS	COVERED USE GROUPS	EXEMPTED USE GROUPS
A-1	All use groups not specifically exempted	Television and radio studios
A-2	Casinos (gaming area)	All other use groups
A-3	Lecture halls, community halls, exhibition halls, gymnasiums, courtrooms, libraries, places of religious worship	All other use groups
A-4, A-5		All use groups
B	All use groups not specifically exempted	Food processing establishments including commercial kitchens, restaurants, cafeterias; laboratories for testing and research; data processing facilities and telephone exchanges; air traffic control towers; animal hospitals, kennels, pounds; and ambulatory care facilities.
F, H, I, R, S, U		All use groups
E, M	All use groups	

C403.3.5.1 Heating and cooling system fan controls.

Heating and cooling equipment fans, heating and cooling circulation pumps, and terminal unit fans shall cycle off and terminal unit primary cooling air shall be shut off when there is no call for heating or cooling in the zone.

Exemption: Fans used for heating and cooling using less than 0.12 watts per cfm may operate when space temperatures are within the set point dead band to provide destratification and air mixing in the space.

C403.3.5.2 Decoupled DOAS supply air.

The DOAS supply air shall be delivered directly to the occupied space or downstream of the terminal heating and/or cooling units.

Exceptions:

1. Active chilled beam systems.
2. Sensible only cooling terminal units with pressure independent variable airflow regulating devices limiting the DOAS supply air to the greater of latent load or minimum ventilation requirements.
3. Terminal heating and/or cooling units that comply with the low fan power allowance requirements in the exception of Section C403.3.5.1.

Revise as follows:

C403.7.4 Energy recovery systems.

Energy recovery ventilation systems shall be provided as specified in Section C403.7.4.3 and either Section C403.7.4.1 or C403.7.4.2, as applicable.

Add new text as follows:

C403.7.4.3 Spaces with Dedicated Outdoor Air Systems (DOAS).

Dedicated outdoor air systems (DOAS) shall include energy recovery ventilation in all cases and shall be in accordance with Section C403.7.4.1 or C403.7.4.2, as applicable.

Exception: Systems installed for the sole purpose of providing makeup air for systems exhausting toxic, flammable, paint, or corrosive fumes or dust, dryer exhaust, or commercial kitchen hoods used for collecting and removing grease vapors and smoke.

Revise as follows:

C406.1 Additional energy efficiency credit requirements.

New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Where not required by Section C403.3.5, the p~~P~~rovision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.

11. Efficient kitchen equipment in accordance with Section C406.12.

Reason Statement:

The majority of commercial HVAC systems are based around a central air handling delivery system. This system typically provides heating, cooling and ventilation air from a single source. Since cooling is typically the largest instantaneous load, the fans must be sized large enough to deliver enough air to meet the peak cooling requirements. When the ventilation is integrated, these large fans must operate during all occupied hours to deliver ventilation effectively to the space. This leads to very high fan energy use. With ventilation separated from the heating and cooling delivery, the large heating/cooling fans can be shut off unless there is a call for heating or cooling and the much smaller ventilation-only fans can operate to deliver fresh air to the space. Furthermore, when the ventilation air is delivered using either Energy Recovery Ventilation (ERV) the heating energy requirements associated with tempering the ventilation air are significantly reduced or eliminated. Compliance with this proposed code amendments requires the following in buildings where the cooling or heating system is not 10 percent more efficient than code requirements.

1. 100% ventilation air delivered directly to each zone separate from the heating/cooling system.
2. Ventilation air delivered using an ERV
3. Run heating and cooling equipment (fans and pumps) only when there is a call for conditioning in the zone.

Note that designs based around a DOAS are not new and it has long been established that this design direction leads to more energy efficient buildings. The General Services Administration required DOAS as the baseline design for all new GSA buildings unless otherwise directed by design programming in 1998 (Mumma, 2001). The specifications require perimeter and interior systems have 100 percent outside air ventilation systems which are completely independent of any other air distribution system. Enthalpy heat recovery must be included if the outside air required or equipment capacity exceeds a stated amount (GSA, 2003).

This proposed code change is similar to the requirements currently adopted in the Washington State Energy Code which requires buildings of only certain occupancy types to have a DOAS system. A DOAS would be required in buildings whose occupancy is intended for Mercantile (Group M), and Educational (Group E). A DOAS would also be required in most Business's (Group B) except those exempted, certain Assembly occupancies (Group A) for performing arts or motion pictures (except for television and radio studios), casinos, and lecture halls, community halls, exhibition halls, gymnasiums, courtrooms, libraries, and places of religious worship. A DOAS would not be required in buildings where the cooling or heating system is 10 percent more efficient than code requirements.A DOAS would also not be required in the building for occupancies for Residential (Group R), Factory and Industrial (Group F), High Hazard (Group H), Institutional (Group I), Storage (Group S), and Utility and Miscellaneous (Group U).The increased cost of requiring DOAS systems is more than offset by operating cost savings. When compared to a code-minimum system upgrade, very high efficiency DOAS can reduce commercial building energy use by an average of 9% to 17% depending on the type of DOAS system used in Climate Zone 4A (Deng, 2014). In California, installing a DOAS was found to save on average $4-$5 in operating costs for every additional dollar spent to install a DOAS in a building (Minezaki et al, 2020). Additionally, the DOAS option in Section C406 appears to provide energy savings in a majority of climate zones for the building occupancies represented. This proposal wound not only save energy but also exhibit improved indoor air quality, which is especially important in businesses and schools.

Bibliography:

Energy Benefits of Different Dedicated Outdoor Air System Configurations in Various Climates, Shihan Deng, University of Nebraska-Lincoln, May 2014, https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=1030&context=archengdiss

Nonresidential HVAC Controls, Minezaki et al, Codes and Standards Enhancement (CASE) Initiative 2022 California Energy Code, Sept. 2020, title24stakeholders.com/wp-content/uploads/2020/10/2022-T24-Final-CASE-Report-HVAC-Controls.pdf.

Cost Impact:

The code change proposal will increase the cost of construction.

On average the incremental cost of adding a DOAS for several building prototypes (small, medium and large office, retail, and schools) was found to be $880 per thousand square foot (Minezaki et al, 2020).

CEPI-98-21

CEPI-99-21

IECC®: SECTION 202 (New), C403.4.1.6 (New)

Proponents:

Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Josh Keeling, representing Cadeo Group (jkeeling@cadeogroup.com); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Matt Tidwell, representing Portland General Electric (matthew.tidwell@pgn.com); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Amber Wood, representing ACEEE (awood@aceee.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 GRID-INTEGRATED CONTROL. An automatic control that can receive, automatically respond to demand response requests from and send information back to a utility, electrical system operator, or third-party demand response program provider.
Add new text as follows:
C403.4.1.6 Grid-Integrated Controls.

All thermostatic controls shall be provided with grid-integrated controls capable of the following:

1. Automatically increasing the zone operating cooling set point by a minimum of 4°F (2.2°C)
2. Automatically decreasing the zone operating heating set point by a minimum of 4°F (2.2°C)
3. Automatically decreasing the zone operating cooling set point by a minimum of 2°F (1.1°C)
4. Automatically increasing the zone operation heating set point by a minimum of 2°F (1.1°C)
5. Both ramp-up and ramp-down logic to prevent the building peak demand from exceeding that expected without the DR implementation.

The thermostatic controls shall be capable of performing all other functions provided by the control when the grid-integrated controls are not available. Systems with direct digital control of individual zones reporting to a central control panel shall be capable of remotely complying.

Exception: Health care and assisted living facilities.

Reason Statement:

Grid-integrated controls for thermostats are added based on language from California Title 24 and ASHRAE Standard 189.1. Any thermostat listed as “Title 24 compliant” would meet this requirement. The controls allow for dialing back heating and cooling, as well as to accept additional heating or cooling when renewable energy generation is high or energy prices are low, and both ramp up and down requirements in relationship to the utility/grid operator/third party aggregator signal to prevent rebound issues on the grid after the signal is released.

In health care and assisted living facilities, thermostat setpoints can impact more than just thermal comfort, and temperature can be part of the health care being provided. To ensure that this requirement cannot have an adverse impact on those services, these facilities have been exempted from this requirement.

HVAC system control, often through thermostats, has been at the center of demand response (DR) programs for decades. DR programs continue to rely deeply on thermostat control strategies, but the need for such controls is fast growing. As electricity systems transform to include more variable wind and solar energy, demand flexibility becomes increasingly critical to both grid operation and further transformation. Building systems that can use energy when it is abundant, clean, and low-cost not only help decarbonize the entire energy system, they also insulate their owners from future increases in demand charges and peak hour energy rates – a current and accelerating trend.

Today’s demand response programs typically set event (call) durations between 15 minutes and 4 hours. The preconditioning strategies (cooling set point reduction / heating set point increase) and temporary setback strategies (cooling set point increase / heating set point reduction) will enable substantial HVAC system energy savings over this time frame. In many cases, in a building compliant with this code, tenants are unlikely to even notice a change in their thermal comfort. The inclusion of preconditioning helps ensure that the building is able to reduce electrical demand by adjusting HVAC setpoints while minimizing the risk of tenant disruption: in many cases the event will end before the higher cooling (or lower heating) set point is reached in the space.

Based on modeling by LBNL (foundational modeling supporting the May 2021 DOE Grid-integrated Efficient Buildings Roadmap), thermostat controls configured to deliver preconditioning and/or space temperature adjustments can reduce building peak demand by roughly 10% in many cases.

Bibliography:

A National Roadmap for Grid-Interactive Efficient Buildings, U.S. Department of Energy, 17 May 2021, https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf.

Final CASE Report: Upgradeable Setback Thermostats, California Statewide Codes and Standards Enhancement (CASE) Program, October 2011, https://title24stakeholders.com/wp-content/uploads/2020/01/2013_CASE-Report_Upgradeable-Setback-Thermostats.pdf

SupplyHouse. “T3700 - Venstar T3700 - Explorer T3700 Residential Digital Thermostat (2 Heat, 1 Cool).” SupplyHouse.com, www.supplyhouse.com/Venstar-T3700-Explorer-T3700-Residential-Digital-Thermostat-2-Heat-1-Cool. SupplyHouse. “T1010 - Venstar T1010 –Single Day Programmable Digital Thermostat” SupplyHouse.com, https://www.supplyhouse.com/Venstar-T1010-Venstar-T1010-Single-Day-Programmable-Digital-Thermostat

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2017 Tier III TRM Characterizations, Advanced Thermostat *https://publicservice.vermont.gov/sites/dps/files/documents/2017%20Tier%20III%20TRM%20Characterizations.pdf.*

Cost Impact:

The code change proposal will increase the cost of construction.

For larger commercial buildings with building management systems, it is not common to install a thermostat without demand response capabilities. Therefore, there is no incremental equipment cost associated with this measure for those building types. However, there could be soft costs to ensure those demand responsive controls function properly with the building management system. Conversations with industry experts indicate these soft costs can be around $0.25/s.f. for a medium office building. The primary cost drivers in thermostats are not the grid-integration controls but rather other features. Therefore, incremental costs vary. An entry-level grid-integrated thermostat currently available from a national retailer costs about $70, while the same retailer lists a similar non-grid-integrated programmable unit for just over $35, indicating an incremental cost of about $35. This cost has dropped in the last (X years) – A 2017 study out of Vermont cited incremental costs for smart thermostats in new construction at roughly $150 – *a decrease in incremental costs of $115 over just 4 years.*

However, smart thermostats (i.e., those with grid-integrated controls) are very common in new construction and represent a growing share of the retrofit market. All major smart thermostat brands already include grid-integration controls that comply with this requirement, so there is generally no incremental cost to include these controls assuming a smart thermostat is installed either based on customer preference or efficiency requirements.

Multifamily buildings and smaller commercial buildings that install direct-attached thermostats, demand responsive thermostats (which were estimated in a 2011 study to cost $68 more than a programmable thermostat) were found to be extremely cost effective. It was

estimated that installing demand responsive thermostats in a 10,000 s.f. office building resulted in 83kWh to 274 kWh of electricity savings and between 0.19 to 1.97kW in demand savings in Climate Zones 2-4. Every dollar spent on demand responsive thermostats yielded between $1.20 to $7 in operating cost savings over a 15-year period for office buildings. In the 10 years since, equipment prices have decrease and incremental costs are estimated to be only $40 making this measure even more cost effective than estimated previously for buildings without building management systems. This measure will not only result in cost savings for consumers but will also result in other significant societal benefits. According to DOE's report, "A National Roadmap for Grid-Interactive Efficient Buildings," every watt in peak demand savings was found to create 17 cents in annual electric grid system value. This value included energy savings, capacity savings, transmission deferral and ancillary services. A 10,000 square foot office building with a demand responsive thermostat which is estimated to reduce peak demand savings between 0.26 to 1.09kW would result in $44 to $334 in annual electric grid system value. Demand responsive thermostats which allow grid operators to reduce demand on the grid during the times when the carbon intensity of the electric grid is high also results in reduced carbon emissions generating additional significant societal benefits.
CEPI-99-21

CEPI-100-21

IECC®: C403.4.2.3

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C403.4.2.3 Automatic start and stop.

Automatic start and stop controls shall be provided for each HVAC system with direct digital control of individual zones. The automatic start controls shall be configured to automatically adjust the daily start time of the HVAC system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy. ~~Automatic stop controls shall be provided for each HVAC system with direct digital control of individual *zones*.~~ The automatic stop controls shall be configured to reduce the HVAC system's heating temperature setpoint and increase the cooling temperature setpoint by not less than 2°F (-16.6ºC) before scheduled unoccupied periods based on the thermal lag and acceptable drift in space temperature that is within comfort limits.

Exception: *Group R* occupancies are not required to have automatic start controls.

Reason Statement:

Based on addendum r to 90.1-2019.

This proposal:

1. Exempts residential occupancies because they do not start and stop equipment based on an occupancy schedule to which the requirement can be applied.
2. Makes an editorial change to make it clear that this applies to DDC-controlled systems. Though there are non-DDC systems that have a primitive automatic start and stop optimization capability, their savings are unproven.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum r

https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

As it is unlikely that automatic start and stop is applied to Group R occupancies in practice, this exception will likely not have an effect on the cost of construction.

CEPI-100-21

CEPI-101-21

IECC®: SECTION 202 (New), 403.4.3 (New)

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202

OCCUPIED-STANDBY MODE

. When a zone is scheduled to be occupied and an occupant sensor indicates no occupants are within the zone.
Add new text as follows:
403.4.3 Occupied-Standby Controls.

Ventilation systems serving room(s) where lighting is required to be turned off or reduced per the requirements of section C405.2.1 and where the ASHRAE Standard 62.1 occupancy category permits ventilation air to be reduced to zero when the space is in *occupied-standby mode when* using the 62.1 Ventilation Rate Procedureshall meet the following within 5 minutes of all room(s) in that zone entering *occupied-standby mode.*

1. Active heating setpoint shall be setback at least 1°F, and
2. Active cooling setpoint shall be setup at least 1°F, and
3. All airflow supplied to the zone shall be shutoff whenever the space temperature is between the active heating and cooling setpoints

Staff Note: ASHRAE 62.1 is only referenced in the IMC as an alternate method to select the system ventilation efficiency in Section 403.3.1.1.2.3.2, by using Appendix A of the standard.

Reason Statement:

Many spaces are unoccupied during normal building occupied hours. Office occupants are often away for long periods, either out of the office or attending to business in other parts of the building. Corridors and storage rooms are often empty of people. The expansion of work-from-home has increased the number of occupied-standby hours.Section C405.2.1 already requires occupancy sensors in many spaces/ Standard 62.1-2016 now allows zero ventilation in occupied standby mode for some occupancy categories including classrooms and offices (see TABLE 6.2.2.1 Minimum Ventilation Rates in Breathing Zone).Tremendous energy savings can be achieved by reducing deadband airflow and thereby reducing fan energy, cooling energy and reheat.

The intent is that for a zone to be unoccupied all spaces in that zone must be unoccupied. For example, if a zone consists of 3 perimeter private offices, then all 3 offices must be unoccupied for the zone to be considered unoccupied. If a zone is served by a dedicated outdoor air system (DOAS) and a separate cooling system then the DOAS flow to that zone must shut off and stay shut off when the zone is vacant and within the deadband. . The rationale for the setback/up is to nudge the zone into deadband in case the normal temperature controls have the zone perched just outside deadband.

The 1 degF setback was chosen to avoid comfort problems (the space temperature cannot instantly snap back when someone returns from lunch, like the lights do) which could leads to occupants defeating the controls. Aggressive setup/setback also has minimal energy savings. Since lighting, people, and ventilation loads are gone in standby mode and the envelope/plug loads typically need to be met either in standby or when the space returns to occupied mode. Large setbacks can actually use more energy than small ones because zones go to max heating or cooling to recover which may force the system to operate in a manner that uses more energy than it would with a smaller setback.

The requirement that the 62.1 Ventilation Rte Procedure be used is so that designers that have applied the Indoor Air Quality Procedure, which typically results in lower overall ventilation rates, d o not have to raise those rates to account for occupied-standby hours.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

Cost Impact:

The code change proposal will increase the cost of construction.

Some additional controls or programming will be required to implement occupied-standby control. Modeling has shown that it is very cost-effective. Data will be shared with the committee.

CEPI-101-21

CEPI-102-21

IECC®: SECTION 202 (New), C403.4.6 (New), C403.4.6.1 (New), C403.4.6.2 (New), C403.4.6.3 (New)

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 HUMIDISTATIC CONTROLS. Automatic controls used to maintain humidity at a fixed or adjustable setpoint.
Add new text as follows:
C403.4.6 Humidification and dehumidification controls..

Humidification and dehumidification controls shall be in accordance with this section.

C403.4.6.1 Dehumidification.

Humidistatic controls shall not use mechanical cooling to reduce the humidity below the lower of a dew point of 55°F or relative humidity of 60% in the coldest zone served by the system. Lower humidity shall be permitted where mechanical cooling is being used for temperature control.

Exceptions:

1. Where approved, systems serving zones where specific humidity levels are required, such as museums and hospitals, and where *humidistatic controls* are capable of and configured to maintain a dead band of at least 10% relative humidity where no active humidification or dehumidification takes place.
2. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5% relative humidity to comply with applicable codes or accreditation standards or as approved by the authority having jurisdiction.

C403.4.6.2 Humidification.

Humidistatic controls shall not use fossil fuels or electricity to produce relative humidity above 30% in the warmest zone served by the system.

Exceptions:

1. Where approved, systems serving zones where specific humidity levels are required, such as museums and hospitals, and where *humidistatic controls* are capable of and configured to maintain a dead band of at least 10% relative humidity where no active humidification or dehumidification takes place.
2. Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5% relative humidity to comply with applicable codes or accreditation standards or as approved by the authority having jurisdiction.

C403.4.6.3 Control Interlock.

Where a zone is served by a system or systems with both humidification and dehumidification capability, means such as limit switches, mechanical stops, or, for DDC systems, software programming shall be provided capable of and configured to prevent simultaneous operation of humidification and dehumidification equipment.

Exception: Systems serving zones where humidity levels are required to be maintained with precision of not more than ±5% relative humidity to comply with applicable codes or accreditation standards or as approved by the authority having jurisdiction.

Reason Statement:

The proposal adds requirements for control of HVAC systems when they are explicitly controlled to maintain humidity at maximum or minimum values or within a range.They prevent wasting of energy by dehumidifying or humidifying beyond the requirements for human comfort and health. Exceptions that allow designers to meet other code or accreditation requirements are included. These requirements do not apply when the space is only controlled by a thermostat and dehumidification is incidental to the cooling.

These requirements have been in ASHRAE 90.1 for many years. The text was updated in the 2019 version of the standard for clarity, including an informative note that explains lower humidity levels are allowed when the space conditions are controlled based on temperature.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposal does not require the use of humidistatic controls nor does it require equipment with capacities that are greater than a designer would have otherwise selected.

CEPI-102-21

CEPI-103-21

IECC®: C403.5

Proponents:

John Bade, representing California Investor Owned Utilities (johnbade@2050partners.com)

2021 International Energy Conservation Code

Revise as follows:
C403.5 Economizers.

Economizers shall comply with Sections C403.5.1 through C403.5.5.

An air or water economizer shall be provided for the following cooling systems:

1. Chilled water systems with a total cooling capacity, less cooling capacity provided with air economizers, as specified in Table C403.5(1).

2. Individual fan systems with cooling capacity greater than or equal to 54,000 Btu/h (15.8 kW) in buildings having other than a *Group R* occupancy,

   The total supply capacity of all fan cooling units not provided with economizers shall not exceed 20 percent of the total supply capacity of all fan cooling units in the building or 300,000 Btu/h (88 kW), whichever is greater.

3. Individual fan systems with cooling capacity greater than or equal to 270,000 Btu/h (79.1 kW) in buildings having a *Group R* occupancy.

   The total supply capacity of all fan cooling units not provided with economizers shall not exceed 20 percent of the total supply capacity of all fan cooling units in the building or 1,500,000 Btu/h (440 kW), whichever is greater.

Exceptions: Economizers are not required for the following systems.

1. Individual fan systems not served by chilled water for buildings located in *Climate Zones* 0A, 0B, 1A and 1B.

2. Where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F (1.7°C) dew-point temperature to satisfy process needs.

3. Systems expected to operate less than 20 hours per week.

4. Systems serving supermarket areas with open refrigerated casework.

5. Where the cooling efficiency is greater than or equal to the efficiency requirements in Table C403.5(2).

6. Systems that include a heat recovery system in accordance with Section C403.10.5.

7. ~~VRF systems~~ Direct-expansion fancoils with a capacity less than 54,000 Btu/h and at least three stages of conpressor capacity installed with a dedicated outdoor air system.

Reason Statement:

The exemption from economizer requirements for variable refrigerant flow (VRF) systems employed with a dedicated outdoor air system added in IECC 2021 was reasonable. However, limiting the exception to only VRF systems created an unfair advantage in the market for those systems. Other zone-level DX fan coil systems with multi-stage compressors, such as water-source heat pumps, provide equal or better energy savings. This proposal levels the playing field and eliminates the need to provide water coils in those products.

The limit to fan coils with a capacity of less than 54,000 Btu/h aligns the exception with the requirements in the body. VRF systems tested under AHRI 1230 do not include fan coils with a capacity of 54,000 Btu/h or more, and engineering analysis indicates that VRF systems that employ such fan coils very likely do not operate at the same level of efficiency as those that employ smaller capacity coils.

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposal will eliminate the need to provide economizer water coils in DX fan coils in non-VRF systems. Since the market share of VRF fan coils with a capacity of 54,000 Btu/h or greater is very small, the net change in cost to builders will be negative.

CEPI-103-21

CEPI-104-21

IECC®: C403.5

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Revise as follows:
C403.5 Economizers.

Economizers shall comply with Sections C403.5.1 through C403.5.5.

An air or water economizer shall be provided for the following cooling systems:

1. Chilled water systems with a total cooling capacity, less cooling capacity provided with air economizers, as specified in Table C403.5(1).

2. Individual fan systems with cooling capacity greater than or equal to 54,000 Btu/h (15.8 kW) in buildings having other than a *Group R* occupancy,

   The total supply capacity of all fan cooling units not provided with economizers shall not exceed 20 percent of the total supply capacity of all fan cooling units in the building or 300,000 Btu/h (88 kW), whichever is greater.

3. Individual fan systems with cooling capacity greater than or equal to 270,000 Btu/h (79.1 kW) in buildings having a *Group R* occupancy.

   The total supply capacity of all fan cooling units not provided with economizers shall not exceed 20 percent of the total supply capacity of all fan cooling units in the building or 1,500,000 Btu/h (440 kW), whichever is greater.

Exceptions: Economizers are not required for the following systems.

1. Individual fan systems not served by chilled water for buildings located in *Climate Zones* 0A, 0B, 1A and 1B.

2. Where more than 25 percent of the air designed to be supplied by the system is to spaces that are designed to be humidified above 35°F (1.7°C) dew-point temperature to satisfy process needs.

3. Systems expected to operate less than 20 hours per week.

4. Systems serving supermarket areas with open refrigerated casework.

5. Where the cooling efficiency is greater than or equal to the efficiency requirements in Table C403.5(2).

6. Systems that include a heat recovery system in accordance with Section C403.10.5.

7. VRF <u>and Water Source Heat Pump</u> systems installed with a dedicated outdoor air system.

Reason Statement:

If VRF systems are exempted when their energy recovery abilities are limited to 35 ton blocks, a WSHP system with no restriction on tonnage or energy recovery sharing capabilities should be exempted as well. VRF is often not designed to take advantage of energy recovery, therefore the projected energy recovery is not realized.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This will lower the cost of construction in some areas, while leaving others neutral.

CEPI-104-21

CEPI-105-21

IECC®: TABLE C403.5.1

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.5.1 DX COOLING STAGE REQUIREMENTS FOR MODULATING AIRFLOW UNITS

RATING CAPACITY	MINIMUM NUMBER OF MECHANICAL COOLING STAGES	MINIMUM COMPRESSOR DISPLACEMENT[a]
≥ 65,000 Btu/h and < 240,000 Btu/h	3 stages	≤ 35% of full load
≥ 240,000 Btu/h	4 stages	≤ 25% full load

For SI: 1 British thermal unit per hour = 0.2931 W.

a. For mechanical cooling stage control that does not use variable compressor displacement, the percent displacement shall be equivalent to the mechanical cooling capacity reduction evaluated at the full load rating conditions for the compressor.

<u>b. Condenser fans shall have head pressure control with an EC motor with a variable speed drive to minimize energy consumption.</u>

Reason Statement:

The use of variable speed condenser fans, improves head pressure control. This extends equipment life, and reduces energy consumption of the condenser fans, improving the overall system efficiency.

Cost Impact:

The code change proposal will increase the cost of construction.

Potential for minor increase in HVAC equipment cost.

CEPI-105-21

CEPI-106-21

IECC®: C403.5.3.4

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:
C403.5.3.4 Relief of excess outdoor air.

Systems shall ~~be~~provide one of the following means ~~capable of~~to ~~relieving~~ relieve excess *outdoor air* during air economizer operation to prevent overpressurizing the building.

1. Return or relief fan(s) meeting the requirements of Section C403.10.1.
2. Barometric or motorized damper relief path with a total pressure drop at design relief airflow rate less than 0.10 inches water column (25 Pa) from the occupied space to outdoors. Design relief airflow rate shall be the design supply airflow rate minus any continuous exhaust flows, such as toilet exhaust fans, whose makeup is provided by the economizer system.

The relief air outlet shall be located to avoid recirculation into the building.

Reason Statement:

Based on addendum g to ASHRAE 90.1-2019.

The current language in Section 403.5.3.4 is vague and unenforceable. Consequently, it is often ignored and violated. The language added in the proposal is specific and enforceable and will achieve the desired intent of the current language.When the relief path has a high static resistance, and the relief is not fan-powered, economizer use results in overpressurization of the building. When the building is overpressurized, occupants often have difficulty opening or closing doors and complain of high air velocities through openings to the outside. The problem is too often resolved by disabling economizer operation and losing the associated energy savings. Requiring return/relief fans or properly sized barometric relief will prevent overpressurization and thus save energy by allowing 100% economizing and eliminating the need for building operators to disable economizers.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum g

https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This change only clarifies the requirements for the prevention of building overpressurization.

CEPI-106-21

CEPI-107-21

IECC®: C403.6.1, ASHRAE Chapter 06 (New)

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:
C403.6.1 Variable air volume and multiple-zone systems.

Supply air systems serving multiple zones shall be variable air volume (VAV) systems that have zone controls configured to reduce the volume of air that is reheated, recooled or mixed in each zone to one of the following:

1. ~~Twenty~~Thirty percent of the zone design peak supply for systems ~~with~~without *direct digital control* (DDC)~~ and 30 percent for other systems~~.
2. Systems with DDC where all of the following apply:
   - 2.1. The airflow rate in the deadband between heating and cooling does not exceed ~~20 percent of the zone design peak supply rate or~~ the ~~higher~~ highest of the allowed rates under Items 3, 4, ~~and~~ 5, or 6 of this section.
   - 2.2. The first stage of heating modulates the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the deadband flow rate.
   - 2.3. The second stage of heating modulates the airflow rate from the deadband flow rate up to the heating maximum flow rate that is less than 50 percent of the zone design peak supply rate.
3. The outdoor airflow rate required to meet the minimum ventilation requirements of Chapter 4 of the International Mechanical Code.
4. The minimum primary airflow rate required to meet the Simplified Procedure ventilation requirements of ASHRAE Standard 62.1 for the zone and is permitted to be the average airflow rate as allowed by ASHRAE Standard 62.1

~~4~~5. Any higher rate that can be demonstrated to reduce overall system annual energy use by offsetting reheat/recool energy losses through a reduction in outdoor air intake for the system as approved by the code official.

~~5~~6. The airflow rate required to comply with applicable codes or accreditation standards such as pressure relationships or minimum air change rates.

Exception: The following individual zones or entire air distribution systems are exempted from the requirement for VAV control:

1. *Zones* or supply air systems where not less than 75 percent of the energy for reheating or for providing warm air in mixing systems is provided from a site-recovered, including condenser heat, or site-solar energy source.
2. Systems that prevent reheating, recooling, mixing or simultaneous supply of air that has been previously cooled, either mechanically or through the use of economizer systems, and air that has been previously mechanically heated.

Add new standard(s) as follows:
ASHRAE ASHRAE 180 Technology Parkway NW Peachtree Corners GA 30092

62.1-2019 Ventilation for Acceptable Indoor Air Quality

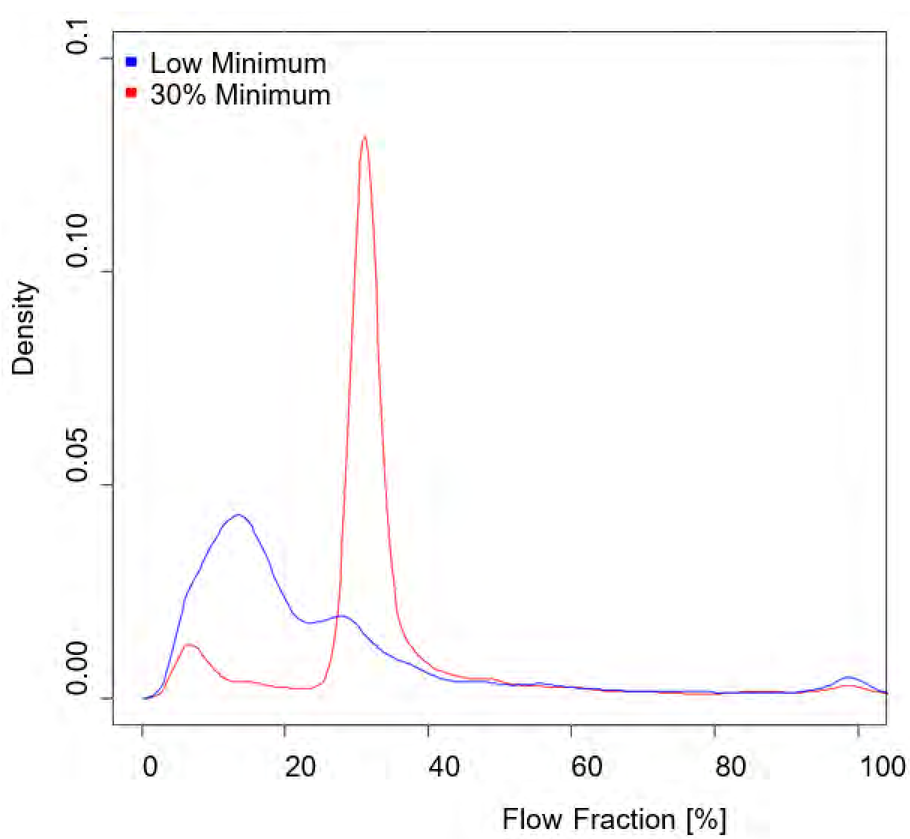
Staff Note: ASHRAE 62.1 is only referenced in the IMC as an alternate method to select the system ventilation efficiency in Section 403.3.1.1.2.3.2,
by using Appendix A of the standard.

Reason Statement:

C403.6.1- Variable air volume and multiple-zone systems provides six options to determine the minimum air in each zone for a VAV system. For systems with DDC controls, there are two paths.

- Option 1 is a simplified method that allows the designer to assign a minimum of 20% of peak design airflow with no other requirements.
- Option 2 allows the user to use 20% of peak design airflow, or a higher value if required by the IMC or other codes or accreditation standards, or if it can be shown to otherwise save energy by reducing outdoor airflow. Unlike Option 1, the energy-saving dual max strategy during heating mode must be applied.

This proposal eliminates the blanket allowance to use 20% of the peak airflow rate in option 1 and the 20% floor in Option 2. Outdoor air rates are generally much lower than 20% of the maximum rate, but designers have felt they needed a higher percentage to meet the requirements of the IMC for multiple zone systems.Moreover, using percentages to determine minimums is problematic because VAV boxes are almost always oversized due to conservative load assumptions for occupants, lights, plug loads, etc. It is not unusual for boxes to be sized 3 or more times larger than they need to be, as was found to be the case in ASHRAE RP-1515 “Thermal and air quality acceptability in buildings that reduce energy by reducing minimum airflow from overhead diffusers.” The figure below from RP-1515 shows measured frequency of airflow rates in 7 California office buildings using 30% minimums (based on earlier versions of Standard 90.1) compared to the current “dual maximum” under Option 2. The figure shows that even if the minimums were set to 20% instead of 30%, excess air would have been supplied due to the oversized cooling maximum setpoint, wasting fan energy, heating energy, and cooling energy. RP-1515 also demonstrated that high minimums increased discomfort by “pushing” zones into heating mode in the summer months, causing overcooling complaints. Thus, based on RP-1515 results, we expect this addendum to both reduce energy costs and improve comfort.



The 20% floor was also removed from Option 2, which saves a lot of energy but does remove a "simplified" option for calculating the minimum airflow. The proposal suggests allowing an alternate simplified method from ASHRAE 62.1 which would save energy vs. the existing 20% floor. While the inclusion of the ASHRAE Simplified Method is not absolutely needed in the code, it would offer a simpler and easier to enforce path.

Addendum f to Standard 62.1 created a simplified way of determining outdoor air rates for multiple zone recirculating air handling systems that includes a simple prescriptive requirement for calculating minimum air handler outdoor air rates and minimum setpoints for VAV zones:

6.2.5.2 System Ventilation Efficiency. The system ventilation efficiency (Ev) shall be determined in accordance with Section 6.2.5.3 for the Simplified Procedure or Normative Appendix A for the Alternative Procedure.

6.2.5.3 Simplified Procedure

6.2.5.3.1 System Ventilation Efficiency. System Ventilation Efficiency (Ev) shall be determined in accordance with Equation 6.2.5.3.1A or B.

$Ev = 0.88*D + 0.22$ for $D<0.60$ (6.2.5.3.1A)

$Ev = 0.75$ for $D\geq 0.60$ (6.2.5.3.1B)

6.2.5.3.2

Zone Minimum Primary Airflow. For each zone, the minimum primary airflow (*Vpz-min*) shall be determined in accordance with equation 6.2.5.3.2.

$Vpz\text{-}min = Voz*1.5$ (6.2.5.3.2)

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Cost impact. This addendum is not expected to increase the cost of construction. The requirement is simply for existing VAV terminal boxes to be set with a different dead band primary air minimum for dual maximum boxes.

CEPI-107-21

CEPI-108-21

IECC®: SECTION 202 (New), C403.7, C403.7.8 (New), C403.7.8.1 (New), C403.7.8.2 (New), CHAPTER 6 [CE], ASHRAE Chapter 06 (New)

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 OCCUPIED-STANDBY MODE. Mode of operation when an HVAC zone is scheduled to be occupied and an occupant sensor indicates no occupants are within the zone.
Revise as follows:
C403.7 Ventilation and exhaust systems.

In addition to other requirements of Section C403 applicable to the provision of ventilation air or the exhaust of air, ventilation and exhaust systems shall be in accordance with Sections C403.7.1 through C403.7.~~7~~8.

Add new text as follows:
C403.7.8 Occupied Standby Controls.

Occupied-standby controls are required for zones and systems serving zones where all spaces served by the zone are required to have occupant sensor lighting controls by Section C405.2.1 and are an ASHRAE Standard 62.1 occupancy category where the 62.1 Ventilation Rate Procedure allows the ventilation air to be reduced to zero when the space is in *occupied-standby mode*. Spaces meeting these criteria include:

1. Post-secondary classrooms/lecture/training rooms
2. Conference/meeting/multipurpose rooms
3. Lounges/breakrooms
4. Enclosed offices
5. Open plan office areas
6. Corridors

C403.7.8.1 Occupied Standby Zone Controls.

For zones meeting the occupied-standby control criteria, within five (5) minutes of all rooms in that zone entering *occupied-standby mode*, the zone control shall operate as follows:

1. Active heating set point shall be setback at least 1°F.
2. Active cooling set point shall be setup at least 1°F.
3. All airflow supplied to the zone shall be shut off whenever the space temperature is between the active heating and cooling set points.

Exception: Multiple zone systems without automatic zone flow control dampers.
C403.7.8.2 Occupied Standby System Controls.

Multiple zone systems that can *automatically* reset the effective minimum outdoor air setpoint and that serve zones with occupied-standby zone controls shall reset the effective minimum outdoor air setpoint based on a zone outdoor air requirement of zero for all zones in *occupied-standby mode*. Sequences of operation for system outside air reset shall comply with ASHRAE Guideline 36 or with an *approved* method.

CHAPTER 6 [CE] REFERENCED STANDARDS

Add new standard(s) as follows:
ASHRAE ASHRAE 180 Technology Parkway NW Peachtree Corners GA 30092

Guideline 36-2021   High-Performance Sequences of Operation for HVAC Systems

Reason Statement:

This proposal would bring into the IECC, the benefits of occupied standby controls that are currently in ASHRAE 90.1 and other building codes. This saves energy by turning off ventilation air to zones that occupancy sensors identify as unoccupied but are scheduled to be occupied. This proposal also expands upon the ASHRAE standard by making explicit that for multiple zone systems, the system outside air also needs to be proportionately reduced when ventilation air has been shut off to one or more zones.

Standard 62.1-2019 allows zero ventilation in occupied standby mode for some occupancy categories including classrooms and offices (see TABLE 6.2.2.1 Minimum Ventilation Rates in Breathing Zone). Section C405.2.1 of the IECC already requires occupancy sensors for lighting control in certain spaces including classrooms, conference rooms, and offices of all sizes. Occupied standby was introduced into the 2019 of ASHRAE 90.1. We are recommending that IECC also capture tremendous global energy savings by reducing deadband airflow and thereby reducing fan energy, cooling energy and reheat. For the spaces chosen, the occupancy sensors are already in the spaces, this proposal requires a modest levels of cost for lighting systems and HVAC integration to realize the energy and operating cost savings.

The occupied standby requirement in 90.1-2019 requires shutting off ventilation air to unoccupied zones. For single zone systems this saves fan energy and the thermal energy associated with conditioning outside air. For multi-zone systems, the zone ventilation air is shut off which reduces fan energy and reheat energy, but currently there is not an explicit requirement in ASHRAE 90.1 to reset the outside air amounts at the system level and thus there is not the thermal energy savings associated with conditioning less outside air. Significant energy savings can be achieved by also resetting the minimum outside airflow setpoint at the air handler. Thus this proposal makes explicit what was implied in ASHRAE 90.1 in regards to resetting multiple zone system outside air amounts.

For systems that already have the ability to reset the minimum outside airflow setpoint this is a minor sequence change. No additional hardware or software is required. ASHRAE Guideline 36-2021 already includes the sequences needed for multiple zone systems to reset the effective minimum outdoor air setpoint based on a zone outdoor air requirement of zero for all zones in occupied standby mode.

Bibliography:

ASHRAE Standard 90.1-2019 *Energy Standard for Buildings Except Low-rise residential Buildings.* Section 6.5.3.8 Occupied- Standby Controls. American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASHRAE Standard 62.1-2019. *Ventilation for Acceptable Indoor Air Quality.* American Society of Heating, Refrigerating and Air-Conditioning Engineers

ASHRAE Guideline 36-2021. *High-Performance Sequences of Operation for HVAC Systems.* American Society of Heating, Refrigerating and Air-Conditioning Engineers

Integral Group and Taylor Engineering. 2018. Codes and Standards Enhancement (CASE) Initiative *2019 California Building Energy Efficiency Standards: Proposals Based on ASHRAE 90.1-2016 – Results Report* http://title24stakeholders.com/wp-content/uploads/2019/01/T24-2019-CASEStudy-Results-Reports-Proposal-Based-on-ASHRAE-90.1-_Final_with_Attachments.pdf

LBNL. 2011. *A Meta-Analysis of Energy Savings from Lighting Controls in Commercial Buildings.* Lawrence Berkeley National Laboratory. LBNL-5095E https://eta-publications.lbl.gov/sites/default/files/a_meta-analysis_of_energy_savings_from_lighting_controls_in_commercial_buildings_lbnl-5095e.pdf

PNNL 2015 *"Cost-effectiveness Analysis of Occupant standby control for HVAC"* prepared by Reid Hart at Pacific Northwest National Laboratory

Texas A&M ARPA-E Projects (see two papers below) - https://hvac.engr.tamu.edu/arpa-e/

Pang, Z., Chen, Y., Zhang, J., O'Neill, Z., Cheng, H., & Dong, B. (2020). *Nationwide HVAC energy-saving potential quantification for office buildings with occupant-centric controls in various climates*. Applied Energy, 279, 115727. https://www.sciencedirect.com/science/article/abs/pii/S0306261920312186

Ye, Y., Chen, Y., Zhang, J., Pang, Z., O'Neill, Z., Dong, B., & Cheng, H. (2021). *Energy-saving potential evaluation for primary schools with occupant-centric controls.* Applied Energy, 293, 116854. https://www.sciencedirect.com/science/article/abs/pii/S0306261921003469

Cost Impact:

The code change proposal will increase the cost of construction.

There is a first cost impact associated with this measure. For the analysis done for ASHRAE 90.1, the estimated cost was $100 per zone plus $20 per room. The cost of the occupancy sensor is not included as this proposal only applies to those zones where all the spaces served by the zone are already required to have occupant sensor control of the lighting.

For the 2019 ASHRAE 90.1 proposal, a typical office building was simulated in eQuest in 3 climates. Assumptions:

- 50,000 ft2, 5 story office
- Packaged VAV with HW reheat
- Standby control reduces zone flow by 0.3 cfm/ft2 in standby mode
- Average single room zone size of 800 ft2
- Average multiple room zone size of 200 ft2/room
- Average utility rates of $0.10/kwh and $1.0/therm
- Required scalar: 10yr simple payback
- Total incremental cost: $100/zone + $20 per additional room if more than one room in the zone.

Life Cycle Cost-Effectiveness Results

In order to meet the scalar a single room zone would only have to be unoccupied 8% of the time in Los Angeles, 9% in Atlanta and 10% is Chicago.

A zone with (5) 200 ft2 rooms must have all rooms unoccupied at least 12% of the time in Los Angeles, 13% in Atlanta and 14% in Chicago. In comparison, the LBNL meta-study of lighting controls found that on average occupancy sensors reduced the operating hours of lighting by 30%. Thus, the savings on average are at least twice that needed to render the measure cost-effective.

Texas A&M ARPA-E Projects (Pang et al and Ye et al Occupant-centric controls studies)

These projects compared a Baseline Case with no occupancy sensing, Advanced Case I with occupancy presence sensing, and Advanced Case II with occupant counting sensing. Advanced Case I is essentially occupied-standby control (turn off ventilation when no one is in the zone) and Advanced Case II is occupied standby control plus demand control ventilation (reduce ventilation based on the number of people in the zone and turn off ventilation when no one is in the zone). The following figure is from the Pang et al paper for the medium office building prototype simulated in the IECC climate zones. The three bars in each climate zone correspond to the baseline case, Advanced Case I, and Advanced Case II from left to right. The yellow and orange texts on top of the bars show the HVAC energy saving fractions of Advanced Case I and Advanced Case II against the baseline. These savings range from 19% to 43% of total HVAC site energy consumption.

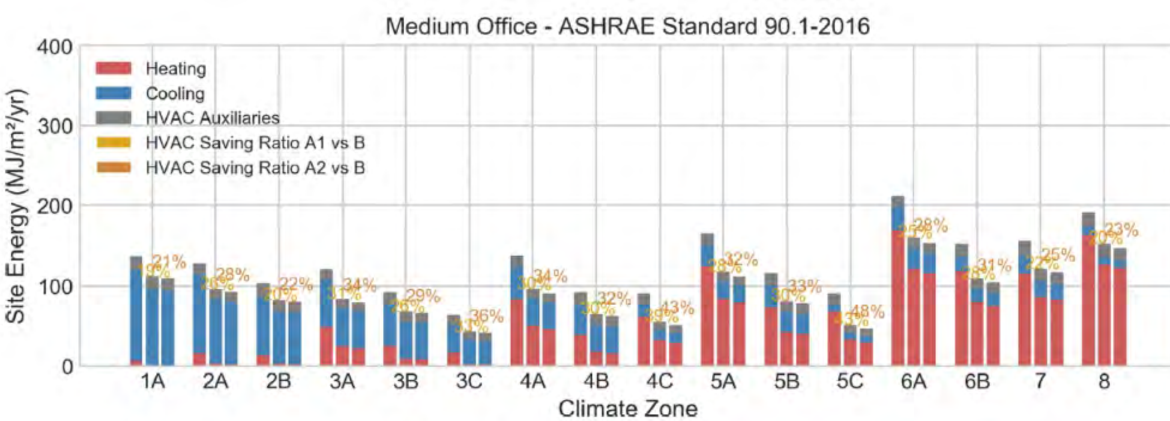
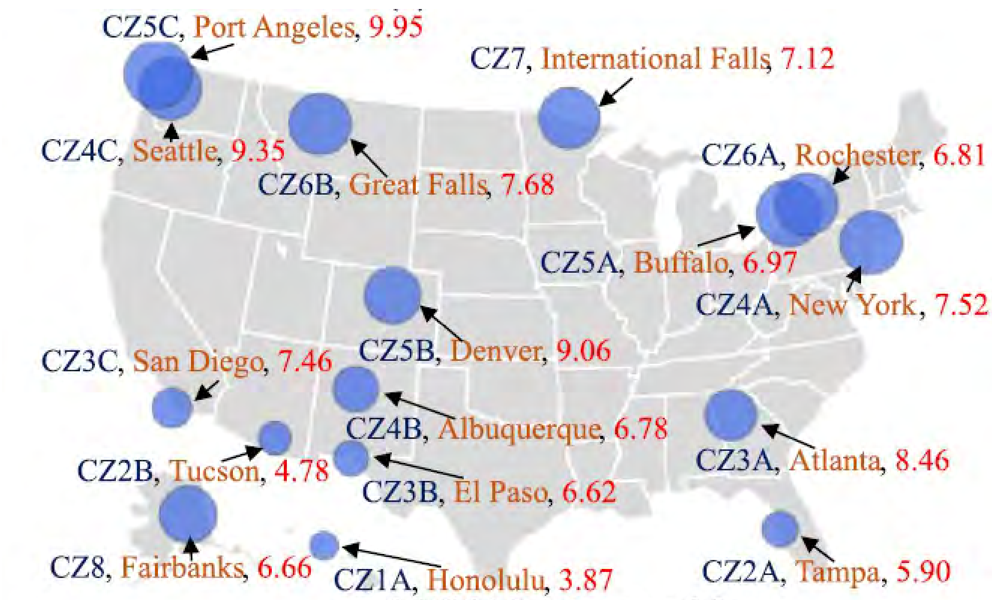


Fig. 18. HVAC energy simulation results of the medium office building per ASHRAE Standard 90.1 – 2016.

The second figure is from the Ye et al paper which conducts the same evaluation for schools. The savings from "Advanced Control 1" represent the occupied-standby control percent savings for the school prototype for all of the reference cities for the various IECC climate zones. These values range between 3% and almost 10% of whole building site energy savings. These are massive savings. More details are in the papers listed in the Bibliography.



(c) 2016 Advanced I

CEPI-108-21

CEPI-109-21

IECC®: C403.7.1

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Revise as follows:
C403.7.1 Demand control ventilation.

Demand control ventilation (DCV) shall be provided for all single-zone systems required to comply with Sections C403.5 through C403.5.3 and spaces larger than 250 ~~500~~ square feet (23.2~~46.5~~ m^2) in climate zones 5A,6,7 and 8 and spaces larger than 500 square feet (46.5m2) in other climate zones and with an average occupant load of 15 people or greater per 1,000 square feet (93 m^2) of floor area, as established in Table 403.3.1.1 of the International Mechanical Code, and served by systems with one or more of the following:

1. An air-side economizer.
2. Automatic modulating control of the outdoor air damper.
3. A design outdoor airflow greater than 3,000 cfm (1416 L/s).

Exceptions:

Spaces served by systems ~~Systems~~ with energy recovery complying with and required by Section C403.7.4.2. that have floor area less than:

1. 1.1. 6000 square feet (2600m^2) in climate zone 3C
   1.2. 2000 square feet (190m^2) in climate zones 1A, 3B and 4B
   1.3. 1000 square feet (90m^2) in climate zones 2A, 2B, 3A, 4A, 4C, 5 and 6.
   1.4. 400 square feet (40m^2) in climate zones 7 and 8.
2. Multiple-zone systems without direct digital control of individual zones communicating with a central control panel.
3. Multiple-zone systems with a design outdoor airflow less than 750 cfm (354 L/s).
4. Spaces where more than 75 percent of the space design outdoor airflow is required for makeup air that is exhausted from the space or transfer air that is required for makeup air that is exhausted from other spaces.
5. Spaces with one of the following occupancy classifications as defined in Table 403.3.1.1 of the *International Mechanical Code*: correctional cells, education laboratories, barber, beauty and nail salons, and bowling alley seating areas.

Reason Statement:

The proposal lowers the general area threshold from 500 to 250 square feet for spaces in cold climate zones, as there is a greater cost to condition outdoor air. This threshold applies to spaces served by systems without energy recovery. Further, demand-controlled ventilation will provide cost effective savings for systems with energy recovery, although the space size threshold will be larger than the general threshold set in the charging language for spaces without energy recovery. The exceptions for energy recovery, rather than being a blanket exception, will now increase the area threshold relative to the savings that DCV will achieve with energy recovery so that DCV will be cost effective for those spaces. The climate zones are grouped in the exception, so that larger spaces are excepted in warmer climate zones. These thresholds are based on a cost-effective analysis for addendum b to ASHRAE Standard 90.1-2019 that showed cost effectiveness for smaller areas generally than prescribed in 2021 IECC. To avoid complexity, climate zones have been grouped for simplification here.

Cost Impact:

The code change proposal will increase the cost of construction.

Typical cost per space for DCV controls is $350. When there is energy recovery, DCV savings is reduced so to maintain cost effectiveness the area threshold in the exceptions is greater than the threshold without DCV in the revised charging language. For larger spaces, more outdoor air is required, and more savings is achieved. Cost effectiveness Can be determined by finding the floor area that matched the scalar payback of 11.8 for a 15 year life. For example, based on the ASHRAE cost effectiveness analysis, a classroom in climate zone 5A without energy recovery would have DCV cost effective for any space size greater than 196 square feet (20 m^2). In the same example with reduced savings due to energy recovery, DCV is cost effective for any space size greater than 703 square feet (70 m^2). The results per climate zone are grouped together and thresholds rounded for simplification.

CEPI-109-21

CEPI-110-21

IECC®: C403.7.1

Proponents:

Mike Kennedy, Mike D. Kennedy Inc., representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:
C403.7.1 Demand control ventilation.

Demand control ventilation (DCV) shall be provided for the following:

1. Spaces with ventilation provided by ~~all~~ single-zone systems where an air-side economizer is provided ~~required~~ to comply with Section~~s~~ C403.5 ~~through C403.5.3 and~~

2. Spaces larger than 500 square feet (46.5 m^2) ~~and~~ which have ~~with~~ an ~~average~~ occupant load of 15 people or greater per 1,000 square feet (93 m^2) of floor area, as established in Table 403.3.1.1 of the International Mechanical Code, and are served by systems with one or more of the following:

   ~~1~~2.1. An air-side economizer.

   ~~2~~2.2. Automatic modulating control of the outdoor air damper.

   ~~3~~2.3. A design outdoor airflow greater than 3,000 cfm (1416 L/s).

Exceptions:

1. Spaces served by systems ~~Systems~~ with energy recovery complying with Section C403.7.4.2.

~~2. Multiple-zone systems without direct digital control of individual zones communicating with a central control panel.~~

2~~3~~. Spaces served by multiple- ~~Multiple~~ zone systems with a design outdoor airflow less than 750 cfm (354 L/s).

3~~4~~. Spaces where more than 75 percent of the space design outdoor airflow is required for makeup air that is exhausted from the space or transfer air that is required for makeup air that is exhausted from other spaces.

4~~5~~. Spaces with one of the following occupancy classifications as defined in Table 403.3.1.1 of the *International Mechanical Code*: correctional cells, education laboratories, barber, beauty and nail salons, and bowling alley seating areas.

Reason Statement:

This proposal clarifies where DCV is required. All exceptions are edited to be space centric since the requirement is for spaces to have DCV. The only substantive change is to remove exception 2. During the Washington State Energy Code technical advisory group meetings several engineers felt this was unneeded: that most all multi-zone systems have DDC, and if not they should.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal is a restatement of the DCV language to clarify the intent and remove an exception that is no longer useful given the state of building controls. There is no cost impact as when and where DCV is required is not changed.

CEPI-110-21

CEPI-111-21

IECC®: SECTION 202 (New), C403.7.2

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202

PARKING GARAGE SECTION

. A part of a parking garage where airflow is restricted from other parts of the garage by solid walls.
Revise as follows:
C403.7.2 ~~Enclosed p~~Parking garage ventilation systems~~controls~~.

~~Enclosed~~ Ventilation systems employed in parking garages used for storing or handling automobiles operating under their own power shall ~~employ~~ meet all of the following:

~~carbon monoxide detectors applied in conjunction with nitrogen dioxide detectors and automatic controls configured to stage fans or modulate fan average airflow rates to 50 percent or less of design capacity, or intermittently operate fans less than 20 percent of the occupied time or as required to maintain acceptable contaminant levels in accordance with International Mechanical Code provisions. Failure of contamination-sensing devices shall cause the exhaust fans to operate continuously at design airflow.~~

1. Separate ventilation systems and control systems shall be provided for each parking garage section.
2. Control systems for each parking garage section shall automatically detect and control contaminant levels and shall be capable of and configured to reduce fan airflow to 20% or less of design capacity.
3. The ventilation system for each parking garage section shall have controls and devices that result in fan motor demand of no more than 30% of design wattage at 50% of the design airflow.

Exception ~~Exceptions~~:

~~1.~~ ~~Garages with a total exhaust capacity less than 8,000 cfm (3,755 L/s) with ventilation systems that do not utilize heating or mechanical cooling.~~ Garage ventilation systems serving a single parking garage section having a total ventilation system motor nameplate horsepower (ventilation system motor nameplate kilowatt) not exceeding 5 hp (3.7 kW) at fan system design conditions and where the parking garage section has no mechanical cooling or mechanical heating.

~~2.~~ ~~Garages that have a garage area to ventilation system motor nameplate power ratio that exceeds 1,125 cfm/hp (710 L/s/kW) and do not utilize heating or mechanical cooling.~~

Reason Statement:

The changes to C403.7.2 including the new definition for parking garage section are based on addendum d to ASHRAE 90.1-2019 for parking garage ventilation. This proposal increases stringency for these systems, with additional requirements for pollutant sensors and fan variable speed drives that SSPC 90.1 has determined to be cost-effective.

The current requirements for garage ventilation are lenient:

- Fan systems are only required to reduce exhaust rates down to 50%. Thus a large garage could meet the requirement with two fans, on one two-speed fan. Currently Standard 62.1 (and model codes based on this standard) require 0.75 cfm/ft^2, which is much higher than is needed to meet ventilation requirements even under peak conditions for modern garages with a typical mix of gasoline, hybrid, and electric vehicles. Moreover, these peak conditions seldom if ever occur—generally only when many vehicles simultaneously experience cold starts, e.g., at around 6 pm for an office building garage. So improved low-capacity

operation is readily justified.
- Provided the system does not have mechanical cooling or heating capability, the exceptions exempt garages smaller than 30,000 ft^2, which would require a 22,500 cfm exhaust system, a relatively large system to run constant volume for the long periods a garage may be open and operational.
- Similarly, systems with more than 1500 ft^2/hp is exempted. This roughly equates to a static pressure of 2.5 in., which is very high for garage exhaust systems. This exception exempts all garage exhaust systems.

This proposal includes the following changes:

- Garages that have separate sections separated by solid walls must have separate exhaust systems and controls. This is so that vehicle activity in one section does not result in unnecessary exhaust is other sections, and it improves safety by ensuring controls are provided in each section. There is no limit to the size of a section; many very large garages have only one section—e.g., all floors of a multistory garage are often open to one another. Mandating separate systems and controls for each floor or for a certain maximum floor area may not be justified depending on the ventilation system design. For example, unducted sweep garage exhaust systems (per Taylor in ASHRAE Journal, July 2016) can very efficiently serve a large garage. With sweep systems, ventilation in one section also ventilates the upstream sections at no added cost. Requiring small sections would disallow the system and essentially mandate much less efficient ducted systems.
- Controls must be able to reduce airflow down to 20% or less, reduced from 50% in the current standard. This minimum is readily provided by multiple-stage fans or fans with variable-speed drives. The 20% value matches the requirements of California's Title 24 requirement of 0.15 cfm/ft^2 (20% of the 0.75 cfm/ft^2 design airflow requirement).
- The system must include variable-speed drives or equivalent to reduce power as airflow is reduced. The language "30% of design wattage at 50% of the design airflow" may appear to conflict with the 20% value in the previous bullet, but it does not; it is simply a rating point. Note that systems that include some low-power constant-volume destratification fans (aka "jet fans") can still meet this requirement provided the main exhaust fans are variable speed. These fans can also be readily made to be variable speed, e.g., with electronically commutated motors.
- The first exception is revised to address motor size, not garage size, since the cost of variable- speed drives is directly a function of motor size. The size of the garage is indirectly addressed, because motor size is tied to airflow rate, which in turn is tied to garage size. The 5 hp limit is the same as that used for fan power in other sections and previously shown to be life-cycle cost effective.
- The second exception is eliminated because, as noted above, it exempts too many systems and is not relevant given the 5 hp limit is included.

Bibliography:

ANSI/ASHRAE/IES 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum d

https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Cost Impact:

The code change proposal will increase the cost of construction.

Costs will increase for pollutant sensors and fan variable-speed drives. Cost-effectiveness is assured by the previous cost analysis done for VAV systems, variable-flow chilled-water pumps, and cooling tower fans, which have the same 5 hp threshold yet operate fewer hours and/or much less turndown than garage ventilation fans.

CEPI-111-21

CEPI-112-21

IECC®: SECTION 202 (New), C403.7.3

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 Energy recovery, series. A three-step process in which the first step is to remove energy from a single airstream without the use of mechanical cooling. In the second step the air stream is mechanically cooled for the purpose of dehumidification. In the third step the energy removed in step one is reintroduced to the air stream.
Revise as follows:
C403.7.3 Ventilation air heating control.

Units that provide ventilation air to multiple zones and operate in conjunction with zone heating and cooling systems shall not use heating or heat recovery to warm supply air to a temperature greater than 60°F (16°C) when representative building loads or outdoor air temperatures indicate that the majority of zones require cooling.

Exception: Units that heat the airstream using only series energy recovery when representative building loads or outdoor air temperature indicate that the majority of zones require cooling in Climate Zones 0A, 1A, 2A, 3A, and 4A.

Reason Statement:

Based on addendum n to 90.1-2019

This proposal

1. Adds a definition for series energy recovery.
2. Provides an exception for systems equipped with series energy recovery to the requirement.

Series energy recovery is a well-established method to provide both passive free cooling and reheating to an airstream. It is typically done with a wrap-around coil where heat is absorbed into the fluid upstream of a dehumidifying cooling and released downstream of the coil to provide reheat. A sensible-only plate heat exchanger can be employed as well. Unlike condenser heat recovery, which only provides free reheat, this process reduces the load on the dehumidifying cooling coil.

The requirement to provide cool air from a 100% outside air unit while the building needs cooling is so that the work done by the compressor to cool the air is not wasted. When air is provided at higher temperatures, the zone cooling systems must recool the air. The exception for series energy recovery is warranted because any excess reheat was provided by a reduction of the cooling load on the dehumidifying coil, so there is no net gain in compressor load. The exception is desirable because adding the capability to control the discharge temperature of a series energy recovery system is expensive.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum n

https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Cost Impact:

The code change proposal will decrease the cost of construction.

The proposal removes the need for costly controls that do not save energy.

CEPI-112-21

CEPI-113-21

IECC®: C403.7.4.1

Proponents:

Mike Moore, Stator LLC, representing The Home Ventilating Institute (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

C403.7.4.1 Nontransient dwelling units.

Nontransient dwelling units shall be provided with balanced outdoor air heat or energy recovery ventilation systems with an *enthalpy recovery ratio* of not less than 50 percent at cooling design condition and not less than 60 percent at heating design condition.

Exceptions:

1. Nontransient dwelling units in Climate Zone 3C.
2. Nontransient dwelling units with not more than 500 square feet (46 m^2) of *conditioned floor area* in Climate Zones ~~0,~~ 1A, 2B, 3B, and 3C ~~4C and 5C~~.
3. *Enthalpy recovery ratio* requirements at heating design condition in Climate Zones 0, 1 and 2.
4. *Enthalpy recovery ratio* requirements at cooling design condition in Climate Zones 4, 5, 6, 7 and 8.

Attached Files

- **HERV Cost Effectiveness Scalars.png**
  http://localhost/proposal/434/814/files/download/121/
- **MF OA Rates.png**
  http://localhost/proposal/434/814/files/download/120/

Reason Statement:

This proposal expands the requirement for heat or energy recovery ventilators (i.e., an HRV or an ERV) for high-rise dwelling units in Group R-2 buildings based on a cost effectiveness analysis. The proposal expands the climate zones and dwelling unit sizes where an H/ERV is considered to be cost effective. Clarity is also provided that the system is expected to be a balanced ventilation system (now defined in the IMC and IRC) and that a heat or energy recovery ventilation system may be used, provided the system meets the minimum performance requirements of this section.

Bibliography:

1. Sontag et al. 2020. Time Dependent Valuation of Energy for Developing Building Efficiency Standards. Prepared by Energy and Environmental Economics, Inc. for the California Energy Commission. See especially p. 47-48.
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Cost Impact:

The code change proposal will increase the cost of construction.

The cost effectiveness analysis was based on the ASHRAE 90.1 scalar method (values < 12.5 were considered cost effective) and also included considerations for the monetization of carbon emissions. The included table highlights cost-effective applications in green. Key assumptions:

- ASHRAE 62.2 ventilation rates (equivalent to 2021 IMC high-rise dwelling unit rates for the 1000 ft2 dwelling unit and slightly lower than the 2021 IMC high-rise dwelling unit rate for the 500 ft2 dwelling unit; tentatively approved for low-rise dwelling R-2 dwelling units in the 2024 IMC pending final approval through the OGCV of M19-21); these rates are ~30% lower than ASHRAE 62.1 and European rates (see additional rationale below). Note: HRVs and ERVs are more cost effective at higher ventilation rates.
- Balanced ventilation as the minimum code-compliant reference system (see additional rationale below)
- Fan efficacy compliant with the 2021 IECC
- 1000 ft2, 2-bed/2-bath and 500 ft2 1-bed/1-bath dwelling units
- Energy prices determined from 5-year national average of EIA data
- Effect of carbon price analyzed at four levels. This analysis was performed to permit the committee to identify the final climate zone exceptions that are appropriate in this section, based on the committee's final selection of a carbon price. See the following table for cost effectiveness under the four carbon pricing scenarios evaluated.
    - $0/metric ton
    - Cap and Trade: $29.63/metric ton[1] (used to justify cost effectiveness for this proposal)
    - IWG Social Cost of Carbon: $51/metric ton[2]
    - CEC Emissions Abatement Cost: $106/metric ton[1]
- Simulation and cost effectiveness analysis documents can be found at the following address: https://www.dropbox.com/sh/yuodjpuvkwrefwl/AADK5WsKTfh1VrlGSCGbqsPVa?dl=0

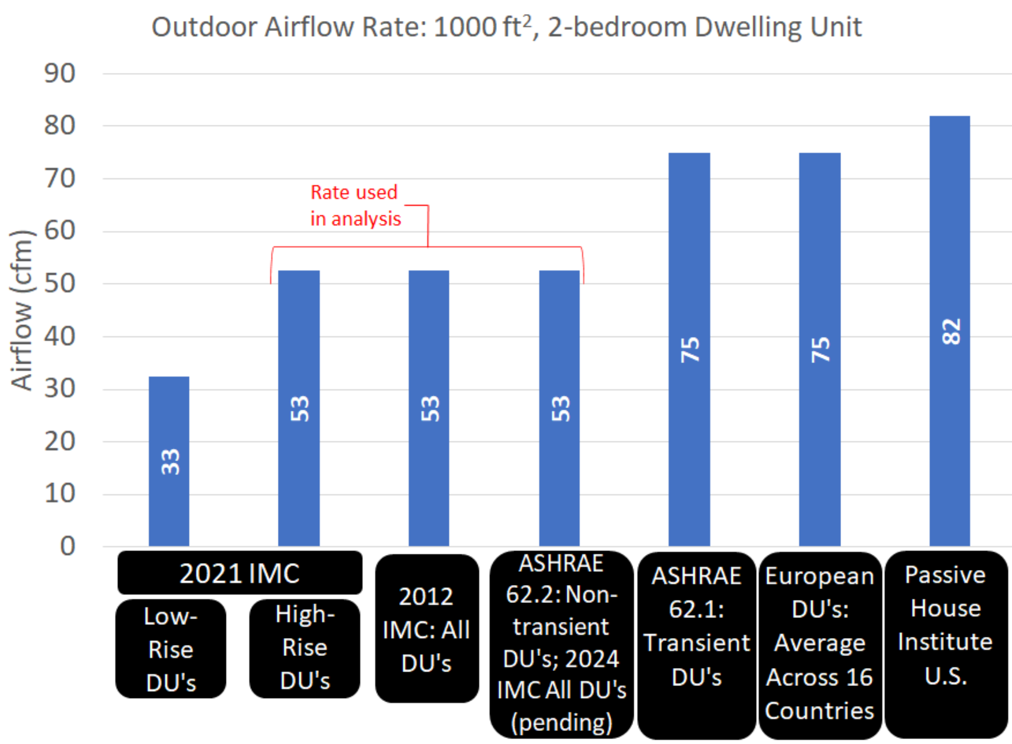
Climate Zone	Scalar Ratio Calculation							
	Carbon @ $0/metric ton		Carbon @ $29.63/metric ton		Carbon @ $51/metric ton		Carbon @ $106/metric ton	
	500 ft^2	1000 ft^2	500 ft^2	1000 ft^2	500 ft^2	1000 ft^2	500 ft^2	1000 ft^2
0A	4.4	1.5	4.0	1.4	3.7	1.3	3.2	1.2
0B	13.7	4.0	12.5	3.6	11.8	3.4	10.2	2.9
1A	44.7	8.0	40.8	7.3	38.4	6.8	33.3	5.9
1B	9.1	2.9	8.2	2.6	7.7	2.5	6.7	2.1
2A	13.7	3.9	12.4	3.6	11.6	3.4	10.0	2.9
2B	42.7	7.8	36.4	6.9	32.8	6.4	26.3	5.3
3A	10.6	3.3	9.1	2.8	8.3	2.6	6.7	2.1
3B	23.5	5.7	19.9	4.9	18.0	4.5	14.3	3.7
3C	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings
4A	5.0	2.0	4.3	1.7	4.0	1.6	3.2	1.3
4B	9.5	3.4	8.2	3.0	7.4	2.7	5.9	2.2
4C	6.6	2.5	5.6	2.2	5.1	2.0	4.1	1.6
5A	4.0	1.6	3.4	1.4	3.1	1.3	2.5	1.1
5B	5.9	2.3	5.1	2.0	4.6	1.8	3.7	1.5
5C	4.8	1.9	4.2	1.7	3.8	1.5	3.1	1.3
6A	3.2	1.3	2.7	1.2	2.5	1.1	2.0	0.9
6B	3.9	1.6	3.3	1.4	3.0	1.3	2.5	1.0
7	2.5	1.0	2.1	0.9	1.9	0.8	1.6	0.7
8	1.9	0.8	1.6	0.7	1.5	0.6	1.2	0.5

Why choose balanced ventilation as the reference ventilation system?

Recent research has documented significant leakage pathways between the walls of newer, tight dwelling units and adjacent corridors in Group R-2 buildings, with approximately 40% of dwelling unit leakage area to the corridor.[3] Based on this finding, operating an unbalanced outdoor air ventilation system in a dwelling unit with a wall adjacent to a corridor is expected to establish a pressure differential with respect to the corridor. When a supply ventilation system is specified for the dwelling unit, this is expected to pressurize the dwelling unit, transferring air from the dwelling unit to the corridor. When an exhaust system is specified for the dwelling unit, this is expected to depressurize the dwelling unit, transferring air from the corridor to the dwelling unit. Transferring air to or from the corridor and an adjoining dwelling unit is a violation of IBC Section 1020.5 and IMC 601.2, which prohibit corridors from serving as "supply, return, exhaust, relief, or ventilation air ducts." Physically speaking, to comply with these requirements in the IBC and IMC, an outdoor air ventilation system must be balanced. Joe Lstiburek provides pages of rationale supporting this concept in his article, "Compartmentalization, Distribution and Balance" – which in 2019 laid out a game plan for energy efficient, construction and ventilation of multifamily dwelling units to achieve the building code's fire safety, IAQ, and energy efficiency objectives.[4] Perhaps for such reasons, prior to 2015, any dwelling unit having mechanical ventilation was required to provide mechanical ventilation "by a method of supply and return or exhaust air," where "the amount of supply air shall be approximately equal to the amount of return and exhaust air" (2012 IMC 403.1). As such, for the cost effectiveness analysis, this proposal assumes a balanced ventilation system for Group R-2 building dwelling units adjoining a corridor.

Why choose ASHRAE 62.2-2019 Ventilation Rates?

Within the cost effectiveness study supporting this proposal, ASHRAE 62.2-2019 ventilation rates were selected for dwelling units in low-rise Group R-2 buildings. ASHRAE 62.2-2019 ventilation rates are roughly equivalent to: the 2012 IMC ventilation rates for all dwelling units, the 2021 IMC ventilation rates for high-rise residential dwelling units in the 2021 IMC, and the pending 2024 IMC ventilation rates for all R-2 dwelling units (pending final action on M19-21). These rates are also more conservative (~30% lower) than European rates,[5] ASHRAE 62.1 rates, and Passive House rates. The 2015-2021 IMC rates for low-rise R-2 dwelling units are incredibly low – and are based on an old ASHRAE 62.2 formula for leaky, single-family, detached homes that is not relevant for tight, multifamily construction with higher occupant density and higher indoor air pollution concentration than single-family detached homes.



Additionally, the rates promulgated by ASHRAE 62.2-2019 and the IMC are recognized as rates needed to provide *minimum acceptable indoor air quality*. It is expected that members of the public seeking improved IAQ may elect to use higher rates to reduce pollutant concentration and support better productivity and health outcomes, which have also been linked to increases in wages. Studies that have shown better health outcomes or improved performance for building occupants as a function of higher ventilation rates include:

- Sundell[6]: Sick building syndrome declines as ventilation rate increases.
- Milton[7]: Sick leave decreases as ventilation rate increases.
- Bornehag[8]: Risk of asthma for children increases with decreasing ventilation rate in homes.

- Seppänen[9]: Productivity decreases with decreasing ventilation rate.
- Tejsen[10]: Productivity increases with increasing residential ventilation rate.

While some of these studies were conducted in commercial buildings, LBNL's[11] analysis of residential studies concluded that, "Just over half of (residential) studies report one or more statistically significant health benefits of increased ventilation rates." LBNL noted that, "The findings of research on how ventilation rates in homes affect health are mixed," but that "overall… the number of reported statistically significant improvements in health with increased ventilation rates far exceeded the anticipated chance improvements in health."

CEPI-113-21

CEPI-114-21

IECC®: C403.7.4.2

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Revise as follows:
C403.7.4.2 Spaces other than nontransient dwelling units.

Where the supply airflow rate of a fan system serving a space other than a nontransient dwelling unit exceeds the values specified in Tables C403.7.4.2(1) and C403.7.4.2(2), the system shall include an energy recovery system. The energy recovery system shall provide an *enthalpy recovery ratio* of not less than 50 percent at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass or controls that permit operation of the economizer as required by Section C403.5.

Exception: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by the *International Mechanical Code* .
2. Laboratory fume hood systems that include not fewer than one of the following features:
   - 2.1. Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.
   - 2.2. Direct makeup (auxiliary) air supply equal to or greater than 75 percent of the exhaust rate, heated not warmer than 2°F (1.1°C) above room setpoint, cooled to not cooler than 3°F (1.7°C) below room setpoint, with no humidification added, and no simultaneous heating and cooling used for dehumidification control.
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and that are not cooled.
4. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy.
5. *Enthalpy recovery ratio* requirements at heating design condition in *Climate Zones* 0, 1 and 2.
6. *Enthalpy recovery ratio* requirements at cooling design condition in *Climate Zones* 3C, 4C, 5B, 5C, 6B, 7 and 8.
7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
8. Where the largest source of air exhausted at a single location at the building exterior is less than 75 percent of the design *outdoor air* flow rate unless the exhaust airflow and OA percentage is greater than the volume required for energy recovery. Providing multiple exhaust fans from the same area to intentionally circumvent this exception is prohibited.
9. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.7.4.2(1).
10. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.
11. Commercial kitchen hoods used for collecting and removing grease vapors and smoke.

Reason Statement:

Energy recovery is important for reducing pollution and energy use and has great paybacks in most situations. If the exhaust airflow from a space is greater than the value in the table, that area should have energy recovery. Sometimes designers, contractors or developers will employ multiple exhaust fans to get below the 75% threshold so as not to have to provide energy recovery, increasing the future owners operating costs. The table has already taken these energy efficiency costs into account when prescribing the threshold to employ energy recovery.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is a clarification to prevent engineers from circumventing energy recovery, it will not change the cost of construction.

CEPI-114-21

CEPI-115-21

IECC®: C403.7.4.2

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Revise as follows:
C403.7.4.2 Spaces other than nontransient dwelling units.

Where the supply airflow rate of a fan system serving a space other than a nontransient dwelling unit exceeds the values specified in Tables C403.7.4.2(1) and C403.7.4.2(2), the system shall include an energy recovery system. The energy recovery system shall provide an *enthalpy recovery ratio* of not less than 50 percent at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass or controls that permit operation of the economizer as required by Section C403.5.

Exception: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by the *International Mechanical Code* .
2. Laboratory fume hood systems that include not fewer than one of the following features:
    2.1. Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.
    2.2. Direct makeup (auxiliary) air supply equal to or greater than 75 percent of the exhaust rate, heated not warmer than 2°F (1.1°C) above room setpoint, cooled to not cooler than 3°F (1.7°C) below room setpoint, with no humidification added, and no simultaneous heating and cooling used for dehumidification control.
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and that are not cooled.
4. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy.
5. *Enthalpy recovery ratio* requirements at heating design condition in *Climate Zones* 0, 1 and 2, cooling enthalpy heating enthalpy recovery applies.
6. *Enthalpy recovery ratio* requirements at cooling design condition in *Climate Zones* 3C, 4C, 5B, 5C, 6B, 7 and 8, heating enthalpy recovery applies.
7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
8. Where the largest source of air exhausted at a single location at the building exterior is less than 75 percent of the design *outdoor air* flow rate.
9. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.7.4.2(1).
10. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.

11. Commercial kitchen hoods used for collecting and removing grease vapors and smoke.

Reason Statement:

In Denver's climate zone, there is an exception for doing cooling energy recovery. However some engineers confuse the exception and interpret it to mean energy recovery in general, so we want to clarify that the exception for cooling does not apply to heating.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is only meant to act as a clarification that will not change the cost of construction.

CEPI-115-21

CEPI-116-21

IECC®: SECTION 202 (New), C403.7.4.2

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new definition as follows:
<u>C202</u> <u>Energy recovery, series</u>. <u>A three-step process in which the first step is to remove energy from a single airstream without the use of mechanical cooling. In the second step, the air stream is mechanically cooled for the purpose of dehumidification. In the third step, the energy removed in step one is reintroduced to the air stream.</u>
<u>C202</u> <u>Energy recovery ratio, series (SERR)</u>. <u>The difference between the dry bulb air temperatures leaving the series energy recovery unit and leaving the dehumidifying coil divided by the difference between 75˚F (24˚C) and the dry bulb temperature of the air leaving the dehumidifying cooling coil.</u>
Revise as follows:
C403.7.4.2 Spaces other than nontransient dwelling units.

Where the supply airflow rate of a fan system serving a space other than a nontransient dwelling unit exceeds the values specified in Tables C403.7.4.2(1) and C403.7.4.2(2), the system shall include an energy recovery system. The energy recovery system shall provide an *enthalpy recovery ratio* of not less than 50 percent at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass or controls that permit operation of the economizer as required by Section C403.5.

Exception: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by the *International Mechanical Code*.
2. Laboratory fume hood systems that include not fewer than one of the following features:
   2.1. Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.
   2.2. Direct makeup (auxiliary) air supply equal to or greater than 75 percent of the exhaust rate, heated not warmer than 2°F (1.1°C) above room setpoint, cooled to not cooler than 3°F (1.7°C) below room setpoint, with no humidification added, and no simultaneous heating and cooling used for dehumidification control.
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and that are not cooled.
4. <u>Heating energy recovery where</u> ~~Where~~ more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy<u>in Climate Zones 5 through 8</u>.
5. *Enthalpy recovery ratio* requirements at heating design condition in *Climate Zones* 0, 1 and 2.
6. *Enthalpy recovery ratio* requirements at cooling design condition in *Climate Zones* 3C, 4C, 5B, 5C, 6B, 7 and 8.
7. Systems <u>in Climate Zones 0 through 4</u> requiring dehumidification that employ <u>*series*</u> *energy recovery* ~~in series with the cooling coil~~ <u>and have a minimum SERR of 0.40</u>.
8. Where the largest source of air exhausted at a single location at the building exterior is less than 75 percent of the design *outdoor air* flow rate.

9. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.7.4.2(1).

10. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.

11. Commercial kitchen hoods used for collecting and removing grease vapors and smoke.

Reason Statement:

This proposal revises two exceptions to the requirement to use energy recovery. One change limits the exception for solar heating to cooler climates.The second clarifies the exemption for the use of "energy recovery in series with the cooling coil" by creating a new definition for series energy recovery. This definition is required because some users of the standard have confused condenser heat recovery and site-recovered energy with series energy recovery. They are quite different.

There is also a new definition that defines the performance of series energy recovery. The purpose is to ensure that the series energy recovery system performs well enough to justify allowing it to be used in lieu of conventional energy recovery. The format of the code does not allow formulas to be used in a definition, so the series energy recovery ratio is described in the text. For clarity, the formula is shown here:

SERR = (TL – TC)/(TE – TC)

Where

SERR = Series energy recovery ratio

TL = Rated dry bulb temperature of the air leaving the device.

TC = Dry bulb temperature of the air leaving the dehumidifying cooling coil TE = Dry bulb temperature of the air entering the first step of 75°F In addition, the exemption for series energy recovery has been limited to warmer climate zones.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The changes only clarify the intent of the code.

CEPI-116-21

CEPI-117-21

IECC®: C403.7.4.2, TABLE C403.7.4.2(1), TABLE C403.7.4.2(2)

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Revise as follows:
C403.7.4.2 Spaces other than nontransient dwelling units.

Where the ~~supply~~ outside or exhaust airflow rate of a ~~fan~~ system serving a space other than a nontransient dwelling unit exceeds the values specified in modified Tables C403.7.4.2(1) and C403.7.4.2(2), the system shall include an energy recovery system. The energy recovery system shall provide an *enthalpy recovery ratio* of not less than ~~50~~ 60 percent at design conditions. Where an air economizer is required, the energy recovery system shall include a bypass on supply and exhaust air or controls that permit operation of the economizer as required by Section C403.5. Maximum energy recovery device pressure drop shall be no greater than 0.6 in. w.c. at sea level and standard air density at 100% outside airflow. Energy recovery device air pressure drops above 0.6 in. w.c. shall include bypass dampers that are open during air side economizer operation. Energy recovery device maximum allowable pressure drop is 1.2 in w.c.. Supply and exhaust fans static efficiency must be 65% or greater.

Projects where exhaust air is rated as class 3 or class 4 will require an enthalpy recovery ratio of not less than 50 percent at design conditions.

When the exhaust flow in table C403.7.4.2(1) and (2) are exceeded, but exhaust to supply ratios are below 60 percent, supply bypass can be utilized to reduce the pressure drop through the OA side of the energy recovery device to 0.6 w.c. at sea level and standard air density.

Exception: An energy recovery ventilation system shall not be required in any of the following conditions:

1. Where energy recovery systems are prohibited by the *International Mechanical Code*.
2. Laboratory fume hood systems that include not fewer than one of the following features:
   - 2.1. Variable-air-volume hood exhaust and room supply systems configured to reduce exhaust and makeup air volume to 50 percent or less of design values.
   - 2.2. Direct makeup (auxiliary) air supply equal to or greater than 75 percent of the exhaust rate, heated not warmer than 2°F (1.1°C) above room setpoint, cooled to not cooler than 3°F (1.7°C) below room setpoint, with no humidification added, and no simultaneous heating and cooling used for dehumidification control.
3. Systems serving spaces that are heated to less than 60°F (15.5°C) and that are not cooled.
4. Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site-solar energy.
5. *Enthalpy recovery ratio* requirements at heating design condition in *Climate Zones* 0, 1 and 2.
6. *Enthalpy recovery ratio* requirements at cooling design condition in *Climate Zones* 3C, 4C, 5B, 5C, 6B, 7 and 8.
7. Systems requiring dehumidification that employ energy recovery in series with the cooling coil.

8. Where the largest source of air exhausted at a single location at the building exterior is less than 75 percent, but greater than 60 percent of the design outdoor air flow rate, provide an enthalpy recovery ratio of not less than 50 percent at design conditions. ~~percent of the design *outdoor air* flow rate.~~

9. Systems expected to operate less than 20 hours per week at the *outdoor air* percentage covered by Table C403.7.4.2(1).

10. Systems exhausting toxic, flammable, paint or corrosive fumes or dust.

11. Commercial kitchen hoods used for collecting and removing grease vapors and smoke.

TABLE C403.7.4.2(1) ENERGY RECOVERY REQUIREMENT (Ventilation systems operating less than 8,000 hours per year)

CLIMATE ZONE	**PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE**							
	≥ 10% and < 20%	**≥ 20% and < 30%**	**≥ 30% and < 40%**	**≥ 40% and < 50%**	**≥ 50% and < 60%**	**≥ 60% and < 70%**	**≥ 70% and < 80%**	**≥ 80%**
	Design ~~Supply Fan~~ Outside or Exhaust Airflow Rate (cfm)							
3B, 3C, 4B, 4C, ~~5B~~	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B, 5C	NR	NR	NR	NR	≥ 26,000	≥ 12,000	≥ 5,000	≥ 4,000
5B Supply	NR	NR	NR	NR	≥ 6,000	≥ 5,500	≥ 5,000	≥ 4,000
5B Exhaust	NR	NR	NR	NR	≥ 4,500	≥ 4,125	≥ 3,750	≥ 3,000
6B	≥ 28,000	≥ 26,5000	≥ 11,000	≥ 5,500	≥ 4,500	≥ 3,500	≥ 2,500	≥ 1,500
0A, 1A, 2A, 3A, 4A, 5A, 6A	≥ 26,000	≥ 16,000	≥ 5,500	≥ 4,500	≥ 3,500	≥ 2,000	≥ 1,000	> 120
7, 8	≥ 4,500	≥ 4,000	≥ 2,500	≥ 1,000	> 140	> 120	> 100	> 80

For SI: 1 cfm = 0.4719 L/s.

NR = Not Required.

TABLE C403.7.4.2(2) ENERGY RECOVERY REQUIREMENT (Ventilation systems operating not less than 8,000 hours per year)

CLIMATE ZONE	**PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE**							
	≥ 10% and < 20%	**≥ 20% and < 30%**	**≥ 30% and < 40%**	**≥ 40% and < 50%**	**≥ 50% and < 60%**	**≥ 60% and < 70%**	**≥ 70% and < 80%**	**≥ 80%**
	Design ~~Supply Fan~~ Outside or Exhaust Airflow Rate (cfm)							
3C	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B, 3B, 4C, 5C	NR	≥ 19,500	≥ 9,000	≥ 5,000	≥ 4,000	≥ 3,000	≥ 1,500	≥ 120
0A, 1A, 2A, 3A, 4B, ~~5B~~	≥ 2,500	≥ 2,000	≥ 1,000	≥ 500	≥ 140	≥ 120	≥ 100	≥ 80
5B Outside	≥ 500	≥ 400	≥ 300	≥ 200	≥ 84	≥ 84	≥ 80	≥ 80
5B Exhaust	≥1,500	≥ 1,200	≥ 900	≥ 600	≥ 252	≥ 252	≥ 240	≥ 240
4A, 5A, 6A, 6B, 7, 8	≥ 200	≥ 130	≥ 100	≥ 80	≥ 70	≥ 60	≥ 50	≥ 40

For SI: 1 cfm = 0.4719 L/s.

NR = Not Required.

Reason Statement:

Purpose: To clarify a previously submitted and approved Denver 2018 code amendment a row was added to table 1 for exhaust. Note that table 2 was not changed from 2018 code amendment.

Reasons: Most heat recovery (90%) is accomplished with heat wheels as they are the most economical form of heat recovery. Normally heat wheels provide enthalpy recovery ratio (ERR) of approximately 70% or higher, depending on exhaust to supply ratio. At a 75% exhaust to supply ratio, 60% ERR is achievable. Increasing the minimum heat recovery from 50% to 60% therefore does not have cost implications and closes a current loophole. Since plate heat exchangers can meet 60% they would not be excluded.

The 60% energy recovery values increase energy savings therefore paybacks are quicker. This has the effect of extending economical energy recovery at lower airflows. Modified values in Table 1 for supply are based on typical Xcel Energy rates in Colorado for electric and gas, 12 hours a day, 5 days a week (typical office building) with a 10 year payback threshold. Note an electric heat base in lieu of gas would result in even lower airflows being economical. Back up available on request.

Some heat recovery devices have higher pressure drop than 0.6 in. w.c.. If the heat recovery has a higher pressure drop than 0.6 in. w.c., bypass dampers that open during economizer provide equal energy as a lower pressure drop heat wheel with no bypass dampers.

Partial energy recover where the exhaust airflow is high enough to be economically feasible is to be allowed, but the exhaust to supply ratio would result in an uneconomical oversized recovery device.

Exception 8 is modified to allow for lower ERR with other heat recovery such as 1) lower exhaust ratio to 60%, 2) other heat recovery devices such as plate heat exchangers, heat pipes and run around coils.

Substantiation: We were involved in a project where a MAU at 17,000 cfm was initially designed, code officials caught that heat recovery was required, the design and construction team revised the project to include energy recovery and the change was cost neutral.

Cost Impact:

The code change proposal will increase the cost of construction.

Saving energy and drastically reducing carbon emissions compared to no energy recovery (in the 60 – 70% range) with a payback below 10 years.

CEPI-117-21

CEPI-118-21

IECC®: C403.7.7

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:
C403.7.7 Shutoff dampers.

Outdoor air intake and exhaust openings and stairway and shaft vents shall be provided with Class I motorized dampers. The dampers shall have an air leakage rate not greater than 4 cfm/ft^2 (20.3 L/s × m^2) of damper surface area at 1.0 inch water gauge (249 Pa) and shall be labeled by an *approved agency* when tested in accordance with AMCA 500D for such purpose.

Outdoor air intake and exhaust dampers shall be installed with automatic controls configured to close when the systems or spaces served are not in use or during unoccupied period warm-up and setback operation, unless the systems served require outdoor or exhaust air in accordance with the International Mechanical Code or the dampers are opened to provide intentional economizer cooling.

Stairway and elevator shaft vent dampers shall be installed with automatic controls configured to open upon the activation of any fire alarm initiating device of the building's fire alarm system, ~~or~~ the interruption of power to the damper, or by thermostatic control systems.

Exception: Nonmotorized gravity dampers shall be an alternative to motorized dampers for exhaust and relief openings as follows:

1. In buildings less than three stories in height above grade plane.

2. In buildings of any height located in *Climate Zones* 0, 1, 2 or 3.

3. Where the design exhaust capacity is not greater than 300 cfm (142 L/s).

Nonmotorized gravity dampers shall have an air leakage rate not greater than 20 cfm/ft^2 (101.6 L/s × m^2) where not less than 24 inches (610 mm) in either dimension and 40 cfm/ft^2 (203.2 L/s × m^2) where less than 24 inches (610 mm) in either dimension. The rate of air leakage shall be determined at 1.0 inch water gauge (249 Pa) when tested in accordance with AMCA 500D for such purpose. The dampers shall be labeled by an *approved agency*.

Reason Statement:

Based on ASHRAE 90.1-2019 Addendum m.

Elevator shaft vents are no longer required by most model codes, but many machine-room-less elevator manufacturers insist on a vent to help maintain shaft temperatures that may rise due to heat produced by the cab-mounted elevator machinery. These vents are not likely necessary or even useful for temperature control in most applications due to the heat losses to the conditioned spaces adjacent to the elevator shaft that should result in acceptable shaft temperatures. However, they are being used nonetheless.

These vents are typically open year-round. This proposal requires that if such vents are installed, they are controlled to only open based on a thermostatic setting.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum m

https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Cost Impact:

The code change proposal will increase the cost of construction.

The cost of construction is increased in cases where elevator manufacturers require a vent in the elevator shaft.

CEPI-118-21

CEPI-119-21

IECC®: SECTION 202, SECTION 202 (New), C202, C403.8.1, TABLE C403.8.1(1), TABLE C403.8.1(1) (New), TABLE C403.8.1(2), TABLE C403.8.1(2) (New), TABLE C403.8.1(3) (New), C403.8.1.1 (New), C403.8.1.2 (New), C503.3, TABLE C503.3 (New), C503.3.1 (New), AHRI Chapter 06 (New)

Proponents:

John Bade, representing California Investor Owned Utilities (johnbade@2050partners.com)

2021 International Energy Conservation Code

Revise as follows:
IECC2021P1E_CE_Ch02_SecC202_DefENTHALPY_RECOVERY_RATIO ENTHALPY RECOVERY RATIO (ERR). Change in the enthalpy of the *outdoor air* supply divided by the difference between the *outdoor air* and entering exhaust air enthalpy, expressed as a percentage.
IECC2021P1E_CE_Ch02_SecC202_DefFAN_SYSTEM_DESIGN_CONDITIONS FAN SYSTEM DESIGN CONDITIONS. Operating conditions that can be expected to occur during normal system operation that result in the highest supply fan airflow rate of ~~to conditioned spaces served by~~ the *fan system* ~~system~~, other than during air economizer operation.
Add new definition as follows:
C202 FAN ELECTRICAL INPUT POWER.

The electrical input power in kilowatts required to operate an individual fan or fan array at design conditions. It includes the power consumption of motor controllers, if present.

C202 FAN NAMEPLATE ELECTRICAL INPUT POWER.

Is the nominal electrical input power rating stamped on a fan assembly nameplate.

C202 FAN SYSTEM. All the fans that contribute to the movement of air serving *spaces* that pass through a point of a common duct, plenum, or cabinet.

Add new definition as follows:
fan system, complex. a *fan system* that combines a *single-cabinet fan system* with other supply fans, exhaust fans, or both.
Fan system, exhaust/relief. A *fan system* dedicated to the removal of air from interior spaces to the outdoors.
Fan system, return.

A *fan system* dedicated to removing air from the interior where some or all the air is to be recirculated except during economizer operation.

fan system, single-cabinet. A *fan system* where a single fan, single fan array, a single set of fans operating in parallel, or fans or fan arrays in series and embedded in the same cabinet that both supply air to a space and recirculate the air.
fan system, transfer. A *fan system* that exclusively moves air from one occupied space to another.

2021 International Energy Conservation Code

Add new definition as follows:
C202 FAN SYSTEM AIRFLOW.

The sum of the airflow of all fans with *fan electrical input power* greater than 1 kW at *fan system design conditions*, excluding the airflow that passes through downstream fans with *fan electrical input power* less than 1 kW.

Revise as follows:
IECC2021P1E_CE_Ch02_SecC202_DefFAN_SYSTEM_ELECTRICAL_INPUT_POWER FAN SYSTEM ELECTRICAL INPUT POWER. The sum of the fan electrical input power of all fans that are required to operate at *fan system design conditions* ~~to supply air from the heating or cooling source to the conditioned spaces and/or return it to the source or exhaust it to the outdoors~~.
Delete and substitute as follows:
~~C403.8.1 Allowable fan horsepower~~.

~~Each HVAC system having a total fan system motor nameplate horsepower exceeding 5 hp (3.7 kW) at fan system design conditions~~

~~shall not exceed the allowable *fan system motor nameplate hp* (Option 1) or *fan system bhp* (Option 2) shown in Table C403.8.1(1). This includes supply fans, exhaust fans, return/relief fans, and fan-powered terminal units associated with systems providing heating or cooling capability. Single-zone variable air volume systems shall comply with the constant volume fan power limitation.~~

~~**Exceptions:**~~

1. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall be permitted to use variable volume fan power limitation.

2. Individual exhaust fans with motor nameplate horsepower of 1 hp (0.746 kW) or less are exempt from the allowable fan horsepower requirement.

C403.8.1 Fan power.
Each *fan system* that includes at least one fan or fan array with *fan electrical input power* ≥ 1 kW, moving air into, out of, or between conditioned spaces or circulating air for the purpose of conditioning air within a space shall comply with Sections C403.8.1.1 through C403.8.1.2.

Delete without substitution:

~~TABLE C403.8.1(1) FAN POWER LIMITATION~~

	LIMIT	**CONSTANT VOLUME**	**VARIABLE VOLUME**
Option 1: Fan system motor nameplate hp	Allowable nameplate motor hp	hp ≤ CFM_S × 0.0011	hp ≤ CFM_S × 0.0015
Option 2: Fan system bhp	Allowable fan system bhp	bhp ≤ CFM_S × 0.00094 + *A*	bhp ≤ CFM_S × 0.0013 + *A*

~~For SI: 1 bhp = 735.5 W, 1 hp = 745.5 W, 1 cfm = 0.4719 L/s.~~

~~where:~~

~~CFM_S = The maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute.~~

~~hp = The maximum combined motor nameplate horsepower.~~

~~bhp = The maximum combined fan brake horsepower.~~

~~*A* = Sum of [*PD* × CFM_D / 4131].~~

~~where:~~

~~*PD* = Each applicable pressure drop adjustment from Table C403.8.1(2) in. w.c.~~

~~CFM_D = The design airflow through each applicable device from Table C403.8.1(2) in cubic feet per minute.~~

Add new text as follows:

TABLE C403.8.1(1)

SUPPLY FAN POWER ALLOWANCES (W/CFM)

Multi-Zone VAV Systems[a] >5,000 and ≤10,000 cfm	**Multi-Zone VAV Systems[a] >10,000 cfm**	**All Other *Fan Systems* ≤5,000 cfm**	**All Other *Fan Systems* > 5,000 and ≤10,000 cfm**	**All Other *Fan Systems* > 10,000 cfm**
0.453	0.413	0.232	0.256	0.236
0.114	0.105	0.139	0.120	0.107

0.188	0.176	0.231	0.197	0.177
0.280	0.265	0.342	0.292	0.264
0.048	0.052	0.046	0.050	0.054
0.038	0.035	0.046	0.040	0.036
0.057	0.070	0.058	0.060	0.072
0.114	0.105	0.139	0.120	0.107
0.132	0.123	0.163	0.139	0.124
0.038	0.035	0.046	0.040	0.036
0.188	0.176	0.231	0.197	0.177
0.000	0.000	0.070	0.100	0.107
0.114	0.105	0.139	0.120	0.107
0.134	0.124	0.165	0.141	0.126
0.155	0.144	0.190	0.163	0.146
0.175	0.163	0.215	0.184	0.165
0.196	0.183	0.240	0.205	0.184
0.216	0.202	0.264	0.226	0.203
0.236	0.222	0.289	0.247	0.222
0.114	0.105	0.139	0.120	0.107
0.188	0.176	0.231	0.197	0.177
0.038	0.035	0.046	0.040	0.036
0.038	0.035	0.046	0.040	0.036

0.029	0.026	0.035	0.030	0.027
-0.100	-0.100	-0.100	-0.100	-0.100
0.000	0.000	0.070	0.100	0.089

a.. See definition of *FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV).*

b. Filter fan power allowance can only be counted once per *fan system*, except *fan systems* in healthcare facilities, which can claim one of the MERV 13 to 16 filter allowances and the HEPA filter allowance if both are included in the *fan system*.

c. Healthcare facilities can claim this fan power allowance twice per *fan system* where coil design leaving air temperature is less than 44 °F.

d. Power allowance requires further calculation by multiplying the actual inches of water gauge (in.w.g.) of the device/ component by the w/ cfm in Table C403.8.1(1).

e. The 100% outdoor air system must serve 3 or more HVAC zones and airflow during non-economizer operating periods must comply with Section C403.2.2.1.

f. Enthalpy Recovery Ratio (ERR) calculated per AHRI 1060.

g. A low-turndown single-zone VAV fan system must be capable of and configured to reduce airflow to 50 percent of design airflow and use no more than 30 percent of the design wattage at that airflow. No more than 10 percent of the design load served by the equipment shall have fixed loads.

Delete without substitution:

~~TABLE C403.8.1(2) FAN POWER LIMITATION PRESSURE DROP ADJUSTMENT~~

DEVICE	ADJUSTMENT
Credits	
Return air or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.5 inch w.c. (2.15 inches w.c. for laboratory and vivarium systems)
Return and exhaust airflow control devices	0.5 inch w.c.
Exhaust filters, scrubbers or other exhaust treatment	The pressure drop of device calculated at fan system design condition
Particulate filtration credit: MERV 9 thru 12	0.5 inch w.c.
Particulate filtration credit: MERV 13 thru 15	0.9 inch w.c.
Particulate filtration credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2 times the clean filter pressure drop at fan system design condition.
Carbon and other gas-phase air cleaners	Clean filter pressure drop at fan system design condition.
Biosafety cabinet	Pressure drop of device at fan system design condition.
Energy recovery device, other than coil runaround loop	For each airstream, (2.2 × energy recovery effectiveness - 0.5) inch w.c.
Coil runaround loop	0.6 inch w.c. for each airstream.
Evaporative humidifier/cooler in series with another cooling coil	Pressure drop of device at fan system design conditions.
Sound attenuation section (fans serving spaces with design background noise goals below NC35)	0.15 inch w.c.
Exhaust system serving fume hoods	0.35 inch w.c.
Laboratory and vivarium exhaust systems in high-rise buildings	0.25 inch w.c./100 feet of vertical duct exceeding 75 feet.
Deductions	
Systems without central cooling device	- 0.6 inch w.c.

Systems without central heating	- 0.3 inch w.c.
Systems with central electric resistance heat	- 0.2 inch w.c.

~~For SI: 1 inch w.c. = 249 Pa, 1 inch = 25.4 mm, 1 foot = 304.8 mm.~~

~~w.c. = Water Column, NC = Noise Criterion.~~

Add new text as follows:

TABLE C403.8.1(2)

EXHAUST, RETURN, RELIEF, TRANSFER FAN POWER ALLOWANCES (W/CFM)

Airflow	**Multi-Zone VAV Systems[a] ≤5,000 cfm**	**Multi-Zone VAV Systems[a] >5,000 and ≤10,000 cfm**	**Multi-Zone VAV Systems[a] >10,000 cfm**	**All Other *Fan Systems* ≤5,000 cfm**	**All Other *Fan Systems* >5,000 and ≤10,000 cfm**	**All Other *Fan Systems* >10,000 cfm**
Exhaust System Base Allowance	0.221	0.246	0.236	0.186	0.184	0.190
Filter (any MERV value)[b]	0.046	0.041	0.036	0.046	0.041	0.035
Energy Recovery Allowance For 0.50 ≤ ERR <0.55[c]	0.139	0.120	0.107	0.139	0.123	0.109
Energy Recovery Allowance For 0.55 ≤ ERR <0.60[c]	0.165	0.142	0.126	0.165	0.144	0.128
Energy Recovery Allowance For 0.60 ≤ ERR <0.65[c]	0.190	0.163	0.146	0.191	0.166	0.148
Energy Recovery Allowance For 0.65 ≤ ERR <0.70[c]	0.215	0.184	0.165	0.216	0.188	0.167
Energy Recovery Allowance For 0.70 ≤ ERR <0.75[c]	0.240	0.206	0.184	0.241	0.209	0.186
Energy Recovery Allowance For 0.75 ≤ ERR <0.80[c]	0.265	0.227	0.203	0.266	0.231	0.205
Energy Recovery Allowance For ERR ≥ 0.80[c]	0.289	0.248	0.222	0.291	0.252	0.225
Coil Runaround Loop	0.139	0.120	0.107	0.139	0.123	0.109
Return or exhaust systems required by code or accreditation standards to be fully ducted, or systems required to maintain air pressure differentials between adjacent rooms	0.116	0.100	0.089	0.116	0.102	0.091
Return and/or exhaust airflow control devices	0.116	0.100	0.089	0.116	0.102	0.091
Laboratory and vivarium exhaust systems in high-rise						

buildings for vertical duct exceeding 75 ft. Value shown is allowed W/cfm per 0.25 in. wg for each 100 feet exceeding 75 feet. [Calculation required, see note d]	0.058	0.051	0.045	0.058	0.052	0.046
Biosafety cabinet. Value shown is allowed W/cfm per 1.0 in. wg air pressure drop. [Calculation required, see note d]	0.231	0.198	0.177	0.232	0.202	0.179
Exhaust filters, scrubbers, or other exhaust treatment required by code or standard. Value shown is allowed W/cfm per 1.0 in. wg air pressure drop. [Calculation required, see note d]	0.231	0.198	0.177	0.232	0.202	0.179
Healthcare facility allowance[e]	0.231	0.198	0.177	0.232	0.202	0.179
Sound attenuation section [Fans serving spaces with design background noise goals below NC35.]	0.035	0.030	0.027	0.035	0.031	0.028

a. *See definition of FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV)* to be classified as a Multi-Zone VAV System.

b. Filter pressure loss can only be counted once per *fan system*.

c. Enthalpy Recovery Ratio (ERR) calculated per AHRI 1060.

d. Power allowance requires further calculation, multiplying the actual pressure drop (in. wg.) of the device/ component by the W/cfm in the Table C403.8.1(2).

e. This allowance can only be taken for healthcare facilities.

TABLE C403.8.1(3)

DEFAULT VALUES FOR FAN KW_{DESIGN} BASED ON MOTOR NAMEPLATE HP

Motor Nameplate HP	**Default Fan kWdesign with variable speed drive (Fan kWdesign)**	**Default Fan kWdesign without variable speed drive (Fan kWdesign)**
<1	0.96	0.89
≥1 and <1.5	1.38	1.29
≥1.5 and <2	1.84	1.72
≥2 and <3	2.73	2.57
≥3 and <5	4.38	4.17
≥5 and <7.5	6.43	6.15
≥7.5 and <10	8.46	8.13

≥10 and <15	12.47	12.03
≥15 and <20	16.55	16.04
≥20 and <25	20.58	19.92
≥25 and <30	24.59	23.77
≥30 and <40	32.74	31.70
≥40 and <50	40.71	39.46
≥50 and <60	48.50	47.10
≥60 and <75	60.45	58.87
≥75 and ≤100	80.40	78.17

a. This table cannot be used for Motor Nameplate Horsepower values greater than 100.

b. This table is to be used only with motors with a service factor ≤1.15. If the service factor is not provided, this table may not be used.

C403.8.1.1 Determining Fan Power Budget.

For each *fan system*, the *fan system electrical input power* (Fan $kW_{design,system}$) determined per Section C403.8.1.2 at the *fan system airflow* shall not exceed Fan kW_{budget}. Calculate Fan Power Budget (Fan kW_{budget}) for each *fan system* as follows:

1. Determine the *fan system airflow* and choose the appropriate table(s) for fan power allowance.
   - 1.1. For *single-cabinet fan systems*, use the *fan system airflow* and the power allowances in both Table C403.8.1(1) and Table C403.8.1(2).
   - 1.2. For *supply-only fan systems*, use the *fan system airflow* and power allowances in Table C403.8.1(1).
   - 1.3. For *relief fan systems*, use the design relief airflow and the power allowances in Table C403.8.1(2).
   - 1.4. For exhaust, return and transfer *fan systems*, use the *fan system airflow* and the power allowances in Table C403.8.1(2).
   - 1.5. For complex and DOAS with energy recovery *fan systems*, separately calculate the fan power allowance for the supply and return/exhaust systems and sum them. For the supply airflow, use supply airflow at the *fan system* design conditions, and the power allowances in Table C403.8.1(1). For the return /exhaust airflow, use return /exhaust airflow at the *fan system* design conditions, and the power allowances in Table C403.8.1(2).

For each *fan system* determine the components included in the *fan system* and sum the Fan Power Allowances of those components. All *fan systems* shall include the System Base Allowance. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall be permitted to use Multizone volume fan power values.If, for a given component, only a portion of the *fan system airflow* passes through the component, calculate the Fan Power Allowance for that component per equation 4-9:

$FPA_{adj} = (Q_{comp}/Q_{sys}) \times FPA_{comp}$

2. Where:

   FPA_{adj} = The corrected fan power allowance for the component in W/cfm

   Q_{comp} = The airflow through component in cfm

   Q_{sys} = The fan system airflow in cfm

   FPA_{comp} = The fan power allowance of the component from Table C403.8.1(1) or Table C403.8.1(2)

3. Multiply the *fan system airflow* by the sum of the fan power allowances for the *fan system*.
4. Divide by 1000 to convert to Fan kW_{budget}
5. For building sites at elevations greater than 3,000’, multiply Fan kW_{budget} by 0.896.

C403.8.1.2 Determining *Fan System Electrical Input Power* (Fan $kW_{design,system}$).

Fan $kW_{design,system}$ is the sum of Fan kW_{design} for each fan or fan array included in the *fan system*. If variable speed drives are used, their efficiency losses shall be included. Fan input power shall be calculated with two-times the clean filter pressure drop. The Fan kW_{design} for each fan or fan array shall be determined using one of the following methods. There is no requirement to use the same method for all fans in a *fan system*:

1. Use the default Fan kW_{design} in Table C403.8.1(3) for one or more of the fans. This method cannot be used for *complex fan systems*.
2. Use the Fan kW_{design} at *fan system design conditions* provided by the manufacturer of the fan, fan array, or equipment that includes the fan or fan array calculated per a test procedure included in USDOE 10 CFR Part 430, USDOE 10 CFR Part 431, ANSI/AMCA Standard 208-2018, ANSI/AMCA Standard 210-2016, AHRI Standard 430-2020 or AHRI Standard 440-2019.
3. Use the Fan kW_{design} provided by the manufacturer, calculated at *fan system design conditions* per one of the methods listed in section 5.3 of ANSI/AMCA 208-2018.
4. Determine the Fan kW_{design} by using the maximum electrical input power provided on the motor nameplate.

C503.3 Heating and cooling systems.
New heating, cooling and duct systems that are part of the *alteration* shall comply with Sections C403 and C408.
Add new text as follows:

TABLE C503.3

ADDITIONAL FAN POWER ALLOWANCES (W/CFM)

Airflow	**Multi-Zone VAV Systems[a] ≤5,000 cfm**	**Multi-Zone VAV Systems[a] >5,000 and ≤10,000 cfm**	**Multi-Zone VAV Systems[a] >10,000 cfm**	**All Other *Fan systems* ≤5,000 cfm**	**All Other *Fan systems* >5,000 and ≤10,000 cfm**	**All Other *Fan systems* >10,000 cfm**
Supply *Fan system* Additional Allowance	0.135	0.114	0.105	0.139	0.120	0.107
Supply *Fan System* Additional Allowance in	0.033	0.033	0.043	0.000	0.000	0.000

unit with adapter curb						
Exhaust/ Relief/ Return/ Transfer *Fan system* Additional Allowance	0.070	0.061	0.054	0.070	0.062	0.055
Exhaust/ Relief/ Return/ Transfer *Fan system* Additional Allowance with adapter curb	0.016	0.017	0.220	0.000	0.000	0.000

a. See definition of *FAN SYSTEM, MULTI-ZONE VARIABLE AIR VOLUME (VAV)*

C503.3.1 Additional fan power allowances.
Additional Fan Power Allowances are available when determining the Fan Power Budget (Fan kW_{budget}) as specified in Table C503.4. These values can be added to the Fan Power Allowance values in Table C403.8.1(1) and Table C403.8.1(2) when calculating a new Fan kW_{budget} for the *fan system* being altered.

Add new standard(s) as follows:

AHRI Air-Conditioning, Heating, & Refrigeration Institute 2111 Wilson Blvd, Suite 500 Arlington VA 22201

AHRI 1060-2018 Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment

AHRI Air-Conditioning, Heating, & Refrigeration Institute 2111 Wilson Blvd, Suite 500 Arlington VA 22201

AHRI Standard 430-2020 Performance Rating of Central Station Air-Handling Units

Reason Statement:

The fan power limits were one of the most successful energy savings addenda in the IECC. However, they have not been updated in a decade. This proposal provides some increase in stringency, but more importantly, it addresses flaws in the original to improve both enforceability and clarity.

The improvements include:

- The requirements are based on actual energy input rather than brake horsepower.
- Designs now get credit for using direct-drive transmissions vs. belt-drive.
- The scope has been expanded to include fan systems down to 1 kW of input power from the previous lower threshold of 5 brake horsepower.
- Fan systems to which the requirements apply have been clearly defined.
- Fan system components that were not included previously have been added (e.g., hot gas reheat coils)
- Equipment that does not include mechanical heating or cooling have been brought into scope.

A similar proposal was approved by the California Energy Commission for Title 24-2022. The measure was reviewed with stakeholders in several meetings and went through three stages of public review. The Codes and Standards Enhancement Report that includes an in=depth discussion of the proposal and energy savings analysis is available at this link: https://title24stakeholders.com/wp-content/uploads/2020/09/2022_T24-Final-CASE-Report_Air-Distribution.pdf.

This proposal is also soon to be voted on by SSPC 90.1. The draft of that addendum has been reviewed in two rounds of stakeholder meetings.

Cost Impact:

The code change proposal will increase the cost of construction.

Cost-effectiveness for Proposal 510 – Fan Power Limits

The proposed values reduce the allowed fan system electrical input power by about 10% on average, the amount varies by system. A large multi-zone VAV system will see a reduction of about 13% if it includes MERV-13 filters. On the other hand with the new credit for single-zone VAV systems that are configured to turn down to 50% of airflow, there is no increase in stringency at all.

There are many ways to improve a system to achieve the goal. Though the improvements here are based on the cost difference between a belt-drive centrifugal fan and a direct-drive plenum fan, there are many options to reduce pressure drop in the fan system that will yield the same results for less money. In fact, the California Title 24 cost-effectiveness was based entirely on improving the design of the duct system while leaving the current minimum-efficiency air handler systems unchanged. Some of the options for improving fan system performance include:

- Reducing duct pressure drop through the selection of high-performance fittings.
- Using angle filters in place of flat filters.
- Locating equipment so that duct runs, and in particular vertical shafts, are straight.
- Careful consideration of design and the placement of the first turn in the duct system after leaving the air handler (this is often the highest pressure drop in the system).

However, for the purpose of this exercise, the cost of a belt-driven centrifugal fan with a variable-frequency drive was compared to a direct-drive plenum fan. The reduction in transmission losses alone make up for most of the required improvement in electrical input power. The two systems were run in the prototype buildings used by ASHRAE 90.1 in all climate zones. The majority of fans in the prototype buildings that are large enough to meet the threshold of 1 kW of input power in the proposal are variable-speed fans. Manufacture cost data was used to compare the cost per design cfm of the two different fans at two different sizes:

- 3,000 cfm - $0.346 per cfm
- 10,000 cfm - $0.192 per cfm

The following tables show the annual energy cost savings for various buildings. The savings vary by climate, with warmer and wetter climates generally showing higher savings. The annual savings were multiplied by 12, which is the ASHRAE scalar limit for equipment with a 15-year lifespan. In nearly all cases, the cost per cfm of an improved fan is less than the scalar limit.
Primary school – these typically have fans that are about 3,000 cfm or a little more. In all cases, the savings are greater than the $0.346 additional cost:

	Elec Energy Savings (kWh)	Gas Energy Savings (Therm)	Elec Energy Cost Savings ($)	Gas Energy Cost Savings ($)	Total Energy Cost Savings ($)	Annual Savings X12	Modeled Airflow	$/cfm
Albuquerque	13085	-84	1438	-67	1371	$16,450	25169.5	$0.65
Atlanta	12935	-7	1422	-5	1416	$16,994	25169.5	$0.68
Buffalo	11531	-51	1267	-41	1226	$14,717	25169.5	$0.58
Denver	12004	-118	1319	-95	1224	$14,694	25169.5	$0.58
Dubai	18103	0	1990	0	1990	$23,875	25169.5	$0.95
ElPaso	13822	-50	1519	-40	1479	$17,744	25169.5	$0.70
Fairbanks	14078	-157	1547	-126	1422	$17,059	25169.5	$0.68
GreatFalls	11509	-40	1265	-32	1232	$14,790	25169.5	$0.59
HoChiMinh	14873	0	1635	0	1635	$19,615	25169.5	$0.78
InternationalFalls	12749	-95	1401	-76	1325	$15,904	25169.5	$0.63
Miami	15460	0	1699	0	1699	$20,384	25169.5	$0.81
NewDelhi	16277	1	1789	1	1790	$21,476	25169.5	$0.85
NewYork	11932	-12	1311	-10	1302	$15,622	25169.5	$0.62
PortAngeles	10436	-1	1147	-1	1146	$13,756	25169.5	$0.55
Rochester	12563	-72	1381	-58	1323	$15,872	25169.5	$0.63
SanDiego	11373	-10	1250	-8	1242	$14,903	25169.5	$0.59
Seattle	11632	-139	1278	-111	1167	$14,004	25169.5	$0.56
Tampa	16769	-1	1843	-1	1842	$22,108	25169.5	$0.88
Tucson	12771	0	1404	0	1404	$16,847	25169.5	$0.67

Large Hotel – These typically use large VAV fans. Again, in all cases, the additional cost of $0.192 per cfm is much less than the projected savings:

	Elec Energy Savings (kWh)	Gas Energy Savings (Therm)	Elec Energy Cost Savings ($)	Gas Energy Cost Savings ($)	Total Energy Cost Savings ($)	Annual Savings X12	Modeled Airflow	$/cfm
Albuquerque	24756	-20	2721	-16	2704	$32,451	40110.4	$0.81
Atlanta	20992	-24	2307	-19	2288	$27,453	40110.4	$0.68
Buffalo	19504	-60	2144	-49	2095	$25,140	40110.4	$0.63
Denver	24984	-45	2746	-36	2710	$32,520	40110.4	$0.81
Dubai	24856	-3	2732	-2	2729	$32,752	40110.4	$0.82
ElPaso	23902	-12	2627	-10	2617	$31,407	40110.4	$0.78
Fairbanks	16880	-72	1855	-58	1797	$21,565	40110.4	$0.54
GreatFalls	21103	-55	2319	-44	2275	$27,300	40110.4	$0.68
HoChiMinh	26707	-10	2935	-8	2927	$35,128	40110.4	$0.88
Honolulu	22710	-3	2496	-3	2493	$29,918	40110.4	$0.75
InternationalFalls	18937	-73	2081	-59	2022	$24,267	40110.4	$0.61
NewDelhi	24433	-8	2685	-7	2679	$32,143	40110.4	$0.80
NewYork	20083	-38	2207	-31	2177	$26,118	40110.4	$0.65
PortAngeles	19082	-24	2097	-19	2078	$24,937	40110.4	$0.62
Rochester	19824	-84	2179	-67	2112	$25,338	40110.4	$0.63
SanDiego	19085	-16	2097	-13	2084	$25,013	40110.4	$0.62
Seattle	19438	-27	2136	-22	2115	$25,375	40110.4	$0.63
Tampa	23725	-9	2607	-7	2600	$31,201	40110.4	$0.78
Tucson	23380	-11	2569	-9	2560	$30,726	40110.4	$0.77

Standalone Retail – These prototypes use a mix of small and large fans. However, the 12-year savings are much higher than the per cfm cost of both sizes.

	Elec Energy Savings (kWh)	Gas Energy Savings (Therm)	Elec Energy Cost Savings ($)	Gas Energy Cost Savings ($)	Total Energy Cost Savings ($)	Annual Savings X12	Modeled Airflow	$/cfm
Albuquerque	7589	-85	834	-68	766	$9,195	23371.2	$0.39
Atlanta	4501	-43	495	-35	460	$5,521	23371.2	$0.24
Buffalo	6972	-152	766	-122	645	$7,736	23371.2	$0.33
Denver	7759	-136	853	-109	744	$8,927	23371.2	$0.38
Dubai	10695	0	1175	0	1175	$14,103	23371.2	$0.60
ElPaso	10139	-66	1114	-53	1061	$12,736	23371.2	$0.54
Fairbanks	7159	-186	787	-149	638	$7,653	23371.2	$0.33
GreatFalls	7475	-171	822	-137	684	$8,210	23371.2	$0.35
HoChiMinh	10356	0	1138	0	1138	$13,657	23371.2	$0.58
InternationalFalls	6591	-140	724	-113	612	$7,341	23371.2	$0.31
Miami	9071	-1	997	-1	996	$11,956	23371.2	$0.51
NewDelhi	9863	-15	1084	-12	1072	$12,863	23371.2	$0.55
NewYork	6897	-121	758	-97	661	$7,927	23371.2	$0.34
PortAngeles	6750	-133	742	-106	635	$7,625	23371.2	$0.33
Rochester	7617	-179	837	-144	693	$8,320	23371.2	$0.36
SanDiego	6986	-11	768	-9	759	$9,109	23371.2	$0.39
Seattle	6975	-114	767	-92	675	$8,100	23371.2	$0.35
Tampa	7270	-12	799	-10	789	$9,472	23371.2	$0.41
Tucson	7817	-10	859	-8	851	$10,216	23371.2	$0.44

Large Office – These prototypes use large VAV fans. In this case, the additional cost of $0.192 per cfm meets the scalar for most climate zones. It does not meet the scalar for Climate Zone 8.

	Elec Energy Sa	Gas Energy Sa	Total Energy U	nergy Savings (	ergy Savings (T	ergy Cost Savi	ergy Cost Savi	nergy Cost Savi	Annual Savings X12	M A
Albuquerque	222.89	-9.75	213.14	61963	-92	6810	-74	6736	$80,828	2
Atlanta	172.59	-0.7	171.89	47980	-7	5273	-5	5268	$63,212	2
Buffalo	152.66	-1.6	151.06	42439	-15	4664	-12	4652	$55,823	2
Denver	200.94	-15.33	185.61	55861	-145	6139	-117	6023	$72,271	2
Dubai	224.07	-0.08	223.99	62291	-1	6846	-1	6845	$82,143	2
ElPaso	231.17	-3.94	227.23	64265	-37	7063	-30	7033	$84,394	2
Fairbanks	52.95	-4.04	48.91	14720	-38	1618	-31	1587	$19,044	2
GreatFalls	148.99	-7.86	141.13	41419	-75	4552	-60	4492	$53,906	2
HoChiMinh	352.43	-0.45	351.98	97976	-4	10768	-3	10764	$129,169	2
InternationalFalls	189.47	-1.72	187.75	52673	-16	5789	-13	5776	$69,308	2
Miami	334.69	-0.31	334.38	93044	-3	10226	-2	10223	$122,678	2
NewDelhi	215.16	-1.05	214.11	59814	-10	6574	-8	6566	$78,788	2
NewYork	226.87	-0.49	226.38	63070	-5	6931	-4	6928	$83,132	2
PortAngeles	191.2	-16.32	174.88	53154	-155	5842	-124	5717	$68,610	2
Rochester	102.91	-0.29	102.62	28609	-3	3144	-2	3142	$37,703	2
SanDiego	158.62	-1.12	157.5	44096	-11	4846	-9	4838	$58,052	2
Seattle	240.28	-13.24	227.04	66798	-126	7341	-101	7240	$86,885	2
Tampa	222.8	-0.17	222.63	61938	-2	6807	-1	6806	$81,669	2
Tucson	219.17	-1.47	217.7	60929	-14	6696	-11	6685	$80,219	2

CEPI-119-21

CEPI-120-21

IECC®: C403.8.4

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:
C403.8.4 Fractional hp fan motors.

Motors for fans that are not less than $^{1}/_{12}$ hp (0.062 kW) and are less than 1 hp (0.746 kW) shall be electronically commutated motors or shall have a minimum motor efficiency of 70 percent, rated in accordance with DOE 10 CFR 431. These motors shall have the means to adjust motor speed for either balancing or remote control. The use of belt-driven fans to sheave adjustments for airflow balancing instead of a varying motor speed shall be permitted. Where an air handler integrated with a space conditioning appliance is the only supply fan providing outdoor air to a dwelling unit, the efficacy of the air handler powered by the motor shall be no less than 1.2 cfm of design outdoor airflow rate per watt of power consumed.

Exceptions: The following motors are not required to comply with this section

1. Motors in the airstream within fan coils and terminal units that only provide heating to the space served.

2. Motors in space-conditioning equipment that comply with Section C403.3.2 or Sections C403.8.1. through C403.8.3.

3. Motors that comply with Section C405.8.

Reason Statement:

This proposal crosswalks the 2021 IECC-R Table R403.6.2 dwelling unit outdoor air fan efficacy requirements to the IECC-C (specifically as related to air handlers; other efficacy requirements are coordinated through other proposals). When space conditioning air handlers are used as the primary supply fan to provide outdoor air to dwelling units, the energy penalty can be significant. Such systems are commonly referred to as "central fan integrated" or CFI systems. The typical energy penalty associated with using a CFI system instead of a dedicated outdoor air supply fan is about 1148 kWh annually per dwelling unit[1] – an enormous penalty that is comparable to adding ~3 refrigerators[2] to a dwelling unit. This proposal would ensure that, where specified, a CFI system's outdoor air fan efficacy requirements would align with the 2021 IECC-R requirements and would comply with at least the minimum fan efficacy requirement of the alternatives provided in Table C403.8.5.

1. Annual central air handler energy use for a typical apartment was estimated at 1270 kWh, based on the following assumptions: 1000 sqft, 2-bedrooms, 53 cfm OA flow requirement, OA duct provides 1.5 x 53 cfm on an intermittent basis (i.e., 79 cfm; 67% annual duty cycle for ventilation), 25% annual duty cycle for central air handler run time to provide heating/cooling (source: Rudd, A., I. Walker 2007. “Whole House Ventilation System Options – Phase 1 Simulation Study.” ARTI Report No. 30090-01, Final Report, March. Air-Conditioning and Refrigeration Technology Institute, Arlington, VA), probability of coincidental operation of central air handler for heating/cooling and variable ventilation system for outdoor air: 67%*25%=17% (this is the % of “free” central air handler energy for distributing ventilation air), 0.58 W/cfm air handler fan efficacy (source: CEC Title 24 Section 150.1(c)10 prescriptive requirement for air handler efficacy that is not connected to a forced air furnace), 1.5-ton central cooling unit with airflow rate of 400 cfm/ton, air handler operates at design airflow rate when providing ventilation air (provides an upper bound for coincidental energy use). Result: 762 kWh/yr consumed by central air handler for heating and cooling, 2032 kWh/yr consumed by central air handler for heating, cooling, and distributing ventilation air, 1270 kWh/yr fan energy use for ventilation. If a dedicated outdoor air supply fan with an efficacy of 3.8 cfm/W were used instead, the dwelling unit would use 387 kWh instead (53 cfm / 3.8 cfm/W, continuous operation), a savings of 1148 kWh annually.

2 U.S. DOE’s Federal Energy Management Program estimates typical, new refrigerators to use 403 kWh annually: https://www.energy.gov/eere/femp/purchasing-energy-efficient-residential-refrigerators.

Motorized Damper for use with Air Handler			
Manufacturer	**Model**	**Price**	**Source**
Honeywell	Y8150A1017	$202.39	Zoro.com
AirCycler	AC-G1D-06	$230.60	AirCycler website
Broan	FIN-6MD	$180.25	camperid.com
Aldes	FAK-II-MD-6	$187.50	HVACQuick.com
		$200.19	

Discrete Supply Fan			
Manufacturer	**Model**	**Price**	**Source**
Broan	FIN-180B	$225.69	SupplyHouse.com
Broan	FIN-180P	$295.00	SupplyHouse.com
AirKing	QuFAM	$397.00	ACWholesalers.com
AprilAire	8142	$321.22	SupplyHouse.com
AprilAire	8145	$309.43	SupplyHouse.com
Panasonic	FV-15NLFS1	$537.50	SupplyHouse.com
Soler & Palau	RF8-120EC	$447.20	HVACQuick.com
		$361.86	

Cost Impact:

The code change proposal will increase the cost of construction.

As noted in the reason statement for the proposal that introduced this requirement in the IECC-R (RE134-19), "For buildings that are already using an independent fan strategy (exhaust, supply, or balanced) or an integrated fan strategy that utilizes a small enough horsepower motor, this proposal will not increase or decrease the cost of construction. For buildings that are currently using (a motorized damper coupled with) a standard AHU/furnace fan motor (i.e., CFI system) as their mechanical ventilation fan, the cost of construction may increase as they will need to adjust their mechanical ventilation design strategy in order to comply." If designers elect to specify a dedicated in-line supply fan, the incremental first cost to the consumer is estimated to average ~$160 (with options as low as ~$45). See the included table for pricing information collected in September 2021. This incremental first cost can be recouped quickly based on energy savings of ~1148 kWh/year by using a dedicated in-line supply fan instead of a CFI system to deliver outdoor air.

CEPI-120-21

CEPI-121-21

IECC®: TABLE C403.8.5, C403.8.5, CSA Chapter 06 (New), ASHRAE Chapter 06 (New)

Proponents: Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE C403.8.5 LOW-CAPACITY VENTILATION FAN EFFICACY[a]

~~FAN LOCATION~~ SYSTEM TYPE	AIRFLOW RATE ~~MINIMUM~~ (CFM)	MINIMUM EFFICACY (CFM/WATT)	TEST PROCEDURE	~~AIRFLOW RATE MAXIMUM (CFM)~~
HRV~~, or~~ ERV, or balanced	Any	1.2~~ cfm/watt~~	CAN/CSA 439-18	~~Any~~
Range hood	Any	2.8		
In-line supply or exhaust fan	Any	3.8~~ cfm/watt~~		~~Any~~
~~Bathroom, utility room~~	~~10~~ < 90	2.8~~ cfm/watt~~	ASHRAE 51	~~< 90~~
	>=90 and < 200	3.5~~ cfm/watt~~		~~Any~~
Other exhaust fan	>= 200	4.0		

For SI: 1 cfm/ft = 47.82 W.

a. Design outdoor airflow rate/watts of fan used.

~~Airflow shall be tested in accordance with HVI 916 and listed. Efficacy shall be listed or shall be derived from listed power and airflow. Fan efficacy for fully ducted HRV, ERV, balanced and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c.~~

C403.8.5 Low-capacity ventilation fans. Mechanical ventilation system fans with motors less than $^{1}/_{12}$ hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.5 at one or more rating points. Airflow shall be tested in accordance with the test procedure referenced by Table C403.8.5 and listed. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ERV, balanced, and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. (49.85 Pa). Fan efficacy for ducted range hoods, bathroom, and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c. (24.91 Pa).

Exceptions:

1. Where ventilation fans are a component of a listed heating or cooling appliance.
2. Dryer exhaust duct power ventilators, domestic range hoods and domestic range booster fans that operate intermittently.
3. Fans in radon mitigation systems.
4. Fans not covered within the scope of the test methods referenced in Table C403.8.5.
5. Ceiling fans regulated under 10 CFR 430 Appendix U.

Add new standard(s) as follows:

CSA

CSA Group
8501 East Pleasant Valley Road
Cleveland, OH 44131-5516

CAN/CSA-C439-18 Laboratory methods of test for rating the performance of heat/energy-recovery ventilators

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

ASHRAE Standard 51-16 / ANSI/*AMCA* Standard 210-16. Laboratory Methods Of Testing Fans For Certified Aerodynamic Performance Rating

Reason: This proposal improves alignment between the IECC-C fan efficacy table with ENERGY STAR specifications and ASHRAE 90.1 and IECC-R fan efficacy tables, providing better organization and clarity, establishing the minimum fan efficacy for balanced systems, establishing minimum fan efficacy for exhaust fans exceeding 200 cfm, and moving footnote information into the main body. Note that the change of the table header from "fan location" to "system type" and the additions of "balanced" and "range hood" system types were approved by ICC through approval of RE133-19, RE137-19, and RE178-19 and should show up in the 2021 version, pending ICC approval of submitted errata. The efficacy value introduced for range hoods is in the 2018 IECC-R table, is aligned with the ENERGY STAR Ventilating Spans v4.1 and is only applicable for range hoods operated continuously (as noted in the exceptions to the table's charging language. The new efficacy value introduced for exhaust fans exceeding 200 cfm is aligned with ENERGY STAR Ventilating Fans v4.1 and was found to be cost effective through the ASHRAE 90.1 process. All efficacy values track with ENERGY STAR values for the product type. The three exceptions were added to ensure that the section does not preempt federal regulations, does not apply to radon fans (which may operate at higher static pressures -- and lower efficacies -- than typical ventilation fans), and does not apply to fans that are not regulated by the test standards referenced (e.g., fans integrated with an appliance are exempt). Finally, the test methods referenced are those referenced by ASHRAE 90.1 and are those used by industry for testing and listing.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The only element of this proposal that may affect first costs is the introduction of a fan efficacy requirement for exhaust fans exceeding 200 cfm and a motor less than 1/12 horsepower. This requirement is aligned with ENERGY STAR Ventilating Fans v4.1 and has already been vetted by ASHRAE 90.1, which has cost effectiveness requirements. Additionally, a small sample of internet retail pricing for units that would be affected by this requirement showed that price was not heavily correlated with efficacy:

Compliant:

Model A: 300 cfm, 7.3 cfm/watt, $185

Model B: 200 cfm, 11.4 cfm/watt, $179

Not Compliant:

Model C 200 cfm, 3.5 cfm/watt, $159

Model D: 200 cfm, 3.6 cfm/watt, $212

Pricing gathered October 2021 from airxheat, ecomfort, homedepot, and amazon.

CEPI-122-21

IECC®: C403.8.5, TABLE C403.8.5, CSA Chapter 06 (New), ASHRAE Chapter 06 (New)

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

C403.8.5 Low-capacity ventilation fans. Mechanical ventilation system fans with motors less than $^1/_{12}$ hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.5 at one or more rating points.

Exceptions:

1. Where ventilation fans are a component of a listed heating or cooling appliance.
2. Dryer exhaust duct power ventilators, domestic range hoods and domestic range booster fans that operate intermittently.
3. <u>Fans in radon mitigation systems.</u>
4. <u>Fans not covered within the scope of the test methods referenced in Table C403.8.5.</u>
5. <u>Ceiling fans regulated under 10CFR 430 Appendix U.</u>

TABLE C403.8.5 LOW-CAPACITY VENTILATION FAN EFFICACY[a]

FAN LOCATION	AIRFLOW RATE ~~MINIMUM~~ (CFM)	MINIMUM EFFICACY (CFM/WATT)	Test Method and Rating Conditions	~~AIRFLOW RATE MAXIMUM (CFM)~~
HRV or ERV	Any	1.2 ~~cfm/watt~~	CAN/CSA 439-18	~~Any~~
In-line supply or exhaust fan	Any	3.8 ~~cfm/watt~~	ASHRAE Standard 51	~~Any~~
~~Bathroom, utility room~~	~~10~~ <90	2.8 ~~cfm/watt~~		~~< 90~~
	>=90 and <200	3.5 ~~cfm/watt~~		~~Any~~
Other exhaust fan	>=200	4.0		

For SI: 1 cfm/ft = 47.82 W.

a. Airflow shall be tested in accordance with ~~HVI 916 and listed~~ the referenced test method. Efficacy shall be listed or shall be derived from listed power and airflow. Fan efficacy for fully ducted HRV, ERV, balanced and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c.

Add new standard(s) as follows:

CSA

CSA Group
8501 East Pleasant Valley Road
Cleveland, OH 44131-5516

CAN/CSA-C439-18 Laboratory methods of test for rating the performance of heat/energy-recovery ventilators

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

ANSI/ASHRAE Standard 51-16 (ANSI/AMCA Standard 210-16) Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating

Reason: Addendum a to ASHRAE 90.1-2019. It was already a partial match but this brings it into greater alignment. This proposal includes additional exceptions for particular fan types. Fans used for radon mitigation are part of systems that operate continuously and are activated by integrated controls. Ceiling fans are now federally regulated products per 10 CFR 430 Appendix U, and therefore have separate and distinct efficiency requirements. It has been determined in the test standards proposed for Table C403.8.5 that certain other types of fans should be excluded from these efficacy requirements for various reasons.
In Table C403.8.5, the Airflow Rate Maximum (cfm) column is being stricken and instead this upper limit is now being handled by the applicable test standards proposed in the new column. ASHRAE Standard 51-16 (ANSI/AMCA Standard 210-16) provides an appropriate test method and rating conditions for the fan types and locations listed in the Table.

Bibliography: ANSI/ASHRAE/IES 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum a.
https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Allowing for more fan type exceptions from the requirement will give flexibility to the designer and building owner. The changes to Table C403.8.5 will not increase the cost of construction.

CEPI-123-21

IECC®: C403.8.6.2 (New)

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

2021 International Energy Conservation Code

Add new text as follows:
C403.8.6.2 Bathroom Intermittent Exhaust Control.

When a bathroom exhaust system is designed for intermittent operation, the power shall be provided through an automatic shutoff timer switch with a maximum time limit of 30 minutes.

Reason Statement:

To reduce energy consumption and unnecessary infiltration in buildings.

Substantiation: Bin analysis was run on a 50 cfm bath exhaust fan in Denver. It was assumed the fan would run 2 hours a day with a manual switch vs. 5 minutes with a timer. Only heating energy and fan energy was reviewed, savings was $ 27 per year based on 10¢/KWH.

Assuming $ 100 installed cost, the payback is 4 years . Added benefit is that occupants no longer need to remember to go back and shutoff the bathroom exhaust fan.

Cost Impact:

The code change proposal will increase the cost of construction.

A small increase in cost can significantly reduce the time a bathroom fan is on.

CEPI-123-21

CEPI-124-21

IECC®: SECTION 202, C403.9, TABLE C403.9 (New), C403.9.1 (New), AMCA Chapter 06, DOE Chapter 06 (New)

Proponents:

Amanda Hickman, representing Air Movement and Control Association (AMCA) (amanda@thehickmangroup.com); Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:
IECC2021P1E_CE_Ch02_SecC202_DefLARGE_DIAMETER_CEILING_FAN LARGE-DIAMETER CEILING FAN. A ceiling fan that is greater than or equal to 84.5 inches (2.15 meters)~~7 feet (2134 mm)~~ in diameter. These fans are sometimes referred to as High-Volume, Low-Speed (HVLS) fans.
C403.9 Large-diameter ceiling fans.
Where provided, *large-diameter ceiling fans* shall be tested and labeled in accordance with AMCA 230 and shall meet the efficiency requirements of Table C403.9 and Section C403.9.1.
Add new text as follows:

TABLE C403.9

CEILING FAN EFFICIENCY REQUIREMENTS[a]

EQUIPMENT TYPE	MINIMUM EFFICIENCY[b,c]	TEST PROCEDURE
Large-diameter ceiling fan for applications outside the U.S.[c]	CFEI ≥ 1.00 at high (maximum) speed CFEI ≥ 1.31 at 40% of high speed or the nearest speed that is not less than 40% of high speed	10 CFR 430 Appendix U or AMCA Standard 230 and AMCA Standard 208 (for FEI calculations)
Large-diameter ceiling fan	CFEI ≥ 1.00 at high (maximum) speed; and CFEI ≥ 1.31 at 40% of high speed or the nearest speed that is not less than 40% of high speed	10 CFR 430 Appendix U

a. The minimum efficiency requirements at both high speed and 40% of maximum speed shall be met or exceeded to comply with this code.

b. Ceiling fans are regulated as consumer products by 10 CFR 430.

c. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

C403.9.1 Ceiling Fan Energy Index (CFEI).

The Ceiling Fan Energy Index shall be calculated as the ratio of the electric input power of a reference large-diameter ceiling fan to the electric input power of the actual large-diameter ceiling fan as calculated in accordance with AMCA 208 with the following modifications to the calculations for the reference fan: using an airflow constant (Q) of 26,500 cfm (12.507 m^3/s), a pressure constant (P) of 0.0027 in. of water (0.6719 Pa), and fan efficiency constant (η) of 42%.

Revise as follows:

AMCA Air Movement and Control Association International 30 West University Drive Arlington Heights IL 60004-1806

230—15 with errata Laboratory Methods of Testing Air Circulating Fans for Rating and Certification

Add new standard(s) as follows:

DOE US Department of Energy c/o Superintendent of Documents 1000 Independence Avenue SW Washington DC 20585

10 CFR, Part 430, App U Uniform Test Method for Measuring the Energy Consumption of Ceiling Fans

Reason Statement:

Large-diameter ceiling fans (LDCF) are used in many buildings covered by the International Energy Conservation Code. In recent years, the usage of this class of products has increased significantly. However, the 2021 IECC has no minimum energy efficiency requirements for this type of fan.

On January 19, 2017, the U.S. Department of Energy (DOE) completed a rulemaking and published a final rule establishing new federal minimum energy efficiency standards for ceiling fans. In doing so, it established the LDCF product class, which are ceiling fans with a blade span greater than 2.13 m (84 in.) and a corresponding efficiency metric of cubic feet per minute per Watt, or CFM/W.

The DOE test procedure's requirement is to round the measured blade span to the nearest inch, which does not appear in AMCA 230-15 or AMCA 208-18. Therefore, to provide equivalent requirements, the LDCF product class is all ceiling fans with blade spans greater than or equal to 84.5 in. (2.15m) when determined in accordance with the AMCA standards and 2.13 m (84 in.) when determined in accordance with 10 CFR 430.

On December 27, 2020, the U.S. House of Representatives Bill HR-133, aka the "Consolidated Appropriations Act, 2021," became Public Law No: 116-260. HR-133, Section 1008, entitled "Ceiling Fan Improvement Act," replaced the CFM/W efficiency metric with Ceiling Fan Energy Index (CFEI).

Specifically, Section 1008 of the Energy Act of 2020 (the ''Act'') amended section 325(ff)(6) of EPCA to specify that LDCF manufactured on or after January 21, 2020, are not required to meet minimum ceiling fan efficiency requirements in terms of the total airflow to the total power consumption, CFM/W, as established in the January 2017 Final Rule. Instead, LDCF are required to meet minimum efficiency requirements based on the CFEI metric. (42 U.S.C. 6295(ff)(6)(C)(i)(I), as codified). Small-diameter ceiling fans use a different test procedure, have a different efficiency metric, and were not impacted by the Energy Act of 2020.

The Act requires large-diameter ceiling fans to have a CFEI greater than or equal to 1.00 at high speed and greater than or equal to 1.31 at 40 percent speed or the nearest speed that is not less than 40 percent speed. (42 U.S.C. 6295(ff)(6)(C)(i)(II), as codified). Further, the Act specifies that CFEI is to be calculated in accordance with ANSI/AMCA Standard 208–18, with the following modifications to the constants used for the reference fan: (I) Using an Airflow Constant (Q_0) of 26,500 cubic feet per minute; (II) Using a Pressure Constant (P_0) of 0.0027 inches water gauge; and (III) Using a Fan Efficiency Constant (h_0) of 42 percent. (42 U.S.C. 6295(ff)(6)(C)(ii), as codified). The EPCA language did not provide metric equivalents for the replacement coefficients, however, the metric conversions are provided in the proposed addendum.

This proposal adds the minimum energy efficiency requirements from 42 U.S.C. 6295(ff)(6)(C)(ii) for large-diameter ceiling fans to the IECC and is consistent with the federal standards. DOE's analysis from the final rule indicates that the adopted energy conservation standards for all ceiling fan product classes would save a significant amount of energy. Relative to the case without amended standards (referred to as the "no-new-standards case"), the lifetime energy savings for ceiling fans purchased in the 30-year period amounts to 2.008 quadrillion British thermal units (Btu), or quads.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Building on the explanation above, additional details regarding the energy savings and economic calculations can be found in DOE's Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Ceiling Fans, published November 2016 which can be found at the link below. https://www.regulations.gov/document/EERE-2012-BT-STD-0045-0149

CEPI-124-21

CEPI-125-21

IECC®: SECTION 202 (New), C404.11 (New), ANSI Chapter 06 (New)

Proponents:

Kimberly Cheslak, NBI, representing NBI (kim@newbuildings.org); Josh Keeling, representing Cadeo Group (jkeeling@cadeogroup.com); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Matt Tidwell, representing Portland General Electric (matthew.tidwell@pgn.com); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Amber Wood, representing ACEEE (awood@aceee.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 GRID-INTEGRATED CONTROL.

An automatic control that can receive, automatically respond to demand response requests from and send information back to a utility, electrical system operator, or third-party demand response program provider.

Add new text as follows:
C404.11 Grid-integrated water heating.

Electric storage water heaters with a storage tank capacity between 37 and 120 gallons shall be provided with *grid-integrated controls* that comply with ANSI/CTA-2045-B Level 2.

Exceptions:

1. Water heaters that provide a hot water delivery temperature of 180°F (82°C) or greater.
2. Water heaters serving health care occupancies.
3. Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code.
4. Water heaters that use 3-phase electric power.

Add new standard(s) as follows:

ANSI American National Standards Institute 25 West 43rd Street, 4th Floor New York NY 10036

ANSI/CTA 2045-B Modular Communications Interface for Energy Management

Reason Statement:

With increasing penetrations of intermittent renewable energy, volatile wholesale power prices, and subsequent growth in dynamic rates/demand response programs, grid-interactive end uses present an opportunity to help homes manage their bills, participate in programs, and support efficient grid operations. Water heaters can provide many services to the grid, including generation, transmission, and distribution capacity, energy arbitrage, and ancillary services. In their assessment of the National Potential for Load Flexibility, Brattle estimated that across all measures these services could provide as much as $15 billion per year in value to the electric system.

As electricity systems transform to include more variable wind and solar energy, demand flexibility becomes increasingly critical to both grid operation and further transformation. Building systems that can use energy when it is abundant, clean, and low-cost not only help decarbonize the entire energy system, they also insulate their owners from future increases in demand charges and peak hour energy rates – a current and accelerating trend. Water heaters offer an unparalleled opportunity for load shifting: tanks full of hot water are inherently energy storage devices. Including the controls necessary to take advantage of this opportunity is relatively simple and affordable in new construction. Compared to other energy storage technologies such as batteries, smart, grid-integrated water heater controls can deliver substantial dispatchable (that is, reliable to the grid operator) energy flexibility. The controls specified by ANSI/CTA-2045-B ensure negligible risk of occupant disruption (that is, the hot water will not run out). Water heaters provide a particularly attractive option as they have inherent thermal storage that allows energy consumption to be shifted with little to no impact to the end user. This capability has been demonstrated in several contexts, most recently through regional demonstrations conducted by EPRI and BPA.

In their Grid-interactive and Efficient Buildings (GEBs) Roadmap, the US Department of Energy estimates that approximately 15 GW of additional load flexibility is expected to be added to the system under reference case assumptions. Combined with energy efficiency, this is expected to provide $13 billion/year of peak demand savings to the power system and its customers. Through a comprehensive literature review and interviewing dozens of national experts, the USDOE team found that one of the biggest barriers was the lack of interoperability. A key tool to solve this problem is building codes, which can help to ensure that interoperable devices and controls are installed at the time of construction. USDOE cited explicitly the use of codes and standards as one of its recommended pathways to enable greater adoption of GEBs technologies.

It is important to include the requirement for two-way communication (specifically, communication from the behind-the-meter control module back to the utility, grid operator, or other third party entity) because this communication ensures that the controls capability can be fully deployed when needed. With legacy demand response systems, a signal is sent out but the ability to track and quantify the impacts of that signal is effectively nonexistent. This one-way communication paradigm is a key reason that the “firmness” or reliability of many flexibility-related demand side management strategies, particularly demand response, is often considered to be very low. However, a two-way communication paradigm enables much more reliable impact tracking. Buildings whose controls include two-way communication capability, that is, those with grid-interactive controls as defined here, will be better able to participate in the demand response programs of the future, and their owners will have improved financial prospects through enhanced ability to participate in potentially lucrative utility demand response programs.

ANSI/CTA-2045-B standardizes the socket, and communications protocol, for electric water heaters so they can communicate with the grid, and with demand response signal providers. In addition, 2045-B adds control and communications requirements for mixing valves in water heaters, which enable them to provide greater storage capacity to support increased load shifting while eliminating scalding risk.

Versions of this standard are included in codes or other requirements in California, Oregon, and Washington and are referenced explicitly by ENERGY STAR.

Bibliography:

Brattle, The National Potential for Load Flexibility (2019) https://brattlefiles.blob.core.windows.net/files/16639_national_potential_for_load_flexibility_-_final.pdf

BPA, CTA-2045 Water Heater Demonstration Report (2018) https://www.bpa.gov/EE/Technology/demand-response/Documents/Demand%20Response%20-%20FINAL%20REPORT%20110918.pdf

EPRI, CEA-2045 Field Demonstrations Project Description (2014) https://www.epri.com/research/products/000000003002004009

USDOE, A National Roadmap for Grid-Interactive Efficient Buildings (2021) https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf

Washington State Revised Code of Washington, Title 19, Chapter 19.260, Section 19.260.080, available at https://app.leg.wa.gov/RCW/default.aspx?cite=19.260.080

Oregon Department of Energy, Energy Efficiency Standards Rulemaking https://www.oregon.gov/energy/Get-Involved/Pages/EE-Standards-Rulemaking.aspx

U.S. EPA Energy Star Program, Connected Criteria for ENERGY STAR Products, https://www.energystar.gov/products/spec/connected_criteria_energy_star_products_pd

Cost Impact:

The code change proposal will increase the cost of construction.

To enable grid-interactive controls, there are two sources of costs: the incremental cost to ensure that equipment is interoperable with CTA-2045-B and the cost of the control module installed in that device. The incremental manufacturing cost is in the range of a few dollars, and negligible at higher volumes. The current incremental cost to include a CTA-2045-B compliant control module ranges from about $60 (direct current, hard-wired connection) to $160 (alternating current, wireless cellular connection); this is expected to decline as manufacturing lines are brought up to larger scale (source: Advanced Water Heating Initiative). The major determinant of cost if the chosen radio pathway as chipset costs vary considerably between different frequencies/standards.

In the BPA report, manufacturers stated a range of $2-$30 for regional deployment, but noted that there would be economies of scale for a national rollout. The main cost was development of firmware/hardware to accommodate the standard, but these costs have already been incurred to meet codes/standards in OR, WA, and CA.

CEPI-125-21

CEPI-126-21

IECC®: TABLE C404.2

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C404.2 MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	SIZE CATEGORY (input)	SUBCATEGORY OR RATING CONDITION	DRAW PATTERN PERFORMANCE REQUIRED[a, b]	TEST PROCEDURE
Water heaters, electric	≤ 12 kW[d]	Tabletop[e], ≥ 20 gallons and ≤ 120 gallons	~~0.93 – 0.00132*V*, EF~~ Very Small 0.6323 – (0.0058 × Vr), UEF Low 0.9188 – (0.0031 × Vr), UEF Medium 0.9577 – (0.0023 × Vr), UEF High 0.9884 – (0.0016 × Vr), UEF	DOE 10 CFR Part 430
		Resistance ≥ 20 gallons and ≤ 55 gallons	~~0.960 – 0.0003*V*, EF~~ Very Small 0.8808 – (0.0008 × Vr), UEF Low 0.9254 – (0.0003 × Vr), UEF Medium 0.9307 – (0.0002 × Vr), UEF High 0.9349 – (0.0001 × Vr), UEF	
		Grid-enabled[f] > 75 gallons and ≤ 120 gallons	~~1.061 – 0.00168V, EF~~ Very Small 1.0136 – (0.0028 × V_r), UEF Low 0.9984 – (0.0014 × V_r), UEF Medium 0.9853 – (0.0010 × V_r), UEF High 0.9720 – (0.0007 × V_r) , UEF	
	> 12 kW	Resistance	(0.3 + 27/V_m), %/h	ANSI Z21.10.3
	≤ 24 amps and ≤ 250 volts	Heat pump > 55 gallons and ≤ 120 gallons	~~2.057 – 0.00113V, EF~~ Very Small 1.9236 – (0.0011 × V_r), UEF Low 2.0440 – (0.0011 × V_r), UEF	DOE 10 CFR Part 430

			Medium 2.1171 − (0.0011 × V_r), UEF High 2.24R18E Q− U(I0.R0E0D1a1, ×b Vr) , UEF	
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gallons and > 55 gallons	~~0.675 – 0.0015V, EF~~ Very Small 0.3456 – (0.0020 × V_r), UEF Low 0.5982 – (0.0019 × V_r), UEF Medium 0.6483 – (0.0017 × V_r), UEF High 0.6920 – (0.0013 × V_r), UEF	DOE 10 CFR Part 430
		> 55 gallons and ≤ 100 gallons	~~0.8012 – 0.00078V, EF~~ Very Small 0.6470 – (0.0006 × V_r), UEF Low 0.7689 – (0.0005 × V_r), UEF Medium 0.7897 – (0.0004 × V_r), UEF High 0.8072 – (0.0003 × V_r), UEF	
	> 75,000 Btu/h and ≤ 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	ANSI Z21.10.3
	> 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Instantaneous water heaters, gas	> 50,000 Btu/h and < 200,000 Btu/h[c]	≥ 4,000 Btu/h/gal and < 2 gal	~~0.82 – 0.00 19V, EF~~ Very Small 0.80 UEF Low 0.81 UEF Medium 0.81 UEF High 0.81 UEF	DOE 10 CFR Part 430
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Storage water heaters, oil	≤ 105,000 Btu/h	≥ 20 gal and ≤ 50 gallons	~~0.68 – 0.0019V, EF~~ Very Small 0.2509 – (0.0012 × V_r), UEF Low 0.5330 – (0.0016 × V_r), UEF Medium 0.6078 – (0.0016 × V_r), UEF High 0.6815 – (0.0014 × V_r), UEF	DOE 10 CFR Part 430
	≥ 105,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	ANSI Z21.10.3
Instantaneous	≤ 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 2 gal	0.59 – 0.0019V, EF	DOE 10 CFR Part 430
		≥ 4,000 Btu/h/gal and		

water heaters, oil	> 210,000 Btu/h > 210,000 Btu/h	< 10 gal ≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t 78% E_t, $(Q/800 + 110\sqrt{V})$SL, Btu/h	ANSI Z21.10.3
Hot water supply boilers, gas and oil	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	
Hot water supply boilers, gas	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	ANSI Z21.10.3
Hot water supply boilers, oil	> 300,000 Btu/h and < 12,500,000 Btu/h	> 4,000 Btu/h/gal and > 10 gal	78% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Pool heaters, gas and oil	All	—	82% E_t	ASHRAE 146
Heat pump pool heaters	All	—	4.0 COP	AHRI 1160
Unfired storage tanks	All	—	Minimum insulation requirement R-12.5 (h × ft^2 × °F)/Btu	(none)

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, °C = [(°F) – 32]/1.8, 1 British thermal unit per hour = 0.2931 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.

a. Uniform Energy factor (EF) and thermal efficiency (E_t) are minimum requirements. In the UEF equation, V_r is the rated volume in gallons.

b. Standby loss (SL) is the maximum Btu/h based on a nominal 70°F temperature difference between stored water and ambient requirements. In the SL equation, Q is the nameplate input rate in Btu/h. In the equations for electric water heaters, V is the rated volume in gallons and V_m is the measured volume in gallons. In the SL equation for oil and gas water heaters and boilers, V is the rated volume in gallons.

c. Instantaneous water heaters with input rates below 200,000 Btu/h shall comply with these requirements where the water heater is designed to heat water to temperatures 180°F or higher.

d. Electric water heaters with an input rating of 12 kW (40,950 Btu/h) or less that are designed to heat water to temperatures of 180°F or greater shall comply with the requirements for electric water heaters that have an input rating greater than 12 kW (40,950 Btu/h).

e A tabletop water heater is a water heater that is enclosed in a rectangular cabinet with a flat top surface not more than 3 feet in height.

A grid-enabled water heater is an electric-resistance water heater that meets all of the following:

1. Has a rated storage tank volume of more than 75 gallons.

2. Was manufactured on or after April 16, 2015.

3. Is equipped at the point of manufacture with an activation lock.

f. Bears a permanent label applied by the manufacturer that complies with all of the following:

4.
   4.1. Is made of material not adversely affected by water.
   4.2. Is attached by means of nonwater-soluble adhesive.
   4.3. Advises purchasers and end users of the intended and appropriate use of the product with the following notice printed in 16.5 point Arial Narrow Bold font: “IMPORTANT INFORMATION: This water heater is intended only for use as part of an electric thermal storage or demand response program. It will not provide adequate hot water unless enrolled in such a program and activated by your utility company or another program operator. Confirm the availability of a program in your local area before purchasing or installing this product.”

CEPI-127-21 proposes changes to Table C404.2 as well.

Reason Statement:

In the United States, residential water heaters are now rated with a new metric known as Uniform Energy Factor, which replaces Energy Factor. In addition, there are different UEF's for different draw patterns, which are listed in federal regulations.

This proposal updates the water heater tables to reflect the new metric and values that have been in place since 2017.

Bibliography:

U.S. Department of Energy, *Energy Conservation Program for Consumer Products and Certain Commercial and Industrial Equipment: Test Procedures for Consumer and Commercial Water Heaters,* Federal Register Volume 81, Number 250, pages 96,204 - 96,239, December 29, 2016,

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal just updates the requirements in the table to reflect the updated metric of UEF.

CEPI-126-21

CEPI-127-21

IECC®: TABLE C404.2

Proponents:

Mike Kennedy, Mike D. Kennedy Inc., representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Delete and substitute as follows:

~~TABLE C404.2 MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT~~

EQUIPMENT TYPE	SIZE CATEGORY (input)	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED[a, b]	TEST PROCEDURE
Water heaters, electric	≤ 12 kW[d]	Tabletop[e], ≥ 20 gallons and ≤ 120 gallons	0.93 – 0.00132*V*, EF	DOE 10 CFR Part 430
		Resistance ≥ 20 gallons and ≤ 55 gallons	0.960 – 0.0003*V*, EF	
		Grid-enabled[f] > 75 gallons and ≤ 120 gallons	1.061 – 0.00168V, EF	
	> 12 kW	Resistance	$(0.3 + 27/V_m)$, %/h	ANSI Z21.10.3
	≤ 24 amps and ≤ 250 volts	Heat pump > 55 gallons and ≤ 120 gallons	2.057 – 0.00113V, EF	DOE 10 CFR Part 430
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gallons and > 55 gallons	0.675 – 0.0015V, EF	DOE 10 CFR Part 430
		> 55 gallons and ≤ 100 gallons	0.8012 – 0.00078V, EF	
	> 75,000 Btu/h and ≤ 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	ANSI Z21.10.3
	> 155,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Instantaneous water heaters, gas	> 50,000 Btu/h and < 200,000 Btu/h[c]	≥ 4,000 Btu/h/gal and < 2 gal	0.82 – 0.00 19V, EF	DOE 10 CFR Part 430
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Storage water heaters, oil	≤ 105,000 Btu/h	≥ 20 gal and ≤ 50 gallons	0.68 – 0.0019V, EF	DOE 10 CFR Part 430
	≥ 105,000 Btu/h	< 4,000 Btu/h/gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	ANSI Z21.10.3
Instantaneous water heaters, oil	≤ 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 2 gal	0.59 – 0.0019V, EF	DOE 10 CFR Part 430
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	78% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	
Hot water supply boilers, gas and oil	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	ANSI Z21.10.3
Hot water supply boilers, gas	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and ≥ 10 gal	80% E_t $(Q/800 + 110\sqrt{V})$SL, Btu/h	

Hot water supply boilers, oil b,	> 300,000 Btu/h and < 12,500,000 Btu/h	> 4,000 Btu/h/gal and > 10 gal	78% Et $(Q/800 + 110\sqrt{V})$SL, Btu/h	**TEST PROCEDURE**
Pool heaters, gas and oil		—	82% E_t	ASHRAE 146
Heat pump pool heaters	All	—	4.0 COP	AHRI 1160
Unfired storage tanks	All	—	Minimum insulation requirement R-12.5 (h × ft^2 × °F)/Btu	(none)

~~For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m^2, °C = [(°F) − 32]/1.8, 1 British thermal unit per hour = 0.2931 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.~~

a. Energy factor (EF) and thermal efficiency *(E_t)* are minimum requirements. In the EF equation, *V* is the rated volume in gallons.

b. Standby loss (SL) is the maximum Btu/h based on a nominal 70°F temperature difference between stored water and ambient requirements. In the SL equation, *Q* is the nameplate input rate in Btu/h. In the equations for electric water heaters, *V* is the rated volume in gallons and V_m is the measured volume in gallons. In the SL equation for oil and gas water heaters and boilers, *V* is the rated volume in gallons.

c. Instantaneous water heaters with input rates below 200,000 Btu/h shall comply with these requirements where the water heater is designed to heat water to temperatures 180°F or higher.

d. Electric water heaters with an input rating of 12 kW (40,950 Btu/h) or less that are designed to heat water to temperatures of 180°F or greater shall comply with the requirements for electric water heaters that have an input rating greater than 12 kW (40,950 Btu/h).

e A tabletop water heater is a water heater that is enclosed in a rectangular cabinet with a flat top surface not more than 3 feet in height.

f. A grid-enabled water heater is an electric-resistance water heater that meets all of the following:

1. Has a rated storage tank volume of more than 75 gallons.
2. Was manufactured on or after April 16, 2015.
3. Is equipped at the point of manufacture with an activation lock.
4. Bears a permanent label applied by the manufacturer that complies with all of the following:
   - 4.1. Is made of material not adversely affected by water.
   - 4.2. Is attached by means of nonwater-soluble adhesive.
   - 4.3. Advises purchasers and end users of the intended and appropriate use of the product with the following notice printed in 16.5 point Arial Narrow Bold font: “IMPORTANT INFORMATION: This water heater is intended only for use as part of an electric thermal storage or demand response program. It will not provide adequate hot water unless enrolled in such a program and activated by your utility company or another program operator. Confirm the availability of a program in your local area before purchasing or installing this product.”

TABLE C404.2 MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	DRAW PATTERN	PERFORMANCE REQUIRED[a]	TEST PROCEDURE[b]
Electric Table-top water heaters[g]	≤12 kW	≥ 20 gal ≤ 55 gal [f]	Very small Low Medium High	UEF ≥ 0.6323 – (0.0058 × Vr) UEF ≥ 0.9188 – (0.0031 × Vr) UEF ≥ 0.9577 – (0.0023 × Vr) UEF ≥ 0.9884 – (0.0016 × Vr)	DOE 10 CFR Part 430 App. E
Electric Storage water heaters[g,i]: resistance and heat pump	≤12 kW	≥ 20 gal ≤ 55 gal [f]	Very small Low Medium High	UEF ≥ 0.8808 – (0.0008 × Vr) UEF ≥ 0.9254 – (0.0003 × Vr) UEF ≥ 0.9307 – (0.0002 × Vr) UEF ≥ 0.9349 – (0.0001 × Vr)	DOE 10 CFR Part 430 App. E
	≤12 kW	> 55 gal ≤120 gal [f]	Very small Low Medium High	UEF ≥ 1.9236 – (0.0011 × Vr) UEF ≥ 2.0440 – (0.0011 × Vr) UEF ≥ 2.1171 – (0.0011 × Vr) UEF ≥ 2.2418 – (0.0011 × Vr)	DOE 10 CFR Part 430 App. E
Electric Storage water heaters[g,i]	> 12 kW			(0.3 + 27/Vm), %h	DOE 10 CFR 431.106 App B.
Grid-enabled water heaters [g]		>75 gal [f]	Very small Low Medium High	UEF ≥ 1.0136 – (0.0028 × Vr) UEF ≥ 0.9984 – (0.0014 × Vr) UEF ≥ 0.9853 – (0.0010 × Vr) UEF ≥ 0.9720 – (0.0007 × Vr)	10 CFR 430 Appendix E
Electric ~~I~~instantaneous water heaters[h]	≤12 kW	< 2 gal [f]	Very small Low Medium High	UEF ≥ 0.91 UEF ≥ 0.91 UEF ≥ 0.91 UEF ≥ 0.92	DOE 10 CFR Part 430
	>12 kW & ≤ 58.6	≤ 2 gal & ≤180F	All	UEF ≥ 0.80	DOE 10 CFR

	kW [c]				Part 430
Gas Storage water heaters[g]	≤ 75,000 Btu/h	≥20 gal & ≤ 55 gal [f]	Very small Low Medium High	UEF ≥ 0.3456 – (0.0020 × Vr) UEF ≥ 0.5982 – (0.0019 × Vr) UEF ≥ 0.6483 – (0.0017 × Vr) UEF ≥ 0.6920 – (0.0013 × Vr)	DOE 10 CFR Part 430 App. E
	≤ 75,000 Btu/h	> 55 gal & ≤ 100 gal [f]	Very small Low Medium High	UEF ≥ 0.6470 – (0.0006 × Vr) UEF ≥ 0.7689 – (0.0005 × Vr) UEF ≥ 0.7897 – (0.0004 × Vr) UEF ≥ 0.8072 – (0.0003 × Vr)	DOE 10 CFR Part 430 App. E
	> 75,000 Btu/h and ≤ 105,000 Btu/h [d]	≤ 120 gal ≤ 180 F	Very small Low Medium High	UEF ≥ 0.2674-0.0009 x Vr UEF ≥ 0.5362-0.0012 x Vr UEF ≥ 0.6002-0.0011 x Vr UEF ≥ 0.6597-0.0009 x Vr	DOE 10 CFR Part 430 App. E
	> 105,000 Btu/h [d,f]			80% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Gas Instantaneous water heaters[h]	> 50,000 Btu/h and < 200,000 Btu/h	< 2 gal	Very small Low Medium High	UEF ≥ 0.80 UEF ≥ 0.81 UEF ≥ 0.81 UEF ≥ 0.81	DOE 10 CFR Part 430 App. E
	≥ 200,000 Btu/h [d,f]	< 10 gal [f]		80% *Et*	DOE 10 CFR 431.106
	≥ 200,000 Btu/h [f]	≥10 gal		80% E_t SL ≤ (Q/800 +110√V), Btu/h	
	≤ 105,000 Btu/h	≤ 50 gal [f]	Very small Low Medium High	UEF = 0.2509 – (0.0012 × Vr) UEF = 0.5330 – (0.0016 × Vr) UEF = 0.6078 – (0.0016 × Vr) UEF = 0.6815 – (0.0014 × Vr)	DOE 10 CFR Part 430

Oil Storage water heaters[g]	> 105,000 Btu/h and ≤ 140,000 Btu/h [e]	≤ 120 gal ≤ 180 F	Very small Low Medium High	UEF ≥ 0.2932-0.0015 x Vr UEF ≥ 0.5596-0.0018 x Vr UEF ≥ 0.6194-0.0016 x Vr UEF ≥ 0.6740-0.0013 x Vr	DOE 10 CFR Part 430 App. E
	>140,000 Btu/h			80% *Et* SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Oil Instantaneous water heaters[h]	≤ 210,000 Btu/h	< 2 gal		80% Et EF ≥ 0.59 - 0.0005 x V	DOE 10 CFR Part 430 App. E
	> 210,000 Btu/h	< 10 gal		80% *Et*	DOE 10 CFR 431.106
	> 210,000 Btu/h	≥ 10 gal		78% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Hot water supply boilers, gas and oil[h]	≥300,000 Btu/h and < 12,500,000 Btu/h	< 10 gal		80% *Et*	DOE 10 CFR 431.106
Hot water supply boilers, gas[h]	≥300,000 Btu/h and < 12,500,000 Btu/h	≥ 10 gal		80% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Hot water supply boilers, oil[h]	≥300,000 Btu/h and < 12,500,000 Btu/h	≥ 10 gal		78% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 CFR 431.106
Pool heaters, gas	All	— f		82% *Et*	DOE 10 CFR Part 430 App. P
Heat pump pool heaters	All	50°F db 44.2°F wb outdoor air 80.0°F entering water		4.0 COP	DOE 10 CFR Part 430 App. P
Unfired storage tanks	All	—		Minimum insulation requirement R-12.5 (h-ft^2-°F)/Btu	(none)

For SI: 1 foot = 304.8 mm, 1 square foot = 0.0929 m2, °C = [(°F) – 32]/1.8, 1 British thermal unit per hour = 0.2931 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.

a. Thermal efficiency (E_t) is a minimum requirement, while standby loss is a maximum requirement. In the standby loss equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h. V_m is the measured volume in the tank in gallons. Standby loss for electric water heaters is in terms of %/h and denoted by the term “S,” and standby loss for gas and oil water heaters is in terms of Btu/h and denoted by the term “SL” Draw pattern (DP) refers to the water draw profile in the Uniform Energy Factor (UEF) test. UEF and Energy Factor (EF) are minimum requirements. In the UEF standard equations, V_r refers to the rated volume in gallons.

b. Chapter 6 contains a complete specification, including the year version, of the referenced test procedure.

c. Electric instantaneous water heaters with input capacity >12 kW and ≤58.6 kW that have either (1) a storage volume >2 gal; or (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power has no efficiency standard.

d. Gas storage water heaters with input capacity >75,000 Btu/h and ≤105,000 Btu/h must comply with the requirements for the >105,000 Btu/h if the water heater either (1) has a storage volume >120 gal; (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power.

e. Oil storage water heaters with input capacity >105,000 Btu/h and ≤140,000 Btu/h must comply with the requirements for the >140,000 Btu/h if the water heater either (1) has a storage volume >120 gal; (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power.

f. Water heaters or gas pool heaters in this category are regulated as consumer products by the USDOE as defined in 10 CFR 430and do not need to be checked for code compliance. Numbers in table are for reference or to use for over code performance determinations.

g. Table top and storage water heaters have a ratio of input capacity (Btu/h) to tank volume (gal) < 4000.

h. Instantaneous water heaters and hot water supply boilers have an input capacity (Btu/h) divided by storage volume (gal) ≥ 4000 Btu/h-gal.

i. Efficiency requirements for electric storage water heaters ≤ 12 kW apply to both electric resistance and heat pump water heaters. There are no minimum efficiency requirements for electric heat pump water heaters greater than 12kW or for gas heat pump water heaters.

CEPI-126-21 proposes changes to Table C404.2 as well.

Reason Statement:

The current IECC Table C404.2 uses Energy Factor (EF) which DOE replaced with the Universal Energy Factor (UEF) in 2017. New equipment are ratings are published in UEF and EF is generally not published. As such this table needs to be changed.

The proposed table C404.2 updates the values to the current DOE standards requirements. It is taken from language proposed for the Washington State Energy Code. Alternate approaches would include deleting the table entirely or adopting a table similar to 90.1. Most of the values in Table C404.2 are based upon national standards of one sort and another. As such most equipment will comply whether the table is in the code or not. Simply eliminating the table is an option and would keep code officials from worrying about water heater efficiency. Or a table similar to that adopted by 90.1 could be used. It lists all the equipment categories but for standards equipment simply states that it's regulated by DOE standards.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal updates code to reflect current federal standards and therefore will not increase the cost.

CEPI-127-21

CEPI-128-21

IECC®: C404.2.1

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:
C404.2.1 High input service water-heating systems.

Gas-fired service water-heating equipment in new buildings where the total input capacity provided by high-capacity service water-heating equipment is 1,000,000 Btu/h (293 W) or greater shall be in compliance with either or both of the following requirements:~~this section.~~

1. Where a singular piece of high-capacity gas-fired service water-heating equipment is installed ~~serves the entire building and the input rating of the equipment is 1,000,000 Btu/h (293 kW) or greater~~, such equipment shall have a thermal efficiency, E_t, of not less than 92 percent.
2. ~~Where multiple~~ Multiple pieces of high-capacity gas-fired service water-heating equipment connected to the same service water-heating system ~~serve the building and the combined input rating of the water-heating equipment is 1,000,000 Btu/h (293 kW) or greater~~, the combined input-capacity-weighted-average thermal efficiency, E_t, shall be not less than 90 percent and a minimum of 30% of the input to the gas-fired equipment in the service water-heating system shall have a thermal efficiency of not less than 92 percent.

High-capacity gas-fired service water-heating equipment is comprised of gas-fired instantaneous water heaters with a rated input both greater than 200,000 Btu/h (58.6 kW) and not less than 4,000 Btu/h per gallon (310 W per litre) of stored water, and gas-fired storage water heaters with a rated input both greater than 105,000 Btu/h (30.8 kW) and less than 4,000 Btu/h per gallon (310 W per litre) of stored water.

Exceptions:

~~1.~~ ~~Where not less than 25 percent of the annual service water-heating requirement is provided by *on-site renewable energy* or site-recovered energy, the minimum thermal efficiency requirements of this section shall not apply.~~

~~2~~ 1. The input rating of water heaters installed in individual dwelling units shall not be required to be included in the total input rating of service water-heating equipment for a building.

~~3~~2. The input rating of water heaters with an input rating of not greater than 100,000 Btu/h (29.3 kW) shall not be required to be included in the total input rating of service water-heating equipment for a building.

Reason Statement:

Addendum ah to 90.1-2019

This addendum makes a slight modification the to requirements for high-capacity water heaters.

- Currently, the 92% E_t requirement applies if there is just one water heater in the entire building. The change requires that the 92% E_t apply for any individual system that is high-capacity.
- Where multiple water heaters are connected to the same system, the average thermal efficiency is still 90%, but now at least 30% of the capacity must have a thermal efficiency of 92% or better.

Clear criteria have been established for high-capacity water heaters.

Commercial water heaters in the United States are regulated by the US Department of Energy (US DOE) under 10 CFR Part 431. These are the definitions of the products from the regulation:

- Gas-fired instantaneous water heaters with a rated input both greater than 200,000 Btu/h and not less than 4,000 Btu/h per gallon of stored water; or,
- Gas-fired storage water heaters with a rated input both greater than 105,000 Btu/h and less than 4,000 Btu/h per gallon of stored water.

These definitions are used to describe “high-capacity gas-fired service water heating equipment.” Service water heaters that are not included are consumer products regulated under 10 CFR Part 430 and “residential-duty commercial water heaters” as defined in 10 CFR Part 431. These products are rated using the Uniform Energy Factor, which cannot be readily compared to Et.

Other changes:

The exception for buildings that use site-solar or on-site recovered energy has been deleted since there are now general provisions covering renewables in other parts of the code.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum ah

https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda/addenda-to-standard-90-1-2019

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Neither US DOE’s Compliance Certification Database nor AHRI’s Certification Database includes any commercial gas-fired storage water heaters rated in the range from 90% to <92% thermal efficiency (Et). There are only four model numbers of commercial gas-fired instantaneous water heaters rated in the range from 90% to <92% Et. Three of these models are part of a product line with a range of Et from 87% to 90%, and the manufacturer’s literature lists all models in that line at 87% Et, leaving only one model number from one manufacturer. That model has a maximum input of 250,000 Btu/h.

CEPI-128-21

CEPI-129-21

IECC®: SECTION 202 (New), C404.2.1, C404.2.2 (New), C404.2.2.1 (New), C404.2.2.2 (New), C406.7.4

Proponents:

Evan Green, representing Ecotope, Inc; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:

C202 MULTI-PASS. A heat pump water heater control strategy requiring multiple passes of water through the heat pump to reach the final target storage water temperature.

C202 PRIMARY SERVICE WATER HEATING EQUIPMENT. Service water heating equipment intended to supply the majority of the service water heating load.

C202 SINGLE-PASS. A heat pump water heater control strategy using variable flow or variable capacity to deliver water from the heat pump at the final target storage water temperature in a single pass through the heat exchanger with variable incoming water temperatures.

C202 SUPPLEMENTAL SERVICE WATER HEATING EQUIPMENT. Equipment intended to heat any service water heating load that is not successfully heated by the primary service water heating equipment.

C202 TEMPERATURE MAINTENANCE. The system used to maintain the temperature of the building domestic hot water delivery system, typically by circulation and reheating or by a heat trace system.

Revise as follows:

C404.2.1 High input service water-heating systems for groups other than R-1 and R-2 occupancies.

Gas-fired water-heating equipment installed in new buildings shall be in compliance with this section. Where a singular piece of water-heating equipment serves the entire building and the input rating of the equipment is 1,000,000 Btu/h (293 kW) or greater, such equipment shall have a thermal efficiency, E_t, of not less than 92 percent. Where multiple pieces of water-heating equipment serve the building and the combined input rating of the water-heating equipment is 1,000,000 Btu/h (293 kW) or greater, the combined input-capacity-weighted-average thermal efficiency, E_t, shall be not less than 90 percent.

Exceptions:

1. Where not less than 25 percent of the annual service water-heating requirement is provided by *on-site renewable energy* or site-recovered energy, the minimum thermal efficiency requirements of this section shall not apply.
2. The input rating of water heaters installed in individual dwelling units shall not be required to be included in the total input rating of service water-heating equipment for a building.
3. The input rating of water heaters with an input rating of not greater than 100,000 Btu/h (29.3 kW) shall not be required to be included in the total input rating of service water-heating equipment for a building.

Add new text as follows:

C404.2.2 Service water heating for Group R-1 and R-2 occupancies.

In buildings that include Group R-1 or R-2 occupancies, the *primary service water heating equipment* for the residential uses shall not use direct combustion fossil fuel or electric resistance heating. Not less than 80 percent of annual building service hot water output capacity shall be provided by air source heat pump water heating systems. *Supplemental service water heating equipment* shall be permitted in accordance with Section C404.2.2.1.

Exceptions:

1. Systems supplying 80 percent of annual building service hot water output capacity using renewable energy generated on site or site recovered energy.
2. Systems supplying 80 percent of annual building service hot water output capacity using gas-fired absorption heat pumps (GAHP) with a COP greater than 1.0.

Solar thermal, wastewater heat recovery, other approved waste heat recovery, biomass, ground source heat pump, other water-

3. source heat pump system utilizing waste heat, and combinations thereof, may be used to offset up to 100% of the required air source HPWH capacity where these systems comply with this code and with the *International Plumbing Code*.

C404.2.2.1 Supplemental service water heating equipment.

Total supplemental water heating equipment shall not have an output capacity greater than the *primary service water heating equipment* at 40°F(4.4ºC) and shall not exceed the capacity restrictions below. Supplemental water heating is permitted for the following uses:

1. *Temperature maintenance* of heated-water circulation systems, physically separate from the *primary service water heating equipment*. *Temperature maintenance* capacity shall be no greater than the primary water heating capacity at 40°F and shall be installed per manufacturer's recommendations.
2. Heat tracing of piping for freeze protection or for *temperature maintenance* in lieu of recirculation of hot water.
3. Supplemental hot water heating where all of the following are true:
   3.1. The supplemental heating capacity is no greater than the primary service water heating capacity at 40°F (4.4ºC).
   3.2. During normal operations the supplemental heating is controlled to operate only when the entering air temperature at the air-source heat pump is below 40°F (4.4ºC), and the primary HPWH compressor continues to operate together with the supplemental heating when the entering air temperature is below 40°F (4.4ºC) and within the manufacturer's acceptable temperature range.
   3.3. The primary water heating equipment cannot satisfy the system load due to equipment failure or entering air temperature below 40°F(4.4ºC).
4. Supplemental heating downstream from a *multi-pass* heat pump water heater system, no greater than the nominal output capacity of the heat pump water heaters.
5. Electric resistance or condensing, gas-fired water heaters serving single zones with a combined capacity no greater than 12 kW or 35,000 Btu/h input capacity.
6. Defrost of compressor coils.

C404.2.2.2 Alarms.

The control system shall be capable of and configured to send automatic error alarms to building or maintenance personnel upon detection of equipment faults, low leaving water temperature from primary storage tanks, or low hot water supply delivery temperature to building distribution system.

Revise as follows:

C406.7.4 High efficiency heat pump water heater.

Where electric resistance water heaters are allowed, all service hot water system heating requirements shall be met using heat pump technology with a combined input-capacity weighted-average EF of 3.0. Air-source heat pump water heaters shall not draw conditioned air from within the building, except exhaust air that would otherwise be exhausted to the exterior.

Reason Statement:

Requiring the use of heat pump water heaters will significantly reduce the amount of energy required for service water heating. Studies of real buildings utilizing current heat pump water heating technology have shown that heat pump water heaters can provide service water heating with efficiencies greater than 300%, which would cut energy usage down to less than 1/3 of the energy required by a gas-fired or electric resistance water heater. This technology is readily available and has been successfully applied across a wide range of R1 and R2 applications throughout the United States.

Cost Impact:

The code change proposal will increase the cost of construction.

The service water heating equipment cost will increase, but substantial energy efficiency gains will result. Furthermore, if electric heat pump water heaters allow installers to forego the installation of gas infrastructure in a building, the money saved from gas infrastructure permit and installation will offset the increased cost of water heating equipment.

CEPI-129-21

CEPI-130-21

IECC®: C404.4, C404.4.1 (New), TABLE C404.4.1 (New)

Proponents:

Gary Klein, Gary Klein and Associates, Inc., representing Self (gary@garykleinassociates.com); Emily Toto, representing ASHRAE (etoto@ashrae.org); John Bade, representing California Investor Owned Utilities (johnbade@2050partners.com)

2021 International Energy Conservation Code

Revise as follows:
C404.4 ~~Insulation of piping~~ Service water heating system piping insulation.

~~Piping from a water heater to the termination of the heated water fixture supply pipe shall be insulated in accordance with Table C403.12.3. On both the inlet and outlet piping of a storage water heater or heated water storage tank, the piping to a heat trap or the first 8 feet (2438 mm) of piping, whichever is less, shall be insulated. Piping that is heat traced shall be insulated in accordance with Table C403.12.3 or the heat trace manufacturer's instructions. Tubular pipe insulation shall be installed in accordance with the insulation manufacturer's instructions. Pipe insulation shall be continuous except where the piping passes through a framing member. The minimum insulation thickness requirements of this section shall not supersede any greater insulation thickness requirements necessary for the protection of piping from freezing temperatures or the protection of personnel against external surface temperatures on the insulation.~~

Service water heating system piping shall be surrounded by uncompressed insulation. The wall thickness of the insulation shall be greater than or equal to the thickness shown in Table C404.4.1. Where the insulation thermal conductivity is not within the range in the table, the following equation shall be used to calculate the minimum insulation thickness:

$t_{alt} = r\cdot[(1 + t_{table}/r)k_{alt}/k_{upper} - 1]$

Where:

t_{alt} = minimum insulation thickness of the alternate material (in.) (mm)

r = actual outside radius of pipe (in.) (mm)

t_{table} = insulation thickness listed in this table for applicable fluid temperature and pipesize

k_{alt} = thermal conductivity
of the alternate material at mean rating temperature indicatedfor the applicable fluid temperature [Btu·in/h·ft2·°F] [W (m·°C)]

k_{upper} = the upper value of the thermal conductivity range listed in this table for the applicable fluid temperature [Btu·in/h·ft2·°F] [W (m·°C)]

For nonmetallic piping thicker than Schedule 80 and having thermal resistance greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot (meter) than a steel pipe of the same size with the insulation thickness shown in the table.

Exception: Tubular pipe insulation shall not be required on the following:

1. ~~The tubing from the connection at the termination of the fixture supply piping to a plumbing fixture or plumbing appliance.~~ Factory-installed piping within water heaters and hot water storage tanks

2. ~~Valves, pumps, strainers and threaded unions in piping that is 1 inch (25 mm) or less in nominal diameter.~~ Piping that conveys hot water that has not been heated through the use of fossil fuels or electricity

3. ~~Piping from user-controlled shower and bath mixing valves to the water outlets.~~ For piping 1 in. (25 mm) or less, insulation is not required for valves or strainers.

4. ~~Cold-water piping of a demand recirculation water system.~~ Piping in existing buildings where alterations are made to existing service water heating systems where there is insufficient space or access to meet the requirements.

~~5. Tubing from a hot drinking-water heating unit to the water outlet.~~

~~6. Piping at locations where a vertical support of the piping is installed.~~

~~7. Piping surrounded by building insulation with a thermal resistance (*R*-value) of not less than R-3.~~

Add new text as follows:

C404.4.1 Installation Requirements.

The following piping shall be insulated per the requirements of this section:

1. Recirculating system piping, including the supply and return piping
2. The first 8 ft (2.4m) of outlet piping from:
   - 2.1. Storage water heaters
   - 2.2. Hot water storage tanks
   - 2.3. Any water heater and hot water supply boiler containing 10 or more gallons (37.9 L) of water heated by a direct heat source, an indirect heat source, or both a direct heat source and an indirect heat source.
3. The first 8 ft (2.4m) of branch piping connecting to recirculated, heat traced, or impedance heated piping.
4. The make-up water inlet piping between heat traps and the storage water heaters and the storage tanks they are serving, nonrecirculating service water heating ~~storage~~ system.
5. Hot water piping between multiple water heaters, between multiple hot water storage tanks, and between water heaters and hot water storage tanks.
6. Piping that is externally heated (such as heat trace or impedance heating).
7. For direct-buried service water heating system piping, reduction of these thicknesses by 1.5 in (38.1 mm) shall be permitted (before thickness adjustment required in Table C404.4.1 (footnote a)) but not to thicknesses less than 1 in (25.4 mm).

TABLE C404.4.1 MINIMUM PIPING INSULATION THICKNESS FOR SERVICE WATER HEAING SYSTEMS[a]

Service Hot-Water Temperature Range	Insulation Thermal Conductivity		Nominal Pipe or Tube Size, in.				
	Conductivity, Btu·in/h·ft2·°F	Mean Rating Temperature,°F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness, in.				
105°F to 140°F	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5
>140°F to 200°F	0.25 to 0.29	125	1.0	1.0	2.0	2.0	2.0
>200°F	0.27 to 0.30	150	1.5	1.5	2.5	3.0	3.0

a. These thicknesses are based on energy efficiency considerations only. Additional insulation may be necessary for safety.

Reason Statement:

This proposal has been submitted to create a placeholder for the IECC to incorporate changes that are being considered for inclusion in the 2022 update to ASHRAE Standard 90.1.

The existing pipe insulation thickness requirements for service water heating piping come from Table C403.12.3, which was developed primarily for space heating. The major change in this proposal is to include a pipe insulation wall thickness table in the service water heating section of the IECC. Having a separate table will allow requirements for service water heating piping insulation to be based on typical service water heating operation and operating temperatures, which may be very different from those for mechanical systems.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The revisions proposed to this section will not change construction costs.

CEPI-130-21

CEPI-131-21

IECC®: C404.6.1

Proponents:

Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:
C404.6.1 Circulation systems.

Heated-water circulation systems shall be provided with a circulation pump. The pump shall have an electronically commutated motor with a means of adjusting motor speed for system balancing. Gravity and thermo-syphon circulation systems are prohibited. The system return pipe shall be a dedicated return pipe. ~~or a cold water supply pipe. Gravity and thermo-syphon circulation systems shall be prohibited. Controls for circulating hot water system pumps~~ Controls shall be configured to automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is not a demand for hot water. ~~The controls shall limit the temperature of the water entering the cold water piping to not greater than 104ºF (40°C).~~ Where the circulation system serves multiple risers or piping zones, controls shall include self-actuating thermostatic balancing valves or another means of flow control to automatically balance the flow rate through each riser or piping zone. For single or multiple riser systems, controls shall be configured with a means to turn off the circulation pump during extended periods when hot water is not required.

Reason Statement:

In service water heating systems, circulation pumps with electronically commutated motors (ECM) offer energy savings compared to circulation pumps with standard induction motors by providing the ability to balance system flow based on demand. The use of thermostatic balancing valves optimizes hot water flow to each zone in multiple zone or multiple riser systems. Both of these strategies reduce waste of heated water.

As a clarification, language regarding the use of a cold water supply pipe as the return has been removed. This language is covered under Section C404.6.1.1 for demand recirculation systems.

Cost Impact:

The code change proposal will increase the cost of construction.

Cost Increase Information

Cost comparison is between a circulation pump with a standard A/C induction motor and a circulation pump with an electronically commutated motor.

Circulation pump size used for cost analysis - 2.5 - 5 gpm at 15 ft/hd, 145 psi

Installed cost for circulation pump with A/C induction motor - $750

Installed cost for circulation pump with ECM - $1,000

$250 incremental cost increase per pump based on manufacturer data from Bell and Gossett. Refer to manufacturer literature attached.

Projected Energy Savings

Assumptions - 4,000 hrs/yr pump operation; Circulation pump w/ECM ~ 30% more efficient

Circulation pump with standard motor - 70 watts

Circulation pump with ECM - 100 watts

30 watt savings x 4,000 hours/yr/1,000 = 120 kWh/yr

CEPI-132-21

IECC®: SECTION C405, C405.1.1, C405.2.2

Proponents:

Harold Jepsen, Legrand, representing Legrand (harold.jepsen@legrand.us)

2021 International Energy Conservation Code

SECTION C405 ELECTRICAL POWER AND LIGHTING SYSTEMS
Revise as follows:
C405.1.1 Lighting for dwelling units.

No less than 90 percent of the permanently installed lighting serving dwelling units, excluding kitchen appliance lighting, shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W, or shall comply with Sections ~~C405.2.4~~ C405.2.5.1 and C405.3.

C405.2.2 Time-switch controls.
Each area of the building that is not provided with *occupant sensor controls* complying with Section C405.2.1.1 shall be provided with *time-switch controls* complying with Section C405.2.2.1.

Exceptions:

1. Luminaires that are required to have specific application controls in accordance with Section ~~C405.2.4~~ C405.2.5

2. Spaces where patient care is directly provided.

3. Spaces where an automatic shutoff would endanger occupant safety or security.

4. Lighting intended for continuous operation.

5. Shop and laboratory classrooms.

Reason Statement:

The lighting Specific Application Control section was changed from C405.2.4 to C405.2.5 during the 2021 IECC update cycle, yet some references were not changed accordingly. This does not change the intent of the code and is a change to correct improper references for both dwelling unit lighting control (C405.1.1) and luminaires controlled by time-switch controls (exception 1 to C405.2.2).

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal updates an incorrect section reference and does not affect the cost of construction.

CEPI-132-21

CEPI-133-21

IECC®: C405.1

Proponents:

Jack Bailey, representing International Association of Lighting Designers (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:
C405.1 General.

Lighting system controls, the maximum lighting power for interior and exterior applications, vertical and horizontal transportation systems, data centers, receptacle controls, electrical system efficiency, and metering and monitoring of electrical energy use ~~and electrical energy consumption~~ shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with either Section C405.1.1 or C405.3. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

Reason Statement:

The description of the scope of this section has not kept pace with the actual content of the section. This should be updated to more accurately represent the current scope.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The change is editorial.

CEPI-133-21

CEPI-134-21

IECC®: C405.1, C405.9 (New)

Proponents:

Jack Bailey, representing International Association of Lighting Designers (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:
C405.1 General.

Lighting system controls, the maximum lighting power for interior and exterior applications, and electrical energy consumption shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with either Section C405.1.1 or C405.3. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

~~Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.~~

Add new text as follows:
C405.9 Data Center Systems.

Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

Reason Statement:

This technical content does not belong in C405.1. It should be in a new subsection C405.9 (between motor efficiencies and vertical and horizontal transportation systems).

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This change is entirely editorial in nature.

CEPI-134-21

CEPI-135-21

IECC®: C405.1, C405.1.1, TABLE C405.3.2(2), TABLE C405.3.2(1), C405.3.2.1, C405.3.2.2, C405.3.1

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.1 General.

Lighting system controls, the maximum lighting power for interior and exterior applications, and electrical energy consumption shall comply with this section. *Sleeping units* shall comply with Section C405.2.5 and with ~~either~~ Section C405.1.1 ~~or C405.3~~. *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

C405.1.1 Lighting power for sleeping units and dwelling units.

No less than 90 percent of the permanently installed lighting serving sleeping units and dwelling units, excluding kitchen appliance lighting, shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W~~, or shall comply with Sections C405.2.4 and C405.3.~~

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/ft^2)
Atrium	
Less than 40 feet in height	0.48
Greater than 40 feet in height	0.60
Audience seating area	
In an auditorium	0.61
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	0.67
In a performing arts theater	1.16
In a religious building	0.72
In a sports arena	0.33
Otherwise	0.33
Banking activity area	0.61
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	0.89
Otherwise	0.71
Computer room, data center	0.94
Conference/meeting/multipurpose room	0.97
Copy/print room	0.31
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	0.71
Otherwise	0.41
Courtroom	1.20

Dining area	0.86
In bar/lounge or leisure dining	0.86
In cafeteria or fast food dining	0.40
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.27
In family dining	0.60
In a penitentiary	0.42
Otherwise	0.43
Electrical/mechanical room	0.43
Emergency vehicle garage	0.52
Food preparation area	1.09
~~Guestroom[c, d]~~	~~0.41~~
Laboratory	
In or as a classroom	1.11
Otherwise	1.33
Laundry/washing area	0.53
Loading dock, interior	0.88
Lobby	
For an elevator	0.65
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.69
In a hotel	0.51
In a motion picture theater	0.23
In a performing arts theater	1.25
Otherwise	0.84
Locker room	0.52
Lounge/breakroom	
In a healthcare facility	0.42
Otherwise	0.59
Office	
Enclosed	0.74
Open plan	0.61
Parking area, interior	0.15
Pharmacy area	1.66
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	1.26
Otherwise	0.63
Sales area	1.05
Seating area, general	0.23
Stairwell	0.49
Storage room	0.38
Vehicular maintenance area	0.60
Workshop	1.26
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft²)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	0.61
~~Dormitory—living quarters[c, d]~~	~~0.50~~
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	0.70
In a recreation room (and not used primarily by the staff)	1.77

~~Fire Station—sleeping quarters[c]~~	~~0.23~~
Gymnasium/fitness center	
In an exercise area	0.90
In a playing area	0.85
Healthcare facility	
In an exam/treatment room	1.40
In an imaging room	0.94
In a medical supply room	0.62
In a nursery	0.92
In a nurse’s station	1.17
In an operating room	2.26
~~In a patient room[c]~~	~~0.68~~
In a physical therapy room	0.91
In a recovery room	1.25
Library	
In a reading area	0.96
In the stacks	1.18
Manufacturing facility	
In a detailed manufacturing area	0.80
In an equipment room	0.76
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	1.42
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
Museum	
In a general exhibition area	0.31
In a restoration room	1.10
Performing arts theater—dressing room	0.41
Post office—sorting area	0.76
Religious buildings	
In a fellowship hall	0.54
In a worship/pulpit/choir area	0.85
Retail facilities	
In a dressing/fitting room	0.51
In a mall concourse	0.82
Sports arena—playing area	
For a Class I facility[~~e~~c]	2.94
For a Class II facility[~~f~~d]	2.01
For a Class III facility[~~g~~e]	1.30
For a Class IV facility[~~h~~f]	0.86
Transportation facility	
At a terminal ticket counter	0.51
In a baggage/carousel area	0.39
In an airport concourse	0.25
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 w/m^2.

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

b. A ‘Facility for the Visually Impaired’ is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

~~c.~~ ~~Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.~~

~~d.~~ ~~Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.~~

~~e~~c. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

~~f.~~d. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

~~g.~~e. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

~~h.~~f. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD

BUILDING AREA TYPE	LPD (w/ft^2)
Automotive facility	0.75
Convention center	0.64
Courthouse	0.79
Dining: bar lounge/leisure	0.80
Dining: cafeteria/fast food	0.76
Dining: family	0.71
Dormitory~~[a, b]~~	0.53
Exercise center	0.72
Fire station~~[a]~~	0.56
Gymnasium	0.76
Health care clinic	0.81
Hospital~~[a]~~	0.96
Hotel/Motel~~[a, b]~~	0.56
Library	0.83
Manufacturing facility	0.82
Motion picture theater	0.44
Multiple-family~~[c]~~	0.45
Museum	0.55
Office	0.64
Parking garage	0.18
Penitentiary	0.69

Performing arts theater	0.84
Police station	0.66
Post office	0.65
Religious building	0.67
Retail	0.84
School/university	0.72
Sports arena	0.76
Town hall	0.69
Transportation	0.50
Warehouse	0.45
Workshop	0.91

For SI: 1 watt per square foot = 10.76 w/m^2.

~~a. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.~~

~~b. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.~~

~~c. Dwelling units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.~~

C405.3.2.1 Building Area Method.
For the Building Area Method, the interior lighting power allowance is calculated as follows:

1. For each building area type inside the building, determine the applicable building area type and the allowed lighting power density for that type from Table C405.3.2(1). For building area types not listed, select the building area type that most closely represents the use of that area. For the purposes of this method, an "area" shall be defined as all contiguous spaces that accommodate or are associated with a single building area type.

2. Determine the floor area for each building area type listed in Table C405.3.2(1) and multiply this area by the applicable value from Table C405.3.2(1) to determine the allowed lighting power (watts) for each building area type. *Sleeping units* and *dwelling units* are excluded from lighting power allowance calculations by application of Section C405.1.1. The area of *sleeping units* and *dwelling units* is not included in the calculation.

3. The total interior lighting power allowance (watts) for the entire building is the sum of the lighting power from each building area type.

C405.3.2.2 Space-by-Space Method.
Where a building has unfinished spaces, the lighting power allowance for the unfinished spaces shall be the total connected lighting power for those spaces, or 0.2 watts per square foot (10.76 w/m^2), whichever is less. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each space enclosed by partitions that are not less than 80 percent of the ceiling height, determine the applicable space type from Table C405.3.2(2). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space may be divided into separate spaces.

2. Determine the total floor area of all the spaces of each space type and multiply by the value for the space type in Table C405.3.2(2) to determine the allowed lighting power (watts) for each space type. *Sleeping units* and *dwelling units* are excluded from lighting power allowance calculations by application of Section C405.1.1. The area of *sleeping units* and *dwelling units* is not included in the calculation.

3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

C405.3.1 Total connected interior lighting power.

The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}]$$
(Equation 4-10)

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).

2. The wattage limit of the permanent current-limiting devices protecting the system.

3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

1. Television broadcast lighting for playing areas in sports arenas.

2. Emergency lighting automatically off during normal building operation.

3. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.

4. Casino gaming areas.

5. Mirror lighting in dressing rooms.

6. Task lighting for medical and dental purposes that is in addition to general lighting.

7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.

8. Lighting for theatrical purposes, including performance, stage, film production and video production.

9. Lighting for photographic processes.

10. Lighting integral to equipment or instrumentation and installed by the manufacturer.

11. Task lighting for plant growth or maintenance.

12. Advertising signage or directional signage.

13. Lighting for food warming.

14. Lighting equipment that is for sale.

15. Lighting demonstration equipment in lighting education facilities.

16. Lighting approved because of safety considerations.

17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.

18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.

19. Exit signs.

20. Antimicrobial lighting used for the sole purpose of disinfecting a space.

21. Lighting in *sleeping units* and *dwelling units*

Reason Statement:

For *sleeping units* the code currently allows the use of either the luminaire efficacy requirement (C405.1.1), **or** lighting power density (C405.3) to limit lighting power, and requires specific controls for *sleeping units* (C405.2.5 #2). The option to use lighting power density to comply with lighting power requirements is not needed, does nothing to improve energy efficiency, and adds unnecessary complexity. Designers and Engineers are always going to choose the luminaire efficacy requirement because it is simple and does not require any calculations.

For *dwelling units* the code currently allows the use of either the luminaire efficacy requirement (C405.1.1), **or** lighting power density (C405.3) and C405.2.5 #3 which requires occupancy sensors and light reduction controls (although it is not clear how this is to be applied to *dwelling units*). Designers/engineers/building owners will always choose the luminaire efficacy option because it is simple and does not require installation of lighting controls in the *dwelling unit*. The option is not necessary because it will never be used.

When the lighting power density option is removed, then the lighting power allowances for "Guestroom", "Dormitory -- living quarters", "Fire Station -- sleeping quarters" and "healthcare facility -- patient room" can be removed from Table C405.3.2 (2). All of these space types are by defintion either *sleeping units*, *dwelling units*, or both.

Five complicated footnotes to Tables C405.3.2(1) and C405.3.2(2) can also be removed and incorporated into C405.3.2.1 #2 and C405.3.2.2 #2 by adding one sentence. For clarity, "Lighting in *sleeping units* and *dwelling units*" is added to the list of lighting that is not included in lighting power calculations.

The clarifying word "allowed" is added to C405.3.2.1 #2 and C405.3.2.2 #2. You are calculating the lighting power allowance, not the lighting power.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This simplification of a the code will not require the use of more expensive equipment and does not eliminate a lower cost option

CEPI-135-21

CEPI-136-21

IECC®: C405.1.1

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
C405.1.1 Lighting for dwelling units.

No less than 90 percent of the permanently installed lighting serving dwelling units, excluding kitchen appliance lighting, shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than ~~45~~ 50 lm/W~~, or shall comply with Sections C405.2.4 and C405.3~~.

Reason Statement:

This proposal makes two changes. It increases the minimum efficacy for fixtures to align with the latest US EPA Energy Star specifications for luminaires (version 2.2, August 2019). It also takes out unnecessary language that allows compliance with C405.2.4 (which is for daylight responsive controls of commercial spaces) and C405.3 (which is interior lighting power requirements and already excludes dwelling units in the building area method tables and space-by-space method).

A review of Sections 9.1 and 9.2 of the updated Energy Star specifications (available at https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf) shows that the range of specifications for Energy Star luminaires is from 50 to 70 lumens/Watt depending on the type of luminaire and the lighting technology being used (fluorescent or LED).

Bibliography:

US EPA, ENERGY STAR® Program Requirements for Luminaires, Washington DC, August 25, 2019 (available at https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf)

Cost Impact:

The code change proposal will increase the cost of construction.

According to the EPA Energy Star web site (https://www.energystar.gov/productfinder/product/certified-light-fixtures/results), there are over 27,000 indoor luminaires that meet the most recent specifications, including:

Accent/Track Lighting (729 products)

Bath Vanity Lights (422 products)

Ceiling Fan Light Kits (75 products)

Ceiling Mount and Pendants (11,825 products)

Chandeliers (40 products)

Portable Lighting (table/desk/floor lamps) (169 products)

Post Lights (34 products)

Recessed Lighting (14,987 products)

In many cases, there will be no cost increase from going from 45 lumens/Watt to 50 lumens/Watt. However, there may be a $1 or $2 cost increase.

If a fixture has a light output of 900 lumens, then under the current language, the maximum Wattage is 20 Watt to meet the 45 lumen/Watt requirement. Under the proposed requirements, the maximum Wattage is 18 Watts (50 lumens/Watt).

If the fixture operates for 2 hours per day, the savings are as follows:

2 hours * 365 Days * 2 Watts saved = 1,460 Watt-hours = 1.46 kWh

1.46 kWh * $0.133 / kWh (US national average residential electricity cost in 2020, according to DOE) = $0.1942 saved per year

Simple payback:

$1 / $0.1942 = 5.15 years

$2 / $0.1942 = 10.30 years

CEPI-136-21

CEPI-137-21

IECC®: C405.1.1, C405.3.1, C405.3.1.1 (New)

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

C405.1.1 Lighting for dwelling units.

No less than 90 percent of the permanently installed lighting serving dwelling units, excluding ~~kitchen appliance~~ lighting equipment and applications that are excluded by Section C405.3.1.1, shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W, or shall comply with Sections C405.2.4 and C405.3.

C405.3.1 Total connected interior lighting power.

The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}]$$

(Equation 4-10)

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).
2. The wattage limit of the permanent current-limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

~~The connected power associated with the following lighting equipment and applications is not in in calculating total connected lighting power.~~

~~1. Television broadcast lighting for playing areas in sports arenas.~~

~~2. Emergency lighting automatically off during normal building operation.~~

~~3. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.~~

~~4. Casino gaming areas.~~

~~5. Mirror lighting in dressing rooms.~~

~~6. Task lighting for medical and dental purposes that is in addition to general lighting.~~

~~7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.~~

~~8. Lighting for theatrical purposes, including performance, stage, film production and video production.~~

~~9. Lighting for photographic processes.~~

~~10. Lighting integral to equipment, appliances, or instrumentation and installed by the manufacturer.~~

~~11. Task lighting for plant growth or maintenance.~~

~~12. Advertising signage or directional signage.~~

~~13. Lighting for food warming.~~

~~14. Lighting equipment that is for sale.~~

~~15. Lighting demonstration equipment in lighting education facilities.~~

~~16. Lighting approved because of safety considerations.~~

~~17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.~~

~~18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.~~

~~19. Exit signs.~~

~~20. Antimicrobial lighting used for the sole purpose of disinfecting a space.~~

Add new text as follows:

C405.3.1.1 Interior lighting power exclusions .

The connected power associated with the following lighting equipment and applications is excluded in calculating total connected lighting power.

1. Television broadcast lighting for playing areas in sports arenas.

2. Emergency lighting automatically off during normal building operation.

Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment

3. and other medical and age-related issues.
4. Casino gaming areas.
5. Mirror lighting in dressing rooms.
6. Task lighting for medical and dental purposes that is in addition to general lighting.
7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.
8. Lighting for theatrical purposes, including performance, stage, film production and video production.
9. Lighting for photographic processes.
10. Lighting integral to equipment, appliances, or instrumentation and installed by the manufacturer.
11. Task lighting for plant growth or maintenance.
12. Advertising signage or directional signage.
13. Lighting for food warming.
14. Lighting equipment that is for sale.
15. Lighting demonstration equipment in lighting education facilities.
16. Lighting approved because of safety considerations.
17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.
18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.
19. Exit signs.
20. Antimicrobial lighting used for the sole purpose of disinfecting a space.

Reason Statement:

The efficacy requirements of Section C405.1.1 were developed to apply to lighting used for illumination. There are multiple exceptions to the requirements that should be recognized for dwelling units, similar to other spaces in other occupancies. Instead of continuing to expand the list of exceptions in C405.1.1 (which should include kitchen appliance lighting equipment and antimicrobial/germicidal lighting at a minimum), it is more reasonable to reference exceptions that are already itemized in Section C405.3.1. This proposal also improves organization of Section C405.3.1 by moving the exceptions to a subsection for clarity and ease of reference.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal clarifies the intent of this section, resulting in no increase or decrease in the cost of construction.

CEPI-137-21

CEPI-138-21

IECC®: C405.12

Proponents:

Kim Cheslak, NBI, representing NBI (kim@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:
C405.12 Energy monitoring.
~~New buildings~~ Buildings ~~with a gross *conditioned floor area* of 25,000 square feet (2322 m^2) or larger~~ shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.

~~Exception~~ Exceptions:

1. Buildings less than 10,000 square feet (929 m^2).
2. Existing buildings.
3. R-2 occupancies with less than 10,000 square feet (929 m^2) of common area
4. ~~and individual~~ Individual tenant spaces ~~are not required to comply with this section provided that the space has its own utility services and meters and has~~ less than 5,000 square feet (464.5 m^2) ~~of *conditioned floor area*~~ with their own utility service and meter.

Reason Statement:

There are currently over 40 benchmarking regulations across the US (38 local jurisdictions and four states) – with size thresholds as low as 10,000 sf. These regulations require the reporting of energy use, and are being used as a steppingstone toward regulation of building performance – either through audit and retro-commissioning requirements or building performance standards. Ensuring that buildings are equipped to comply with these policies is a critical function of the code.

This change amends the structure of the code language slightly, but its primary focus is to drop the size threshold for compliance to 10,000 sqft – adding additional exceptions that align with similar language in ASHRAE 90.1-2019 under Section 8.4.3.

Bibliography:

Benchmarking policy data: https://www.buildingrating.org/

Cost Impact:

The code change proposal will increase the cost of construction.

A similar measure has proven cost effective in 90.1.

CEPI-138-21

CEPI-139-21

IECC®: C405.12, C405.12.2

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
C405.12 Energy monitoring.
New buildings with a gross *conditioned floor area* of 25,000 square feet (2322 m^2) or larger shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12.1 through C405.12.5.
Exception: R-2 occupancies and individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than ~~5,000~~ 10,000 square feet (~~464.5~~ 929.0 m^2) of *conditioned floor area*.
C405.12.2 End-use metering categories.
Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than ~~5~~ 10 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than ~~2,500~~ 10,000 square feet (~~232~~ 929.0 m^2) where a dedicated source meter complying with Section C405.12.3 is provided.

Reason Statement:

These proposed changes will align the submetering threshold requirements with the requirements in ASHRAE 90.1-2019, Section 8.4.3.1 and 8.4.3.2.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019, *Energy Standard for Buildings Except Low-Rise Residential Buildings*, October 2019, Atlanta GA

US Department of Energy, *Determination Regarding Energy Efficiency Improvements in ANSI/ASHRAE/IES Standard 90.1–2013:Energy Standard for Buildings, Except Low-Rise Residential Buildings*, Federal Register Volume 79 Number 187, September 26, 2014, p. 57,908

Cost Impact:

The code change proposal will decrease the cost of construction.

This is a modification (relaxation) of the current requirements to align with the requirements of ASHRAE 90.1-2019, and therefore will reduce the cost of construction.

It should be noted that under the ASHRAE and DOE/PNNL simulation methodologies for determining energy savings when adding new requirements, submetering does not produce any energy savings (e.g., it was not given any energy savings credit for the determination of the energy efficiency improvement of 90.1). In the DOE determination of ASHRAE 90.1-2013, where submetering was first included, the DOE final analysis stated that the impact was " Neutral (metering by itself does not save energy)."

As a result, changing the requirements will not increase the simulated energy usage of commercial buildings.

CEPI-139-21

CEPI-140-21

IECC®: SECTION 202 (New), TABLE C405.12.2

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, electric motorcycles, and the like, primarily powered by an electric motor that draws current from a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current. Plug-in hybrid electric vehicles are electric vehicles having a second source of motive power. Off-road, self-propelled electric mobile equipment, such as industrial trucks, hoists, lifts, transports, golf carts, airline ground support equipment, tractors, boats and the like, are not considered electric vehicles.
Revise as follows:

TABLE C405.12.2 ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Electric vehicle charging	*Electric vehicle* charging loads.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.

Reason Statement:

As electric vehicles become more common place, even if not required by code, the electricity supplied to these chargers will increase the overall energy use when compared to the same building without EV charging. Combined with the increasing regulations from jurisdictions on benchmarking and building performance, it will be important that owners know and understand the EV charging use separate from the base building uses. It is far more cost-effective to sub-meter these loads during new construction than to try to isolate them and add additional sub-meters as part of a retrofit.

“Electrical Vehicle Supply Equipment is separately metered” is a requirement to deduct your EV electricity from Boston’s recent update to BERDO. Currently ENERGY STAR Portfolio Manager and most other BPS and benchmarking policies do not give explicit instructions on how to account for EV charging in reporting. By getting these loads sub-metered upfront, building owners will be better able to meet needs of local policies and their own energy planning.

Cost Impact:

The code change proposal will increase the cost of construction.

Because electrical submetering is already required for many building systems in the code, the incremental cost for submetering an additional system is nominal. NBI and partners estimate based on cost-data from RS Means, estimated labor costs and indirect markups that separately metering Electric Vehicle equipment increases construction costs on the order of $0.02 per square foot for a 53,000 square foot office building.

CEPI-140-21

CEPI-141-21

IECC®: C405.12.2, TABLE C405.12.2

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

C405.12.2 End-use metering categories. Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.12.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.12.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet (232 m^2) where a dedicated source meter complying with Section C405.12.3 is provided.
4. End-use metering shall not be required for plug loads where a group of plug loads is rated at less than 25 kVA of connected load in an area that is less than 5000 square feet (5 VA per square foot (.09 m^2)).

TABLE C405.12.2 ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads (for groups of plug loads > 25 kVA of connected load in an area < 5,000 square feet (464 m^2))	Devices, appliances and equipment connected to ~~convenience~~ receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.

Reason: Many plug loads in buildings are used by occupants, and facility managers / building owners have no control over when or how they are used.
This proposed change will match the language in California Title 24-2019 and 2022, Section 130.5 (Table 130.5-B), which correctly focuses on monitoring larger plug loads in smaller areas that can be controlled by facility managers (such as commercial kitchens, commercial refrigeration equipment, laundry equipment, etc.).

Bibliography: California Energy Commission, TN # 238848, *15-Day Express Terms 2022 Energy Code - Residential and Nonresidential*, July 14, 2021
Accessible at:
https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

Cost Impact: The code change proposal will decrease the cost of construction.
This will reduce submetering costs, since only larger plug loads that can be controlled for energy savings will be metered.

CEPI-142-21

IECC®: C405.13 (New), IEEE Chapter 06 (New), UL Chapter 06 (New)

Proponents:

Kimberly Cheslak, NBI, representing NBI (kim@newbuildings.org); Josh Keeling, representing Cadeo Group (jkeeling@cadeogroup.com); Matt Tidwell, representing Portland General Electric (matthew.tidwell@pgn.com)

2021 International Energy Conservation Code

Add new text as follows:
C405.13 Inverters.

Direct-current-to-alternating-current inverters serving on-site renewable energy systems or electrical energy storage systems shall be compliant with IEEE 1547-2018a and UL 1741.

Add new standard(s) as follows:

IEEE Institute of Electrical and Electronic Engineers 3 Park Avenue, 17th Floor New York NY 10016

1547-2018a	IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

UL UL LLC 333 Pfingsten Road Northbrook IL 60062

1741	UL Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources

Reason Statement:

IEEE 1547-2018a governs requirements for the interconnection of distributed energy resources that operate in parallel to the electric grid. This standard (and its implementation at the device level through (UL 1741) ensure that these resources can support and potentially enhance grid stability, thereby improving reliability, reducing curtailments, stabilizing voltage, and maintaining power quality. Requirements to implement IEEE 1547-2018 are being explored in several states and the standard is already required as a part of California's Rule 21 interconnection requirements. The National Association of Regulatory Utilities Commissioners (NARUC) has already recommended that state utility commissions require implementation of IEEE1547-2018a as a part of their interconnection requirements.

While commission rulemaking will help to accelerate adoption, codifying the requirement within building code will provide further clarity to DER installers and provide consistency across unregulated (consumer-owned/public) utility service areas. This will help to avoid inconsistency and requirements and/or potentially future retrofit costs if a non-compliant unit must be retrofitted later at interconnection.

Smart inverter functionality can provide several benefits, with potentially significant cost advantage over traditional solutions. While the primary purpose of smart inverter functionality is grid stability, there are several additional benefits to the grid and its stakeholders. When operating in volt-VAR mode supporting reactive power, these inverters can actually provide energy savings, particularly when operating within distribution networks already operating conservation voltage reduction schemes. Additionally, smart inverters can help to increase DER hosting capacity of distribution networks, enabling greater access to renewable energy systems while maintaining safety and reliability.

Bibliography:

[1]IEEE 1547-2018 Status of Adoption across the U.S. (2021) https://sagroups.ieee.org/scc21/wp-content/uploads/sites/285/2021/09/IEEE-1547-2018_States-and-ISOs-RTOs-Adoption_IEEE-Format.pdf

[2] CPUC, Rule 21 Rulemaking, https://www.cpuc.ca.gov/Rule21/

[3] NARUC, Recommending State Commissions Act to Adopt and Implement Distributed Energy Resource Standard IEEE 1547-2018 (2021) https://pubs.naruc.org/pub/E86EF74B-155D-0A36-3138-B1A08D20E52B

[4] IEEE PES, Impact of IEEE 1547 Standard on Smart Inverters and the Applications in Power Systems (2020) https://www.nrel.gov/grid/ieee-standard-1547/assets/pdfs/smart-inverters-applications-in-power-systems.pdf

[5] EPRI, The Economic Impact of Real Power Management of Solar Photovoltaic Systems (2019) https://www.epri.com/research/products/000000003002013325

[6] NREL, Photovoltaic Impact Assessment of Smart Inverter Volt-VAR Control on Distribution System Conservation Voltage Reduction and Power Quality (2016) https://www.nrel.gov/docs/fy17osti/67296.pdf

[7] PG&E, EPIC 2.03A: Test Smart Inverter Enhanced Capabilities – Photovoltaics (PV): Smart Inverter Modeling Report (2019) https://www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/PGE-EPIC-Project-2.03A_Modeling-Report.pdf

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

In an economic assessment of 1547-2018 functionality, EPRI found that an increase of 25% in distribution hosting capacity for solar could be achieved at a savings of $20,000/year per feeder in the reference case and could reach as high as $100,000/year. In its assessment of smart inverter benefits in high DER areas, NREL found an additional energy savings of up to 1% from smart inverters when coupled with traditional conservation voltage regulation (baseline savings of 1.5%-3%) while also improving power quality scores by up to 0.26. A study by PG&E of a set of representative feeders found deferred distribution upgrade costs of up to $200,000 per feeder at the highest levels of DER penetration and that smart inverter functionality was cost-effective across a wide range of scenarios.

Given the growing prevalence of smart inverter requirements, this is likely to have a low to no incremental cost. While communication with utility and/or third-party systems is enabled by IEEE 1547-2018a, it is not required and smart inverters can provide much of their value autonomously based on their operating setpoint. Individual utilities or jurisdictions may dictate specific setpoints and/or communications integration with utility/third-party systems as they see fit based on the specific grid context, like how loads might be integrated for demand response programs. The physical communication pathway for smart inverters is typically wi-fi, which is standard for inverters already for the purposes of system monitoring and commissioning.

CEPI-142-21

CEPI-143-21

IECC®: C405.13 (New), C405.13.1 (New), TABLE C405.13.1 (New), TABLE C407.4.1(1)

Proponents:

Jeremy Williams, U.S. Department of Energy, representing U.S. Department of Energy
(jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Add new text as follows:

C405.13 On site renewable energy.

Each building site shall have equipment for on-site renewable electricity generation with a nameplate direct current(DC) power rating calculated in accordance with Equation 4-12.

DC Power Rating = REN_{DF} x REN_{AREA}
(Equation 4-12)

where:

REN_{DF} = Renewable Density Factor selected from Table C405.13.1 based on building occupancy.

REN_{AREA} = the sum of gross conditioned floor area for all floors up to the three (3) largest floors

Exceptions:

1. Any building in climate zone 8

2. Any building located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily aver- age incident solar radiation less than 3.5 kWh/m2·day (1.1 kBtu/ft2·day).

3. Any building where more than 80% of the roof area is covered by any combination of equipment other than for on-site renewable energy systems, planters, vegetated space, skylights, or occupied roof deck.

4. Any building where more than 50% of roof area is shaded from direct-beam sunlightby natural objects or by structures that are not part of the building for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.

5. Alterations that do not include additions.

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C405.13.1 Renewable energy certificate documentation.
Documentation shall be provided to the code official that indicates that renewable energy certificates (RECs) associated with the on-site renewable energy will be retained and retired by or on behalf of the owner or tenant.

TABLE C405.13.1 ON-SITE RENEWABLE ELECTRICITY DENSITY FACTORS

Occupancy	Renewable Density Factor (W/ft^2)
R-1, R-2, R-4, I-1, I-2 and E	0.75
B with IT & phone equip. > 0.5 W/ft^2	0.75
B with IT & phone equip. ≤ 0.5 W/ft^2	0.50
A-2 and M	1.50
S-1 and S-2	0.50
All Other	0.68

For SI: 1 W/ft^2 = 10.76 W/m^2

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
On-site Renewable Energy	Where a *system* providing *on-site renewable energy* has been modeled in the *proposed design* the same *system* shall be modeled identically in the *standard reference design* except the rated capacity shall meet the requirements of Section C405.13	As proposed
	Where no system is designed or included in the proposed design, model an unshaded photovoltaic system with the following	

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	characteristics:	
	Size: Rated capacity per Section C405.13	
	Module Type: Crystalline Silicon Panel with a glass cover, 19.1% nominal efficiency and temperature coefficient of -0.35%/°C, Performance shall be based on a reference temperature of 77°F (25°C) and irradiance of 317 Btu/h·ft^2 (1000 W/m^2).	
	Array Type: Rack mounted array with installed nominal operating cell temperature (INOCT) of 103°F (45°C).	
	Total System Losses (DC output to AC output): 11.3%.	
	Tilt: 0-degrees (mounted horizontally).	
	Azimuth: 180 degrees.	

Reason:

On-site electricity generation using photovoltaics is a key technology for reducing greenhouse gas emissions associated with Commercial and Residential buildings. According to the most recent assessment by the National Renewable Energy Lab (NREL) the cost of installed photovoltaics in 2020 was 3% lower than in 2019 and 65-70% lower than the cost of similar sized systems in 2010. With the continued drop in cost of installing on-site PV the cost per kilowatt hour of PV generated electricity is at parity with grid purchased electricity in many States throughout the country. The Solar Energy Industries Association 2019 Solar Means Business Report found a 10% increase in on-site commercial solar PV capacity in 2019 compared to 2017 and 2018 driven largely by the reduction in cost. More recently in the SEIA 2021 Q3 Solar Insight Report they reported that new installed commercial solar PV in 2021 has rebounded to pre-COVID levels. The demand for Commercial on-site solar PV continues to grow and has been proven to be an effective technology for reducing the energy cost and greenhouse gas emissions of buildings. This proposal describes requirements for prescriptive solar PV that must be installed at the time of construction. ASHRAE 90.1-2022 will include similar renewable energy requirements and the model code language in this proposal expands those requirements. Analysis by PNNL shows that higher levels of on-site renewable electricity generation is cost effective. The analysis was done for each of the commercial prototypes in each ASHRAE climate zone and calculated the maximum capacity that limited electricity export back to the grid. The threshold used for determining these capacities was a grid export limit of less than 0.5% of total annual building electricity consumption. A review of the hourly results showed it was unrealistic to set a hard limit of zero overproduction. When calculating cost effectiveness, no credit was taken for electricity that was exported back to the grid. The calculation of grid exports was done on an hourly basis. The proposed requirements reduce purchased energy from the electrical grid which will help reduce greenhouse gas emissions and energy costs for building owners. The potential impact of the requirements varies by building type and climate zone but have the potential to achieve a weighted national average annual emission reduction of 1,780,110 metric tons.

The approach used for this proposal requires that building owners incorporate a modest amount of cost effective on-site solar PV. This approach addresses the management and dispatch challenge faced by Utilities when distributed solar resource export large amounts of unused electricity back into the grid by setting the required capacity to minimize exports. Where solar-PV is required by this proposal, no less than 99.5% of the generated electricity will be used directly by the building. Distributed generation also helps reduce transmission losses and the burden for new transmission infrastructure to centralized renewable resources.

On-site solar PV provides substantial benefits to the consumer and society by helping to reduce GHG emissions associated with electricity generation. PV market growth combined with a cleaner grid will support goals of reduced GHG emissions established across the U.S. and others by federal agencies, as well as many states and local governments.

Potential Impact of Solar Required Measures

Metric	Units	PV Required
Annual Reduced Electric Grid Energy Consumption	MWH	2,164,300
Consumer Annual Purchased Electricity Cost Savings	million $US	$237.9m
Annual Emission Reductions, CO_2	metric tons	1,780,110

Cost Impact:

The code change proposal will increase the cost of construction.

For this analysis the Scalar Method was used to evaluate cost effectiveness. The Scalar Method is used by ASHRAE 90.1 to evaluate cost effectiveness and is being considered by the Commercial IECC Cost Effectiveness WG as the preferred approach for the Commercial IECC.

The Scalar Method is an alternative life-cycle cost approach for individual energy efficiency changes with a defined useful life, taking into account first costs, annual energy cost savings, annual maintenance, taxes, inflation, energy escalation, and financing impacts. The Scalar Method allows a discounted payback threshold (scalar ratio limit) to be calculated based on the measure life. A measure is considered cost effective if the simple payback (scalar ratio) is less than the scalar limit. For this study an average measure life of 32.5 years was established based on data published by the National Renewable Energy Laboratory(NREL) indicating the useful life of installed solar PV is 25-40 years. The table below shows the economic parameters used for the scalar calculations.

Scalar Ratio Method Economic Parameters and Scalar Ratio Limit

Input Economic Variables	Cooling (electricity) SRc
Economic Life – Years	32.5
Down Payment - $	0.00
Energy Escalation Rate - %[(a)]	2.25
Nominal Discount Rate - %[(b)]	8.1
Loan Interest Rate - %	5.0
Federal Tax Rate - %[(b)]	NA[(b)]
State Tax Rate - %[(b)]	NA[(b)]
Heating – Natural Gas Price, $/therm	
Cooling - Electricity Price $/kWh	0.1099
Scalar Ratio Limit	**20.0**

(a) The energy escalation rate used in the scalar calculation for 90.1-2022 includes inflation, so it is a nominal rather than a real escalation rate.

(b) Beginning with addenda for 90.1-2016, SSPC 90.1 eliminated tax analysis from the Scalar Method by using a pre-tax discount rate.

The installed cost of solar PV was based on costs reported in the U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020 published by NREL in 2021. Installed costs were scaled based on solar PV capacity from 2kW up to 200kW and applied based on the calculated capacity required for each prototype in each climate zone.

Energy cost savings were based on evaluating the impact of solar PV on hourly electric consumption in each of the PNNL prototype buildings across all of the ASHRAE climate zones. On-site solar PV capacity was constrained by the following:

1. An array occupying no more than 20% of the roof area, and
2. A limit on electricity export back into the grid of no more than 0.5% of the total annual building electricity consumption.

The proposed solar PV capacities are cost effective for the consumer based on established metrics and criteria for determining cost effectiveness for all building types in all climate zones except for climate zone 8.

CEPI-144-21

IECC®: C405.13 (New), C406.5, C406.5.1, TABLE C407.4.1(1), C502.3.7 (New)

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new text as follows:
C405.13 On site renewable energy.

Each building site shall have equipment for on-site renewable energy with a rated capacity of not less than 0.25 W/ft² (2.7 W/m²) multiplied by the sum of the gross conditioned floor area of the three largest floors.

Exceptions:

1. Any building located where an unshaded flat plate collector oriented towards the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 3.5 kWh/m²·day (1.1 kBtu/ft²·day).
2. Any building where more than 80 percent of the roof area is covered by any combination of equipment other than for on-site renewable energy systems, planters, vegetated space, skylights, or occupied roof deck.
3. Any building where more than 50 percent of roof area is shaded from direct- beam sunlight by natural objects or by structures that are not part of the building for more than 2,500 annual hours between 8:00 AM and 4:00PM.
4. New construction or additions in which the sum of the gross conditioned floor area of the three largest floors of the new construction or addition is less than 10,000 ft^2 (929 m^2).

C406.5 On-site renewable energy.

Buildings shall comply with Section C406.5.1 or C406.5.2.

Revise as follows:
C406.5.1 Basic renewable credit.
The total minimum ratings of on-site renewable energy systems, not including systems used for credits under Sections C406.7.2, shall be one of the following:

1. Not less than 0.86 Btu/h per square foot (2.7 W/m^2) or 0.25 watts per square foot (2.7 W/m^2) of *conditioned floor area*.
2. Not less than 2 percent of the annual energy used within the building for building mechanical and service water-heating equipment and lighting regulated in Section C405.

The Basic renewable credit shall be determined based on Equation 14-4.

$$AEEC_B = AEEC_{2.5} \times (RR_1 - RR_{REQ})/RR_1$$

(Equation 14-4)

where:

$AEEC_B$ = Section C406.5.1 additional energy efficiency credits

$AECC_{2.5}$ = Section 406.5 credits from Tables C406.1(1) through C406.1(5)

RR1 = Minimum ratings of on-site renewable energy systems required by Section C406.5.1 (in BTU/h, watts per square foot or W/m2)

RR_{REQ} = Minimum ratings of on-site renewable energy systems required by Section C405.13

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
On-site Renewable Energy	Where a *system* providing *on-site renewable energy* has been modeled in the *proposed design* the same *system* shall be modeled identically in the *standard reference design* except the rated capacity shall meet the requirements of Section C405.13 Where no system is designed or included in the proposed design, model an unshaded photovoltaic system with the following characteristics: **Size:** Rated capacity per Section C405.13 **Module Type:** Crystalline Silicon Panel with a glass cover, 19.1% nominal efficiency and temperature coefficient of -0.35%/°C, Performance shall be based on a reference temperature of 77°F (25°C) and irradiance of 317 Btu/h·ft^2 (1000 W/m^2). **Array Type**: Rack mounted array with installed nominal operating cell temperature (INOCT) of 103°F (45°C). **Total System Losses** (DC output to AC output): 11.3%. **Tilt**: 0-degrees (mounted horizontally). **Azimuth:** 180 degrees.	As proposed

Add new text as follows:

C502.3.7 On-site Renewable Energy.

Additions shall comply with Section C405.13 for the addition alone.

Reason Statement:

This proposal adds a minimum prescriptive requirement for on-site renewable energy for new construction. This proposal is consistent with Addenda BY, CK, and CP to ANSI/ASHRAE/IES Standard 90.1-2019, published August 2020.

The prescriptive requirement and cost effectiveness were developed around solar PV generation as the most ubiquitous and cost-effective renewable energy resource, but the designer and building owner is free to use other types of renewable energy, or just make up for it in the performance path. The capacity component was determined through a comparative analysis exercise considering economics, roof space competition, annual energy production/contribution to the building energy budget, and equivalences against other energy efficiency measures.

In short, if following the prescriptive path, the building or building site must provide on-site renewable energy systems with capacity of 0.25 W/ft2 (0.85 Btu/ft2) multiplied by the sum of the conditioned floor area of up to the 3 largest floors. Using ‘up to the three largest floors’ allows this requirement to apply to both short and tall buildings, and works for both a 1 story warehouse with lots of roof space, and a 40 story urban tower with limited space. Exceptions are included for buildings that are shaded and/or have insufficient solar irradiation; buildings where over 80% of roof area covered by equipment, planters, vegetated space, skylights, or occupied roof deck; and only applies to new buildings and additions where the three largest floors are over 10,000 ft^2.

Language is also added to sections C406 and C407 to ensure that credit is only given for additional on-site renewable energy in excess of the prescriptive requirement, and that if a designer chooses to not include a renewable energy system in accordance with C405.13, it must be made up for through the performance path. In that case, the renewable energy allowance included in the budget building design will be based on a horizontal photovoltaic array with a rated capacity equal to but not to exceed the requirement in

Section C405.13.

The reduction in purchased annual energy associated with this proposal is estimated at 4.5%, based on PNNL prototype models.

Bibliography:

Addenda BY, CK, and CP to ANSI/ASHRAE/IES Standard 90.1-2019, published August 2020:

https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_by

U.S. Solar Photovoltaic System Cost Benchmark, 2018: https://www.nrel.gov/docs/fy19osti/72399.pdf

Cost Impact:

The code change proposal will increase the cost of construction.

The renewable energy capacity requirement of 0.25 W/ft^2 was determined thru the ASHRAE cost effectiveness analysis to meet the required scalar value (17.2) across the different insolation zones, considering the costs for different system types and sizes. This showed cost effectiveness across all zones at $2.65/W installed cost without subsidies or incentives. This lines up with 2018 costs from the NREL Cost Benchmark Report, which showed an average cost of $2.54/W for small residential systems (string inverter), and $1.83/W for commercial sized systems between 6-200 kW. As one example, a 50,000 ft2 building would require a 12.5 kW system that would cost $33k at $2.65/W with a 13-19 simple payback, or $23k at $1.83/W with a 10-14 year simple payback. In fact, costs have already continued to drop below these 2018 costs for both larger and smaller systems, and a larger capacity requirement could be justified. There are no assumptions of tax incentives, subsidies, or net-metering policies. The capacity requirement was sized to minimize net generation, less than 1% of the hours.

CEPI-144-21

CEPI-145-21

IECC®: SECTION 202 (New), C405.13 (New), TABLE C405.13 (New), DoD (New)

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Add new definition as follows:

C202 PEI_{CL}. The pump energy index for a constant load (hp).

C202 PEI_{VL}. The pump energy index for a variable load.

C202 PER_{CL}. The pump energy rating for a constant load (hp), determined in accordance with either testing for bare pumps, pumps sold with single-phase induction motors, and pumps sold with drivers other than electric motors, or testing for pumps sold with motors and rated using the testing-based approach, or testing for pumps sold with motors and rated using the calculation-based approach.

C202 PER_{STD}. The PER_{CL} for a pump that is minimally compliant with USDOE energy conservation standards with the same flow and specific speed characteristics as the tested pump (hp).

C202 PER_{VL}. The pump energy rating for a variable load (hp), determined in accordance with testing for pumps sold with motors and continuous or noncontinuous controls rated using the testing-based approach, or testing for pumps sold with motors and continuous controls rated using the calculation-based approach.

C202 PUMP. Equipment designed to move liquids that may include entrained gases, free solids, and totally dissolved solids by physical or mechanical action and that includes a bare pump and, if included by the manufacturer at the time of sale, mechanical equipment, driver, and controls.

C202 CLEAN-WATER PUMP. A device that is designed for use in pumping water with a maximum nonabsorbent free solid content of 0.016 lb/ft3 (0.256 kg/m^3) and with a maximum dissolved solid content of 3.1 lb/ft3 (49.66 kg/m^3), provided that the total gas content of the water does not exceed the saturation volume, and disregarding any additives necessary to prevent the water from freezing at a minimum of 14°F (-10°C).

C202 END-SUCTION CLOSE-COUPLED (ESCC) PUMP. A close-coupled, dry-rotor, end-suction device that has a shaft input power greater than or equal to 1.0 hp (0.74 kW) and less than or equal to 200 hp (149.1 kW) at its best efficiency point (BEP) and full impeller diameter and that is not a dedicated-purpose pool pump. It is also a single-stage, rotodynamic pump in which the liquid enters the bare pump in a direction parallel to the impeller shaft and on the side opposite the bare pump's driver end and is then discharged through a volute in a plane perpendicular to the shaft.

C202 END-SUCTION FRAME-MOUNTED/OWN-BEARINGS (ESFM) PUMP. A mechanically coupled, dry-rotor, end-suction device that has a shaft input power greater than or equal to 1.0 hp (0.75 kW) and less than or equal to 200 hp (149.1 kW) at its best efficiency point (BEP) and full impeller diameter and that is not a dedicated-purpose pool pump. It is also a single-stage, rotodynamic pump in which the liquid enters the bare pump in a direction parallel to the impeller shaft and on the side opposite the bare pump's driver end and is then discharged through a volute in a plane perpendicular to the shaft.

C202 INLINE (IL) PUMP. A device that is either a twin-head pump or a single-stage, single axis flow, dry-rotor, rotodynamic pump that has a shaft input power greater than or equal to 1.0 hp (0.75 kW) and less than or equal to 200 hp (149.1 kW) at its best efficiency point (BEP) and full impeller diameter, in which liquid is discharged through a volute in a plane perpendicular to the shaft. Such pumps do not include pumps that are mechanically coupled or close-coupled, have a pump power output that is less than or equal to 5.0 hp (3.73 kW) at its BEP at full impeller diameter, and are distributed in commerce with a horizontal motor.

C202

RADIALLY SPLIT, MULTISTAGE, VERTICAL, INLINE DIFFUSER CASING (RSV) PUMP

. A device that is a vertically suspended, multistage, single-axis-flow, dry-rotor, rotodynamic pump and:

a. Has a shaft input power greater than or equal to 1.0 hp (0.75 kW) and less than or equal to 200 hp (149.1 kW) at its best efficiency point (BEP) and full impeller diameter and at the number of stages required for testing;
b. In which liquid is discharged in a place perpendicular to the impeller shaft;
c. For which each stage (or bowl) consists of an impeller and diffuser; and d. for which no external part of such a pump is designed to be submerged in the pumped liquid.

C202

SUBMERSIBLE TURBINE (ST) PUMP

. A device that is a single-stage or multistage, dry-rotor, rotodynamic pump that is designed to be operated with the motor and stage(s) fully submerged in the pumped liquid; that has a shaft input power greater than or equal to 1.0 hp (0.75 kW) and less than or equal to 200 hp (149.1 kW) at its best efficiency point (BEP) and full impeller diameter and at the number of stages required for testing; and in which each stage of this pump consists of an impeller and diffuser, and liquid enters and exits each stage of the bare pump in a direction parallel to the impeller shaft.

C202 PUMP SYSTEM POWER. The sum of the nominal power demand (nameplate horsepower) of motors of all pumps that are required to operate at design conditions to supply fluid from the heating or cooling source to all heat transfer devices (e.g., coils, heat exchanger) and return it to the source.

Add new text as follows:

C405.13 Pumps.

Clean water pumps meeting the following criteria shall comply with the requirements shown in Table C403.15:

1. A flow rate of 25 gal/min (1.58 L/s) or greater at its *best efficiency point (BEP)* at full impeller diameter
2. Maximum head of 459 ft at its *BEP* at full impeller diameter and the number of stages required for testing
3. Design temperature range from 14°F (-10°C) to 248°F (120°C)
4. Designed to operate with either:
   4.1. a 2- or 4-pole induction motor, or
   4.2. a non-induction motor with a speed of rotation operating range that includes speeds of rotation between 2880 and 4320 rpm and/or 1440 and 2160 rpm, and
   4.3. in either (1) or (2), the driver and impeller must rotate at the same speed
5. For submersible turbine pumps, a 6 in. (152 mm) or smaller bowl diameter
6. For end-suction close-coupled pumps and end-suction frame-mounted/own bearings pumps, specific speed less than or equal to 5000 rpm when calculated using U.S. customary units

Exceptions: The following pumps are exempt from these requirements:

1. Fire pumps
2. Self-priming pumps
3. Prime-assisted pumps
4. Magnet-driven pumps
5. Pumps designed to be used in a nuclear facility subject to 10 CFR 50, “Domestic Licensing of Production and Utilization Facilities.”
6. Pumps meeting the design and construction requirements set forth in U.S. Military Specification MIL-P-17639F, “Pumps, Centrifugal, Miscellaneous Service, Naval Shipboard Use” (as amended); MIL-P-17881D, “Pumps, Centrifugal, Boiler Feed, (Multi-Stage)” (as amended); MIL-P-17840C, “Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)” (as amended); MIL-P-18682D, “Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard” (as amended); MIL-P-18472G, “Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, And Distilling Plant” (as amended).

TABLE C405.13 MAXIMUM PUMP ENERGY INDEX (PEI)

Pump Type	**Nominal Speed of Rotation (RPM)**	**Operating Mode**	**Maximum PEI[a]**	**C-value[b]**	**Test Procedure**
End suction, close coupled	1800	Constant load	1.00	128.47	10 CFR Part 431
End suction, close coupled	3600	Constant load	1.00	130.42	
End suction, close coupled	1800	Variable load	1.00	128.47	
End suction, close coupled	3600	Variable load	1.00	130.42	
End suction, frame mounted	1800	Constant load	1.00	128.85	
End suction, frame mounted	3600	Constant load	1.00	130.99	
End suction, frame mounted	1800	Variable load	1.00	128.85	
End suction, frame mounted	3600	Variable load	1.00	130.99	
In-line	1800	Constant load	1.00	129.30	
In-line	3600	Constant load	1.00	133.84	
In-line	1800	Variable load	1.00	129.30	

In-line	3600	Variable load	1.00	133.84	
Radially split, vertical	1800	Constant load	1.00	129.63	
Radially split, vertical	3600	Constant load	1.00	133.20	
Radially split, vertical	1800	Variable load	1.00	129.63	
Radially split, vertical	3600	Variable load	1.00	133.20	
Submersible turbine	1800	Constant load	1.00	138.78	
Submersible turbine	3600	Constant load	1.00	134.85	
Submersible turbine	1800	Variable load	1.00	138.78	
Submersible turbine	3600	Variable load	1.00	134.85	

a. For pumps with the constant load operating mode, the relevant PEI is PEI_{CL}. For pumps with the variable load operating mode, the relevant PEI is PEI_{VL}.

b. The C-values shown in this table shall be used in the equation for PEI_{STD} when calculating PEI_{CL} or PEI_{VL}.

DoD U.S. Department of Defens 3010 Defense Pentagon Washington DC 20301

DoD U.S. Department of Defens.
MIL-P-17639F (1996) Pumps, Centrifugal, Miscellaneous Service, Naval Shipboard Use
DoD U.S. Department of Defense.
MIL-P-17840C (1986) Pumps, Centrifugal, Close-Coupled, Navy Standard (For Surface Ship Application)
DoD U.S. Department of Defense.
MIL-P-17881D (1972) Pumps, Centrifugal, Boiler Feed (Multi-Stage)
DoD U.S. Department of Defense.
MIL-P-18472 (1989) Pumps, Centrifugal, Condensate, Feed Booster, Waste Heat Boiler, and Distilling Plant
DoD U.S. Department of Defense.
MIL-P-18682D Pump, Centrifugal, Main Condenser Circulating, Naval Shipboard

Reason Statement:

In 2016, the U.S. Department of Energy published a final rule for energy conservations standards for commercial and industrial clean water pumps that went into effect on January 27, 2020. This proposal provides a new table of information about the new efficiency requirements to users of of the IECC that will be consistent with Addendum AN to ASHRAE 90.1-2016, which was approved for publication in ASHRAE 90.1-2019.

It also provides new definitions and reference standards that are needed to accompany the table.

This will have an energy savings impact in those buildings that use clean water pumps.

Bibliography:

ASHRAE Standards Addendum AN to 90.1-2016, which can be downloaded from:

https://www.ashrae.org/technical-resources/standards-and-guidelines/standards-addenda

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The information in the proposed change show the minimum "baseline" products that are allowed to be used in the United States as of January 27, 2020. Pumps meeting these efficiency levels represent the current minimum efficiency and the now minimum cost products available in the US.

CEPI-145-21

CEPI-146-21 Part I

IECC®: SECTION 202 (New), TABLE C405.12.2, C405.13 (New), TABLE C405.13 (New), C405.13.1 (New), C405.13.2 (New), C405.13.3 (New), C405.13.4 (New)

Proponents: Sharon Bonesteel, representing Salt River Project (sharon.bonesteel@srpnet.com); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Mark Rodriguez, representing Sunrun (mark.rodriguez@sunrun.com); Kimberly Newcomer, representing NBI (kim@newbuildings.org); Sean Denniston, representing New Buildings Institute (sean@newbuildings.org); Matthew Frommer, representing Southwest Energy Efficiency Project (mfrommer@swenergy.org)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Add new definition as follows:

AUTOMATIC LOAD MANAGEMENT SYSTEM (ALMS). A system designed to manage load across one or more electric vehicle supply equipment (*EVSE*) to share electrical capacity and/or automatically manage power at each connection point.

AUTOMOBILE PARKING SPACE (APS). A space within a building or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile .

ELECTRIC VEHICLE (EV). An automobile for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, electric motorcycles, and the like, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current. Plug-in hybrid electric vehicles are electric vehicles having a second source of motive power. Off-road, self-propelled electric mobile equipment, such as industrial trucks, hoists, lifts, transports, golf carts, airline ground support equipment, tractors, boats and the like, are not considered electric vehicles for this code.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The conductors, including the ungrounded, grounded, and equipment grounding conductors, and the *electric vehicle* connectors, attachment plugs, personnel protection system, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle*.

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED (EVSE) SPACE. An *automobile parking space* that is provided with a dedicated *EVSE*.

EV CAPABLE SPACE. An *automobile parking space* that is provided with infrastructure, such as, but not limited to, raceways, cables, electrical capacity, and panel space, necessary for the future installation of an *EVSE*.

EV READY SPACE. An *automobile parking space* that is provided with an electrical circuit that will support an installed *EVSE* .

Revise as follows:

TABLE C405.12.2 ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Electric vehicle charging	*Electric vehicle* charging loads.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.

Add new text as follows:

C405.13 Electric Vehicle Charging Infrastructure. New parking facilities shall be provided with electric vehicle charging infrastructure in accordance with this section and Table C405.13 based on the total number of parking spaces and rounded up to the nearest whole number. *EVSE spaces*, *EV ready spaces* and *EV capable spaces* may be counted toward meeting minimum parking requirements. *EVSE spaces* may be used to meet requirements for *EV ready spaces* and *EV capable spaces*. *EV ready spaces* may be used to meet requirements for *EV capable spaces*. Each *EVSE space* capable of delivering not less than 50kW to an electric vehicle shall be permitted to reduce the total number of *EV spaces* required by this section by five. Where more than one parking facility is provided on a building site, the number of parking spaces required shall be calculated separately for each parking facility.

TABLE C405.13
ELECTRIC VEHICLE CHARGING INFRASTRUCTURE REQUIREMENTS[b]

OCCUPANCY	EVSE SPACES	EV READY SPACES	EV CAPABLE SPACES
Group B Occupancies	15%	NA	30%
Group M Occupancies	10%	NA	10%
R-2 Occupancy[a]	20%	5%	75%
Groups U, H, and S Occupancies	1	NA	NA
All other Occupancies	2%	NA	5%

a. Where *EV ready spaces* are provided in accordance with Section C405.13.3, the requirement for *EVSE spaces* and *EV Capable spaces* shall be permitted to be reduced to 0%.

b. Where staff parking is designated, quantities shall be proportionally distributed between public and staff EV charging.

C405.13.1 Electric Vehicle Charging Stations and Systems. Where provided, electric vehicle charging systems shall be installed in accordance with NFPA 70. Electric vehicle charging system equipment shall be listed and labeled in accordance with UL 2202. *EVSE* shall be listed and labeled in accordance with UL 2594. Accessibility to *EVSE* shall be provided in accordance with IBC Section 1108. Electric vehicle charging infrastructure shall be in accordance with C405.13.

C405.13.2 EV Capable Spaces. *EV Capable Spaces* shall be provided with electrical infrastructure that conforms to the following requirements:

1. A raceway or cable that is continuous between a junction box or outlet located within 3 feet (914 mm) of the parking space and connected by continuous conduit to an electrical panel serving the area of the parking space
2. The raceway or cable shall be sized and rated to accommodate a minimum 40-amp, 208/240-volt branch circuit, and the raceway shall have a minimum nominal trade size of 1 inch (25 mm).
3. The electrical panel to which the raceway or cable connects shall have sufficient dedicated physical space for a 2-pole breaker.
4. The electrical junction box and the electrical panel directory entry for the dedicated space in the electrical panel shall have labels stating, "For future *electric vehicle* charging."

Exception: In parking garages, the raceway or cable required for *EV capable space* may be omitted provided the parking garage electrical service has no less than 4.1 kVA of additional reserved capacity per *EV Capable space.*

C405.13.3 EV Ready Spaces. Where permitted by Table C405.13, one *EV ready space* shall be provided per *dwelling unit.* The branch circuit serving *EV Ready Spaces* shall conform to the following requirements:

1. Conductors or cables capable of supporting a 40-amp, 208/240-volt circuit,
2. Terminates at a receptacle outlet located within 3 feet (914 mm) of the parking space,
3. A minimum load capacity of 4.1 kVA,
4. The electrical panel directory shall designate the branch circuit as "For electric vehicle charging" and the junction box or receptacle shall be labelled "For *electric vehicle* charging."

Exception: Where 100% of *automobile parking spaces* are *EV ready spaces* or *EVSE spaces.*

C405.13.4 EVSE Spaces. The *EVSE* serving *EVSE spaces* shall be rated to supply not less than 6 .2 kW to an electric vehicle and shall be located within 3 feet (914 mm) of the parking space. An *EVSE* with multiple vehicle connections shall be permitted to serve multiple *EVSE spaces* provided each connection meets the requirements of this section for power delivery and location. An *ALMS* may be used to reduce the total electrical capacity required by *EVSE spaces* provided that all *EVSE spaces* are capable of simultaneously charging at a minimum rate of 3.3 kW.

Reason: Preparing our buildings for safe and convenient EV charging infrastructure is critical to deployment of electric vehicles. The transportation sector is the single largest source of GHG emissions in the nation. Near complete electrification of the transportation sector is necessary to achieve the GHG emission reductions needed to avoid the worst effects of climate change.
Electric vehicle sales increased by 80 percent from 2017 to 2018, and is expected to grow from 1 million vehicles at the end of 2018 to 18.7 million by 2030. As newer EVs with longer drive ranges enter the market, the older, shorter drive range EVs will move to the used vehicle market, and become readily accessible to a secondary market for which the accessibility of EV charging infrastructure at home and at work will be critical.

Inclusion in the IECC of EV Infrastructure requirements is critical in the prevention of the use of extension cords to inappropriate outlets for the purpose of vehicle charging. We must be building structures that will address the vehicles that the major automakers have already shown us they are producing, especially as they close out the production of ICE vehicles and switch to total EV manufacturing.

Buildings built in 2022 should last 50 years. By 2045 Ernst & Young predicts internal combustion engine (ICE) vehicles will make up less than 1% of new car sales globally. Bloomberg reports that the automakers' capital expenditures on capital equipment for electric vehicle manufacturing is important because it is the culmination of a manufacturer's multi-year exploration of the future; "Capex is Destiny." *

Shouldn't we be building structures to accommodate the vehicles that the automakers are telling us they are switching to? Shouldn't we be installing the infrastructure when it is least expensive to install? Shouldn't we be addressing the single largest source of GHG emissions?

*Read more at: https://www.bloombergquint.com/business/automakers-are-investing-billions-of-dollars-in-evs

Cost Impact: The code change proposal will increase the cost of construction.
Recent analysis by NBI and partners using cost data from RSMeans and the PNNL medium office prototype found that the average total cost of an EVSE space in a commercial parking lot was $4702: $1558 in materials and $3145 in labor. These costs include a dual-head commercial Clipper Creek EVSE mounted on a commercial pedestal, raceways, and all electrical conductors. If the electrical panel and onsite transformer have to be upsized – something that will only happen on some projects – there would be an additional cost of $1200 per space.

Using the same prototype and data sources, each EV capable space required an additional cost of $123 per space for conduit (assuming an average 100' run) and junction boxes if no capacity upgrade is required. If the panel and onsite transformer have to upsized to accommodate design loads, then that cost could increase by $1200 per space.

However, with the future demand for EVs and EV charging discussed in the reason statement, commercial parking facilities that do not include EV spaces during new construction will face substantially higher costs to retrofit those spaces in the future. For example, a cost-effectiveness study for the City and County of San Francisco conducted by Pacific Gas & Electric (PG&E) showed that the cost of an EV Ready space (full circuit for level 2 charging) installed during new construction was $860-$920, while a retrofit would cost $2370-$3710,[1] 3-4 times the cost. An analysis conducted by the California Air Resource Board found much higher cost savings of $7000 from avoided retrofit costs when EV spaces are installed during construction rather than retrofit, with the majority of the cost delta due to the cost of retrenching parking lots and doing costly panel and transformer upgrades.[2] The EV Capable spaces required by this proposal avoid nearly all of these incremental retrofit costs by including the most difficult elements to retrofit (trenching and panels) during new construction.

These EV chargers will also yield substantial economic benefits for both the individual that owns the EV and the building owner. For individuals, EVs cost much less to fuel and maintain than gas-powered vehicles. According to AAA, an electric vehicle (EV) will save roughly $1,039 per year in total fuel and maintenance costs compared to a comparable gasoline vehicle. Although Electric Vehicles are often more expensive than gasoline powered vehicles, Bloomberg New Energy Finance on battery costs suggests EVs could reach upfront cost parity with gasoline vehicles by the early-to-mid 2020s. For building owners, installing EV chargers will increase property values, attract new customers or tenants and improve staff and tenant retention.

With the growing market demand for EVs and the growing demand for charging they create, it not a question of if EV spaces will be needed, but when. Building owners and tenants will be paying for this cost now or in the future. Failing to install a minimal number of EVSE spaces and EV capable spaces now will saddle building owners and tenants with substantially higher costs due to costly future retrofits.

Bibliography:

Plug-In Electric Vehicle Infrastructure Cost-Effectiveness Report for San Francisco, PG&E, 17 Nov. 2016, http://evchargingpros.com/wp-content/uploads/2017/04/City-of-SF-PEV-Infrastructure-Cost-Effectiveness-Report-2016.pdf

"Electric Cars Only Cost Slightly More to Own than Gas-Powered Ones, AAA FINDS." *True Cost of EV Ownership*, www.ace.aaa.com/automotive/advocacy/true-cost-of-electric-vehicle-ownership.html.

Baldwin, Roberto. *EVs Could Soon Cost Same as Gas Cars Thanks to Lower Battery Costs*. Car and Driver, 19 Feb. 2021, www.caranddriver.com/news/a34992832/battery-price-drop-2023/.

[1] http://evchargingpros.com/wp-content/uploads/2017/04/City-of-SF-EV-Infrastructure-Cost- Effectiveness-Report-2016.pdf

[2] https://ww2.arb.ca.gov/sites/default/files/2020-08/CARB_Technical_Analysis_EV_Charging_Nonresidential_CALGreen_2019_2020_Intervening_Code.pdf

Attached Files

- **AmerLungAssn -AZ_AQ-SURVEY_MEMO.pdf**
  https://energy.cdpaccess.com/proposal/429/810/files/download/157/
- **NESCAUM_Public Comment on Proposal G66-21-FROMMER-4_vFinal (002).pdf**
  https://energy.cdpaccess.com/proposal/429/810/files/download/156/
- **EV Ready Reason Statement 2021.pdf**
  https://energy.cdpaccess.com/proposal/429/810/files/download/155/

GSG
GLOBAL STRATEGY GROUP

TO: American Lung Association
FROM: Andrew Baumann and Nicole Jaconetty, Global Strategy Group
DATE: December 10, 2020
RE: **NEW POLL:** Arizona Voters Concerned about Climate, Strongly Support Clean Energy Policies

New survey data from research conducted by Global Strategy Group shows that Arizona voters demonstrate significant concern about climate change and want to see the state move away from fossil fuels like coal and oil and toward clean energy like wind and, especially, solar. Further, there is strong support for proposals that do just that – including policies that support electric vehicles and energy efficiency, as well as a plan to require Arizona utilities to cut carbon emissions in half by the year 2032 and get 100% of their electricity from clean, carbon-free sources by 2050. Finally, support for this proposal is broad and robust; it holds up after a simulated debate that includes messaging using the actual language from opponents. Moreover, after this debate, voters believe such a plan would have a positive impact on all metrics tested, including Arizona's economy and families like theirs.

The following memo contains key findings from the survey conducted for the American Lung Association between November 19 and November 29, 2020 among 800 registered voters in Arizona.[1]

KEY FINDINGS

Arizona voters see climate change as a serious problem that is impacting them now and, without action, will soon be as big of a problem as the pandemic. Nearly eight in 10 voters call climate change a serious problem (a crisis, a very serious problem, or a somewhat serious problem), including nearly all Democrats as well as a majority of Republicans. Over half say it is a crisis or a *very* serious problem. Moreover, nearly seven-in-10 agree that climate change is already having a serious impact on the southwest region, six-in-10 agree that if we fail to act that climate change will soon be as big of a concern as the coronavirus, and over three-quarters believe we should

CLIMATE CHANGE

	Registered Voters	Dem.	Ind.	GOP	Latino	White Non-college	White College
% Crisis/Very serious problem	54	84	53	28	64	49	53
% Total serious problem	78	**97**	**80**	**59**	88	73	76

CLIMATE CHANGE STATEMENTS

	Registered Voters								
	Agree	Disagree	NET	Dem.	Ind.	GOP	Latino	White Non-col.	White College
We should let scientists and experts guide our response to climate change.	76%	19%	**+57**	+88	**+53**	+32	+65	+48	+64
Climate change is already having a serious impact on this part of the country.	67%	28%	**+39**	+88	**+42**	-4	+55	+32	+34
If we fail to act, climate change will soon be as big of a concern as the coronavirus is now.	62%	34%	**+28**	+83	**+27**	-18	+50	+15	+27

[1] Interviewing was paused on Thanksgiving Day, November 26, 2020.

let science and experts guide the response to it. An overwhelming majority of independents and even a sizeable share of Republicans join with Democrats in these beliefs.

Voters overwhelmingly want to see Arizona move toward clean energy and away from fossil fuels like coal and oil. Voters on both sides of the aisle want to see their state use more solar (by a 75-point margin) and wind (by over a 50-point margin) as well as less oil and coal. Further, over three-quarters agree that America should make significant investments in clean energy as a part of the effort to rebuild the economy, and two-thirds agree we should do it in a just and equitable way – statements with which Democrats, Independents, and Republicans agree by wide margins.

ENERGY SOURCE USAGE

	Registered Voters									
	More	Less	About the same/DK	NET	Dem.	Ind.	GOP	Latino	White Non-col.	White College
Solar	**79%**	4%	17%	**+75**	+83	+73	+69	+75	+74	+80
Wind	**60%**	7%	33%	**+53**	+72	+53	+36	+57	+52	+54
Natural gas	30%	12%	**58%**	**+18**	+6	+20	+26	+7	+14	+31
Fracked gas	12%	**34%**	**54%**	**-22**	-44	-26	-4	-33	-11	-31
Oil	7%	**41%**	52%	**-34**	-55	-38	-14	-36	-32	-39
Coal	7%	**50%**	43%	**-43**	-60	-45	-27	-40	-35	-57

CLEAN ENERGY STATEMENTS

	Registered Voters								
	Agree	Disagree	NET	Dem.	Ind.	GOP	Latino	White Non-col.	White College
America should make significant investments in clean energy as part of our efforts to rebuild the economy.	**79%**	17%	**+62**	**+93**	**+64**	**+35**	+68	+58	+64
As we move the country to clean energy, we should make sure that our investments benefit the communities most impacted by pollution, including Black, Hispanic, and Native American communities.	67%	19%	**+48**	**+87**	**+42**	**+17**	+62	+37	+47

As a result, policies to boost clean energy, electric vehicles, and energy efficiency have broad, cross-partisan appeal. All five of the proposals tested are supported by more than two-thirds of Arizona voters and by majorities of Democrats, independents, and Republicans. Most popular among these policies is a proposal to help homeowners increase their home energy efficiency (84% support). Additionally, transitioning public vehicle fleets to electric vehicles (70% support), incentivizing the purchase of electric vehicles (69% support), and investing in publicly available charging infrastructure for electric vehicles on highways and roads (69% support) are all popular. Finally, voters strongly back a plan to require Arizona utilities to cut carbon emissions in half by the year 2032 and get 100% of their electricity from clean, carbon-free sources like wind and solar by 2050**.**

CLEAN ENERGY POLICIES

	Registered Voters								
	Support	Oppose	NET	Dem.	Ind.	GOP	Latino	White Non-col.	White College
Providing assistance for homeowners and renters to increase the energy efficiency of their homes and reduce energy use	84%	10%	**+74**	+92	+65	+64	+77	+70	+77
Investing in publicly available infrastructure for charging electric vehicles along major highways and roads	69%	18%	**+51**	+79	+49	+27	+56	+44	+54
Policies that will transition public vehicle fleets like transit buses, school buses, maintenance trucks, and government-owned cars to all electric vehicles	70%	20%	**+50**	+77	+44	+31	+57	+41	+59
A plan to require Arizona utilities to cut carbon emissions in half by the year 2032 and get 100% of their electricity from clean, carbon-free sources like wind and solar by 2050	70%	20%	**+50**	+84	+55	+15	+59	+43	+49
Providing consumer incentives to encourage the purchase of electric vehicles	69%	21%	**+48**	+78	+47	+23	+52	+42	+52

Support for a plan to require utilities to be 100% carbon-free by 2050 is robust and remains broad after a simulated debate that includes strong attacks using actual language from the opposition. After a simulated debate that includes strong attacks using actual language from opponents claiming that the plan would supposedly raise energy prices and kill jobs (see language in appendix), support remains robust, at nearly two-thirds. After this debate, Democrats, independents, and less-conservative Republicans support the plan and only the 12% of Arizonans who identify as very conservative Republicans are in opposition.

POST-MESSAGING SUPPORT

	Registered Voters									
	Support	Oppose	NET	Dem.	Ind.	Non-V Cons. GOP	Very Cons. GOP	Latino	White Non-col.	White College
A plan to require Arizona utilities to cut carbon emissions in half by the year 2032 and get 100% of their electricity from clean, carbon-free sources like wind and solar by 2050	64%	30%	**+34**	+85	+25	+8	-34	+45	+23	+39

Support is strong because the attacks fall flat and fail to convince voters that the plan will not have a positive impact. Even after opposition messaging, voters believe the proposal will have a positive impact on Arizona's economy, their own family, and their own finances, not to mention climate change, air quality, and health.

PROPOSAL IMPACTS

	Positive impact	Negative impact	No impact	NET Positive Impact
Air quality in Arizona	76%	12%	13%	**+64**
Climate change	68%	11%	20%	**+57**
The health of families like yours	68%	16%	17%	**+52**
Future generations of your family	67%	21%	12%	**+46**
Your family	60%	27%	13%	**+33**
The economy and jobs in Arizona	60%	34%	6%	**+26**
The finances of family's like yours	46%	41%	13%	**+5**

APPENDIX

MESSAGING

Supporters say:

Whether Black or white, Latino or Native American, we all deserve an opportunity to live in a healthy community – and we all have a basic responsibility to leave a better world for our kids. But unchecked pollution from dirty energy sources like coal and oil is putting the health and future of our children at risk.

The coronavirus pandemic has shown us what happens when we don't listen to the experts. We can't afford to make the same mistake when it comes to climate change – 97% of scientists, NASA, and the Department of Defense all agree that climate change is a threat to our kids' future.

This plan to accelerate Arizona's transition to clean energy is supported by both Republican and Democratic policymakers because it will not only dramatically reduce the carbon pollution that is disrupting our climate, but also reduce the sulfur and arsenic pollution that cause asthma attacks, heart and lung disease, and even cancer – especially in children and seniors.

And economists say that moving to clean energy will help Arizona's economy recover more quickly from the pandemic and create thousands of good-paying jobs for all kinds of people, from engineers, to factory workers, to installers, while eventually saving Arizona families thousands of dollars a year in energy and health care costs.

Opponents say:

This proposal amounts to nothing more than an economically devastating energy tax at a time we can least afford it. By forcing us to use unreliable and expensive energy sources, its mandates would cause electricity bills to skyrocket, costing Arizona families hundreds of dollars per year.

And this proposal would drive energy prices up for businesses by thousands of dollars per year, killing jobs, stifling innovation, and reversing the economic recovery that is just beginning in Arizona. Companies will be forced to send good-paying jobs to other states or countries overseas where costs are lower.

In 2018, Arizona voters rejected a proposal like this one because it was bad for Arizona for all of these reasons. But now, liberal activists who are funded by radical, out-of-state environmental groups are trying to overrule the will of the people.

We should leave renewable energy to the free market – not big government: if consumers want it, producers will provide it. In the meantime, it makes no sense to pass laws mandating monopolies for renewable energy companies that will only help people rich enough to put solar panels on their homes.

ABOUT THIS RESEARCH

Global Strategy Group conducted an online survey of 800 Arizona registered voters from November 19 to November 29, 2020. The margin of error at the 95% confidence level for registered voters is +/- 3.5%. Care was taken to ensure the demographic composition of the sample matched Arizona's registered voter population across a variety of demographic variables including race, gender, age, education, and region.

NESCAUM
www.nescaum.org
Northeast States for Coordinated Air Use Management
89 South Street, Suite 602 Boston, MA 02111
Phone 617-259-2000 Fax 617-742-9162
Paul J. Miller, Executive Director

September 21, 2021

International Code Council
International Building Code Committee
500 New Jersey Avenue, NW, 6th Floor
Washington, DC 20001

Re: Support for Proposal G66-21 as Modified by Public Comment

Dear International Building Code Committee Members:

The Northeast States for Coordinated Air Use Management (NESCAUM) is writing to support proposal G66-21[1] as modified by public comment from the Southwest Energy Efficiency Project (SWEEP).[2] The proposed amendments to the 2024 International Building Code (IBC) would require a certain percentage of parking spaces associated with new multi-unit residential construction and certain renovations to be equipped with electrical capacity (e.g., circuitry) and pre-wiring (e.g., conduit) infrastructure to power electric vehicle (EV) charging stations.

NESCAUM is the regional association of state air pollution control agencies in Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Rhode Island, and Vermont. NESCAUM provides technical analysis and policy advice to its member states on a wide range of air pollution and climate issues and facilitates multi-state initiatives to accelerate transportation electrification.[3]

Amendments to the residential building code as modified by SWEEP's public comment would apply to all new residential buildings with more than two units, referred to as Group R-2 buildings,[4] where parking is provided. For Group R-2 buildings, the amendments would require no less than 20 percent of parking spaces to be EV-ready.[5] When more than 10 new parking

[1] The original amendments proposed by SWEEP are numbered as G66-21 in the 2021 Group A Proposed Changes to the I-Codes, IBC – General. Accessible at https://cdn-web.iccsafe.org/wp-content/uploads/IBC-General-compressed-2021-Group-A.pdf.

[2] See, G66-21 Public Comment FROMMER-4.

[3] See, e.g., *State Zero-Emission Vehicle Programs Memorandum of Understanding*, accessible at https://www.nescaum.org/documents/zev-mou-10-governors-signed-20191120.pdf/; *Multi-State ZEV Action Plan*, accessible at https://www.nescaum.org/documents/2018-zev-action-plan.pdf; *Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding*, accessible at https://www.nescaum.org/documents/multistate-truck-zev-governors-mou-20200714.pdf.

[4] Group R-2 buildings include occupancies containing sleeping units of more than two dwelling units where the occupants are primarily permanent in nature, including: apartment houses; non-transient congregate living facilities with more than 16 occupants, hotels, and motels; live/work units; and vacation timeshare properties.

[5] "EV-ready" refers to a parking space that has allocated 208/240V 40-amp panel capacity, conduit, wiring, receptacle, and overprotection devices, with an endpoint near to the parking space.

spaces are added to an existing multi-unit residential building, only the new spaces would be subject to these requirements. In addition, SWEEP's public comment modifies the original proposal to delete requirements for Electric Vehicle Supply Equipment-installed spaces, EV-ready spaces, and EV-capable spaces in commercial buildings, and to remove requirements embedded in the proposal's definitions.

Expanding safe and convenient EV charging infrastructure is a high priority for our states. NESCAUM member states have adopted aggressive science-based greenhouse gas (GHG) emission targets requiring an 80 percent or greater reduction in GHG emissions by 2050. This has important implications for the transportation sector, which is now the single largest source of GHG emissions in the nation. Near complete electrification of the transportation sector is necessary to achieve the GHG emission reductions needed to avoid the worst effects of climate change.

To accelerate electrification of the transportation sector, seven of the NESCAUM-member states, along with Colorado, Maryland, Oregon, and mostly recently, Minnesota, have adopted the California Zero-Emission Vehicle (ZEV)[6] regulation, which require automakers to place increasing numbers of ZEVs in states that have adopted the ZEV program. Two additional states – Nevada and Washington – are in the process of adopting California's ZEV regulation, and New Mexico, Pennsylvania, and Virginia have announced their intention to adopt the ZEV regulation. These states, when combined with California, represent nearly 40 percent of the national new car sales market. In addition, many other states are actively engaged in transportation electrification efforts to accelerate EV adoption.

The EV market is showing strong growth trends. Collectively, automakers and suppliers have pledged $250 billion in electrification investments by 2023 and IHS Markit projects there will be 130 EV models available in the U.S. by 2026.[7] Furthermore, a 2018 EV sales forecast developed by the Edison Electric Institute (EEI) and the Institute for Electric Innovation (IEI)[8] estimates that the number of EVs on U.S. roads will reach roughly 19 million by 2030. An EV tipping point is approaching, and it is imperative that we scale up deployment of charging infrastructure to keep pace with the growth of EV sales. EEI and IEI estimate that of the total 9.6 million charging ports needed to support the expanded market in 2030, 7.5 million Level 2 home chargers will be needed. Residential charging is particularly important because charging at home provides unparalleled convenience for consumers, can be done during times of off-peak power

[6] Zero-emission vehicles as a category includes three types of electric vehicles: full battery electric, plug-in hybrid, and hydrogen fuel cell vehicles. The ZEV and EV acronyms are often used interchangeably.

[7] Auto Industry EV Policy Letter to President Biden. Alliance for Automotive Innovation. March 30, 2021. Accessible at https://www.autosinnovate.org/posts/press-release/ev-policy-letter-to-president-biden.

[8] *Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030*. Edison Electric Institute and Institute for Electric Innovation. November 2018. Accessible at http://www.ehcar.net/library/rapport/rapport233.pdf.

demand, and costs less than paid public charging.[9] More than 80 percent of all EV charging is done at home for these reasons.[10]

The lack of access to home charging is a significant barrier to EV adoption, and especially for residents of apartments and condominiums. Multi-unit residential housing makes up nearly 27 percent of housing stock in the United States,[11] and over 15 million lower-to-middle income households rent apartments.[12] Without access to convenient and reliable at-home charging, lower-to-middle income residents living in multi-unit residences are less likely to consider an EV to meet their mobility needs. Some states are actively working to expand access to at-home charging. This summer, the state of New Jersey enacted a model statewide municipal ordinance[13] that establishes minimum mandatory EV-ready and electric vehicle supply equipment-installed requirements for parking facilities at multi-unit dwellings with more than five units. This model ordinance will make it easier for residents of multi-unit dwellings to conveniently charge at home while bringing down development costs associated with charging infrastructure installation. Similarly, SWEEP's proposal, as amended, will increase equitable access to at-home charging infrastructure for residents of apartments and condominiums, helping to achieve more widespread EV adoption while ensuring these residents share in the many benefits of driving electric such as vehicle fuel and maintenance savings.

Equally important are the documented cost savings associated with installation of EV-ready charging infrastructure at the time of construction. Retrofitting existing buildings with charging equipment is significantly more costly than equipping buildings with the necessary EV-ready electrical infrastructure at the time of construction. For example, a 2020 report on EV-readiness in the City of Oakland, California found that the costs of installing EV-ready (i.e., complete circuits) in new construction to be significantly lower than in building retrofits in all modeled scenarios (*see* Figure 1).[14]

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[9] For example, in March 2019, 66 percent of EV rebate recipients in Massachusetts reported that they have, or will, purchase an EV charger.

[10] *Charging at Home.* U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. Accessible at https://www.energy.gov/eere/electricvehicles/charging-home.

[11] 2019 American Community Survey 1-Year Estimates, Table DP04 "Selected Housing Characteristics". U.S. Census Bureau. Accessible at https://data.census.gov/cedsci/table?d=ACS%201-Year%20Estimates%20Data%20Profiles&tid=ACSDP1Y2019.DP04&hidePreview=false.

[12] Household Incomes. National Multi-Family Housing Council. Accessible at https://www.nmhc.org/research-insight/quick-facts-figures/quick-facts-resident-demographics/household-incomes/.

[13] DCA Model Statewide Municipal EV Ordinance. New Jersey Department of Community Affairs. Accessible at https://www.nj.gov/dca/dlps/home/modelEVordinance.shtml.

[14] City of Oakland Plug-in Electric Vehicle Readiness Grant. City of Oakland. January 2020. Accessible at https://ww2.energy.ca.gov/2020publications/CEC-600-2020-FTD/CEC-600-2020-116.pdf.

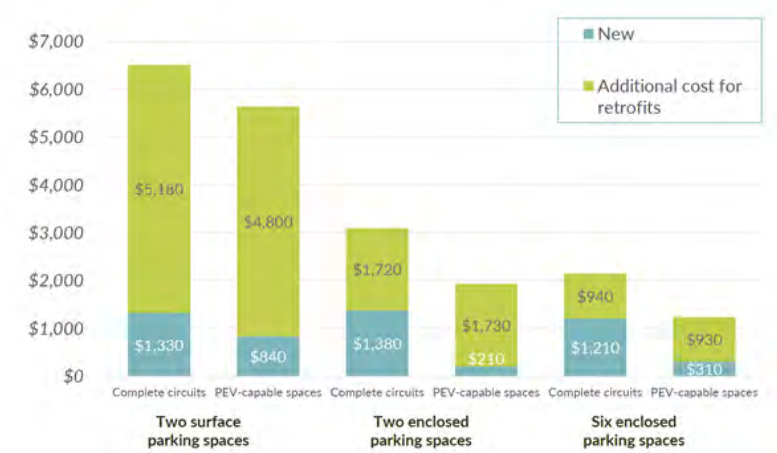

Figure 1. Cost Savings for the City of Oakland (2020)

Mandatory minimum EV-ready requirements are a proactive, efficient, and cost-effective way to equip the next generation of multi-unit residential buildings with charging capacity to meet the nation's evolving transportation needs. Furthermore, EV-ready requirements in proposal G66-21 as modified by SWEEP's public comment will help improve the energy efficiency of our transportation sector and, when combined with other proposals that would improve the energy efficiency of homes, will contribute to lower overall household energy spending. Incorporating EV-ready building code standards for new multi-unit residential construction and certain renovations into the IBC will establish an important national standard and facilitate adoption by state and local government building code bodies.

Thank you for your consideration of these comments.

Sincerely,

Paul J. Miller
Executive Director

cc: NESCAUM Directors
Lynne Hamjian and Cynthia Greene, EPA R1
Richard Ruvo, EPA R2

Reason: Electric vehicle (EV) sales increased by 80 percent from 2017 to 2018 (1). According to a November 2018 forecast from the Edison Electric Institute, the number of EVs on US roads is projected to grow from 1 million vehicles at the end of 2018, to 18.7 million by 2030. To recharge these new EVs, the US will need 9.6 million charge ports, a substantial portion of which will be installed in workplace commercial buildings (2).

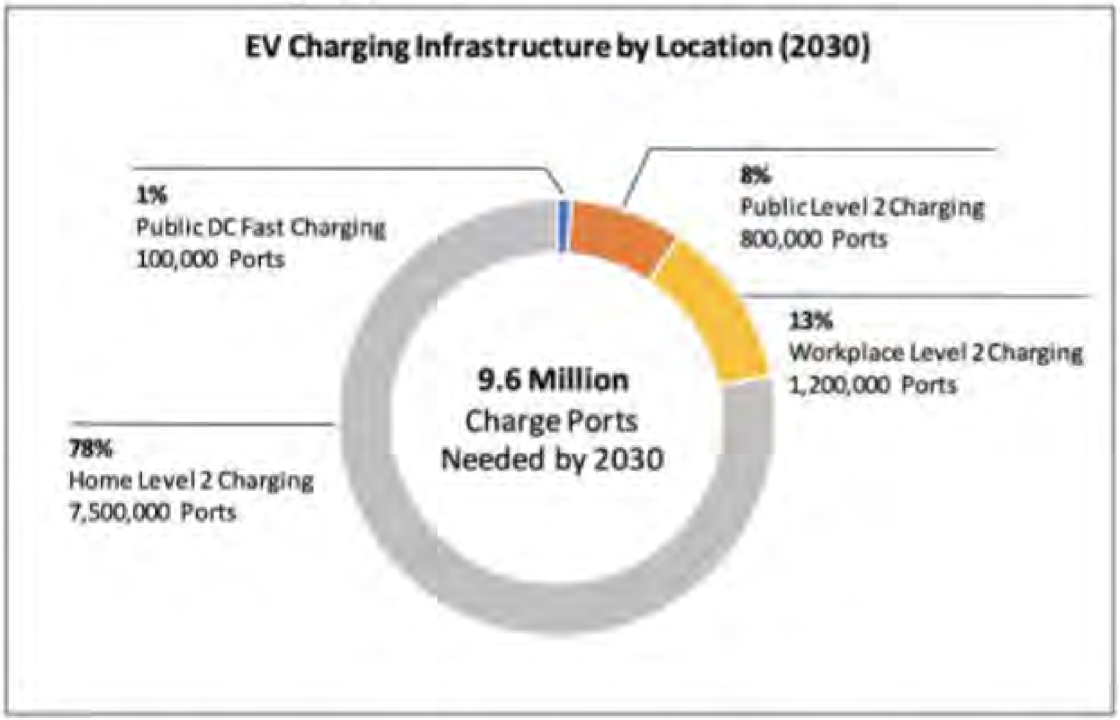

Figure 1. EV Charging Infrastructure in 2030 Based on EEI/IEI Forecast.

EVs provide significant benefits for consumers through fuel and maintenance cost savings, and have been identified as a key climate strategy to reduce GHG emissions from the U.S. transportation sector. The interest in EVs has grown alongside greater EV model availability and increased vehicle range. Every major auto manufacturer in the world has announced a plan to electrify a significant portion of their vehicle fleets over the next 3-5 years. Norway is expected to have 100% EV sales by early 2022 based on current trends. Interest in EVs has grown alongside greater model availability and increased vehicle range, and there are now well over 1.5 million EVs on the road . Affordable EVs are being showcased by auto manufacturers at an increased pace, such as the Chevrolet Bolt which comes in just over $30k with a range in excess of 250 miles. Ford is currently taking reservations for the F-150 Lightning, modeled after the best selling vehicle in the U.S., the Ford F-150, and the Mach-E, modeled after the Ford Mustang. Most industry experts agree that we are entering a big market transformation from gas-powered vehicles to electric.

This transformation is being accelerated by state and federal policy – over a dozen countries plus California and Massachusetts have announced plans to ban the sale of gasoline and diesel vehicles by 2035 or 2040. Twelve other states have adopted California's Zero-Emission Vehicle (ZEV) Standards requiring an increasing percentage of new vehicle sales to be electric each year and at least 3 others – Nevada, New Mexico, and Minnesota – plan to adopt the ZEV Standards in 2021. New buildings constructed with the 2024 IBC will only be 10 years old by the time all new vehicle sales are electric in these states.

These government commitments have encouraged the biggest global auto manufacturers to electrify their vehicle models. By 2022, the U.S. market will have a selection of over 100 electric models including over 20 electric SUV and pickup truck models. The auto industry is investing $435 billion in electric transportation over the next decade.

Figure 1: Automaker Commitments to Electric Vehicles.

Automaker	Electrificaon Commitmen t
Audi	20 new EV models by 2025. 800,000 EV sales annually (1/3 of all sales).
BMW	25 electrified vehicle models by 2025. 15 - 25% of annual sales are electric.
Ford	40 EVs by 2022: 16 BEVs, 24 PHEVs
General Motors	20 electric cars by 2023
Honda	2/3 of all sales to be electric by 2030. Every model to have EV opon b y 2022.
Hyundai Motor Group	44 EV models by 2025
Nissan	8 new EVs by 2022. EVs make up 20-30% of US sales by 2025.
Tesla	Sold 500,000 EVs in 2020.
Toyota	Half of sales are electric by 2025. Every model to have electric or hybrid opon.
Volkswagen Group	70 new electric models by 2028. 1 million EVs sold by end of 2023.
Volvo	50% of sales are electric by 2025 (5 new BEVs by 2021)

However, the lack of access to EV charging stations continues to be a critical barrier to EV adoption. In particular, there are significant logistical barriers for commercial building tenants to upgrade existing electrical infrastructure and install new EV charging stations. Unsafe conditions may exist where tenants make connections with extension cords or other unpermitted methods.

A lack of pre-existing EV charging infrastructure, such as electrical panel capacity, raceways, and pre-wiring, can make the installation of a new charging station cost-prohibitive for a potential EV-owner. The installation of an EV charging station is made three to four times less expensive when the infrastructure is installed during the initial construction phase as opposed to retrofitting existing building structures to accommodate the new electrical equipment.

Retrofitting existing buildings may require trenching through hardscaping and finished parking areas over long distances at significant cost. A lack of planned infrastructure may require new buildings to undergo service upgrades, replacing relatively new equipment, like service panels and wiring, to support the increased capacity required for EV charging.

Occupants of a building, whether they are the owners, tenants, or workers, need access to charging systems proportional to their time on the site. Residential occupants are expected to charge EVs while at home when the vehicle is not in use. Workers at a business may commute to a location and require a charging connection while completing the day's work in order to return home. Customers, and workers, at a shopping structure would require access to charging facilities, as well.

New residential and commercial buildings are constructed to last for 100 years or more, and so it is critical that charging infrastructure is incorporated at the pre-construction stage to ensure that new buildings can accommodate the charging needs of future EV-owners. Governments and automakers around the world have announced plans to move toward 100% electric transportation over the next two decades. It's time for the 2024 IBC model code to support the transition by including EV charging infrastructure requirements for new commercial buildings.

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CEPI-146-21 Part II

IECC®: SECTION 202 (New), R202 (N1101.6) (New), R404.4 (N1104.4) (New), R404.4.1 (N1104.4.1) (New)

Proponents:

Sharon Bonesteel, representing Salt River Project (sharon.bonesteel@srpnet.com); Kimberly Cheslak, NBI, representing NBI (kim@newbuildings.org); Sean Denniston, representing New Buildings Institute (sean@newbuildings.org); Matthew Frommer, representing Southwest Energy Efficiency Project (mfrommer@swenergy.org); Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov)

2021 International Energy Conservation Code

Add new definition as follows:
R202 (N1101.6) ELECTRIC VEHICLE (EV).

An automobile for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, electric motorcycles, and the like, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current. Plug-in hybrid electric vehicles are electric vehicles having a second source of motive power. Off-road, self-propelled electric mobile equipment, such as industrial trucks, hoists, lifts, transports, golf carts, airline ground support equipment, tractors, boats and the like, are not considered electric vehicles for this code.

R202 (N1101.6) EV READY SPACE. An *automobile parking space* that is provided with a dedicated electrical circuit capable of supporting an installed *EVSE*.
R202 (N1101.6) ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The conductors, including the ungrounded, grounded, and equipment grounding conductors, and the *electric vehicle* connectors, attachment plugs, personnel protection system, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle*
R202 (N1101.6) ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED (EVSE) SPACE.

An *automobile parking space* that is provided with a dedicated *EVSE*.

Add new text as follows:
R202 (N1101.6) Electric vehicle charging infrastructure.

Electric vehicle charging infrastructure. Electric infrastructure for the charging of *electric vehicles* shall be installed in accordance with this section. *EV ready spaces* are permitted to be counted toward meeting minimum parking requirements.

R404.4 (N1104.4) One- and two- family dwellings and townhouses.

New One- and two-family dwellings and townhouses with a dedicated attached or detached garage or on-site parking spaces and new detached garages shall be provided with one *EV-ready space* per *dwelling unit.* The branch circuit shall terminate in a receptacle outlet and shall comply with the following requirements:

1. Panel capacity for a 40-amp, 208/240-volt circuit with a minimum capacity of 9.6 kVA.
2. Terminates at a receptacle outlet or an EVSE, located within 3 feet (914 mm) of the parking space.
3. The electrical panel directory shall designate the branch circuit as "For electric vehicle charging" and the junction box or receptacle shall be labelled "For electric vehicle charging".

R404.4.1 (N1104.4.1) Group R occupancies.
New Parking facilities serving all other Group R occupancies shall comply with Section C405.14 of the International Energy Conservation Code – Commercial Provisions.

Attached Files

- **NESCAUM_Public Comment on Proposal G66-21-FROMMER-4_vFinal (002).pdf**
  http://localhost/proposal/452/811/files/download/162/
- **EV Ready Reason Statement 2021.pdf**

http://localhost/proposal/452/811/files/download/161/
- **AmerLungAssn -AZ_AQ-SURVEY_MEMO.pdf**
  http://localhost/proposal/452/811/files/download/160/

Reason Statement:

Preparing our residential buildings for safe and convenient EV charging infrastructure is critical to deployment of electric vehicles. The transportation sector is the single largest source of GHG emissions in the nation. Near complete electrification of the transportation sector is necessary to achieve the GHG emission reductions needed to avoid the worst effects of climate change.

Electric vehicle sales increased by 80 percent from 2017 to 2018, and is expected to grow from 1 million vehicles at the end of 2018 to 18.7 million by 2030. As newer EVs with longer drive ranges enter the market, the older, shorter drive range EVs will move to the used vehicle market, and become readily accessible to a secondary market for which the accessibility of EV charging infrastructure at home and at work will be critical.

Inclusion in the IECC of EV Infrastructure requirements is critical in the prevention of the use of extension cords to inappropriate outlets for the purpose of vehicle charging. We must be building residential structures that will address the vehicles that the major automakers have already shown us they are producing, especially as they close out the production of ICE vehicles and switch to total EV manufacturing.

Not including EV infrastructure during the initial build is forcing consumers to pay a significantly higher cost to retrofit their homes at a later date. Multi-family and apartments may not even allow that, or may have unresolvable barriers that result in this consumer not even having the choice to drive an EV. Without these requirements in the code we will be forcing significant costs onto the resident that could have been avoided by including EV infrastructure during the original construction phase.

Buildings built in 2022 should last 50 years. By 2045 Ernst & Young predicts internal combustion engine (ICE) vehicles will make up less than 1% of new car sales globally. Bloomberg reports that the automakers' capital expenditures on capital equipment for electric vehicle manufacturing is important because it is the culmination of a manufacturer's multi-year exploration of the future; "Capex is Destiny." *

Shouldn't we be building residential structures to accommodate the vehicles that the automakers are telling us they are switching to? Shouldn't we be installing the infrastructure when it is least expensive to install? Shouldn't we be addressing the single largest source of GHG emissions?

*Read more at: https://www.bloombergquint.com/business/automakers-are-investing-billions-of-dollars-in-evs
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Cost Impact:

The code change proposal will increase the cost of construction.

Research by NBI and partners indicate that the cost of adding a dedicated branch circuit to parking in a single-family home to create an EV Ready space would come to $49 in materials – for 2-pole breaker, wiring, junction box and receptacle – and $65 in labor – ½ hour for an electrician already on-site during new construction – for a total incremental cost of $114.

Retrofit costs are highly variable, and can range from $400-1700 (not including the cost of the charger itself) according to homeguide.com.

Neither of these costs include the cost of panel upgrades. Upsizing during new construction incurs minimal costs. All of the costs of a panel upgrade during new construction (panel, connection fees, potential wiring upgrades) are also part of the retrofit cost. If an EV space necessitates a service retrofit, the costs increase substantially with the cost of upgrading to a 200A service, averaging from $1300 to $2500 (also according to homeguide.com).

This change will also allow Illinois residents to purchase an Electric Vehicle which will save them money. According to AAA, an electric vehicle (EV) will save roughly $1,039 per year in total fuel and maintenance costs compared to a comparable gasoline vehicle.

Although Electric Vehicles are often more expensive than gasoline powered vehicles, Bloomberg New Energy Finance on battery costs suggests EVs could reach upfront cost parity with gasoline vehicles by the early-to-mid 2020s.

A small investment during new construction will save homeowners substantial future costs. Given the market trends identified in the reason statement, it is not a question of whether homes will need EV charging infrastructure, but when. Failing to adopt this proposal will be saddling future homeowners with substantially higher costs.

CEPI-146-21 Part II

CEPI-147-21

IECC®: C405.2

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2 Lighting controls.

Lighting systems shall be provided with controls that comply with ~~one of the following.~~

~~1. Lighting controls as specified in~~ Sections C405.2.1 through C405.2.8.

~~2.~~ ~~Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:~~

- ~~2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.~~
- ~~2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.~~
- ~~2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.~~

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency egress lighting that is normally off.

Reason Statement:

The language that we propose to delete is completely unnecessary and does nothing to improve the energy efficiency of buildings. It just causes confusion and increases complexity with no benefit.

- LLLC's, as defined, are allowed by the code without this language. There is no regulatory hurdle that needs to be overcome for these products to be more widely used in the marketplace.
- There is no requirement in this proposal for LLLC's to be used. When this language was introduced in IECC 2018, it did not add a new requirement, or modify an existing requirement, so why is it in the code?
- This language does not provide clarification on the controls requirements in the code. It does the opposite -- it makes the code more complicated and confusing.

LLLC is not a term that is in widespread use in the lighting industry, and there is no clear definition or rating or qualification for what an LLLC would be. Under these circumstances it would be easier for these systems to comply with the code without this language rather than getting into a debate over whether a particular manufacturer's system (which may be called an LLLC by the manufacturer, and which may be considered an LLLC by DLC or some other trade group) actually meets the requirement for being an LLLC as defined in the IECC.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal removes unnecessary language and does not modify a code requirement

CEPI-147-21

CEPI-148-21

IECC®: C405.2

Proponents:

Jack Bailey, representing International Association of Lighting Designers (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2 Lighting controls.

Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:
   - 2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
   - 2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.
   - 2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency ~~egress~~ lighting that is normally off.
4. Emergency lighting required by the *International Building Code* in exit access components which are not provided with fire alarm systems.
5. Up to 0.02 watts per square foot (0.06 W/m^2)of lighting in exit access components which are provided with fire alarm systems.

Reason Statement:

A lot of energy is wasted in buildings by operating emergency lights as 24-hour "night lights" when buildings are unoccupied. There are a variety of reasons why this is done, but the most important is to prevent shared exit access components from being completely dark when spaces they serve may be occupied. A good example of this is an elevator lobby in a multi-story, multi-tenant building, where it may be desired to keep a light burning at all times so that the elevator lobby will never be completely dark when an elevator arrives at the floor.

Over the years, the lighting industry has developed a convention of leaving emergency lights operating continuously in commercial buildings, even though this is not currently permitted by the IECC. This proposal would call attention to the fact that this practice is not currently permitted by code, by adding exceptions allowing more limited night lighting than is common practice today.

But in doing this, we need to make sure that we are not creating unsafe conditions or violating requirements of the IBC/IFC, specifically the requirement that egress lighting be maintained in exit access components while the spaces they serve are occupied. This implies that occupant sensors could not be used to control minimum egress lighting in exit access components, and in fact it would be unsafe to use occupant sensors alone to turn off egress lighting in common exit access components since occupant sensors are not tested in smoke.

The solution for this is to provide a tie-in to fire alarm system, so that egress lighting can be automatically turned on when the premises fire alarm system is activated, ensuring that egress lighting is present during an emergency. This proposal therefore establishes a separate set of requirements for buildings provided with fire alarm systems, compared to those not provided with fire alarm systems.

The 0.02 watt/sf number is copied from other codes, and this is likely to be sufficient for emergency lighting that complies with the IBC, but not sufficient for egress lighting that complies with the IBC.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

One the one hand, this proposal creates exceptions which don't currently exist in the code, so that compliance with the code will be easier and less expensive.

On the other hand, this limits the use of 24 hour night lighting in buildings, which will create additional costs for the vast majority of projects which are not currently complying with code.

CEPI-148-21

CEPI-149-21

IECC®: C405.2

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2 Lighting controls.

Lighting systems shall be provided with controls that comply with ~~one of the following~~.

~~1. Lighting controls as specified in~~ Sections C405.2.1 through C405.2.8.

~~2.~~ ~~Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:~~

- ~~2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.~~
- ~~2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.~~
- ~~2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.~~

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.

2. Interior exit stairways, interior exit ramps and exit passageways.

3. Emergency egress lighting that is normally off.

4, Spaces were all the lighting are controlled with luminaire level lighting controls (LLLCs). Each luminaire is independently controlled such that they:

- 4.1. Brighten or dim (OFF complies) lighting when spaces are occupied or unoccupied during operating hours
- 4.2. Turn OFF lighting automatically during non-operating hours.
- 4.3. Brighten or dim lighting based on daylight to maintain desired light level.
- 4.4. Are capable of reconfiguration of performance parameters including bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.
- 4.5. Are controlled with a manual control complying with section C405.2.6.

Reason Statement:

Clarity. Want to ensure that LLLCs can still provide an alternate compliance option to the mandatory lighting control requirements provided that all the lighting in a space must use LLLCs in order to comply. It's not clear in the existing language how many LLLCs are needed to comply. This proposal clarifies this by requiring all lighting in the space to be LLLCs in order for the space meet the lighting control requirements.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposal is editorial to provide clarity on the how projects can use LLLCs to comply with the mandatory lighting control requirements.

CEPI-149-21

CEPI-150-21

IECC®: C405.2

Proponents:

Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2 Lighting controls.

Lighting systems <u>powered through the energy service for the building</u> shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:
   - 2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
   - 2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.
   - 2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency egress lighting that is normally off.

Reason Statement:

The code is clear in C405.5.1 that the scope of exterior lighting power requirements is "all lighting that is powered through the energy service for the building". But the code is not clear about the scope of exterior lighting controls requirements. This proposal will clarify the scope of exterior lighting controls.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Mot users assume that the scope of lighting controls requirements matches the scope of lighting power requirements, so this proposal will not be likely to change the scope of the code in practice.

CEPI-150-21

CEPI-151-21

IECC®: C405.2, C405.2.1.3, C405.2.7 (New), C405.2.7.1 (New), C405.2.7.2 (New), C405.7.3 (New), C406.4

Proponents:

Mike Kennedy, Mike D. Kennedy Inc., representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

C405.2 Lighting controls.

Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections~~s~~ C405.2.7.1.~~C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:~~

   ~~2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.~~

   ~~2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.~~

   ~~2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.~~

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency egress lighting that is normally off.

C405.2.1.3 Occupant sensor control function in open plan office areas.

Occupant sensor controls in open plan office spaces less than 300 square feet (28 m^2) in area shall comply with Section C405.2.1.1. Occupant sensor controls in all other open plan office spaces shall comply with all of the following:

1. The controls shall be configured so that general lighting can be controlled separately in control zones with floor areas not greater than 600 square feet (55 m^2) within the open plan office space.
2. General lighting in each control zone shall be permitted to automatically turn on upon occupancy within the control zone. General lighting in other unoccupied zones within the open plan office space shall be permitted to turn on to not more than 20 percent of full power or remain unaffected.
3. The controls shall automatically turn off general lighting in all control zones within 20 minutes after all occupants have left the open plan office space.

3. **Exception:** Where general lighting is turned off by time-switch control complying with Section C405.2.2.1.

4. General lighting in each control zone shall turn off or uniformly reduce lighting power to an unoccupied setpoint of not more than 20 percent of full power within 20 minutes after all occupants have left the control zone.

5. Lighting controls in open plan office are required to be LLLC controls complying with C405.2.7.1.

Add new text as follows:

C405.2.7 Advanced Lighting Controls.

Where required, luminaire level lighting controls (LLLC) and enhanced or network lighting controls shall comply with the requirements in this section.

C405.2.7.1 Luminaire level lighting controls.

Where luminaire level lighting controls are required, they shall be configured to provide the controls or equivalent control function as specified in Sections C405.2.1, C405.2.3, C405.2.4.1, C405.2.5, C405.2.6, and C405.2.7. In addition, each LLLC luminaire shall be independently configured to:

1. Provide for continuous full range dimming.
2. Monitor occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
3. Monitor ambient light, both electric and daylight, and brighten or dim electric light to maintain desired light level. A maximum of 8 fixtures are permitted to be controlled together to maintain uniform light levels within a single daylight zone.
4. Allow configuration and re-configuration of performance parameters for each control strategy including: high trim and low trim set points, timeouts, dimming fade rates, sensor sensitivity adjustments.
5. Construction documents shall include a submittal of a Sequence of Operations including a specification outlining each of the functions required by this section
6. Luminaires shall be configured with High End Trim in accordance with C405.2.7.3

C405.2.7.2 Networked lighting control (NLC).

Where NLC are required they shall be configured to provide controls and minimum function as specified in Section C405.2. In addition, each NLC luminaire shall be independently configured to:

1. Provide for continuous full range dimming.
2. Each luminaire shall be individually addressed.

   Exceptions:

   1. Multiple luminaires mounted on no more than 12 linear feet (3.7 m) of a single lighting track and addressed as a single luminaire.
   2. Multiple linear luminaires that are ganged together to create the appearance of a single longer fixture and addressed as a single luminaire, where the total length of the combined luminaires is not more than 12 feet (3.7 m).
3. Monitor occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
4. Monitor ambient light, both electric and daylight, and brighten or dim electric light to maintain desired light level. A maximum of 8 fixtures are permitted to be controlled together to maintain uniform light levels within a single daylight zone.

5. Allow configuration and re-configuration of performance parameters for each control strategy including: high trim and low trim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustment, zoning configuration.

6. Allow for demand response load shed.

7. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.

8. Luminaires shall be configured with High End Trim in accordance with C405.2.7.3.

<u>C405.7.3</u> <u>High-end trim</u>.

<u>Luminaires subject to high end trim shall be initially configured with the following:</u>

1. Programmed to limit the initial maximum lumen output or maximum lighting power to 85 percent or less of full light output or full power from full output or to meet the target light level documented in project Sequence of Operations using the least amount of power.
2. High end trim power levels are allowed to automatically reset to accommodate lumen maintenance.
3. High end trim controls shall be accessible only to authorized personnel.

Revise as follows:

C406.4 Enhanced digital lighting controls.

Interior general lighting in the building shall have ~~the following~~ enhanced lighting controls<u> complying with Section C405.2.7.2.</u>~~that shall be located, scheduled and operated in accordance with Sections C405.2.1 through C405.2.3.~~

~~1. Luminaires shall be configured for continuous dimming.~~

~~2. Luminaires shall be addressed individually. Where individual addressability is not available for the luminaire class type, a controlled group of not more than four luminaries shall be allowed.~~

~~3. Not more than eight luminaires shall be controlled together in a *daylight zone*.~~

~~4. Fixtures shall be controlled through a digital control system that includes the following function:~~

~~4.1. Control reconfiguration based on digital addressability.~~

~~4.2. Load shedding.~~

~~4.3. Occupancy sensors shall be capable of being reconfigured through the digital control system.~~

~~5. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions in Item 4.~~

~~6. Functional testing of lighting controls shall comply with Section C408.~~

Reason Statement:

This proposal restructures the luminaire level lighting control (LLLC) and C406 enhanced lighting control language, modifies the LLLC requirements, adds a high-end trim requirement for LLLC and enhanced controls, and proposes to require LLLC luminaires for general lighting in open offices areas over 5,000 square feet. The goal is to clarify language and increase energy savings.

The proposal moves the C402.2 luminaire level lighting control (LLLC) functional requirements and C406.4 enhanced lighting functional requirements to a new section. The C402.2 LLLC control alternate and C406.4 language requirement now point to this new section. This arrangement is more congruous with the format of the sections where these requirements currently reside. The LLLC control requirements are clarified so that it is clear that LLLC controls must implement all code required control functions.

The proposal adds high-end trim requirements to both LLLC and enhanced lighting control. New luminaires deliver excess light in anticipation of lumen depreciation and other factors. High-end trim involves the adjustment of the maximum light output fixture so that the delivered light meets design specifications much like test and balance in fan systems. A study by NEEA, Energy Savings from Networked Lighting Control systems With and Without Luminaire Level Lighting Controls - October 2, 2020, found high-end trim savings of 27% for LLLC and network lighting controls across a study of 194 buildings (Table 2).

Lastly, the proposal adds a requirement to have LLLC for the general lighting in open office spaces larger than 5,000 square feet. A study by NEEA, Energy Savings from Networked Lighting Control systems With and Without Luminaire Level Lighting Controls - October 2, 2020, found LLLC savings of 25% across a study of 194 buildings (Table 2). Savings derived from the finer control resolution afforded by LLLC and possibly the greater usability of the controls. Note that these savings are not over the current 2021 IECC open office control requirements. Savings will be less but still should be significant.

Proposal is drawn from the Washington State Energy Code and the Seattle energy code which have adopted similar language.

Bibliography:

2020 Luminaire Level Lighting Controls Incremental Cost Study. Page 18. January 7, 2021. Northwest Energy Efficiency Alliance. Available at: https://neea.org/resources/2020-luminaire-level-lighting-controls-incremental-cost-study

Energy Savings from Networked Lighting Control systems With and Without Luminaire Level Lighting Controls. October 2, 2020. Northwest Energy Efficiency Alliance. Portland OR. Available at: https://neea.org/resources/energy-savings-from-networked-lighting-control-systems-with-and-without-luminaire-level-lighting-controls

Adjusting lighting levels in commercial buildings: Energy savings from institutional tuning. 2015. Minnesota Department of Commerce, Division of Energy Resources. MN. Available at: http://mn.gov/commerce-stat/pdfs/card-report-lighting-levels-commercial.pdf

Cost Impact:

The code change proposal will increase the cost of construction.

Task tuning is estimated to coast $0.03/sf to $0.06/sf by the Minnesota Dept. of Commerce. Assuming 80 square feet per fixture, task tuning costs $4.80 per fixture.

The Northwest Energy Efficiency Alliance found an incremental LLLC fixture cost of $29 (2020 Luminaire Level Lighting Controls Incremental Cost Study, page 18). This cost was over a code baseline control that did not include the current IECC requirement for open office to have OS control of all general lighting with zones no larger than 600 square feet. The discussion indicates only 2 occupancy sensors are required (2020 Luminaire Level Lighting Controls Incremental Cost Study, page 16). If the base line control is double to account for 4 sensors and optionally additional time wiring and configuring the baseline cost increases by $200 (controls only) to $500 (controls and labor) which would reduce the incremental cost by $8 to as much as $20 per fixture. This results in an incremental cost for LLLC fixtures of $9 to $21.

CEPI-151-21

CEPI-152-21

IECC®: C405.2, C405.2.2

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2 Lighting controls.

Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:
   - 2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
   - 2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.
   - 2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

1. ~~Areas designated as security or emergency areas that are required to be continuously lighted.~~ Spaces where an automatic shutoff could endanger occupant safety or security
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency egress lighting that is normally off.

C405.2.2 Time-switch controls.
Each area of the building that is not provided with *occupant sensor controls* complying with Section C405.2.1.1 shall be provided with *time-switch controls* complying with Section C405.2.2.1.

Exceptions:

1. Luminaires that are required to have specific application controls in accordance with Section C405.2.4.
2. Spaces where patient care is directly provided.
3. ~~Spaces where an automatic shutoff would endanger occupant safety or security.~~
4. ~~Lighting intended for continuous operation.~~

~~5. Shop and laboratory classrooms.~~

Reason Statement:

The “safety” exception in C405.2 is quite important. If written too narrowly, it can compromise safety. But if written too broadly, it can become a loophole that creates unnecessary exceptions from the lighting controls requirements in the code. Let’s examine the current language.

Areas “designated as security or emergency areas”. Designated by whom? Such designations are shown on floor plans? Is this meant to be limited to 911 call centers and prisons? Or is this meant to include bank branches and fire stations?Refuge areas? Muster points?

“That are required to be continuously lighted”. Required by whom? What jurisdiction requires that lights operate continuously in buildings that are unoccupied? Jurisdictional lighting requirements are common – for bank ATM areas,Hospitals, swimming pools, kitchens, parking lots, etc. as well as for egress lighting required by IBC. But these requirements are almost always limited in duration – either while the space or building is occupied, while a certain activity is occurring, or after dark for exterior areas. There is almost never a requirement that lights operate continuously. So if this “requirement” that the space be continuously lighted does not come from the jurisdiction, does it come from the building owner?

It is also possible that the current exception does not cover all spaces where lighting controls could endanger occupants. For example, dangerous work is performed in some (but not all) laboratories and workshops.

The proposed language, “Spaces where an automatic shutoff would endanger occupant safety or security” is already an exception from the time-switch controls requirements in section C405.2.2, and it makes sense to apply this language more broadly as the exception from occupant sensor and daylight responsive controls requirements as well.

An “automatic shutoff” could be planned or unplanned, and could be the result of a malfunctioning control system (e.g. occupant sensors shut off lights in an occupied space).

“Would” endanger is strong language. There is no guarantee that any shutoff would endanger occupants, but this is better than the permissive language alternates "could", "may" etc.

And finally, it is the “occupants” who would need to be endangered. We are not using this as an excuse to leave lights burning continuously for “security” lighting to secure an empty room. In the 21st century we have better ways to secure spaces than leaving the lights on all the time and having a guard walk by occasionally to look in.

Once we have made this change in C405.2 then we can eliminate some additional exceptions in C405.2.2.

- “Lighting intended for continuous operation” has always been problematic. “Intended” by whom? Since it is quite rare for an authority to have such a requirement, this is usually interpreted to mean that a building owner “requires” (i.e.“wants”) the lighting to be operated continuously. If an authority has such a requirement, then that requirement would supercede this code (per C101.3). But even if this is an owner “requirement” at the time the space is built, requirements change over time. A store which is intended to be 24-hour operation may well change to 18-hour operation during an economic downturn, or close and be re-opened by someone else who runs a 12-hour operation.

- “Shop and laboratory classrooms” – if there is a safety concern then the proposed Exception 1 to C405.2 would provide an exemption. It should be noted, however, that in practice many spaces of this type are currently provided with occupant sensors.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is a clarification and simplification that does not change code requirements

CEPI-152-21

CEPI-153-21

IECC®: C405.2.1.1

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2.1.1 Occupant sensor control function.

Occupant sensor controls in warehouses shall comply with Section C405.2.1.2. Occupant sensor controls in open plan office areas shall comply with Section C405.2.1.3. Occupant sensor controls in corridors shall comply with Section C405.2.1.4. Occupant sensor controls for all other spaces specified in Section C405.2.1 shall comply with the following:

1. They shall automatically turn off lights within 20 minutes after all occupants have left the space.
2. They shall be manual on ~~or controlled to automatically turn on the lighting to not more than 50-percent power.~~
3. They shall incorporate a manual control to allow occupants to turn off lights.

Exception: Full automatic-on controls with no manual control shall be permitted in corridors, interior parking areas, stairways, restrooms, locker rooms, lobbies, library stacks and areas where manual operation would endanger occupant safety or security.

Reason Statement:

Auto-on to 50% is not necessary, and if implemented and only leads to energy waste and more complicated and expensive control systems.

Cost Impact:

The code change proposal will decrease the cost of construction.

This simplification removes an unnecessary option that requires more complicated controls. Because of this, it *could* decrease the cost of construction.

CEPI-153-21

CEPI-154-21

IECC®: C405.2.3

Proponents:

Harold Jepsen, representing Legrand (harold.jepsen@legrand.us)

2021 International Energy Conservation Code

Revise as follows:
C405.2.3 Light-reduction controls.
Where not provided with occupant sensor controls complying with Section C405.2.1.1, general lighting shall be provided with light-reduction controls complying with Section C405.2.3.1.

Exceptions:

~~1. Luminaires controlled by daylight responsive controls complying with Section C405.2.4.~~

1~~2~~. Luminaires controlled by special application controls complying with Section C405.2.5.

Where provided with manual control, the following areas are not required to have light-reduction control:

2.1.~~3.1.~~ Spaces that have only one luminaire with a rated power of less than 60 watts.

2~~3~~.

2.2 ~~3.2.~~ Spaces that use less than 0.45 watts per square foot (4.9 W/m^2).

2.3.~~3.3.~~ Corridors, lobbies, electrical rooms and/or mechanical rooms.

Reason Statement:

This exception for daylight responsive controls is a hold over from the florescent lighting era. During that time, it was difficult and costly to have lighting controls properly coordinate both manual light reduction control devices with daylight responsive controls (manual or automatic). With the prevalence of LED light source and driver dimming capability as the default commercial lighting technology today, this exception no longer serves its intended purpose from when it was introduced into the code in 2012.

Removal of this exception aligns today's design practice and lighting controls that already coordinate the operation of light reduction control with daylight responsive controls. By removing the exception it further acknowledges the ability of users to have light reduction control across the entire space, inclusive of the daylight responsive zones. This makes far better design sense and promotes further energy efficiency when the user preference is to adjust space lighting down below the daylight responsive control setpoint.

There is no cost adder to construction since LED lighting is already controllable and the controls used for daylight responsive continuous dimming control in C405.2.4, already provide manual light reduction control dimming capability.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

As presented in the reason statement, today's LED lighting technology dimmability and accompanying controls already provide this capability at not added cost.

CEPI-154-21

CEPI-155-21

IECC®: C405.2.3, C405.2.4 (New), C405.2.4.1 (New)

Proponents:

Megan Hayes, representing NEMA (Megan.Hayes@nema.org)

2021 International Energy Conservation Code

Revise as follows:
C405.2.3 Light-reduction controls.
Where not provided with occupant sensor controls complying with Section C405.2.1.1, general lighting shall be provided with light-reduction controls complying with Section C405.2.3.1.

Exceptions:

1. Luminaires controlled by multi-level controls complying with Section C405.2.4.2.

~~1~~2. Luminaires controlled by daylight responsive controls complying with Section ~~C405.2.1~~ C405.2.5.

~~2~~3. Luminaires controlled by special application controls complying with Section C405.2.~~5~~ 6.

Where provided with manual control, the following areas are not required to have light-reduction control:

~~3.1~~4.1. Spaces that have only one luminaire with a rated power of less than 60 watts.

~~3~~4.

~~3.2~~4.2. Spaces that use less than 0.45 watts per square foot (4.9 W/m²).

~~3.3~~4.3. Corridors, lobbies, electrical rooms and/or mechanical rooms.

Add new text as follows:
C405.2.4 Multi-level controls.
General lighting shall be provided with multi-level controls complying with Section C405.2.4

1. Classroom/lecture hall/training room
2. Computer room
3. Conference/meeting/multipurpose room
4. Dining area in bar/lounge, leisure or family dining.
5. Guestroom
6. Lounge/breakroom
7. Enclosed office
8. Dormitory-living quarters
9. Fire Station - sleeping quarters
10. Healthcare facility - imaging room, nursery, nurses' station, patient room
11. Museum general exhibition area

C405.2.4.1 Multi-level control function.

Luminaires in spaces required to have multi-level controls shall have a manual control that dims lighting continuously from full power to 10 percent of full power or lower in a uniform illumination pattern.

Reason Statement:

This proposal introduces multi-level continuous dimming control of lighting in specific spaces giving users more lighting controllability and greater energy efficiency. This only applies to the general lighting and is only applied to specific spaces types where multi-level control makes application sense for usability and energy savings.

This proposal will:

- Increase energy efficiency

- Improve user ability to operate lighting

- Simplify applying light reduction control in specific spaces

- Increase cost effectiveness over switching two-level lighting control- Rely on ubiquitously available dimming technology for controllability and efficiency

Traditionally, dimming of lighting in commercial buildings was difficult and expensive due to the challenge of controlling pre-LED light sources. Today, LED lighting is easily dimmable and is a standard capability in most luminaires and drivers without additional cost. This proposal utilizes this capability for user convenience and energy savings.

Many lighting designs and installations already use continuous dimming due to its flexibility, installation simplicity, cost effectiveness and user preference for controllability. In many applications, multi-level dimming control has become a more cost-effective approach for spaces not required to use occupancy sensor shut off control, to comply with the existing C405.2.3 Light-reduction control requirement. The cost of multi-level dimming control is less than the added line voltage wiring, control relay and manual control that meets the current Light-reduction control requirement of C405.2.3. This proposal makes this cost-effective change for the following spaces:

- Computer room

- Dining areas

- Guestroom

- Dormitory

- Fire Station

- Healthcare facility – imaging room, nursery, nurses' station, patient room

- Museum general exhibition area

Spaces which require occupancy sensor shut-off control are not required to meet the current light-reduction control requirement, but achieve energy savings cost effectiveness through the existing capability of luminaires to dim, and the controllability of lighting power being reduced by the space users. This applies to the following spaces:

- Classroom/lecture hall/training room

- Conference/meeting/multipurpose room

- Lounge/breakroom

- Enclosed office

Listed studies support that users regularly reduce the lighting in their space to achieve visual comfort or to support specific visual tasks. This additionally saves energy. Since lighting is typically designed with lighting loss factors and some degree of overlighting due to equipment sizing break points and inaccuracies in photometric calculations, providing multi-level dimming encourages lighting level “task tuning” of the space. In the CASE report “Requirements for Controllable Lighting…” it was estimated that task tuning would save 15% of lighting power over the life of the lighting installation.

Multi-level dimming control is widely accepted and has been part of California’s Title 24 standard since 2013 in all spaces over 100 square feet using LED lighting, highlighting its adoptability and experience in energy efficiency standards.

We highly recommend the committee accept and adopt what is already cost effective and well established in the lighting design industry to achieve further energy efficiency savings within the IECC.

Bibliography:

Doug Avery, et al. (March 21, 2011) Requirements for Controllable Lighting: California Building Energy Efficiency standards.

Galasiu AD, et al. (2007) Energy saving lighting control systems for open-plan offices: A field study. Leukos. 4(1) pg 7–29

Janne Viitanen, Jorma Lehtovaara, Eino Tetri D.Sc & Liisa Halonen D.Sc (2013) User Preferences in Office Lighting: A Case Study Comparing LED and T5 Lighting, LEUKOS, 9:4, 261-290, DOI: 10.1582/LEUKOS.2013.09.04.003

Cost Impact:

The code change proposal will increase the cost of construction.

The dimmability of SSL sources and drivers, allows building occupants to set lower lighting levels at their discretion. Multi-level control requirement increases energy efficiency by adding continuous dimming to many common spaces and delivers greater usability by occupants.

CEPI-155-21

CEPI-156-21

IECC®: C405.2.3, C405.2.3.1

Proponents:

Jack Bailey, representing International Association of Lighting Designers (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:

C405.2.3 ~~Light-reduction controls~~ Dimming controls..

~~Where not provided with occupant sensor controls complying with Section C405.2.1.1, general lighting shall be provided with light-reduction controls complying with Section C405.2.3.1~~. Dimming controls complying with Section C405.2.3.1 are required for the following space types:

1. Classroom / lecture hall / training room.
2. Conference / multipurpose / meeting room.
3. Dining area.
4. Laboratory.
5. Lobby.
6. Lounge / Break Room.
7. Offices.
8. Gymnasium / fitness center.
9. Library reading room.
10. Spaces not provided with occupant sensor controls complying with Section C405.2.1.1.

Exceptions:

1. Luminaires controlled by daylight responsive controls complying with Section C405.2.4.

2. Luminaires controlled by special application controls complying with Section C405.2.5.

~~3.~~ ~~Where provided with manual control, the following areas are not required to have light-reduction control:~~

~~3.1. Spaces that have only one luminaire with a rated power of less than 60 watts.~~

~~3.2. Spaces that use less than 0.45 watts per square foot (4.9 W/m²).~~

~~3.3. Corridors, lobbies, electrical rooms and/or mechanical rooms.~~

C405.2.3.1 ~~Light-reduction~~ Dimming control function.

Spaces required to have ~~light-reduction controls shall have a *manual control* that allows the occupant to reduce the connected lighting load by not less than 50 percent in a reasonably uniform illumination pattern with an intermediate step in addition to full on or off, or with continuous dimming control, using one of the following or another *approved* method~~ dimming control shall be provided with controls that allow lights to be dimmed from full output to less than 20 percent of full power with continuous dimming, as well as turning lights off. Manual control shall be provided within each room to dim lights.

Exception: Manual control is not required where lights are controlled by a programmable dimming system which allows lights to be set to one or more pre-programmed (dimmed) levels.

~~1. Continuous dimming of all luminaires from full output to less than 20 percent of full power.~~

~~2. Switching all luminaires to a reduced output of not less than 30 percent and not more than 70 percent of full power.~~

~~3. Switching alternate luminaires or alternate rows of luminaires to achieve a reduced output of not less than 30 percent and not more than 70 percent of full power.~~

Reason Statement:

1. Dimming lights saves energy, whether is done through dimmer switches that are accessible to users, or through central "task tuning" systems. California T24 has required dimming of most lights in commercial buildings for years.

2. Almost all LED luminaires sold today are inherently dimmable at no additional cost. The daylight responsive controls section of the code already requires diming for lights in daylight zones, so this is not new, unfamiliar, or controversial.

3. Realistically in 2025 no one will be switching alternate rows of luminaires or lamps because it will be less expensive to dim the lights. It is probably less expensive to dim lights today.

From an editorial standpoint this proposal streamlines a very clunky section of the code.

From an energy efficiency standpoint, this is one of the only remaining lighting controls strategies which can save meaningful amounts of energy.

From a practical standpoint, this is proven technology which is familiar to almost all designers, builders, and owners.

Cost Impact:

The code change proposal will increase the cost of construction.

The changes in Section C405.2.3.1 will not increase the cost of construction.

The additional scope in Section C405.2.3 (items 1 through 9) will expand the scope of dimming controls and will therefore increase the cost of construction.

CEPI-156-21

CEPI-157-21

IECC®: C405.2.3, C405.2.3.1

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2.3 Light-reduction controls.
~~Where not provided with occupant sensor controls complying with Section C405.2.1.1, g~~General lighting shall be provided with light-reduction controls complying with Section C405.2.3.1.

Exceptions:

1. Luminaires controlled by daylight responsive controls complying with Section C405.2.4.
2. Luminaires controlled by special application controls complying with Section C405.2.5.
3. Where provided with manual control, the following areas are not required to have light-reduction control:
   3.1. Spaces that have only one luminaire with a rated power of less than 60 watts.
   3.2. Spaces that use less than 0.45 watts per square foot (4.9 W/m²).
   3.3. Corridors, lobbies, electrical rooms and/or mechanical rooms.

C405.2.3.1 Light-reduction control function.

Spaces required to have light-reduction controls shall have a *manual control* that allows the occupant to reduce the connected lighting load by not less than 50 percent in a reasonably uniform illumination pattern with an intermediate step in addition to full on or off, or with continuous dimming control, using one of the following or another *approved* method:

1. Continuous dimming of all luminaires from full output to less than ~~20~~10 percent of full power.
2. Switching all luminaires to a reduced output of not less than 30 percent and not more than 70 percent of full power.
3. Switching alternate luminaires or alternate rows of luminaires to achieve a reduced output of not less than 30 percent and not more than 70 percent of full power.

Reason Statement:

The proposal removes the occupancy sensor loophole from light reduction control. Automatic shutoff whether using occupancy sensors or timeclock should not affect whether light reduction controls are needed. Both automatic lighting shutoff and lighting reduction controls should be required. Lighting can go off automatically when no occupants are present. However, while occupants are present giving them the ability to select lighting level in addition to ON and OFF increases energy savings in addition to occupant comfort and productivity (see the Light Right Consortium study).

This is will bring IECC at par with CA Title 24 and 90.1 which do not have an exception to their light reduction control requirement for spaces that use occupancy sensors.

Lastly, changing the continuous dimming threshold down to 10% as a lamp that is dimmed to 20% of its maximum measured light output is perceived as being dimmed to only 45% per the Square Law of Dimming (IESNA Lighting Handbook, 9th Edition, (New York; IESNA, 2000), 27-4). The human eye responds to low light levels by enlarging the pupil, allowing more light to enter the eye. This response results in a difference between measured and perceived light levels. A lamp dimmed to 10% of its measured light output is perceived by the human eye as being dimmed to 32% of maximum output.

Bibliography:

https://www.lutron.com/TechnicalDocumentLibrary/Measured_vs_Perceived.pdf

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal may slightly increase the cost of construction. It may require additional wall controls for the lighting (switches, dimmers, or scene controls) in some spaces.

CEPI-157-21

CEPI-158-21

IECC®: C405.2.3.1

Proponents:

Harold Jepsen, representing Legrand (harold.jepsen@legrand.us)

2021 International Energy Conservation Code

Revise as follows:
C405.2.3.1 Light-reduction control function.

Spaces required to have light-reduction controls shall have a *manual control* that allows the occupant to reduce the connected lighting load ~~by not less than 50 percent~~ in a reasonably uniform illumination pattern ~~with an intermediate step in addition to full on or off, or with continuous dimming control,~~ using one of the following or another *approved* method:

1. Continuous dimming of all luminaires from full output to less than 20 percent of full power.
2. Switching all luminaires to a reduced output of not less than 30 percent and not more than 70 percent of full power.
3. Switching alternate luminaires or alternate rows of luminaires to achieve a reduced output of not less than 30 percent and not more than 70 percent of full power.

Reason Statement:

During the 2021 IECC code cycle, four proposals affecting the light-reduction control section were submitted to provide greater clarity to the language and improved implementation given the transition to LED lighting technologies. Those proposals were CE175, CE179, CE181 and CE183. In order to better coordinate the final language from these proposals, PC1 to CE181-19 was submitted and approved. However, the final published language does not fully reflect the change PC1 made.

Specifically, why would the language in C405.2.3.1 say "shall have a manual control that allows the occupant to reduce the connected lighting load by not less than 50%" and then go on to state "using one of the following or another approved method:"? Three methods are then enumerated which allows either continuous dimming, or switching lighting to reduce lighting between 30-70% of full power. This is confusing and in conflict with the "by not less than 50%" language, which was to be deleted by the approval of PC1 to CE181-19. Further, there is no need to have the language "with an intermediate step in addition to full on or off, or with continuous dimming control" when similarly, these methods are contained in the three enumerated methods which follow.

This proposals is a simple editorial correction from an error in merging the 2021 IECC proposals and PC1 to CE181-19.

CE181-19

IECC®: C405.2.2.2

Proposed Change as Submitted

Proponents: Marilyn Williams, representing National Electrical Manufacturers Association (mar_williams@nema.org)

2018 International Energy Conservation Code

Revise as follows:

C405.2.2.2 Light-reduction controls. Spaces required to have light-reduction controls shall have a *manual control* that allows the occupant to reduce the connected lighting load by not less than 50 percent in a reasonably uniform illumination pattern ~~by not less than 50 percent,~~ with an intermediate step in addition to full on or off, or with continuous dimming control. Lighting reduction shall be achieved by one of the following or another *approved* method:

1. Controlling all lamps or luminaires.
2. Dual switching of alternate rows of luminaires, alternate luminaires or alternate lamps.
3. Switching the middle lamp luminaires independently of the outer lamps.
4. Switching each luminaire or each lamp.

   Exception: Light reduction controls are not required in *daylight zones* with *daylight responsive controls* complying with Section C405.2.3.

Reason: Revising this language will:
1. Increase energy efficiency

2. Reduce inconsistency and confusion with light-reduction control requirements

3. Increase code interpretation, application and enforcement

4. Correct an unintended loophole

The ability to reduce light level either by lighting load on/off switch control or by coninuouse dimming, provides energy savings as well as lighting adjustibility benefits for the occupant. The intent of the provision is to allow space occupants to manually reduce their lighting level by at least 50% of lighting load for personal preference, to avoid glare or simply because full lighting levels is not needed in the space. The light-reduction control requirement has a loophole which allows provision compliance without meeting the intent. Manual lighting controls which turns lighting all the way off, can be interpreted as a reduciton of the lighting load of "not less than 50 percent." The way the language is written, full shut off would comply with the provision, bu would not meet the intent of the code.

The proposed language would indicate light-reduction control is an intermediate step, in addition to lighting full on and full off control steps, typically provided by manual control requirements. This language eliminates the present loop hole allowing no light reduction control, as the code intends just the opposite. The proposed language also clarifies that continuous dimming would comply with the control requirement while providing further adjustibility benefits to the space occupants.

Cost Impact: The code change proposal will not increase or decrease the cost of construction
This is an editorial change to clarify the code's intent. It will improve compliance and consistency for energy efficient control of lighting.

CE181-19

Individual Consideration Agenda

Public Comment JEPSEN-1:

IECC®: C405.2.2.2

Proponents: Harold Jepsen, representing National Electrical Manufacturers Association (harold.jepsen@legrand.us) requests As Modified by Public Comment

2018 International Energy Conservation Code

C405.2.2.2 Light-reduction controls. Spaces required to have light-reduction controls shall have a *manual control* that allows the occupant to reduce the connected lighting load ~~by not less than 50 percent~~ in a reasonably uniform illumination pattern ~~with an intermediate step in addition to full on or off, or with continuous dimming control. Lighting reduction shall be achieved by~~ using one of the following or another *approved* method:

1. ~~Controlling all lamps or luminaires~~ Continuous dimming of all luminaires from full output to less than 20 percent of full power.
2. ~~Dual switching of alternate rows of luminaires, alternate luminaires or alternate lamps~~ Switching all luminaires to a reduced output of not less than 30 percent, and not more than 70 percent of full power.
3. Switching alternate luminaires or alternate rows of luminaires to achieve a reduced output of not less than 30 percent, and not more than 70 percent of full power ~~the middle lamp luminaires independently of the outer lamps~~.
4. ~~Switching each luminaire or each lamp.~~

~~**Exception:** Light reduction controls are not required in *daylight zones* with *daylight responsive controls* complying with Section C405.2.3.~~

Commenter's Reason: This public comment and modification responds to the Committee Action Hearing guidance by coordinating proposals CE179-19 and CE181-19, and resolving the dated lighting control language by accomplishing the following:

- Making the code language technology neutral
- Removing archaic terminology that only applies to fluorescent lighting
- Assuring lighting uniformity when space lighting levels are reduced
- Incorporating the word "dimming", clarifying it as an acceptable Light Reduction Control method(as currently written, unclear to some practitioners)
- Fixing a gap in the code language by clarifying that Light Reduction Control is an intermediate lighting control step between On and Off
- Maintaining light controllability for occupants in spaces with daylight responsive zones
- Creating language that is clear and enforceable by building officials without the burden of a additional requirements. In fact, it reduces the requirements and exceptions that need to be verified.

These modifications make the code understandable to read, clear to implement, up to date with technology and easy to enforce by building officials.

Bibliography:

IECC Public Comment 1 of CE181-19

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is an editorial change correcting an error in the code language and does not impact the cost of construction.

CEPI-158-21

Dining: cafeteria/fast food	~~0.76~~ 0.68
Dining: family	~~0.71~~ 0.64
Dormitory[a, b]	~~0.53~~ 0.51
Exercise center	~~0.72~~ 0.70
Fire station[a]	~~0.56~~ 0.55
Gymnasium	~~0.76~~ 0.73
Health care clinic	~~0.81~~ 0.76
Hospital[a]	~~0.96~~ 0.92
Hotel/Motel[a, b]	~~0.56~~ 0.52
Library	0.83
Manufacturing facility	0.82
Motion picture theater	~~0.44~~ 0.42
Multiple-family[c]	0.45
Museum	0.55
Office	~~0.64~~ 0.61
Parking garage	~~0.18~~ 0.17
Penitentiary	~~0.69~~ 0.65
Performing arts theater	~~0.84~~ 0.81
Police station	~~0.66~~ 0.61
Post office	~~0.65~~ 0.63
Religious building	~~0.67~~ 0.65
Retail	~~0.84~~ 0.77
School/university	~~0.72~~ 0.69
Sports arena	~~0.76~~ 0.70
Town hall	~~0.69~~ 0.66
Transportation	~~0.50~~ 0.54
Warehouse	0.45
Workshop	~~0.91~~ 0.86

For SI: 1 watt per square foot = 10.76 w/m^2.

- a.

  Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

- b.

  Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

- c.

  Dwelling units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	**LPD (watts/ft^2)**
Atrium	
Less than 40 feet in height	~~0.48~~ 0.41
Greater than 40 feet in height	~~0.60~~ 0.51
Audience seating area	
In an auditorium	~~0.61~~ 0.57
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	~~0.67~~ 0.56
In a performing arts theater	~~1.16~~ 1.10
In a religious building	0.72
In a sports arena	~~0.33~~ 0.27
Otherwise	~~0.33~~ 0.23
Banking activity area	~~0.61~~ 0.56
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
Shop Classroom	1.17
In a penitentiary	~~0.89~~ 0.74
Otherwise	~~0.71~~ 0.72
Computer room, data center	~~0.94~~ 0.75
Conference/meeting/multipurpose room	~~0.97~~ 0.88
Copy/print room	~~0.31~~ 0.56
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	~~0.71~~ 0.61
Otherwise	~~0.41~~ 0.44
Courtroom	~~1.20~~ 1.08
Dining area	
In bar/lounge or leisure dining	~~0.86~~ 0.76
In cafeteria or fast food dining	~~0.40~~ 0.36
In a facility for the visually impaired (and not used primarily by the staff)[b]	~~1.27~~ 1.22
In family dining	~~0.60~~ 0.52

COMMON SPACE TYPES[a]	LPD (watts/ft^2)
In a penitentiary	~~0.42~~ 0.35
Otherwise	~~0.43~~ 0.42
Electrical/mechanical room	~~0.43~~ 0.71
Emergency vehicle garage	~~0.52~~ 0.51
Food preparation area	~~1.09~~ 1.19
Guestroom[c, d]	0.41
Laboratory	
In or as a classroom	~~1.11~~ 1.05
Otherwise	~~1.33~~ 1.21
Laundry/washing area	~~0.53~~ 0.51
Loading dock, interior	0.88
Lobby	
For an elevator	~~0.65~~ 0.64
In a facility for the visually impaired (and not used primarily by the staff)[b]	~~1.69~~ 1.44
In a hotel	0.51
In a motion picture theater	~~0.23~~ 0.20
In a performing arts theater	~~1.25~~ 1.21
Otherwise	~~0.84~~ 0.77
Locker room	~~0.52~~ 0.43
Lounge/breakroom	
In a healthcare facility	~~0.42~~ 0.77
Mother's / Wellness Room	0.68
Otherwise	~~0.59~~ 0.55
Office	
~~Enclosed~~ Office less than or equal to 150 ft^2	~~0.74~~ 0.73
Office > 150 ft2 and less than or equal to 300ft^2	0.66
~~Open plan~~ Office > 300 ft^2	~~0.61~~ 0.56
Parking area, daylight transition	1.06
Parking area, interior	~~0.15~~ 0.11
Pharmacy area	~~1.66~~ 1.59
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	~~1.26~~ 0.96
Otherwise	~~0.63~~ 0.56
Sales area	~~1.05~~ 0.85
Seating area, general	~~0.23~~ 0.21

COMMON SPACE TYPES[a]	LPD (watts/ft^2)
Security Areas	
General Security Spaces	0.64
Transportation Screening Queue	0.56
Transportation Screening	0.93
Stairwell	~~0.49~~ 0.47
Storage room	~~0.38~~ 0.35
Vehicular maintenance area	~~0.60~~ 0.59
Workshop	~~1.26~~ 1.17
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft^2)**
Automotive (see Vehicular maintenance area)	
Casino - Gaming Area	
Betting / Sportsbook / Keno / Bingo	0.82
High Limit Game Area	1.68
Slot Machine / Digital Gaming Area	0.54
Table Games Area	1.09
Convention Center—exhibit space	~~0.61~~ 0.50
Dormitory—living quarters[c, d]	~~0.50~~ 0.48
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	~~0.70~~ 0.58
In a recreation room (and not used primarily by the staff)	~~1.77~~ 1.20
Fire Station—sleeping quarters[c]	0.23
Gymnasium/fitness center	
In an exercise area	~~0.90~~ 0.82
In a playing area	~~0.85~~ 0.62
Healthcare facility	
Control Room (MRI / CT / Radiology)	0.78
In an exam/treatment room	~~1.40~~ 1.33
In an imaging room	0.94
In a medical supply room	~~0.62~~ 0.56
In a nursery	~~0.92~~ 0.87
In a nurse's station	~~1.17~~ 1.07
In an operating room	~~2.26~~ 2.31
In a patient room[c]	~~0.68~~ 0.78
In a physical therapy room	~~0.91~~ 0.82
In a recovery room	~~1.25~~ 1.18

COMMON SPACE TYPES[a]	LPD (watts/ft^2)
Telemedicine	1.44
Library	
In a reading area	~~0.96~~ 0.86
In the stacks	1.18
Manufacturing facility	
In a detailed manufacturing area	~~0.80~~ 0.75
In an equipment room	~~0.76~~ 0.73
~~In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)~~	~~1.42~~
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
~~In a low-bay area (less than 25 feet floor-to-ceiling height)~~	~~0.86~~
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	1.36
Museum	
In a general exhibition area	0.31
In a restoration room	~~1.10~~ 1.24
Performing arts theater—dressing room	~~0.41~~ 0.39
Post office—sorting area	~~0.76~~ 0.71
Religious buildings	
In a fellowship hall	~~0.54~~ 0.50
In a worship/pulpit/choir area	~~0.85~~ 0.75
Retail facilities	
In a dressing/fitting room	~~0.51~~ 0.45
Hair Care	0.65
Nail Care	0.75
In a mall concourse	~~0.82~~ 0.57
Massage	0.81
Sports arena—playing area	
For a Class I facility[e]	~~2.94~~ 2.86
For a Class II facility[f]	~~2.01~~ 1.98
For a Class III facility[g]	~~1.30~~ 1.29
For a Class IV facility[h]	0.86
Sports - Natatorium	
Class I facility	2.20
Class II facility	1.47
Class III facility	0.99

COMMON SPACE TYPES[a]	LPD (watts/ft^2)
Class IV facility	0.60
Transportation facility	
Airport Hanger	1.36
At a terminal ticket counter	~~0.51~~ 0.40
In a baggage/carousel area	~~0.39~~ 0.28
Passenger Loading Area	0.71
In an airport concourse	~~0.25~~ 0.49
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 w/m^2.

- a.

  In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

- b.

  A 'Facility for the Visually Impaired' is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

- c.

  Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

- d.

  Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

- e.

  Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

- f.

  Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

- g.

Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

- h.

  Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

C405.3.2.1 Building Area Method.

For the Building Area Method, the interior lighting power allowance is calculated as follows:

- 1.

  For each building area type inside the building, determine the applicable building area type and the allowed lighting power density for that type from Table C405.3.2(1). For building area types not listed, select the building area type that most closely represents the use of that area. For the purposes of this method, an "area" shall be defined as all contiguous spaces that accommodate or are associated with a single building area type.

- 2.

  Determine the floor area for each building area type listed in Table C405.3.2(1) and multiply this area by the applicable value from Table C405.3.2(1) to determine the lighting power (watts) for each building area type.

- 3.

  The total interior lighting power allowance (watts) for the entire building is the sum of the lighting power from each building area type.

Reason:

The reason for this proposal is to adjust the lighting power density values to account for an improvement in LED efficacy since the ANSI/ASHRAE/IES Standard 90.1-2019 values were developed.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no cost increase for this proposal. The proposed reduced lighting power density values are based on manufacturer data sheets. Manufacturers have improved the performance of their products and these values are based on their improvements.

More than 150 data sheets from more than 10 lighting manufacturers data sheets were compiled. The 2021 data sheets indicate increased efficacy compared to products from 2018 and 2019. At least 2/3 of the data sheets compared were the same fixture from 2019 and 2021. For most of the directly tracked products, the efficacy of these fixtures had increased in this time. Lighting conditions were modeled for each of the spaces using these 2021 efficacy values and the resultant lighting power density values were these proposed values.

CEPI-160-21

IECC®: SECTION 202 (New), C405.2.3.2 (New), C406.1, C406.13 (New), TABLE C406.1(1), TABLE C406.1(2), TABLE C406.1(3), TABLE C406.1(4), TABLE C406.1(5)

Proponents: Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Add new definition as follows:

HIGH-END TRIM. The process of setting the maximum light output of individual luminaires or groups of luminaires to support visual needs of a *space*, task, or area. *High-end trim* is also known as "institutional tuning".

Add new text as follows:

C405.2.3.2 High-end trim of luminaires. General lighting in spaces that must comply with C405.2.3 light-reduction controls, shall be controlled such that the luminaires have a maximum high-end trim of no greater than 85% of full light output or power. Only authorized personal shall be permitted to access the means of setting the high-end trim limit; and the construction documents shall specify that the maximum light output or maximum power draw set to no greater than 85% of full light output or full power draw.

Exceptions:

1. Projects having a total installed interior lighting power of less than 4,000 watts in spaces that must comply with C404.2.3 light-reduction controls.
2. Spaces where the designed lighting power density is more than 15% lower than the interior lighting power allowance per Table C405.3.2(2) space-by-space method.
3. Buildings where the designed lighting power density is more than 15% lower than the interior lighting power allowance per Table C405.3.2(1) building area method.

Revise as follows:

C406.1 Additional energy efficiency credit requirements. New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.
13. When not required to comply with C405.2.3.2 high-end trim of luminaires, general lighting shall be controlled using high-end trim in accordance with C406.13.

Add new text as follows:

C406.13 High-end trim of luminaires. High-end trimmed luminaires shall comply with all of the following requirements:

1. The lighting controls shall limit the maximum output or maximum power draw of the controlled lighting to 85 percent or less of full light output or full power draw; and
2. The means of setting the limit is accessible only to authorized personnel; and

3. The construction documents specify which lighting systems shall have their maximum light output or maximum power draw set to no greater than 85% of full light output or full power draw.

Revise as follows:

TABLE C406.1(1) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pumpwater heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced air infiltration	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.13 High-end trim of luminaires	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6

NA = Not Applicable.

TABLE C406.1(2) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406.2.2: 5% cooling efficiency improvement	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% cooling efficiency improvement	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3: Reduced lighting power	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C406.4: Enhanced digital lighting controls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: On-site renewable energy	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.2: Recovered or renewable water heating	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Reduced air infiltration	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3
C406.10: Energy monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.11: Fault detection and diagnostics system	1	1	1	1	1	1	NA	1	1	NA	1	1	NA	1	1	1	1
<u>C406.13 High-end trim of luminaires</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>2</u>

NA = Not Applicable.

TABLE C406.1(3) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP E OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	4
C406.2.2: 5% cooling efficiency improvement	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	3	4	3	4	3	4	3	5	7
C406.2.4: 10% cooling efficiency improvement	7	8	7	6	5	4	3	4	3	1	2	2	1	2	2	2	1
C406.3: Reduced lighting power	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
C406.5: On-site renewable energy	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
C406.6: Dedicatedoutdoor air system	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.2: Recoveredor renewable water heating[a]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.7.3: Efficient fossil fuel water heater[a]	NA	1	1	1	1	1	1	2	2	3	2	3	2	3	3	3	5
C406.7.4: Heat pump water heater[a]	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1	1	1	1
C406.8: Enhanced envelope performance	3	7	3	4	2	4	1	1	3	1	2	3	NA	4	3	6	9
C406.9: Reduced air infiltration	1	1	1	2	NA	NA	NA	NA	NA	NA	1	NA	NA	4	1	4	3
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	2	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
C406.13 High-end trim of luminaires	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7

NA = Not Applicable.

a. For schools with showers or full-service kitchens.

TABLE C406.1(4) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP M OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	NA	1	1	2	2	2	2	3	2	3	4
C406.2.2: 5% cooling efficiency improvement	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	4	3	4	5	5	3	6	8
C406.2.4: 10% cooling efficiency improvement	9	12	9	8	6	6	3	4	4	1	2	3	NA	2	2	2	1
C406.3: Reduced lighting power	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12
C406.4: Enhanced digital lighting controls	3	3	4	3	4	3	4	4	4	3	3	3	3	4	4	3	3
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
C406.6: Dedicated outdoor air system	3	4	3	3	3	3	1	3	2	2	2	3	2	4	3	4	4
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pump water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	4	6	3	4	3	3	1	6	4	4	4	5	4	6	5	8	9
C406.9: Reduced air infiltration	1	1	1	2	1	1	NA	3	1	1	3	2	1	7	3	6	3
C406.10: Energy monitoring	4	5	5	5	5	4	4	4	4	3	3	4	3	4	4	4	3
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2
C406.13 High-end trim of luminaires	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12

NA = Not Applicable.

TABLE C406.1(5) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR OTHER[a] OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	3
C406.2.2: 5% cooling efficiency improvement	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	3	3	3	3	4	3	5	5
C406.2.4: 10% cooling efficiency improvement	8	9	8	7	5	5	3	4	4	2	2	3	2	2	2	2	2
C406.3: Reduced lighting power	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	8	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	3	2	5	3	3	5	4	3	7	5	7	6
C406.7.2: Recovered or renewable water heating [b]	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater [b]	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater [b]	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	4	3	4	1	5	4	3	5	5	4	7	6	9	10
C406.9: Reduced air infiltration	3	2	2	4	4	2	NA	6	2	2	6	4	1	10	5	7	4
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	3	2	3	2	2	2	3	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.13 High-end trim of luminaires	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	8	7

NA = Not Applicable.

a. Other occupancy groups include all groups except Groups B, E, I, M and R.

b. For occupancy groups listed in Section C406.7.1.

Reason: High-end trim (also known as institutional tuning) of lighting is a key energy saving measure that should be included in the IECC. Essentially this strategy saves energy by using a lighting control system which is setup to cap the maximum light output lower than the full lighting power for various areas in a building (the proposal conservatively caps it at 85% of full lighting power, however, most projects cap the lighting at 80% or lower). Some spaces or floors can have a high-end trim set to 60% while others can be set to 80% depending the tasks to be performed in the space(s).
The strategy essentially provides energy savings for free. First, LED lighting is well suited for this strategy since LEDs are inherently controllable, adjustable, and dimmable. And most lighting control systems have this capability built in, no additional equipment is needed. Second, light fixtures are usually over lit (too bright) to begin with to account for lumen deprecation overtime of the fixture. So, tuning the fixtures down to begin with helps to compensate for the over-lighting. Lastly, occupants don't even notice the reduced lighting levels as the human eye can't detect the first 20-25% of lights dimming from 100% yet providing a high-end trim of 20% saves about 20% in lighting energy.

The Lawrence Berkeley Lab Meta-Analysis of Energy Savings from Lighting Controls shows an average 38% energy savings from institutional tuning.

This energy efficiency measure has been included as lighting power adjustment factor in CA Title 24 2019, whereby projects can get additional lighting power to use when intuitional tuning is done. ASHRAE 90.1-2022 has added institutional tuning to the energy credits options. So, adding this proposal will better align IECC with what's in Title 24 and 90.1. Additionally, the state of WA is looking at adding high-end trim for their 2021 energy code.

Bibliography: See section D.2.5.2 L02 Lighting Dimming & Tuning. https://www.energycodes.gov/sites/default/files/2021-07/TechBrief_EnergyCredits_July2021.pdf
LBNL Meta Analysis of Energy Savings from Lighting Controls in Commercial Buildings. https://eta-publications.lbl.gov/sites/default/files/a_meta-analysis_of_energy_savings_from_lighting_controls_in_commercial_buildings_lbnl-5095e.pdf

State of WA 2021 energy code with high-end trim: https://sbcc.wa.gov/sites/default/files/2021-07/126etal_TRev_LLLC_124_126_178combo_070921.pdf

Cost Impact: The code change proposal will increase the cost of construction.
This proposal may increase the cost of construction for projects that don't use a lighting control system and LED lighting which is quickly recouped from the 15%+ lighting energy savings year-over-year.
However, most projects will be using easily controllable LED lighting plus a lighting control system which already has high-end trim capability. So for these cases there is no additional equipment needed to comply.

CEPI-161-21

IECC®: C405.2.4

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com); Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2.4 Daylight-responsive controls.

Daylight-responsive controls complying with Section C405.2.4.1 shall be provided to control the general lighting within *daylight zones* in the following spaces:

1. Spaces with a total of more than 150 watts of *gen eral lighting* within primary sidelit daylight zones complying with Section C405.2.4.2.

2. Spaces with a total of more than 300 watts of *general lighting* within sidelit daylight zones complying with Section C405.2.4.2.

3. Spaces with a total of more than 150 watts of *general lighting* within toplit daylight zones complying with Section C405.2.4.3.

Exceptions: Daylight responsive controls are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.

2. Sidelit daylight zones on the first floor above grade in Group A-2 and Group M occupancies.

3. ~~New buildings where the total connected lighting power calculated in accordance with Section C405.3.1 is not greater than the adjusted interior lighting power allowance (*LPA*$_{adj}$) calculated in accordance with Equation 4-9.~~

$$LPA_{adj} = [LPA_{norm} \times (1.0 - 0.4 \times UDZFA / TBFA)]$$

~~(Equation 4-9)~~

~~where:~~

~~*LPA*$_{adj}$ = Adjusted building interior lighting power allowance in watts.~~

~~*LPA*$_{norm}$ = Normal building lighting power allowance in watts calculated in accordance with Section C405.3.2 and reduced in accordance with Section C406.3 where Option 2 of Section C406.1 is used to comply with the requirements of Section C406.~~

~~*UDZFA* = Uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones, calculated in accordance with Sections C405.2.4.2 and C405.2.4.3, that do not have daylight responsive controls.~~

~~*TBFA* = Total building floor area is the sum of all floor areas included in the lighting power allowance calculation in Section C405.3.2.~~

Reason Statement:

Heinmiller: Exception #3 was added to IECC 2018. It created unnecessary complexity with no benefit. It does not improve energy efficiency or the usability of the code -- and actually does the opposite. Exception #4 attempts to solve a problem that does not exist. The “problem” is assumed to be that the installation of daylight responsive controls is an unreasonable burden. This was not the case three years ago, and is not the case today. Designers have not, and are not, asking for this exception. We believe that this exception will hurt energy efficiency in the long run by discouraging the use of daylight responsive controls. While designers welcome alternate paths around unreasonable requirements, we do not welcome alternate paths that provide no benefit and only make the code more complex and confusing.

Jouaneh: This proposal strikes an unnecessary and complicated exception to daylight responsive controls. The requirement to use daylight responsive controls already has a built-in wattage exception (i.e., spaces where lighting power less than 150 watts in all the daylight zones are already exempt from daylight responsive control). So, there is no need for this additional lighting power exception. What's more is that this exception not likely get used as projects can simply with the wattage exception in the requirement. Thus, this proposal will simplify the language by eliminating these extra words.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Heinmiller: Because this proposal eliminates an option to avoid the small cost of installing daylight responsive controls (if certain power density limits are met), it could conceivably increase the cost of construction slightly. But this assumes that the option would commonly be taken. We believe that the option currently in the code is unlikely to be used. Daylight responsive controls are standard practice today and we believe will likely be installed anyhow, regardless of whether or not this option is available. Therefore a possible small increase in construction cost is only a hypothetical and not a given.

Jouaneh: Proposal is editorial. The exception is not needed since there already is a wattage exception in the requirement.

CEPI-161-21

CEPI-162-21

IECC®: C405.2.4

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org); Megan Hayes, representing NEMA (megan.hayes@nema.org)

2021 International Energy Conservation Code

Revise as follows:
C405.2.4 Daylight-responsive controls.

Daylight-responsive controls complying with Section C405.2.4.1 shall be provided to control the general lighting within *daylight zones* in the following spaces:

1. Spaces with a total of more than ~~150~~75 watts of *gen eral lighting* within primary sidelit daylight zones complying with Section C405.2.4.2.

2. Spaces with a total of more than ~~300~~150 watts of *general lighting* within sidelit daylight zones complying with Section C405.2.4.2.

3. Spaces with a total of more than ~~150~~75 watts of *general lighting* within toplit daylight zones complying with Section C405.2.4.3.

Exceptions: Daylight responsive controls are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.

2. Sidelit daylight zones on the first floor above grade in Group A-2 and Group M occupancies.

3. New buildings where the total connected lighting power calculated in accordance with Section C405.3.1 is not greater than the adjusted interior lighting power allowance (LPA_{adj}) calculated in accordance with Equation 4-9.

$$LPA_{adj} = [LPA_{norm} \times (1.0 - 0.4 \times UDZFA / TBFA)]$$

(Equation 4-9)

where:

LPA_{adj} = Adjusted building interior lighting power allowance in watts.

LPA_{norm} = Normal building lighting power allowance in watts calculated in accordance with Section C405.3.2 and reduced in accordance with Section C406.3 where Option 2 of Section C406.1 is used to comply with the requirements of Section C406.

UDZFA = Uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones, calculated in accordance with Sections C405.2.4.2 and C405.2.4.3, that do not have daylight responsive controls.

TBFA = Total building floor area is the sum of all floor areas included in the lighting power allowance calculation in Section C405.3.2.

Reason Statement:

A study was conducted and found that most spaces no longer have connected load in the daylighted zones that would require daylight responsive controls at the current thresholds. This reduced load is because of the shift to LEDs. Therefore, it is fitting to lower the wattage threshold to a level that will actually trigger the control requirements, while also being cost effective. ded by the IECC.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

Cost Impact:

The code change proposal will increase the cost of construction.

When last modified, this section assumed the use of either a dimming fluorescent ballast or multiple fluorescent ballasts adding between ($30 - $100 per fixture adder). Dimming drivers are a standard no-cost feature of LED equipment. Therefore, it does not cost for the fixture to be dimmable. There two methods of daylight sensor, zone-based or luminaire-based. The cost analysis primarily focused on integral daylight sensors, but zone-based sensor layout can be cost effective as well. Others in the country have adopted similar proposals including California's Title 24.

CEPI-162-21

CEPI-164-21

IECC®: C405.2.4

Proponents:

Megan Hayes, representing NEMA (Megan.Hayes@nema.org)

2021 International Energy Conservation Code

Revise as follows:
C405.2.4 Daylight-responsive controls.

Daylight-responsive controls complying with Section C405.2.4.1 shall be provided to control the general lighting within *daylight zones* in the following spaces:

1. Spaces with a total of more than 75 ~~150~~ watts of *gen eral lighting* within primary sidelit daylight zones complying with Section C405.2.4.2.

2. Spaces with a total of more than 150 ~~300~~ watts of *general lighting* within sidelit daylight zones complying with Section C405.2.4.2.

3. Spaces with a total of more than 75 ~~150~~ watts of *general lighting* within toplit daylight zones complying with Section C405.2.4.3.

Exceptions: Daylight responsive controls are not required for the following:

1. Spaces in health care facilities where patient care is directly provided.

2. Sidelit daylight zones on the first floor above grade in Group A-2 and Group M occupancies.

3. New buildings where the total connected lighting power calculated in accordance with Section C405.3.1 is not greater than the adjusted interior lighting power allowance (LPA_{adj}) calculated in accordance with Equation 4-9.

$$LPA_{adj} = [LPA_{norm} \times (1.0 - 0.4 \times UDZFA / TBFA)]$$

(Equation 4-9)

where:

LPA_{adj} = Adjusted building interior lighting power allowance in watts.

LPA_{norm} = Normal building lighting power allowance in watts calculated in accordance with Section C405.3.2 and reduced in accordance with Section C406.3 where Option 2 of Section C406.1 is used to comply with the requirements of Section C406.

UDZFA = Uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones, calculated in accordance with Sections C405.2.4.2 and C405.2.4.3, that do not have daylight responsive controls.

TBFA = Total building floor area is the sum of all floor areas included in the lighting power allowance calculation in Section C405.3.2.

Reason Statement:

This proposal reduces the daylight responsive control wattage threshold from 150W to 75W in primary toplight and sidelight daylight areas and 150 Watts of combined wattage for primary and secondary daylighting areas for sidelit areas. This will qualify more daylight areas for the energy efficiency and energy savings opportunity of daylight responsive controls. This proposal will:

1. Increase energy efficiency by expanding the number daylight responsive controlled areas2. Rely on the efficiency of readily

available dimming technology

3. Maintain the same level of enforceability with the code

4. Coincide with amendments happening to current IECC versions and align with wattage threshold reduction of other standards: ASHRAE 90.1, CA Title 24.

The IECC daylighting threshold requirement was established and adopted in the 2015 IECC. It was based on the high cost of controlling and dimming fluorescent technology. The conversion to LED lighting technology has substantially reduced the cost for luminaire dimming controllability. LED luminaires now typically come standard with dimmable drivers without an added cost, where this was not the case with fluorescent lighting technology. As LED technology is a much more efficacious lighting source, maintaining a 150W threshold for daylight responsive control is now reducing the number of spaces where the requirement should apply and save energy.

Recognizing these facts, certain jurisdictions have amended the 2018 IECC daylight responsive control wattage threshold and other standards have or are changing to lower wattage thresholds as follows:

New York City – 100 Watts

Massachusetts – 100 Watts

Washington State – more than two luminaires in the daylight area

Washington DC – toplight 105 Watts, sidelight 150 Watts

Lower wattage thresholds in other standards:

California Title 24 Part 6 versions 2013, 2016, 2019, 2022 – 120 Watts

ASHRAE 90.1 – 2019 Addendum O – 75 Watts

ASHRAE 90.1 Addendum O forward stated:

"Costs have shifted since 2013. In 2013, the fluorescent system needed either a dimming ballast or multiple ballasts adding between ($30 - $100 per fixture adder). Dimming drivers are a standard no-cost feature of LED equipment. Other costs have changed between 2013 and now because of the advent of sensors that are integral to the fixtures."

Overall, the cost of construction will not increase as these spaces would have already qualified for daylight responsive controls with prior lighting technologies which consumed more power. As the efficacy of lighting has dropped considerably with LED lighting technology, this proposal adapts the code to this shift in more efficient and more controllable lighting.

We highly recommend the committee accept and adopt this shift to LED lighting efficacy and its effect on daylight responsive control in order to maintain the energy savings intended by the IECC.

Bibliography:

Daylighting Analysis for ASHRAE 90.1 Code Development – Final Results, March 29, 2012, PNNL: Athalye, Xie, Rosenberg, Liu and Heschong Mahone Group: Saxena, Perry, Chappell.
"Daylighting Control Wattage Threshold", ASHRAE 90.1-2019 Motion 9, Addendum O, First Public Review, June 2020

California Title 24 Part 6 versions 2013, 2016, 2019, 2022

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

With the cost effective dimmability of LED sources, LED drivers, and widespread availability of daylight responsive controls, greater daylight areas and energy savings can be realized by reducing the daylight responsive control threshold from 150W to 120W.

CEPI-164-21

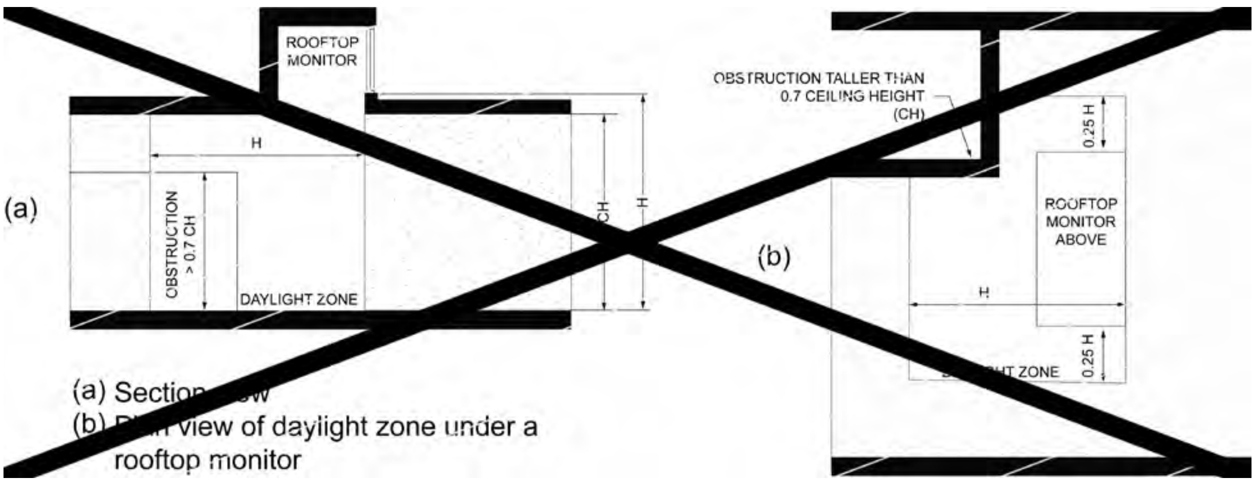
CEPI-165-21

IECC®: FIGURE C405.2.4.2(2)

Proponents: Harold Jepsen, representing Legrand (harold.jepsen@legrand.us)

2021 International Energy Conservation Code

Delete and substitute as follows:



~~FIGURE C405.2.4.2(2)~~
~~DAYLIGHT ZONE UNDER A ROOFTOP MONITOR~~

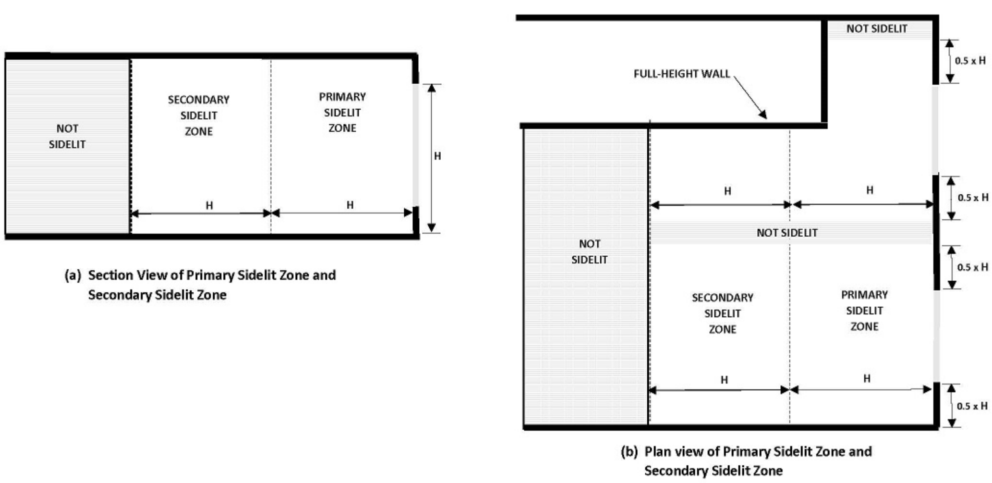
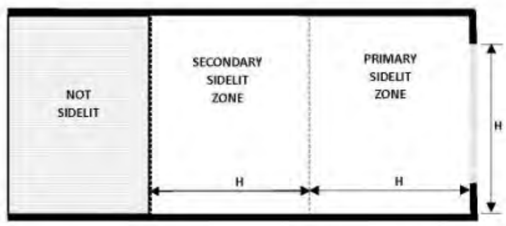
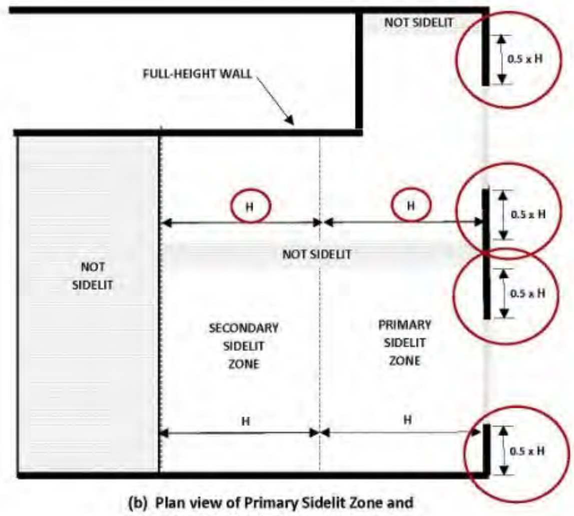


FIGURE C405.2.4.2(2)
DAYLIGHT ZONE UNDER A ROOFTOP MONITOR

Reason: Figure C405.2.4.2(1) is incorrect. The definition for a sidelit daylight zone is to extend longitudinally from the edge of the fenestration up to 0.5 times the height from the floor to the top of the fenestration. Figures attached show in red outline where the figure needs correction in order to match the definition of a sidelit daylight zone in C405.2.4.2.



(a) Section View of Primary Sidelit Zone and Secondary Sidelit Zone



(b) Plan view of Primary Sidelit Zone and Secondary Sidelit Zone

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

This is an editorial correction to the code and has no impact on construction costs.

CEPI-165-21

CEPI-166-21

IECC®: C405.2.4.2

Proponents:

Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2.4.2 Sidelit daylight zone.

The sidelit daylight zone is the floor area adjacent to vertical *fenestration* that complies with all of the following:

1. Where the fenestration is located in a wall, the <u>primary </u>sidelit daylight zone shall extend laterally to the nearest full-height wall, or up to 1.0 times the height from the floor to the top of the fenestration, and longitudinally from the edge of the fenestration to the nearest full-height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1).
2. Where the fenestration is located in a rooftop monitor, the <u>primary </u>sidelit daylight zone shall extend laterally to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 1.0 times the height from the floor to the bottom of the fenestration, whichever is less, and longitudinally from the edge of the fenestration to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.25 times the height from the floor to the bottom of the fenestration, whichever is less, as indicated in Figures C405.2.4.2(2) and C405.2.4.2(3).
3. <u>Where the fenestration is located in a wall, </u>the secondary sidelit daylight zone is directly adjacent to the primary sidelit daylight zone and shall extend laterally to 2.0 times the height from the floor to the top of the fenestration or to the nearest full height wall, whichever is less, and longitudinally from the edge of the fenestration to the nearest full height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1). The area of secondary sidelit zones shall not be considered in the calculation of the daylight zones in Section C402.4.1.1.
4. The area of the fenestration is not less than 24 square feet (2.23 m^2).
5. The distance from the fenestration to any building or geological formation that would block *access to* daylight is greater than one-half of the height from the bottom of the fenestration to the top of the building or geologic formation.
6. The visible transmittance of the fenestration is not less than 0.20.
7. The projection factor (determined in accordance with Equation 4-5) for any overhanging projection that is shading the fenestration is not greater than 1.0 for fenestration oriented 45 degrees or less from true north and not greater than 1.5 for all other orientations.

Reason Statement:

The change clarifies the language describing the secondary daylight zone, which was added in the last code cycle.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no change to the technical content of the code.

CEPI-166-21

CEPI-167-21

IECC®: C405.2.4.2, C402.4.1.1

Proponents:

Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2.4.2 Sidelit daylight zone.

The sidelit daylight zone is the floor area adjacent to vertical *fenestration* that complies with all of the following:

1. Where the fenestration is located in a wall, the sidelit daylight zone shall extend laterally to the nearest full-height wall, or up to 1.0 times the height from the floor to the top of the fenestration, and longitudinally from the edge of the fenestration to the nearest full-height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1).
2. Where the fenestration is located in a rooftop monitor, the sidelit daylight zone shall extend laterally to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 1.0 times the height from the floor to the bottom of the fenestration, whichever is less, and longitudinally from the edge of the fenestration to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.25 times the height from the floor to the bottom of the fenestration, whichever is less, as indicated in Figures C405.2.4.2(2) and C405.2.4.2(3).
3. The secondary sidelit daylight zone is directly adjacent to the primary sidelit daylight zone and shall extend laterally to 2.0 times the height from the floor to the top of the fenestration or to the nearest full height wall, whichever is less, and longitudinally from the edge of the fenestration to the nearest full height wall, or up to 0.5 times the height from the floor to the top of the fenestration, whichever is less, as indicated in Figure C405.2.4.2(1). ~~The area of secondary sidelit zones shall not be considered in the calculation of the daylight zones in Section C402.4.1.1.~~
4. The area of the fenestration is not less than 24 square feet (2.23 m^2).
5. The distance from the fenestration to any building or geological formation that would block *access to* daylight is greater than one-half of the height from the bottom of the fenestration to the top of the building or geologic formation.
6. The visible transmittance of the fenestration is not less than 0.20.
7. The projection factor (determined in accordance with Equation 4-5) for any overhanging projection that is shading the fenestration is not greater than 1.0 for fenestration oriented 45 degrees or less from true north and not greater than 1.5 for all other orientations.

C402.4.1.1 Increased vertical fenestration area with daylight responsive controls.

In *Climate Zones* 0 through 6, not more than 40 percent of the gross above-grade wall area shall be vertical fenestration, provided that all of the following requirements are met:

1. In buildings not greater than two stories above grade, not less than 50 percent of the net floor area is within a <u>primary sidelit</u> *daylight zone* <u>or a toplit *daylight zone*</u>.
2. In buildings three or more stories above grade, not less than 25 percent of the net floor area is within a <u>primary sidelit</u> *daylight zone* <u>or a toplight *daylight zone*</u>.

3. *Daylight responsive controls* are installed in *daylight zones.*

4. Visible transmittance (VT) of vertical fenestration is not less than 1.1 times solar heat gain coefficient (SHGC).

   Exception: Fenestration that is outside the scope of NFRC 200 is not required to comply with Item 4.

Reason Statement:

The description of how C402.4.1.1 counts daylight zones belongs in C402.4.1.1 not in C405.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The change is entirely editorial in nature.

CEPI-167-21

CEPI-168-21

IECC®: C405.2.5

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2.5 Specific application controls.

Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:

   1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.

   1.2. Display ~~and accent.~~ lighting

   ~~1.3. Lighting in display cases.~~

   ~~1.4~~ 1.3. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.

   ~~1.5~~ 1.4. Lighting equipment that is for sale or demonstration in lighting education.

   ~~1.6. Display lighting for exhibits in galleries, museums and monuments that is in addition to *general lighting*.~~

2. *Sleeping units* shall have control devices or systems that are configured to automatically switch off all permanently installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.

   Exceptions:

   1. Lighting and switched receptacles controlled by card key controls.

   2. Spaces where patient care is directly provided.

3. Permanently installed luminaires within *dwelling units* shall be provided with controls complying with Section C405.2.1.1 or C405.2.3.1.

4. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.

5. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual control*.

Reason Statement:

This proposal simplifies and clarifies the requirements by eliminating redundancy and unclear terminology. Three related types of lighting are consolidated under one type: "Display lighting"

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is a simplification for clarity and does not change code requirements.

CEPI-168-21

CEPI-169-21

IECC®: C405.2.5

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2.5 Specific application controls.

Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:

   1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.

   1.2. Display and accent.

   1.3. Lighting in display cases.

   1.4. Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.

   1.5. Lighting equipment that is for sale or demonstration in lighting education.

   1.6. Display lighting for exhibits in galleries, museums and monuments that is in addition to *general lighting*.

2. *Sleeping units* shall have control devices or systems that are configured to automatically switch off all permanently installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit. Hotels/motels with fewer than 50 guestrooms shall be permitted to use manual captive card key controls to comply.

   ~~**Exceptions**~~ **Exception**:

   ~~1. Lighting and switched receptacles controlled by card key controls.~~

   ~~2.~~ Spaces where patient care is directly provided.

3. Permanently installed luminaires within *dwelling units* shall be provided with controls complying with Section C405.2.1.1 or C405.2.3.1.

4. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.

5. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual control*.

Reason Statement:

Reason Statement:

Captive card key controls should not be considered an equivalent compliance option to occupant sensing or automatic controls in hotel guestrooms. Captive card key controls are a manual control (not automatic) that are easily and often bypassed thereby negating any potential energy savings. If they are to remain as an option, then only permit them to comply in the smaller hotels/motels. The larger hotels should be required to use automatic guestroom controls that will guarantee the energy savings and provide guests with a more satisfactory experience.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Will not increase cost of construction. The removal of captive card option plus installation/wiring is roughly equivalent to if not more than the cost of guest room systems with occupancy detection.

CEPI-169-21

CEPI-170-21

IECC®: C405.2.7.1 (New), C405.2.7.1, C405.2.7.2, C405.2.7.3, TABLE C405.5.2(2), TABLE C405.5.2(3)

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Add new text as follows:
C405.2.7.1 Off Control.
There shall be one or more lighting *control(s)* that turns off all of the lighting in the area or surface.
Revise as follows:
~~C405.2.7.1~~ C405.2.7.2 Daylight shutoff.

Lights shall be automatically turned off when daylight is present and satisfies the lighting needs, or within 30 minutes of sunrise.

~~C405.2.7.2~~ C405.2.7.3 ~~Building facade and landscape lighting~~ Scheduled OFF control.

~~Building facade and landscape~~ Exterior lighting shall automatically shut off from not later than 1 hour after business closing to not earlier than 1 hour before business opening.

~~C405.2.7.3~~ C405.2.7.4 Lighting setback.

Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:
   1.1. From not later than midnight to not earlier than 6 a.m.
   1.2. From not later than one hour after business closing to not earlier than one hour before business opening.
   ~~1.3. During any time where activity has not been detected for 15 minutes or more.~~
2. ~~Luminaires serving outdoor parking areas and having a rated input wattage of greater than 78 watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such~~Be controlled so that lighting power is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.

TABLE C405.5.2(2) LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

	LIGHTING ZONES			
	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
Base Site Allowance	~~350~~ 160 W	~~400~~ 280 W	~~500~~ 400 W	~~900~~560 W
Uncovered Parking Areas				
Parking areas and drives	~~0.03~~ 0.015 W/ft^2	~~0.04~~ 0.026 W/ft^2	~~0.06~~ 0.037 W/ft^2	~~0.08~~ 0.052 W/ft^2
~~Building~~ Grounds				
Walkways and ramps less than 10 feet wide	~~0.50~~ 0.04 W/~~linear foot~~ft^2	~~0.50~~ 0.07 W/~~linear foot~~ft^2	~~0.60~~ 0.10 W/~~linear foot~~ft^2	~~0.70~~ 0.14 W/~~linear foot~~ft^2
Walkways and ramps 10 feet wide or greater, plaza areas~~, special feature areas~~	~~0.10~~ 0.028 W/ft^2	~~0.10~~ 0.049 W/ft^2	~~0.10~~ 0.070 W/ft^2	~~0.14~~ 0.098 W/ft^2

Roof terraces and Special features	0.04 W/ft^2	0.07 W/ft^2	0.10 W/ft2	0.140 W/ft^2
Dining areas	~~0.65~~ 0.156 W/ft2	~~0.65~~ 0.273 W/ft2	~~0.75~~ 0.390 W/ft2	~~0.95~~ 0.546 W/ft2
~~Stairways~~	~~0.60 W/ft^2~~	~~0.70 W/ft^2~~	~~0.70 W/ft^2~~	~~0.70 W/ft^2~~
Pedestrian tunnels	~~0.12~~ 0.063 W/ft^2	~~0.12~~ 0.110 W/ft^2	~~0.14~~ 0.157 W/ft^2	~~0.21~~ 0.220 W/ft^2
Landscaping	~~0.03~~ 0.014 W/ft^2	~~0.04~~ 0.025 W/ft^2	~~0.04~~ 0.036 W/ft^2	~~0.04~~ 0.050 W/ft^2
Building Entrances and Exits				
Pedestrian and vehicular entrances and exits	~~14~~5.6 W/linear foot of opening	~~14~~9.8 W/linear foot of opening	~~21~~14.0 W/linear foot of opening	~~21~~19.6 W/linear foot of opening
Entry canopies	~~0.20~~ 0.072 W/ft^2	~~0.25~~ 0.126 W/ft^2	~~0.40~~0.180 W/ft^2	~~0.40~~0.252 W/ft^2
Loading docks	~~0.35~~ 0.104 W/ft^2	~~0.35~~ 0.182 W/ft^2	~~0.35~~ 0.260 W/ft^2	~~0.35~~ 0.364 W/ft^2
Sales Canopies				
Free-standing and attached	~~0.40~~ 0.20 W/ft^2	~~0.40~~ 0.35 W/ft^2	~~0.60~~ 0.50 W/ft^2	0.70 W/ft^2
Outdoor Sales				
Open areas (including vehicle sales lots)	~~0.20~~ 0.072 W/ft^2	~~0.20~~ 0.126 W/ft^2	~~0.35~~ 0.180 W/ft^2	~~0.50~~ 0.252 W/ft^2
Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	7.2 W/linear foot	~~7~~ 10.3 W/linear foot	~~21~~ 14.4 W/linear foot

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 W/ m^2.

W = watts.

TABLE C405.5.2(3) INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

LIGHTING ZONES				
	Zone 1	**Zone 2**	**Zone 3**	**Zone 4**
Building facades	No allowance	0.075 W/ft^2 of gross above-grade wall area	0.113 W/ft^2 of gross above-grade wall area	0.15 W/ft^2 of gross above-grade wall area
Automated teller machines (ATM) and night depositories	~~135~~90 W per location plus ~~45~~35 W per additional ATM per location			
~~Uncovered entrances and gatehouse inspection stations at guarded facilities~~	~~0.50 W/ft^2 of area~~			
Uncovered entrances and gatehouse inspection stations at guarded facilities	0.144 W/ft^2	0.252 W/ft^2	0.360 W/ft^2	0.504 W/ft^2
~~Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles~~	~~0.35 W/ft^2 of area~~			
Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.104 W/ft^2	0.182 W/ft^2	0.260 W/ft^2	0.364 W/ft^2
~~Drive-up windows and doors~~	~~200 W per drive through~~			
Drive-up windows and doors	53 W per drive-through	92 W per drive-through	132 W per drive-through	185 W per drive-through
~~Parking near 24-hour retail entrances.~~	~~400 W per main entry~~			
Parking near 24-hour retail entrances.	80 W per main entry	140 W per main entry	200 W per main entry	280 W per main entry
For areas that are not listed in Tables C405.5.2 (2) or (3), or are not comparable to areas listed in these tables, use the comparable interior space type from Table C405.3.2(2), as modified by factors in this row.	22% of the interior lighting power allowance	39% of the interior lighting power allowance	55% of the interior lighting power allowance	77% of the interior lighting power allowance

For SI: For SI: 1 watt per square foot = 10.76 W/ m^2.

W = watts.

Reason Statement:

The changes proposed here are based on improvements in technology and revised lighting practices related to light loss factors. Although there are four lighting zones, the vast majority of the population lives (and therefore buildings and energy use) in Lighting Zone 2 or 3.

Values were established based on criteria for Lighting Zone 3 and then scaled to the other lighting zones accordingly. This update represents roughly a 40% reduction in the values that were last modified in the ANSI/ASHRAE/IES Standard 90.1-2016. This reduction directly relates from improvements in LED technology as well as new data on light loss factors.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019 Energy Standard for Buildings Except Low-Rise Residential Buildings

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This addendum is cost effective and meets the ANSI/ASHRAE/IES Std. 90.1 scalar ratio. The proposal was developed in coordination with BC Hydro. BC Hydro contracted a third-party engineering firm to conduct multiple analyses including a cost / price analysis. The engineering firm found prices for exterior lighting fixtures have remained relatively flat related to previous 2016 and 2018 equipment. The engineering firm to account for both prices in Canada as well as the U.S. Fixture prices did change in this period as a result of supply chain, material costs, and inflation, but not as a result of more efficient lighting technologies.

CEPI-170-21

CEPI-171-21

IECC®: C405.2.7.2

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2.7.2 Building facade and landscape lighting.

Building facade and landscape lighting shall automatically shut off ~~from not later than 1 hour after business closing to not earlier than 1 hour before business opening.~~ at business closing, or midnight, whichever comes first, and shall remain off until the following evening.

Reason Statement:

The code currently allows for facade and landscape lighting to remain on as long as a business in the building is open. There is no reason for facade or landscape lighting to be on late at night or early in the morning.
This proposal requires facade and landscape lighting to be shut off at business closing time or midnight whichever comes first, and not be turned on again until the following evening.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal only affects the operation of the lighting equipment after it is installed, and not the construction cost of the lighting equipment

CEPI-171-21

CEPI-172-21

IECC®: C405.2.7.2, C405.2.7.3

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.2.7.2 Building facade and landscape lighting.

Building facade and landscape lighting shall automatically shut off from not later than 1 hour after *building* or business closing to not earlier than 1 hour before *building* or business opening.

C405.2.7.3 Lighting setback.

Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:
   - 1.1. From not later than midnight to not earlier than 6 a.m.
   - 1.2. From not later than one hour after *building* or business closing to not earlier than one hour before *building* or business opening.
   - 1.3. During any time where activity has not been detected for 15 minutes or more.
2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 78 watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.

Reason Statement:

- As currently written, the code exempts any *buildings* that do not contain "businesses" such as schools, community centers, houses of worship, public/government buildings, university campuses, etc. We do not believe that this is the intent of this code provision.
- All of the "businesses" in an office building might be "closed" to visitors but the *building* would still be open so that workers could access the offices after the business is "closed". The C405.2.7.3 setback should not apply because the *building* is still open, even though the businesses are closed.
- The important criteria is whether the *building* is closed or open. This makes sense because the code is applicable to commercial *buildings* and their *building sites* (C405.1). *Building* is a defined term in the code.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal is only a clarification of code requirements

CEPI-172-21

CEPI-173-21

IECC®: C405.2.7.3

Proponents:

Mike Kennedy, Mike D Kennedy Inc, representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

C405.2.7.3 Lighting setback.

Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:

   1.1. From not later than midnight to not earlier than 6 a.m.

   1.2. From not later than one hour after business closing to not earlier than one hour before business opening.

   1.3. During any time where activity has not been detected for 15 minutes or more.

2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 40~~78~~ watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. Not more than 1,500 watts of lighting power shall be controlled together.

Reason Statement:

Current language has little impact as most luminaires mounted under 24 feet use less than 78 watts. This proposal, by lowering the fixture wattage threshold to 40 watts, will result in greater applicability of this measure that has shown good energy savings potential.

Parking lot activity sensors were evaluated for California Title 24 with estimated costs and savings detailed in Nonresidential Outdoor Lighting Controls - Final Report from the California Codes and Standards Enhancement (CASE) Initiative (see Cost Impact).

The 2021 IECC base case control is a time clock reducing light from midnight to 6 am by 50%. The full load hours for this control are estimated to be 3285 full load hours. (6pm to midnight at 100%, midnight to 6 - 50% reduction). Table 16 of the California Title 24 CASE report determined the equivalent full load hours of various control strategies. For fixtures with activity sensors and no time clock they estimated full load hours at 2,874. This results in an estimated 40 watts / fixture * 411 full load hours / 1000 = 16 kWh / year savings for the lowest savings case of the current proposal.

In Californian and Washington the minimum wattage threshold was established based upon the limit of cost effectiveness. In California there is not minimum wattage. Looking at the distribution of light sources they determined to apply it to all parking lot lights. They also require time clock control with 75% turn down for the same fixtures. Washington applied a minimum wattage of 40 watts as proposed here. The cost effectiveness of this measure could warrant a lower minimum threshold or even eliminating the threshold.

Bibliography:

Nonresidential Outdoor Lighting Controls - Final Report from the California Codes and Standards Enhancement (CASE) Initiative. Available online at: https://t24stakeholder.wpengine.com/wp-content/uploads/2017/09/2019-T24-CASE-Report_Outdoor-Ltg-Controls_Final_September-2017.pdf.

Cost Impact:

The code change proposal will increase the cost of construction.

Parking lot activity sensors were evaluated for California Title 24 with estimated costs and savings detailed in Nonresidential Outdoor Lighting Controls - Final Report from the California Codes and Standards Enhancement (CASE) Initiative. Section 5.3.2 of the report found the cost of an integral activity sensor control of $59. Section 5.3.1 of the same report found an cost of wiring a control signal from a time clock, the baseline control, to each pole to be $53. Therefore the incremental cost for the proposed control is $7 per fixture. This cost data is from 2017. An 11.4% inflation factor was used to adjust the cost to year end 2021 for a cost of $7.80. Sales tax was not included in this because many states also tax commercial electricity consumption or utilities bills but if that is accounted for in the electric cost then tax should be added to this cost.

CEPI-173-21

CEPI-174-21

IECC®: C405.2.7.3

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
C405.2.7.3 Lighting setback.

Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent by selectively switching off or dimming luminaires at one of the following times:

   1.1. From not later than midnight to not earlier than 6 a.m.

   1.2. From not later than one hour after business closing to not earlier than one hour before business opening.

   1.3. During any time where activity has not been detected for 15 minutes or more.

2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 78 watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than 50 percent during any time where activity has not been detected for 15 minutes or more. <u>Controls shall be installed to allow manual or automatic increase of reduced light output during periods of inclement weather.</u> Not more than 1,500 watts of lighting power shall be controlled together.

Reason Statement:

This proposal addresses a safety issue. During periods of inclement weather, there is a possibility or probability that motion sensors will have a reduced probability of detecting people going back to their car, or will have a significantly reduced range of detection in an outdoor parking area. This could also turn into a liability issue for a building owner if someone slips or falls with reduced light levels and bad weather.

This proposal produces a remedy that will increase the safety of these systems. While this could or will reduce the amount of lighting reductions, the "lost" energy savings will be made up by other proposals that reduce the allowed lighting power allowances for building exteriors, or by the building project owner installing fixtures with higher efficacies than allowed in Tables C405.5.2(2) and C405.5.2(3).

Cost Impact:

The code change proposal will increase the cost of construction.

The cost of additional lighting controls will increase the cost of construction. The cost of such controls could range between $50 and $250 per control, depending on the features (manual versus automatic) and extra wiring needed.

It will also have the benefits of increased safety and reduced potential liability for the building project owner.

CEPI-174-21

CEPI-175-21

IECC®: SECTION 202 (New), C405.2.8

Proponents:

Mike Kennedy, Mike D. Kennedy Inc., representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202

PARKING GARAGE DAYLIGHT TRANSITION ZONE

. Covered vehicle entrances and exits from buildings and parking structures not exceeding a depth of 66 ft (20m) inside the structure and a width of 50 ft(15m).
Revise as follows:
C405.2.8 Parking garage lighting control.
Parking garage lighting shall be controlled by an *occupant sensor* complying with Section C405.2.1.1 or a *time-switch control* complying with Section C405.2.2.1. Additional lighting controls shall be provided as follows:

1. Lighting power of each luminaire shall be automatically reduced by not less than 50~~30~~ percent when there is no activity detected within a lighting zone for 10~~20~~ minutes. Lighting zones for this requirement shall be not larger than 3,600 square feet (334.5 m^2).

   ~~**Exception:** Lighting zones provided with less than 1.5 footcandles of illumination on the floor at the darkest point with all lights on are not required to have automatic light-reduction controls.~~

2. ~~Where lighting for eye adaptation is provided at covered vehicle entrances and exits from buildings and parking structures, such lighting~~ Lighting in *parking garage daylight transition zones* shall be separately controlled by a device that automatically reduces lighting ~~power by at least 50 percent~~ to no more than the general lighting level of the surrounding parking area from sunset to sunrise.

3. The power to luminaires within 20 feet (6096 mm) of perimeter wall openings shall automatically reduce in response to daylight by at least 50 percent.

   Exceptions:

   1. Where the opening-to-wall ratio is less than 40 percent as viewed from the interior and encompassing the vertical distance from the driving surface to the lowest structural element.
   2. Where the distance from the opening to any exterior daylight blocking obstruction is less than one-half the height from the bottom of the opening or fenestration to the top of the obstruction.
   3. Where openings are obstructed by permanent screens or architectural elements restricting daylight entering the interior space.
   4. Lighting in *parking garage daylight transition zones*.

Reason Statement:

The proposal here is to adopt the ASHRAE 90.1-2019 lighting reduction requirements for parking garages, clarify the application of the exceptions, and remove the exception related to foot candles.

ASHRAE 90.1-2019 requires 50% reduction in garage lighting after 10 minutes based upon OS control whereas current IECC requires 30%. The 30% value was based upon HID technology. With the advent of LED lighting 50% is technically feasible in garage lighting equipment.

The lighting transition zone control definition and exemption from the daylight control item are changed to align with that in ASHRAE 90.1. The 66 foot depth is based on the adaptation transition areas near entrances to parking garages described in ANSI/IES RP-8-18 Recommended Practice For Design And Maintenance Of Roadway And Parking Facility Lighting. This recommended practice also recommends that near the entrance that illuminance should be around 500 lux (46 footcandles). See discussion page 17-13. This standard also notes that the illuminance in the general area in a parking garage can be 10 lux (0.9 fc). More typical average illuminance values for the general area of parking garages, accounting for the perception of safety are around 5 fc. This is 10 times lower than the transition illuminance recommended near entrances and exits. At night time, the daylight transition zone daytime illuminance value 500 lux near the exit would hinder adaptation either entering or exiting the parking garage. Thus this proposal requires that the designer provide sufficient lighting reduction to reduce adaptation visibility issues and in most cases would result in a design that reduces lighting power substantially greater than 50%. Selecting a higher power reduction does not add cost but saves on energy and operating cost. Additionally this proposal aligns closely with the requirements in ASHRAE 90.1.

This proposal also removes the exception from OS control when the darkest spot is less than 1.5 foot candles. This exception is difficult from the perspective of enforcement as it puts all the power in the hands of the lighting designer. Code officials will be unable to check or verify this. This exception is not included in 90.1. It is the lighting designer's responsibility to meet the design objectives, and this potentially rewards bad lighting designs. If the concern is that designers may choose very low lighting power designs where this might be an issue even with good design, an exception based upon a low LPD would be preferable as it is the metric generally used and easily enforced by code officials. Assuming garage activity controls are active 8 hours a day the equivalent lpd would be 66% of the code space maximum allowance. However since excess garage lighting power allowances can be used to offset lighting in other areas and often contributes to C406 compliance, true energy equivalence is difficult. Therefore some discount would be appropriate. Perhaps garages with proposed lighting below 0.05W/sf or something of the like. This would keep very low light garages from having to implement this control but make it possible for code officials to enforce.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Configuring fixtures to a different control sequence will not cost more.

CEPI-175-21

CEPI-176-21

IECC®: C405.2.9 (New), C406.1

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Add new text as follows:
C405.2.9 Demand responsive lighting controls.

Spaces required to comply with Section C405.2.3 light-reduction controls shall install controls that are capable of automatically reducing lighting power in response to a demand response signal.

Exception: Buildings with less than 4,000 watts of combined installed lighting power in spaces that are required to comply with C405.2.3.

Revise as follows:
C406.1 Additional energy efficiency credit requirements.

New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.
12. Where not required by Section C405.2.9, include demand responsive lighting controls complaint with C405.2.9.

Reason Statement:

Demand responsive systems help projects savings on energy costs, especially peak demand charges, by helping to curtail/shift loads during times of peak electricity pricing or demand. Lighting is particularly well suited for demand response as lighting can often be adjusted without any disruption to the occupants (unlike cooling). Lights can gradually dim during a demand response event so that occupants don't notice the change in lighting (note that the first 20-25% of lighting dimming is undetectable by the human eye, yet that saves 20-25% in lighting energy). And after the DR event lighting can be brought back to previous levels quickly (unlike cooling loads which can take time for the space to be brought back to previous temperature).

What's more is that most networked lighting control (NLC) systems have native automated demand response capability. So, no new equipment is required.

Studies show that demand responsive lighting can save 30–50% of lighting power during peak periods (Newsham GR & Birt B. 2010. Demand-responsive lighting: a field study).

Lastly, demand responsive lighting has been in CA Title 24 since 2008 and in the ASHRAE 189.1 energy chapter since 2014. Plus, demand response is worth optional points in LEED v4 and demand response will be in the upcoming ASHRAE 90.1-2022 energy efficiency credits. Thus, the addition of demand responsive lighting will help bring the IECC inline with the other major building standards and rating systems.

Bibliography:

Newsham GR & Birt B. 2010. Demand-responsive lighting: a field study. Leukos. 6(3) pg 203–225

Title 24 Stakeholders CASE report on demand response: https://title24stakeholders.com/wp-content/uploads/2020/08/NR-Grid-Integration_Final-CASE-Report_Statewide-CASE-Team.pdf

https://lightingcontrolsassociation.org/2014/05/20/lighting-control-and-demand-response/

https://www.energy.gov/sites/prod/files/2020/02/f71/ssl-rd2020-ghosh-market.pdf

Cost Impact:

The code change proposal will increase the cost of construction.

The code change proposal may increase the cost of construction. However, savings from peak demand charges more than offsets any increased costs. Plus, most projects with over 4000 watts of lighting power will be using a networked lighting control system to comply with the mandatory lighting control provisions. And since most networked lighting control provisions have demand response built-in, no additional cost is incurred.

CEPI-176-21

CEPI-177-21

IECC®: C405.3.1, C405.5.1

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.3.1 Total connected interior lighting power.

The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}]$$
(Equation 4-10)

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).

2. The wattage limit of the permanent current-limiting devices protecting the system.

3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

~~1. Television broadcast lighting for playing areas in sports arenas.~~

~~2~~ 1. Emergency lighting automatically off during normal building operation.

~~3~~ 2. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.

~~4~~ 3. Casino gaming areas.

~~5~~ Mirror lighting in makeup or dressing ~~rooms.~~ areas used for video broadcasting, video or film recording, or live theatrical and

4. music performance.

~~6~~ 5. Task lighting for medical and dental purposes that is in addition to general lighting.

~~7~~ 6. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.

~~8~~ 7. ~~Lighting for theatrical purposes, including performance, stage, film production and video production.~~Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance

~~9~~ 8. Lighting for photographic processes.

~~10~~ 9. Lighting integral to equipment or instrumentation and installed by the manufacturer.

~~11~~ 10. Task lighting for plant growth or maintenance.

~~12~~ 11. Advertising signage or directional signage.

~~13~~ 12. Lighting for food warming.

~~14~~ 13. Lighting equipment that is for sale.

~~15~~ 14. Lighting demonstration equipment in lighting education facilities.

~~16~~ 15. Lighting approved because of safety considerations.

~~17~~ 16. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.

~~18~~ 17. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.

~~19~~ 18. Exit signs.

~~20~~ 19. Antimicrobial lighting used for the sole purpose of disinfecting a space.

C405.5.1 Total connected exterior building exterior lighting power.

The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.

2. Emergency lighting automatically off during normal business operation.

3. Exit signs.

4. Specialized signal, directional and marker lighting associated with transportation.

5. Advertising signage or directional signage.

6. Integral to equipment or instrumentation and installed by its manufacturer.

7. ~~Theatrical purposes, including performance, stage, film production and video production~~. Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance

8. Athletic playing areas.

9. Temporary lighting.

10. Industrial production, material handling, transportation sites and associated storage areas.

11. Theme elements in theme/amusement parks.

12. Used to highlight features of art, public monuments and the national flag.

13. Lighting for water features and swimming pools.

14. Lighting controlled from within dwelling units, where the lighting complies with Section R404.1.

Reason Statement:

This proposal clarifies the exemption from interior and exterior lighting power requirements for the lighting for dressing room mirrors and for video production and live performance.

- C405.3.1 #1 is consolidated into revised #8
- C405.3.1 #5 is revised to clarify that this only applies to mirror lighting in dressing areas used for video and performance, not mirrors in retail dressing/fitting rooms. Retail dressing room mirror lighting is covered by the lighting power allowance in Table C405.3.2(2)
- C405.3.1 #8 is revised to clarify the exemption by using more accurate terms and clear language
- C405.5.1 #7 is revised to clarify the exemption by using more accurate terms and clear language

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is a clarification of code requirements and does not change intent or stringency

CEPI-177-21

CEPI-178-21

IECC®: C405.3.1, TABLE C405.3.2(2)

Proponents:

Jonathan McHugh, representing McHugh Energy Consultants Inc.; Jamie Howland, representing California Statewide Codes and Standards Enhancement (CASE) Team (iecc-lighting@2050partners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.3.1 Total connected interior lighting power.

The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}]$$
(Equation 4-10)

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).

2. The wattage limit of the permanent current-limiting devices protecting the system.

3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

1. Television broadcast lighting for playing areas in sports arenas.

2. Emergency lighting automatically off during normal building operation.

~~3.~~ ~~Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.~~

~~4.~~ ~~Casino gaming areas.~~

~~5~~3. Mirror lighting in dressing rooms.

~~6~~4. Task lighting for medical and dental purposes that is in addition to general lighting.

~~7~~5. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.

~~8~~6. Lighting for theatrical purposes, including performance, stage, film production and video production.

~~9~~7. Lighting for photographic processes.

~~10~~8. Lighting integral to equipment or instrumentation and installed by the manufacturer.

~~11~~9. Task lighting for plant growth or maintenance compliant with Section C405.4

~~12~~10. Advertising signage or directional signage.

~~13~~11. Lighting for food warming.

~~14~~12. Lighting equipment that is for sale.

~~15~~13. Lighting demonstration equipment in lighting education facilities.

~~16~~14. Lighting approved because of safety considerations.

~~17~~15. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.

~~18~~16. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.

~~19~~17. Exit signs.

~~20~~18. Antimicrobial lighting used for the sole purpose of disinfecting a space.

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/ft²)
Atrium	
Not greater than 20 feet in height	0.33
Greater than 20 feet and ~~Less~~ less than 40 feet in height	~~0.48~~ 0.42
Greater than 40 feet in height	~~0.60~~ 0.52
Audience seating area	
In an auditorium	~~0.61~~ 0.57
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	~~0.67~~ 0.60
In a performing arts theater	~~1.16~~ 1.00
In a religious building	0.72

~~In a sports arena 0.33 0.23~~ Otherwise	~~0.33~~ 0.23 ~~0.33~~ 0.23
Banking activity area	~~0.61~~0.56
Beauty and Spa (barber, hair care, manicure, massage)	0.80
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	~~0.89~~ 0.60
Otherwise	~~0.71~~ 0.60
Computer room, data center	~~0.94~~ 0.60
Conference/meeting/multipurpose room	~~0.97~~ 0.75
Copy/print room	0.31
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	~~0.71~~ 0.61
Otherwise	~~0.41~~ 0.37
Courtroom	~~1.20~~ 0.90
Dining area	
In bar/lounge or leisure dining	~~0.86~~ 0.76
In cafeteria or fast food dining	0.40
In a facility for the visually impaired (and not used primarily by the staff)[b]	~~1.27~~ 0.90
In family dining	~~0.60~~ 0.40
In a penitentiary	0.42
Otherwise	~~0.43~~ 0.40
Electrical/mechanical room	0.43
Emergency vehicle garage	0.52
Food preparation area	~~1.09~~ 0.95
Guestroom[c, d]	~~0.41~~ 0.35
Laboratory	
In or as a classroom	1.11
Otherwise	~~1.33~~ 1.25
Laundry/washing area	~~0.53~~ 0.45
Loading dock, interior	~~0.88~~ 0.60
Lobby	
For an elevator	~~0.65~~ 0.61
In a facility for the visually impaired (and not used primarily by the staff)[b]	~~1.69~~ 0.85
In a hotel	0.51
In a motion picture theater	0.23
In a performing arts theater	~~1.25~~ 1.00
Otherwise	~~0.84~~ 0.75
Locker room	~~0.52~~ 0.42
Lounge/breakroom	
In a healthcare facility	0.42
Otherwise	~~0.59~~ 0.42
Office	
~~Enclosed~~ In office space no greater than 300 ft^2	~~0.74~~ 0.65
~~Open plan~~ In office space > 300 ft^2	0.61
~~Parking area, interior~~ *(moved to Parking Garage below)*	~~0.15~~
Pharmacy area	~~1.66~~ 1.35

Restroom	
In a facility for the visually (and not used primarily by the staffb	~~1.26~~ <u>1.00</u>
Otherwise	0.63
Sales area	~~1.05~~ <u>0.85</u>
Seating area, general	0.23
Stairwell	0.49
Storage room	0.38
Vehicular maintenance area	0.60
Workshop	~~1.26~~ <u>1.00</u>
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft²)**
Automotive (see Vehicular maintenance area)	
<u>Casino</u>	
<u>In betting, sportbook, keno bingo areas</u>	<u>1.00</u>
<u>In slot machine and digital gaming areas</u>	<u>0.55</u>
<u>In table gaming areas</u>	<u>1.00</u>
Convention Center—exhibit space	~~0.61~~ <u>0.54</u>
Dormitory—living quarters[c, d]	~~0.50~~ <u>0.40</u>
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	~~0.70~~ <u>0.90</u>
In a recreation room (and not used primarily by the staff)	~~1.77~~ <u>095</u>
Fire Station—sleeping quarters[c]	0.23
Gymnasium/fitness center	
In an exercise area	~~0.90~~ <u>0.50</u>
In a playing area	0.85
Healthcare facility	
In an exam/treatment room	~~1.40~~ <u>1.15</u>
In an imaging room	~~0.94~~ <u>0.60</u>
In a medical supply room	~~0.62~~ <u>0.55</u>
In a nursery	~~0.92~~ <u>0.80</u>
In a nurse's station	~~1.17~~ <u>1.05</u>
In an operating room	~~2.26~~ <u>1.90</u>
In a patient room[c]	0.68
In a physical therapy room	~~0.91~~ <u>0.80</u>
In a recovery room	~~1.25~~ <u>0.90</u>
Library	
In a reading area	~~0.96~~ <u>0.80</u>
In the stacks	~~1.18~~ <u>1.00</u>
Manufacturing facility	
In a detailed manufacturing area	0.80
In an equipment room	0.76
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	1.42
In a high-bay area (25–50 feet floor-to-ceiling height)	~~1.24~~ <u>1.00</u>
In a low-bay area (less than 25 feet floor-to-ceiling height)	~~0.86~~ <u>0.75</u>
Museum	
In a general exhibition area	0.31
In a restoration room	1.10
<u>Parking Garage</u>	

In a daylight transition[i] -	1.00
In all other parking and drive areas	~~0.15~~ 0.10
Performing arts theater—dressing room	0.41
Post office—sorting area	~~0.76~~ 0.60
Religious buildings	
In a fellowship hall	0.54
In a worship/pulpit/choir area	0.85
Retail facilities	
In a dressing/fitting room	0.51
In a mall concourse	~~0.82~~ 0.50
Sports arena—playing area	
For a Class I facility[e]	2.94
For a Class II facility[f]	2.01
For a Class III facility[g]	1.30
For a Class IV facility[h]	0.86
Swimming pools and surrounding deck area	
For a Class I facility[e]	2.20
For a Class II facility[f]	1.47
For a Class III facility[g]	0.88
For a Class IV facility[h]	0.40
Transportation facility	
At a terminal ticket counter	~~0.51~~ 0.45
In a baggage/carousel area	0.39
In an airport concourse	~~0.25~~ 0.40
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	~~0.69~~ 0.60

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 w/m^2.

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

b. A ‘Facility for the Visually Impaired’ is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

c. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

d. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

e. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

f. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

g. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

h. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

i. Lighting in parking garage daylight transition zones shall be separately controlled by a device that automatically reduces lighting power by at least 50 percent to no more than the general lighting level of the surrounding parking area from sunset to sunrise.

Attached Files

- **Additional Lighting PowerIECC.pdf**
  http://localhost/proposal/400/802/files/download/143/
- **90.1 Retail Models-Combined with Summary v1-sm.pdf**
  http://localhost/proposal/400/802/files/download/142/

Reason Statement:

- This proposal provides allowed lighting power to develop beautiful lighting designs that enhance the built environment while limiting energy waste and helping preserve resources and the global environment
- This proposal will reduce costs initially and over the life of the lighting system.
- Reduced lighting power results in less wattage of luminaires installed and reduced electrical operating cost. Payback is instantaneous.
- This proposal will reduce the amount of environmental pollution associated with operating electric lighting.

This proposal updates the lighting power densities based upon and advanced inverse lumen method model, AGI-32 models and comments from lighting designers. Much of this work builds on work initiated to support the 2022 California Title 24, part 6 (energy code) updates but has matched to more closely the match the structure and the format of the IECC code. This proposal is intended to be used in conjunction with proposal 289 which updated the additional lighting power requirements.

This proposal has two parts:

1. Updates to the total connected interior lighting power calculation to remove or modify exempted power where new limits have been created either this code cycle or in prior code cycles of the IECC.

2. Updated to the Space by Space Lighting Power Density (LPD) Allowances

Lighting power exemptions removed or modified:

Lighting for the visually impaired – the space by space table has higher lighting wattage allowance for the visually impaired; this exemption is no longer needed

Casino gaming areas – in this proposal lighting power allowances have been developed for casino gaming areas. This exemption is no longer needed.

Task lighting for plant growth or maintenance. In the 2021 version of the IECC Section C405.4 “Lighting for Plant Growth or Maintenance” was added. This exception should refer to this section.

Besides updating the LPDs for the various spaces, **the following new application were added**:

- Beauty and spa lighting
- Casino lighting
- Indoor swimming pool lighting
- Parking garage daylighting transition zones

These applications because they are specifically different than all the pre-existing space types in the space by space method and have different lighting power needs.

The two attachments on additional lighting power for ornamental lighting and for retails display allowances are also useful in evaluating the base allowances provided in the space by space table. These supporting documents were developed by Bernie Bauer of Integrated Lighting Concepts, lighting designer and former chair of the IES Mercantile lighting committee, reviewed reasonable adjustments to the decorative lighting allowance and the additional lighting power allowance for retail lighting displays. These additional allowances are designed to layer on top of the general lighting power allowances in the space by space LPD table.

Bibliography:

CASE. 2021. *2022 California Energy Code: Nonresidential Indoor Lighting with March 2021 Addendum*. Codes and Standards Enhancement (CASE) Initiative https://title24stakeholders.com/wp-content/uploads/2021/03/2022-T24-Indoor-Lighting_Final-CASE-Report_Statewid-CASE-Team_w-Addendum.pdf

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposal will **reduce costs initially and over the life of the lighting system**. Reduced lighting power results in less wattage of luminaires installed and reduced electrical operating cost. Societal cost associated with reduced GHG and other emissions is also saved.

CEPI-178-21

CEPI-179-21

IECC®: TABLE C405.3.2(1), TABLE C405.3.2(2)

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Revise as follows:

TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD

Portions of table not shown remain unchanged.

BUILDING AREA TYPE	LPD (w/ft^2)
Automotive facility	~~0.75~~ 0.719
Convention center	~~0.64~~ 0.629
Courthouse	~~0.79~~ 0.729
Dining: bar lounge/leisure	~~0.80~~ 0.729
Dining: cafeteria/fast food	~~0.76~~ 0.679
Dining: family	~~0.71~~ 0.639
Dormitory[a, b]	~~0.53~~ 0.509
Exercise center	~~0.72~~ 0.699
Fire station[a]	~~0.56~~ 0.559
Gymnasium	~~0.76~~ 0.729
Health care clinic	~~0.81~~ 0.759
Hospital[a]	~~0.96~~ 0.919
Hotel/Motel[a, b]	~~0.56~~ 0.519
Library	0.83
Manufacturing facility	0.82
Motion picture theater	~~0.44~~ 0.419
Multiple-family[c]	0.45
Museum	0.55
Office	~~0.64~~ 0.609
Parking garage	~~0.18~~ 0.169
Penitentiary	~~0.69~~ 0.649
Performing arts theater	~~0.84~~ 0.809
Police station	~~0.66~~ 0.609
Post office	0.65 ~~0.629~~
Religious building	~~0.67~~ 0.649
Retail	~~0.84~~ 0.769
School/university	~~0.72~~ 0.689
Sports arena	~~0.76~~ 0.699
Town hall	~~0.69~~ 0.659
Transportation	~~0.50~~ 0.539
Warehouse	0.45
Workshop	~~0.91~~ 0.859

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

Portions of table not shown remain unchanged.

COMMON SPACE TYPES[a]	LPD (watts/ft²)
Atrium	
Less than 40 feet in height	~~0.48~~ 0.409
Greater than 40 feet in height	~~0.60~~ 0.509
Audience seating area	
In an auditorium	~~0.61~~ 0.569
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	~~0.67~~ 0.559
In a performing arts theater	~~1.16~~ 1.09
In a religious building	0.72
In a sports arena	~~0.33~~ 0.269
Otherwise	0.33
Banking activity area	~~0.61~~ 0.559
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	~~0.89~~ 0.739
Otherwise	~~0.71~~ 0.719
Computer room, data center	~~0.94~~ 0.749
Conference/meeting/multipurpose room	~~0.97~~ 0.879
Copy/print room	~~0.31~~ 0.559
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	~~0.71~~ 0.609
Otherwise	~~0.41~~ 0.439
Courtroom	~~1.20~~ 1.079
Dining area	
In bar/lounge or leisure dining	~~0.86~~ 0.759
In cafeteria or fast food dining	~~0.40~~ 0.359
In a facility for the visually impaired (and not used primarily by the staff)[b]	~~1.27~~ 1.219
In family dining	~~0.60~~ 0.519
In a penitentiary	~~0.42~~ 0.349
Otherwise	~~0.43~~ 0.419
Electrical/mechanical room	~~0.43~~ 0.709
Emergency vehicle garage	~~0.52~~ 0.509
Food preparation area	~~1.09~~ 1.189
Guestroom[c, d]	0.41
Laboratory	
In or as a classroom	~~1.11~~ 1.049
Otherwise	~~1.33~~ 1.209
Laundry/washing area	~~0.53~~ 0.509
Loading dock, interior	0.88
Lobby	
For an elevator	~~0.65~~ 0.639
In a facility for the visually impaired (and not used primarily by the staff)[b]	~~1.69~~ 1.439
In a hotel	0.51
In a motion picture theater	~~0.23~~ 0.199

In a performing arts theater	~~1.25~~ 1.209
Otherwise	~~0.84~~ 0.769
Locker room	0.52
Lounge/breakroom	
In a healthcare facility	~~0.42~~ 0.769
Otherwise	~~0.59~~ 0.549
Office	
Enclosed	~~0.74~~ 0.729
Open plan	~~0.61~~ 0.559
Parking area daylight transition zone	1.059
Parking area, interior	~~0.15~~ 0.109
Pharmacy area	~~1.66~~ 1.589
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	~~1.26~~ 0.959
Otherwise	~~0.63~~ 0.559
Sales area	~~1.05~~ 0.849
Seating area, general	~~0.23~~ 0.209
Security Screening General Areas	0.639
Security Screening in Transportation Facilities	0.929
Security Screening Transportation Waiting Area	0.559
Stairwell	~~0.49~~ 0.469
Storage room	~~0.38~~ 0.349
Vehicular maintenance area	~~0.60~~ 0.589
Workshop	~~1.26~~ 1.169
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft²)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	~~0.61~~ 0.499
Dormitory—living quarters[c, d]	~~0.50~~ 0.479
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	~~0.70~~ 0.579
In a recreation room (and not used primarily by the staff)	~~1.77~~ 1.119
Fire Station—sleeping quarters[c]	0.23
Gaming Establishments	
High Rollers Area	1.679
Slots	0.539
Sportsbook	0.819
Table Games	1.089
Gymnasium/fitness center	
In an exercise area	~~0.90~~ 0.819
In a playing area	~~0.85~~ 0.619
Healthcare facility	
In an exam/treatment room	1.40 ~~1.329~~
In an imaging room	0.94
In a medical supply room	0.62 ~~0.559~~
In a nursery	0.92 ~~0.869~~
In a nurse’s station	1.17 ~~1.069~~
In an operating room	2.26 ~~2.309~~
In a patient room[c]	0.68 ~~0.779~~

In a physical therapy room	0.91 ~~0.819~~
In a recovery room	1.25 ~~1.179~~
In a telemedicine room	1.439
Library	
In a reading area	~~0.96~~ 0.859
In the stacks	1.18
Manufacturing facility	
In a detailed manufacturing area	0.80 0.749
In an equipment room	0.76 0.729
~~In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)~~	~~1.42~~
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
~~In a low-bay area (less than 25 feet floor-to-ceiling height)~~	~~0.86~~
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	~~1.42~~ 1.36
Museum	
In a general exhibition area	0.31
In a restoration room	~~1.10~~ 1.239
Performing arts theater—dressing room	~~0.41~~ 0.389
Post office—sorting area	~~0.76~~ 0.709
Religious buildings	
In a fellowship hall	~~0.54~~ 0.499
In a worship/pulpit/choir area	~~0.85~~ 0.749
Retail facilities	
In a dressing/fitting room	~~0.51~~ 0.449
Hair salon	0.649
Nail salon	0.749
In a mall concourse	~~0.82~~ 0.569
Massage space	0.809
Sports arena—playing area	
For a Class I facility[e]	~~2.94~~ 2.859
For a Class II facility[f]	~~2.01~~ 1.979
For a Class III facility[g]	~~1.30~~ 1.289
For a Class IV facility[h]	0.86
Sports arena—Pools	
For a Class I facility	2.199
For a Class II facility	1.469
For a Class III facility	0.989
For a Class IV facility	0.589
Transportation facility	
Airport Hanger	1.359
At a terminal ticket counter	~~0.51~~ 0.399
In a baggage/carousel area	~~0.39~~ 0.279
In an airport concourse	~~0.25~~ 0.489
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69

Reason Statement:

The values in Table C405.3.2(2) are interlinked with the values in Table C405.3.2(1). The building values [Table C405.3.2(1)] are comprised via aggregating the individual space values [Table C405.3.2(1)].

These proposed values were developed via a multi-step analysis:

- More than 150 data sheets from more than 10 lighting manufacturers data sheets were compiled.
- The 2021 data sheets indicate increased efficacy compared to products from 2018 and 2019. At least 2/3 of the data sheets compared were the same fixture from 2019 and 2021. For most of the directly tracked products, the efficacy of these fixtures had increased in this time.
- Lighting conditions were modeled for each of the spaces using these 2021 efficacy values and the resultant lighting power density values were these proposed values.

These proposed values represent a 4 - 5% reduction (based on a straight average of changes) compared to the previous version. These proposed values are similar to those that are being considered by ANSI/ASHRAE/IES Standard 90.1.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no cost increase for this proposal. The proposed reduced lighting power density values are based on manufacturer data sheets. Manufacturers have improved the performance of their products and these values are based on their improvements. As stated in the rationale, more than 150 products were evaluated. Between 2018 and 2021, these fixtures became more efficient. Cost changes between 2018 and 2021 are not from changes in efficacy, but inflation, supply chain, and material constraints.

CEPI-179-21

CEPI-180-21

IECC®: TABLE C405.3.2(2), C405.3.2.2.1

Proponents: Mike Kennedy, Mike D Kennedy Inc, representing Northwest Energy Efficiency Alliance; Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C405.3.2(2)
INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPESa	**LPD (watts/ft²)**
Atrium	
Less than 40 feet in height	0.48
Greater than 40 feet in height	0.60
Audience seating area[c]	
In an auditorium	0.61
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	0.67
In a performing arts theater	1.16
In a religious building	0.72
In a sports arena	0.33
Otherwise	0.33
Banking activity area	0.61
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	0.89
Otherwise	0.71
Computer room, data center	0.94
Conference/meeting/multipurpose room	0.97
Copy/print room	0.31
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[d]~~[b]~~	0.71
In a hospital	0.71

Otherwise[b,c]	0.41
Courtroom	1.20
Dining area	
In bar/lounge or leisure dining	0.86
In cafeteria or fast food dining	0.40
In a facility for the visually impaired (and not used primarily by the staff)[d] ~~[b]~~	1.27
In family dining[c]	0.60
In a penitentiary	0.42
Otherwise	0.43
Electrical/mechanical room	0.43
Emergency vehicle garage	0.52
Food preparation area	1.09
Guestroom[e,f] ~~[c, d]~~	0.41
Laboratory	
In or as a classroom	1.11
Otherwise	1.33
Laundry/washing area	0.53
Loading dock, interior	0.88
Lobby[b]	
For an elevator	0.65
In a facility for the visually impaired (and not used primarily by the staff)[d] ~~[b]~~	1.69
In a hotel	0.51
In a motion picture theater	0.23
In a performing arts theater	1.25
Otherwise	0.84
Locker room	0.52
Lounge/breakroom[b,c]	
In a healthcare facility	0.42
Otherwise	0.59
Office	
Enclosed	0.74
Open plan	0.61
Parking area, interior	0.15
Pharmacy area	1.66
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[d] ~~[b]~~	1.26
Otherwise[c]	0.63
Sales area	1.05

Seating area, general	0.23
Stairwell[b,c]	0.49
Storage room	0.38
Vehicular maintenance area	0.60
Workshop	1.26
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft²)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space[c]	0.61
Dormitory—living quarters[e, f~~c, d~~]	0.50
Facility for the visually impaired[d~~b~~]	
In a chapel (and not used primarily by the staff)	0.70
In a recreation room (and not used primarily by the staff)	1.77
Fire Station—sleeping quarters[e~~c~~]	0.23
Gymnasium/fitness center	
In an exercise area	0.90
In a playing area	0.85
Healthcare facility[b,c]	
In an exam/treatment room	1.40
In an imaging room	0.94
In a medical supply room	0.62
In a nursery	0.92
In a nurse’s station	1.17
In an operating room	2.26
In a patient room[e~~c~~]	0.68
In a physical therapy room	0.91
In a recovery room	1.25
Library	
In a reading area[c]	0.96
In the stacks	1.18
Manufacturing facility	
In a detailed manufacturing area	0.80
In an equipment room	0.76
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	1.42
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
Museum	
In a general exhibition area[c]	0.31
In a restoration room	1.10
Performing arts theater—dressing room	0.41
Post office—sorting area	0.76

Religious buildings	
In a fellowship hall[n]	0.54
In a worship/pulpit/choir area[n]	0.85
Retail facilities	
In a dressing/fitting room	0.51
In a mall concourse	0.82
Sports arena—playing area	
For a Class I facility[g ~~e~~]	2.94
For a Class II facility[h ~~f~~]	2.01
For a Class III facility[i ~~g~~]	1.30
For a Class IV facility[j ~~h~~]	0.86
Transportation facility	
At a terminal ticket counter[c]	0.51
In a baggage/carousel area[c]	0.39
In an airport concourse[c]	0.25
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 w/m^2.

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

b. Additional lighting power allowance of 0.2 watts per square foot for the purpose of highlighting art and exhibits. This additional power shall be permitted only for the stated purpose and only when it is in addition to and controlled separately from ornamental and general lighting. This additional power shall be permitted only in the space for which it is claimed and may not be added to the interior power allowance.

c. Additional lighting power allowance of 0.15 watts per square foot for ornamental lighting. Qualifying ornamental lighting includes luminaires that are specifically used in a decorative manner. This additional power shall be permitted only for the stated purpose and only when it is in addition to and controlled separately from display and general lighting. This additional power shall be permitted only in the space for which it is claimed and may not be added to the interior power allowance.

d ~~b~~. A ‘Facility for the Visually Impaired’ is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

e ~~c~~. Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

f ~~d~~. Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

g ~~e~~. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

h ~~f~~. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

i ~~g~~. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

j ~~h~~. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

C405.3.2.2.1 Additional interior lighting power. Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed and controlled in accordance with Section C405.2.5. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose. An increase in the interior lighting power allowance is permitted in the following cases:

1. For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power shall be determined in accordance with Equation 4-11.

Additional interior lighting power allowance = 1000 W + (Retail Area 1 × 0.45 W/ft^2) + (Retail Area 2 × 0.45W/ft^2) + (Retail Area 3 × 1.05 W/ft^2) + (Retail Area 4 × 1.87 W/ft^2)

For SI units:

Additional interior lighting power allowance = 1000 W + (Retail Area 1 × 4.8 W/m^2) + (Retail Area 2 × 4.84 W/m^2) + (Retail Area 3 × 11 W/m^2) + (Retail Area 4 × 20 W/m^2) **(Equation 4-11)**

where:

Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast or other critical display is approved by the code official.

2. ~~For spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance or for highlighting art or exhibits, provided that the additional lighting power shall be not more than 0.9 W/ft^2 (9.7 W/m^2) in lobbies and not more than 0.75 W/ft^2 (8.1 W/m^2) in other spaces.~~

Reason: ASHRAE 90.1-1999 had a decorative lighting power allowance of 1.0 W/sf. In 1999 the main light source appropriate for decorative and accent lighting was incandescent. This value was maintained through 90.1-2013 and was incorporated into the 2015 IECC. ASHRAE 90.1-2016 lowered the additional decorative lighting allowance to 0.75 W/ft2 and this value was incorporated into the 2018 IECC. ASHRAE 90.1-2019 and the 2021 IECC maintain the 0.75W/ft2 allowance. The 0.75 W/ft2 value roughly represents the change in efficacy from standard incandescent to halogen lighting. LED lighting has proliferated so that LED options are available in most all form factors. With LED lighting efficacies that are 4 times that of halogen lighting, the current decorative allowance is excessive. The current allowance is higher than the general lighting power allowance in over half of the space types.

This proposal eliminates the general decorative allowance that applies to all spaces in the space-by-space method and replaces it with two footnotes in the space-by-space allowance table to allow additional display (0.2W/sf) and ornamental (0.15W/sf) lighting power. One or both of the footnotes are applied to common area space types (corridors, lobbies, stairwells, restrooms) and as well as a few other individual space types (audience seating areas, lounge/breakrooms, exhibition areas, healthcare, and transportation areas).

The language is also modified to clarifies that the additional lighting allowance must be used in the space for which it is claimed. Excess allowance from one space may not be applied in another one.

This approach was developed and adopted by the Washington State Energy Code. It is roughly based upon California Title 24 2022 express language and an extensive technical advisory group process to hone the values was conducted. It balances the need for interesting and beautiful lighting with the need to reduce energy consumption and carbon emissions.

Bibliography: 15-Day Express Terms 2022 Energy Code - Residential and Nonresidential. Section 140.6. Available at: https://efiling.energy.ca.gov/GetDocument.aspx?tn=238848

Cost Impact: The code change proposal will decrease the cost of construction.

By reducing the amount of display light the first cost and energy costs will be reduced.

CEPI-180-21

CEPI-181-21

IECC®: C405.3.2.2

Proponents:

Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:
C405.3.2.2 Space-by-Space Method.
Where a building has ~~unfinished spaces,~~ spaces designated as unfinished, the area and lighting power within the unfinished spaces shall not be included in the Space-by-Space Method calculation for finished spaces. The lighting power allowance for the unfinished spaces shall be the total connected lighting power for those spaces, or 0.2 watts per square foot (~~10.76 w/m2~~ 2.15 W/m^2), whichever is less. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each space enclosed by partitions that are not less than 80 percent of the ceiling height, determine the applicable space type from Table C405.3.2(2). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space may be divided into separate spaces.
2. Determine the total floor area of all the spaces of each space type and multiply by the value for the space type in Table C405.3.2(2) to determine the lighting power (watts) for each space type.
3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

Reason Statement:

Clarifies that the lighting power allowance and the total connected lighting power within an unfinished space cannot be included in the Space-by-space calculation for finished spaces. Prevents trading of lighting power between finished and unfinished areas.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal clarifies code intent. It does not increase code stringency.

CEPI-181-21

CEPI-182-21

IECC®: C405.3.2.2.1

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Revise as follows:
C405.3.2.2.1 Additional interior lighting power.

Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed and controlled in accordance with Section C405.2.5. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose. An increase in the interior lighting power allowance is permitted in the following cases:

1. For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power shall be determined in accordance with Equation 4-11.

   Additional lighting power allowance = 1000 W + (Retail Area 1 x 0.45 W/ft^2) + (Retail Area 2 x 0.45 W/ft^2) + (Retail Area 3 x 1.05 W/ft^2) + (Retail Area 4 x 1.88 W/ft^2)

   For SI units:

   Additional lighting power allowance = 1000 W + (Retail Area 1 x 4.8 W/m^2) + (Retail Area 2 x 4.84 W/m^2) + (Retail Area 3 x 11.0 W/m^2) + (Retail Area 4 x 20.0 W/m^2)
   (Equation 4-11)

   where:

   Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

   Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

   Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

   Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

   Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast or other critical display is approved by the code official.

2. For spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance or for highlighting art or exhibits, provided that the additional lighting power shall be not more than

   ~~0.9 W/ft^2 (9.7 W/m^2)~~ 0.66 W/ft^2 (7.1 W/m^2) in lobbies and not more than ~~0.75 W/ft^2 (8.1 W/m^2)~~0.55 W/ft^2 (5.9 W/m^2) in other spaces.

Reason Statement:

The decorative allowance was added in 2015 version at 1.0 W/ft^2. Commercial LED technology was still very new in 2015. In 2018, the values shifted to 0.9 W/ft^2 for lobbies and 0.75 W/ft^2 for all other spaces. In 2018, more commercial LED options existed, however, it was still not the dominant technology. Since 2018, LED technology has only become more prevalent.

The underlying lighting model that developed these values in 2018 relied on halogen sources. In 2021, most commercial spaces have started using high color quality LED lighting rather than halogen lighting. National Electrical Manufacturers Association (NEMA) routinely publishes lamp shipment data. Since 2017, NEMA data indicates that halogen lamp shipment reductions have reduced by 50% (https://www.nema.org/analytics/lamp-indices) indicating the shift away from this technology. The same NEMA data indicates that in 2021, halogen sources represent less than 25% of market penetration.

A value of 0.75 W/ft^2 for decorative lighting is greater than 2/3 of all of the values in the proposed LPD values. This allowance can apply to any space that is not a lobby. Since 2018, even decorative fixtures have become available in LED. In 2015, this value was 1.0 W/ft^2. When the 2015 version was being developed, LED technology was still nascent. In 2015, mostly halogen and some fluorescent sources would have been used for decorative fixtures. As the industry shifts to LEDs which are much more efficient than halogen and somewhat more efficient than fluorescent, the value should be reconsidered.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This section of the code is optional and is allowance if a space needs more lighting power for decorative lighting. It is not required to be used. The changes in the allowed value reflect that more efficient sources exist and that more decorative lighting fixtures are using those more efficient light sources.

Decorative lighting comes in many forms. The cost of decorative lighting will be affected by the appearance of the light fixture more than the efficiency of the light fixture.

<u>Socket-based example</u>

Many (not all) decorative fixtures utilize a socket. Per a national home improvement website, table below is a comparison of halogen and LED decorative lamps. The LED lamp is equal or less expensive than the halogen lamp. The LED lamp lasts longer and uses less power.

Metric

Halogen

- Lamp Shape / Size: G25
- Lumens: 550
- Input Power40
- Lamp Life: 2,500 hours
- Cost$2.99

LED

- Lamp shape / size: G25
- Lumens: 500
- Input Power 5.5 W
- Lamp Life: 15,000 hours
- Cost: $2.60

Coves

Decorative lighting can involve cove lighting as well. Coves can be constructed via strip lights and drywall or cove fixtures and drywall. Using a national distributor, two types of strip lights were compared.

Fluorescent

- 2 F32T8 striplight
- Lumens: 4,800
- Input power: 56 W
- Lamp Life: 36,000 hours
- $60.50

LED

- LED
- Lumens: 4,700
- Input Power 34 W
- Life: 50,000 hours
- $135.16

Cove example assumed a measure life of 15 years. Using the ANSI/ASHRAE/IES Standard 90.1 scalar methodology, this cove example meets the scalar ratio threshold for a 15-year measure life.

CEPI-182-21

CEPI-183-21

IECC®: C405.3.2.2.1

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Revise as follows:
C405.3.2.2.1 Additional interior lighting power.

Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed and controlled in accordance with Section C405.2.5. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose. An increase in the interior lighting power allowance is permitted in the following cases:

1. For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power shall be determined in accordance with Equation 4-11.

   Additional lighting power allowance = 750 W + (Retail Area 1 x ~~0.45~~0.40 W/ft^2) + (Retail Area 2 x ~~0.45~~0.40 W/ft^2) + (Retail Area 3 x ~~1.05~~0.70 W/ft^2) + (Retail Area 4 x ~~1.87~~1.00 W/ft^2)

   For SI units:

   Additional lighting power allowance = ~~1000~~750 W + (Retail Area 1 x ~~4.8~~4.3 W/m^2) + (Retail Area 2 x ~~4.8~~4.3 W/m^2) + (Retail Area 3 x ~~11~~7.5 W/m^2) + (Retail Area 4 x ~~20~~10.8 W/m^2)
   (Equation 4-11)

   where:

   Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

   Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

   Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

   Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

   Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast or other critical display is approved by the code official.

2. For spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance or for highlighting art or exhibits, provided that the additional lighting power shall be not more than 0.9 W/ft^2 (9.7 W/m^2) in lobbies and not more than 0.75 W/ft^2 (8.1 W/m^2) in other spaces.

Reason Statement:

These values were adjusted in the 2018 version. Since then, LED technology has only become more prevalent. The underlying model that developed these values in 2018 relied on halogen sources. In 2021, most commercial spaces have started using high color quality LED lighting rather than halogen lighting. National Electrical Manufacturers Association (NEMA) routinely publishes lamp shipment data. Since 2017, NEMA data indicates that halogen lamp shipment reductions have reduced by 50% (https://www.nema.org/analytics/lamp-indices) indicating the shift away from this technology. The same NEMA data indicates that in 2021, halogen sources represent less than 25% of market penetration.

The large reductions in lighting power density for Retail Area 3 and 4 directly stems from assuming a high color LED source for those application..

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This section of the code is optional and is allowance if a space needs more lighting power for retail lighting. It is not used by all projects. It is not required to be used. The changes in the allowed value reflect that more efficient sources exist and that more retail lighting fixtures are using these more efficient light sources.

Some retail accent lighting is via track lighting. Track lighting relies on directional light sources. One type of directional light source is the PAR lamp. A survey of a national home improvement store has a halogen 1,350 lumen (72 watts) PAR lamp at $7.20 per lamp. In contrast, an LED 1,000 lumen (12 watts) PAR lamp is $5.89. LED directional lamps are near cost parity while saving significant energy

CEPI-183-21

CEPI-184-21

IECC®: C405.3.2.2.1

Proponents:

Jonathan McHugh, representing McHugh Energy Consultants Inc.; Jamie Howland, representing California Statewide Codes and Standards Enhancement (CASE) Team (iecc-lighting@2050partners.com)

2021 International Energy Conservation Code

Revise as follows:
C405.3.2.2.1 Additional interior lighting power.

Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed and controlled in accordance with Section C405.2.5. This additional power shall be used only for the specified luminaires and shall not be used for any other purpose. This additional power shall be permitted only in the space for which it is claimed and may not be added to the interior power allowance for other spaces. An increase in the interior lighting power allowance is permitted in the following cases:

For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power shall be determined in accordance with Equation 4-11.

~~Additional interior lighting power allowance = 1000 W + (Retail Area 1 × 0.45 W/ft^2) + (Retail Area 2 × 0.45W/ft^2) + (Retail Area 3 × 1.05 W/ft^2) + (Retail Area 4 × 1.87 W/ft^2)~~

~~For SI units:~~

~~Additional interior lighting power allowance = 1000 W + (Retail Area 1 × 4.8 W/m^2) + (Retail Area 2 × 4.84 W/m^2) + (Retail Area 3 × 11 W/m^2) + (Retail Area 4 × 20 W/m^2)~~

(Equation 4-11)

Additional Interior Lighting Power Allowance =
500 W + (Retail Area 1 x 0.40 W/ft^2) +
(Retail Area 2 x 0.40 W/ft^2) + (Retail Area 3 x 1.0 W/ft^2) +
(Retail Area 4 x 1.2 W/ft^2)

1. For SI Units
Additional Interior Lighting Power Allowance =
500 W + (Retail Area 1 x 4.3 W/m^2) +
(Retail Area 2 x 4.3 W/m^2) + (Retail Area 3 x 11 W/m^2) +
(Retail Area 4 x 13 W/m^2)

where:

Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast or other critical display is approved by the code official.

2. For spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance or for highlighting art or exhibits, provided that the additional lighting power shall be not more than ~~0.9~~ 0.45 W/ft^2 (~~9.7~~ 4.8 W/m^2) in ballrooms, beauty & spa, casinos, facilities for the visually impaired, leisure dining, lobbies, performing arts, retail sales, religious worship and not more than ~~0.75~~ 0.25 W/ft^2 (~~8.1~~ 2.7 W/m^2) in other spaces.

3. In facilities for the visually impaired, lobby entrance/exit spaces with transition lighting that is turned OFF at night by astronomical time clock, the wattage of the controlled lighting power up to 0.90 W/ft2 (9.6 W/m^2) of additional power is allowed for areas within 30 feet (9.1 m) of an an entrance of exit that is not in a skylight daylit zone or a sidelit daylit zone.

Attached Files

- **90.1 Retail Models-Combined with Summary v1-sm.pdf**
  http://localhost/proposal/289/758/files/download/83/
- **Additional Lighting PowerIECC.pdf**
  http://localhost/proposal/289/758/files/download/70/

Reason Statement:

- This proposal provides sufficient decorative and retail lighting additional lighting power to develop beautiful lighting designs that enhance the built environment while limiting energy waste and helping preserve resources and the global environment
- This proposal will reduce costs initially and over the life of the lighting system.
- Reduced lighting power results in less wattage of luminaires installed and reduced electrical operating cost. Payback is instantaneous.
- This proposal will reduce the amount of environmental pollution associated with operating electric lighting.

The IECC decorative allowance of 0.75 W/ft^2 is the same as the decorative allowance in ASHRAE 90.1-2019, except for one space type; the IECC allows a decorative allowance of 0.9 W/ft^2 in lobbies. Versions of ASHRAE 90.1 from 1999 through 2013 had a decorative lighting power allowance of 1.0 Wft^2. In 1999 the main light source appropriate for decorative and accent lighting was incandescent. Since the 2016 version of the ASHRAE 90.1, the additional decorative lighting allowance has been remained at 0.75 W/ft^2 which if 1 W/ft^2 is representative of standard incandescent lighting, this lower value would be representative of the change in efficacy to halogen lighting. With the LED lighting revolution and efficacies that are 4 times that of halogen lighting, the decorative allowance could reasonably drop to one third of its current value.

The California Statewide Codes and Standards program retained a highly qualified lighting designer and ex-chair of the IES Mercantile lighting committee, Bernie Bauer of Integrated Lighting Concepts, to review reasonable adjustments to the decorative lighting allowance and the additional lighting power allowance for retail lighting displays. The results of his work are attached in a separate document. For decorative lighting power he conducted a “top down” evaluation by considering the efficacy of incandescent, halogen and LED light sources and evaluated the relative efficacy of these sources. Additionally, for decorative lighting, he conducted “bottom up” evaluation of several decorative lighting applications with considerable amounts of decorative lighting power and evaluated the additional lighting power that was required over the general lighting allowance.

The results converged on values that are reflected in the proposal of 0.25 W/ft^2 to 0.45 W/ft^2 depending upon the application. These results are also reflected in the recently adopted 2022 version of California’s Title 24, part 6, which applies to approximately 12% of the commercial built environment in the United States. Note that the areas included in the 0.45 W/ft2 additional lighting power allowance are mostly the same applications in Title 24, part 6 which can use the Tailored Method lighting power allowances.

This analysis also provides examples from lighting designs for a range of retail clients from the more basic designs seen in a big box store to a high-end jewelry store. These designs informed the adjustment of the additional lighting power allowances. Note, these additional allowances were based on an assumed retail sales general lighting allowance of 0.85 W/ft^2; if the base allowance is adjusted, the additional allowances for each retail areas number should be adjusted to match a similar total lighting power allowance proposed here.

These cost and environmental savings must be considered in the context of artistry, beauty, and amenity of electric lighting. The limitations here on decorative lighting and display lighting budgets are not limiting task performance or visibility but do place an upper limit on the amount of electric lighting used for the artistic effects of highlighting, accenting and accentuating the built environment. The whole building performance approach allows trade-offs between different components for extraordinary designs. However, there is no limit on the amount of lighting energy that can be expended on branding or creating a presence with light. In certain commercial districts around the world, the authorities having jurisdiction have blown through even the relatively high values that are in the existing version of the IECC. These special jurisdiction and applications will likely continue to exist, but this standard sets a standard of care for the sustainability of the built environment appropriate for most jurisdictions.

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Morgan Pattison et al. *Respond to LED Lighting Efficacy: Status and Directions.* Comptes Rendus Physique Volume 19, Issue 3, March–April 2018, Pages 134-145 https://www.sciencedirect.com/science/article/pii/S1631070517300932

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposal will reduce costs initially and over the life of the lighting system. Reduced lighting power results in less wattage of luminaires installed and reduced electrical operating cost. Societal cost associated with reduced GHG and other emissions is also saved.

Over the last 9 years, 10 Billion square feet of new commercial buildings have been built. Approximately three times that much of building space is remodeled per year. Combining these areas is approximately 4.5 Billion square feet. The proposed maximum lighting power reduction is around 0.5 W/ft^2, assuming that half of this reduction applies (not everyone was using the full allowance) and that only 25% of spaces are even using the decorative allowance at all, and that the lighting systems on average operate 2,500 full load hours per year, the electricity savings would be approximately:

(4,564 Million square feet) x (0.5 W/ft^2) x (0.5 avg reduction) x (0.25 fraction spaces) x (2,500 h/yr) =

1st year new Construction and Alterations Saving = 713 Million kWh/yr.

The USEPA keeps track of greenhouse gas (GHG) emissions by each eGRID region. The EPA estimates that the average GHG emissions for the United States electricity grid as whole is a CO2e emission factor of 952.9 lbs/MWH which is equivalent to 432 Metric Tonnes/ Million kWh. Using this nationwide annual emission factor, the GHG reductions associated with this proposal for each year's new construction and alterations is:

GHG Reductions = 713 Million kWh/yr x 432 Metric Tonnes/ Million kWh = **308,000 Metric Tonnes CO2e.**

CEPI-184-21

CEPI-185-21

IECC®: SECTION 202, SECTION 202 (New), C405.4

Proponents:

Diana Burk, New Buildings Institute, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:
IECC2021P1E_CE_Ch02_SecC202_DefGREENHOUSE GREENHOUSE. A structure or a thermally isolated area of a building that maintains a specialized sunlit environment with a skylight roof ratio of 50% or more above the growing area exclusively used for, and essential to, the cultivation, protection or maintenance of plants.*Greenhouses* are those that are erected for a period of 180 days or more.
Add new definition as follows:
C202 HORTICULTURAL LIGHTING.

Electric lighting used for horticultural production, cultivation or maintenance.

C202 PHOTOSYNTHETIC PHOTON EFFICACY (PPE).

Photosynthetic photon flux emitted by a light source divided by its electrical input power in units of micromoles per second per watt, or micromoles per joule (µmol/J) between 400-700nm as defined by ANSI/ASABE S640.

Revise as follows:
C405.4 ~~Lighting for plant growth and maintenance~~Horticultural Lighting.

~~Not less than 95 percent of the p~~Permanently installed luminaires ~~used for plant growth and maintenance~~ shall have a ~~photon efficiency~~ *photosynthetic photon efficacy* of not less than ~~1.6~~ 1.7 µmol/J for *horticultural lighting* in *greenhouses* and not less than 1.9 µmol/J for all other *horticultural lighting.*Luminaires for *horticultural lighting* in *greenhouses* shall be controlled by a device that automatically turns off the luminaire when sufficient daylight is available. Luminaires for *horticultural lighting* shall be controlled by a device that automatically turns off the luminaire at specific programmed times.

~~µmol/J as defined in accordance with ANSI/ASABE S640.~~

Reason Statement:

Indoor agriculture energy usage is projected to grow substantially nationwide over the next several years, driven in large part (but not entirely) by the legalization of medical and recreational marijuana across the country. A total of 46 million square feet of grow area in the U.S. is lit by electric horticultural lighting, 58% of which was in supplemental greenhouses, 41% in non-stacked indoor farms, and 1% in vertical farms. Lighting in greenhouses operate on average 2,120 hours per year or 6 hours per day and lighting in non-stacked indoor operations were on 5,475 hours per year or 15 hours per day. Because of these long operating hours, lighting can account for 50 to 80% of a facilities energy use in indoor operations and 30% of energy use in greenhouses. Because sales of both recreational and medical marijuana are becoming legal across the country, it is critical to ensure these facilities are as efficient as possible.

Because of the large opportunity for energy savings, the 2021 IECC has already adopted requirements for lighting in these applications using the efficiency metric of µmol/J (micromoles per Joule) which was developed in collaboration with the American Society of Agricultural and Biological Engineers to measure the efficacy of lighting used for plant growth. A double-ended High Pressure Sodium (HPS) luminaire can meet the existing 2021 IECC standard of1.6 µmol/J.The proposed requirement increases the efficacy level required to 1.9 µmol/J. This new efficacy standard does not require a technology shift within indoor horticulture because slightly more efficient double-ended HPS lamps that meet the existing standard can also meet the proposed standard. Because a technology shift is not required, the additional energy savings from increasing the standard from 1.6 µmol/J to 1.9 µmol/J for indoor operations is very cost-effective. This proposed amendment also institutes a lower efficacy requirement of 1.7 µmol/J for greenhouses due to lower operating hours and thus longer payback periods in these applications.

This amendment also introduces requirements for lighting controls that are able to turn off the luminaire at specific times during the day and a lighting control requirement for greenhouses to ensure lights are off when sufficient daylight is available. Finally, the amendment clarifies these requirements by introducing horticultural lighting and photosynthetic photon efficacy as new definitions and by amending the definition for greenhouse.

These requirements are consistent with proposed Addendum ar-2019 recently released for public review to ASHRAE Standard 90.1 and with code requirements proposed for inclusion in Section 120.6(h)2 of California's Title 24-2022. The Technical Advisory Groups in Minnesota, Washington State, and Washington D.C. are also recommending these efficacy requirements as amendments to their local commercial energy codes.

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, ASHRAE, Aug. 2021, http://osr.ashrae.org/Online-Comment-Database/ShowDoc2/Table/DocumentAttachments/FileName/3689-90.1(2019)ar%20PPR1%20Draft.pdf/download/false.

Morlino, Lauren, Emerging Technologies & Services Manager at Vermont Energy Investment Corporation . Re: Cost Information for VT Luminaires, 21 June 2021.

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal will result in no additional cost for growers using greenhouses because there is little to no cost difference between luminaires meeting the current 2021 IECC requirement of 1.6 µmol/J and the proposed requirement of 1.7 µmol/J and because lighting control requirements are already common practice for these applications. For indoor grow operations, the cost of purchasing a luminaire that meets a 1.9 µmol/J requirement vs a 1.6 µmol/J would result in increased costs of approximately $13/square foot. Assuming an electricity rate of 11.09 cents/kWh, annual energy cost savings from this code proposal is approximately $4.55/square foot resulting in a three-year simple payback period.

CEPI-185-21

CEPI-186-21

IECC®: SECTION 202 (New), C405.4, C405.5, C405.5.1, C405.5.2, TABLE C405.5.2(1), TABLE C405.5.2(2), TABLE C405.5.2(3), C405.5.2.1, C405.5 (New), C405.5.1 (New), C405.5.2 (New), C405.5.2.1 (New), C409 (New), C409.1 (New), C409.1.1 (New), C409.1.2 (New), C409.1.2.1 (New), C409.1.2.2 (New), C409.1.3 (New), C409.1.4 (New), C409.1.5 (New), C409.1.5.1 (New), C409.1.5.2 (New), C409.1.6 (New), C409.2 (New), C409.3 (New), C409.3.1 (New), Table C409.3.1(1) (New), C409.3.2 (New), C409.3.3 (New), Table C409.3.3(1) (New), Table 409.3.3(2) (New), C409.3.3.1 (New), C409.3.3.2 (New), C409.3.3.2.1 (New), C409.3.3.3 (New), C409.3.4 (New), Table C409.3.4(1) (New), Table C409.3.4(2) (New), Table C409.3.4(3) (New), C409.3.4.1 (New), C409.3.4.2 (New), C409.3.4.3 (New), C409.3.5 (New), C409.3.5.1 (New), C409.3.5.2 (New), Table C409.3.5.2(2) (New), C405.5.1.1 (New), C405.5.1.2 (New), C405.5.1.3 (New)

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Add new definition as follows:

C202 **LIGHTING CONTROL ZONE.**

A designation used when calculating the proposed lighting system performance in accordance with C409, of one or more luminaires within a single interior space or subspace controlled by one or more lighting controls or one or more luminaires lighting an exterior area or surface controlled by one or more lighting controls.

C202 **PROPOSED LIGHTING SYSTEM.** The combination of luminaires and lighting controls included in the construction documents.

C202 **PROPOSED LIGHTING SYSTEM PERFORMANCE.**

The annual lighting site *energy* in kWh of *lighting systems* calculated for a *proposed lighting system* in accordance with C409.

C202 **REFERENCE LIGHTING SYSTEM PERFORMANCE.** The annual lighting site *energy* in kWh of a lighting system design intended for use as a reference case when using Lighting System Performance as an alternate path for minimum standard compliance of *lighting systems* in accordance with Section C405.5.

Revise as follows:

C405.1.2 ~~C405.4~~ Lighting for plant growth and maintenance.

Not less than 95 percent of the permanently installed luminaires used for plant growth and maintenance shall have a photon efficiency of not less than 1.6 μmol/J as defined in accordance with ANSI/ASABE S640.

C405.4 ~~C405.5~~ Exterior lighting power requirements.

The total connected exterior lighting power calculated in accordance with Section C405.4.1 ~~C405.4.1~~ shall be not greater than the exterior lighting power allowance calculated in accordance with Section C405.4.2 ~~C405.5.2.~~

.

C405.4.1 ~~C405.5.1~~ Total connected exterior building exterior lighting power.

The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception:

1. Lighting *approved* because of safety considerations.

2. Emergency lighting automatically off during normal business operation.

3. Exit signs.

4. Specialized signal, directional and marker lighting associated with transportation.

5. Advertising signage or directional signage.

6. Integral to equipment or instrumentation and installed by its manufacturer.

7. Theatrical purposes, including performance, stage, film production and video production.

8. Athletic playing areas.

9. Temporary lighting.

10. Industrial production, material handling, transportation sites and associated storage areas.

11. Theme elements in theme/amusement parks.

12. Used to highlight features of art, public monuments and the national flag.

13. Lighting for water features and swimming pools.

14. Lighting controlled from within dwelling units, where the lighting complies with Section R404.1.

C405.4.2 ~~C405.5.2~~ Exterior lighting power allowance.

The exterior lighting power allowance (watts) is calculated as follows:

- 1.

  Determine the Lighting Zone (LZ) for the building according to Table C405.4.2(1) ~~C405.5.2(1)~~, unless otherwise specified by the code official.

- 2.

  For each exterior area that is to be illuminated by lighting that is powered through the energy service for the building, determine the applicable area type from Table C405.4.2(2) ~~C405.5.2(2)~~. For area types not listed, select the area type that most closely represents the proposed use of the area.

- 3.

  Determine the total area or length of each area type and multiply by the value for the area type in Table C405.4.2(2) ~~C405.5.2(2)~~ to determine the lighting power (watts) allowed for each area type.

- 4.

The total exterior lighting power allowance (watts) is the sum of the base site allowance determined according to Table C405.4.2(2) ~~C405.5.2(2)~~, plus the watts from each area type.

TABLE C405.4.2(1) ~~C405.5.2(1)~~ EXTERIOR LIGHTING ZONES

Portions of table not shown remain unchanged.

TABLE C405.4.2(2) ~~C405.5.2(2)~~ LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

Portions of table not shown remain unchanged.

TABLE C405.4.2(3) ~~C405.5.2(3)~~ INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

Portions of table not shown remain unchanged.

C405.4.2.1 ~~C405.5.2.1~~ Additional exterior lighting power.

Additional exterior lighting power allowances are available for the specific lighting applications listed in Table C405.4.2(3) ~~C405.5.2(3)~~. These additional power allowances shall be used only for the luminaires serving these specific applications and shall not be used to increase any other lighting power allowance.

Add new text as follows:

C405.5 Alternate Compliance Path

C405.5.1 Lighting System Performance.

The *proposed lighting system* complies with the standard if

- 1.

  and

  the proposed lighting system satisfies the provisions of Sections C405.1 and C409

- 2.

  the proposed lighting system performance is less than or equal to the reference lighting system performance.

C405.5.2 Proposed Lighting System Performance.

Use the following steps to determine the *proposed lighting system performance,* in accordance with the procedures of Sections C405.5.2 through C405.5.8.

C405.5.2.1 Interior Lighting.

- 1.

  lighting system from Table C405.3.2(1) and the *gross lighted floor area* in ft^2 (m^2) of each *building* type. For *building* types not listed, selection of a reasonably equivalent type shall be permitted.

  Determine the appropriate building type(s) of the proposed

- 2.

  Identify all of the spaces and or subspaces in proposed lighting system based on the requirements in Section C405.3.

- 3.

  For space types not listed, selection of the closest similar category shall be permitted.

- 4.

  Each identified space or subspace shall be assigned to one of the building types identified in Section C405.5.1.1 Item 1.

- 5.

  For each lighting control zone within a space or subspace allocate the type, quantity and wattage of each installed luminaire and the associated lighting control types. The wattage of all lighting equipment shall be determined in accordance with Equation 4-10 and Section C405.3.1. Lighting controls types shall be based on Table C409.3.3(2).

C405.5.2.1 Exterior Lighting.

- 1.

  Determine the exterior lighting zonefrom Table C405.4.2(1).

- 2.

  Identify the applicable lighting building exterior areas type of each exterior building area that is design to be illuminated as permitted in Table C405.4.2(2) and Table C405.4.2(3) and determine the applicable unit (e.g., area (square feet) (square meters), length (linear feet) (linear meters), number of ATMs, etc.) of each surface. Include any exterior areas or surfaces listed as an exception to Section C405.4.1 and indicate that those areas or surfaces are exempt.

- 3.

  For each building exterior area or surface that is designed to be illuminated determine the type, quantity and wattage of each installed luminaire lighting that area or surface. The wattage of all lighting equipment shall be determined in accordance with Sections C405.3 and C405.5.1.

C409 Lighting System Performance

C409.1 Minimum Information.

The following minimum information shall be specified to calculate the *proposed lighting system performance* and the *reference lighting system performance.*

C409.1.1 Building Information.

The building area type and the associated *gross lighted floor area* in ft^2 (m^2) of each *building* area type shall be specified. Each *building* area type shall be chosen from Table C405.3.2. The appropriate exterior lighting zone from Table C405.4.2(1) shall be specified

C409.1.2 Interior Space Information.

The space type, *gross lighted floor area* in ft^2 (m^2) and ceiling height of shall be specified for each *space* or subspace identified in accordance with Section C405.5.1.1. Each *space* type shall be chosen from Table C405.3.2(2).

C409.1.2.1 For Sidelighting.

The number of windows, *fenestration* head height in ft (m), total horizontal exterior *wall* length in ft (m) and total *fenestration* horizontal length in ft (m) of each *space* or subspace shall be specified. The user shall also be permitted to enter *primary sidelighted area* and *secondary sidelighted area* calculated *in* accordance with Section C405.2.4.2.

C409.1.2.2 For Toplighting with Skylights.

The number of *skylights*, *skylight* area in ft^2 (m^2), *skylight well* factor in ft (m) and *visible transmittance* shall be specified. The user shall also be permitted to enter the *daylighted area under skylights* calculated in accordance with Section C405.2.4.3 or C405.2.4.4.

C409.1.3 Luminaire Schedule.

The *lamp* type, wattage per *luminaire*, name and description of each unique *luminaire* in the *proposed lighting system*shall be specified. Interior *luminaires* and exterior *luminaries* shall be specified in separate tables. The total watts, length, voltage, breaker amps and whether a current limiter is installed shall be specified for *luminaires* designated as line-voltage lighting track.

C409.1.4 Interior Space Lighting Luminaires and Controls.

For each *lighting control zone* in a *space* or subspace the zone name, *luminaire* type, *luminaire* quantity and lighting control types shall be specified. Users shall specify one of the allowable interior lighting control configurations listed in Table C409.3.4(1).

C409.1.5 Exterior Area Lighting.

Exterior area lighting surfaces and additional power shall be specified in accordance with Sections C409.1.5.1 and C409.1.5.2.

C409.1.5.1 For Exterior Lighting Surfaces.

The name, surface area type and area in ft^2 (m^2) or length in ft (m) shall be specified.

C409.1.5.2 For Additional Exterior Lighting Power.

The name, surface area type and area in ft^2 (m^2) or length in ft (m) shall be specified.

C409.1.6 Exterior Lighting Luminaires and Controls.

For each tradeable or non-tradeable exterior surface the surface name, *luminaire* type, *luminaire* quantity or length in linear ft (m), fixture mounting height and lighting control types shall be specified. Applicable exterior lighting control types are listed in Table C409.3.3(2).

C409.2 Reporting Requirements.

A report detailing the calculation of the *proposed lighting system performance* and *reference lighting system performance* shall contain the following information.

- 1.

  Name and contact information of the entity executing the Lighting System Performance and date of report.

- 2.

  Location of the building, including street address, climate zone, and exterior lighting zone.

- 3.

  Tables summarizing the minimum information described in Section C409.1.

- 4.

Simulation program used to perform the simulation

- 5.

  Table summarizing the calculated proposed lighting system performance and reference lighting system performance differentiated by exterior lighting and interior lighting annual lighting energy in kWh.

C409.3 Simulation Requirements.

Proposed lighting system performance and reference lighting system performance calculations shall be in accordance with Sections C409.3.1 through C409.3.5

C409.3.1 Calculation Tool.

The calculation tool shall be a computer-based software program. The calculation tool shall be capable of providing the calculations described in this appendix. Examples of calculation tools include (but not limited) Microsoft Excel, Google Sheets, or custom-built software.

- 1.

  The calculation tool shall be approved by the authority having jurisdiction and shall, at a minimum, have the ability to explicitly calculate the reference lighting system performance for interior and exterior lighting systems based only on the inputs for the proposed lighting system performance.

- 2.

  after construction. Actual experience will differ from these calculations because of variations such as occupancy and building operation.

  The calculation tool shall have the ability to explicitly calculate the proposed lighting system performance and reference lighting system performance of a proposed lighting system. Neither the proposed lighting system performance nor the reference lighting system performance are predictions of actual energy consumption for the proposed lighting system

Table C409.3.1(1) Reference Lighting Control Strategies for Building Interiors

Common S*pace* Types	**LPD**	**CFNDL**	**CFDL**	**Common S*pace* Types**	**LPD**	**CFNDL**	**CFDL**
Atrium	-		-	Sales Area	1.05	0%	28%
<20 ft in height	0.48	2%	30%	Seating Area, General	0.23	0%	28%
>40 ft in height	0.60	2%	30%	Storage Room	0.51	40%	40%
	-	-	-				

Audience Seating Area				-	-	-	-
In an auditorium	0.61	50%	64%	-	-	-	-
In a gymnasium	0.23	50%	64%	Vehicular Maintenance Area	0.60	0%	28%
In a motion picture theater	0.27	50%	50%	Workshop	1.26	0%	28%
In a ppenitentiary	0.67	50%	64%	Automotive (See "Vehicular Maintenance Area")	0.60	0%	28%
In a performing arts theater	1.16	50%	50%	Convention Center—Exhibit *Space*	0.61	0%	28%
In a religious building	0.72	50%	64%	Dormitory—Living Quarters	0.50	80%	80%
In a sports arena	0.33	50%	64%	Facility for the visually impaired	-	-	-
Otherwise	0.23	50%	64%	In a chapel (and not used primarily by the staff)	0.70	0%	28%
Banking Activity Area	0.61	10%	38%	In a recreation room (and not used primarily by the staff)	1.77	0%	28%

Breakroom (See Lounge/Breakroom)	-	-	-	Fire Station—Sleeping Quarters	0.23	80%	80%
Classroom/Lecture Hall/Training Room	-	-	-	Gymnasium/Fitness Center	-	-	-
In a penitentiary	0.89	29%	43%	In an eexercise area	0.90	0%	28%
Otherwise	0.71	29%	43%	In a playing area	0.85	0%	28%
Computer Room, data center	0.94	29%	43%	Healthcare Facility	-	-	-
Conference/Meeting/ Multipurpose Room	0.97	30%	44%	In an exam/treatment room	1.40	2%	30%
Confinement Cells	0.70	10%	10%	In an imaging room	0.94	2%	2%
Copy/Print Room	0.31	29%	43%	In a medical supply room	0.51	40%	40%
Corridor	-	-	-	43%	0.92	2%	30%
In a facility for the visually impaired (and not used primarily by the staff)[1]	0.71	20%	34%	In a nurse's station	1.17	2%	30%

In a hospital	0.71	0%	28%	In an operating room	2.26	2%	2%
Otherwise	0.41	20%	34%	In a patient room	0.68	2%	30%
Courtroom	1.20	0%	28%	In a physical therapy room	0.91	2%	30%
Dining Area	-	-	-	In a recovery room	1.25	2%	30%
In a bar /lounge or leisure dining	0.86	10%	38%	-	-	-	-
In a cafeteria or fast food dining	0.40	0%	28%	Library	-	-	-
In a facility for the visually impaired (and not used primarily by the staff)[1]	1.27	0%	28%	In a reading area	0.96	0%	28%
In a family dining	0.60	0%	28%	In the stacks	1.18	12%	34%
In a penitentiary	0.42	0%	28%	Manufacturing Facility	-	-	-
Otherwise	0.43	0%	28%	In a detailed manufacturing area	-	-	-

					0.80	0%	28%
-	-	-	-	*In an equipment* room	0.76 -	50%	64%
-	-	-	-	In an extra high bay area (>50 ft *floor*-to-ceiling height)	1.42 -	0%	28%
-	-	-	-	-	-	-	-
-	-	-	-	In a high bay area (>25 to 50 ft *floor*-to-ceiling height)	- - 1.24	- 0%	- 28%
-	-	-	-	-	-	-	-
-	-	-	-	In a low bay area (<25 ft *floor*-to-ceiling height)	0.86	0%	28%
-	-	-	-	-	-	-	-

Electrical/Mechanical Room	0.43	50%	50%	Museum	-	-	-
Emergency Vehicle Garage	0.52	5%	33%	In a general exhibition area	0.31	0%	28%
Food Preparation Area	1.09	0%	28%	In a restoration room	1.10	0%	28%
Guest Room	0.41	0.41	-	-	0.41	10%	33%
Laboratory	-	-	-	Post Office—Sorting Area	0.76	12%	32%
In or as a classroom	1.11	12%	34%	Religious Facility	-	-	-
All other laboratories	1.33	0%	28%	In a fellowship hall	0.54	10%	33%
Laundry/Washing Area	0.53	0%	28%	In a worship/pulpit/choir area	0.85	20%	38%
Loading Dock, Interior	0.88	0%	28%	Retail Facilities	-	-	-
-	-	-	-	In a dressing /fitting room	0.51	24%	24%
Lobby	-	-	-	In a mall concourse	0.82	0%	28%

Facility for the visually impaired (and not used primarily by the staff)[1]	1.69	12%	26%	Sports Arena—Playing Area[2]	-	-	-
Elevator	0.65	0%	28%	Class I facility	2.94	0%	28%
Hotel	0.51	0%	28%	Class II facility	2.01	0%	28%
Motion picture theater	0.23	0%	28%	Class III facility	1.30	0%	28%
Performing arts theater	1.25	12%	32%	Class IV facility	0.86	0%	28%
All other lobbies	0.84	12%	32%	Natatorium[2]	-	-	-
Locker Room	0.52	24%	24%	Class I facility	2.94	0%	28%
Lounge/Breakroom	-	-	-	Class II facility	2.01	0%	28%
Healthcare facility	0.42	24%	38%	Class III facility	1.30	0%	28%
All other lounges/breakrooms	0.59	24%	38%	Class IV facility	0.86	0%	28%
Office	-	-	-	Transportation Facility	-	-	-

Enclosed and ≤250 ft^2	0.74	29%	43%	At a terminal ticket counter	0.51	0%	28%
Enclosed and >250 ft^2	0.66	5%	33%	In a baggage/carousel area	0.39	0%	28%
Open plan	0.61	5%	33%	In an airport concourse	0.25	0%	28%
Parking Area, Interior	0.15	40%	58%	Warehouse—Storage Area	-	-	-
Pharmacy Area	1.66	0%	0%	Medium to bulky, palletized items	0.33	12%	34%
Restroom	-	-	-	Smaller, hand-carried items[3]	0.69	12%	34%
Facility for the visually impaired (and not used primarily by the staff)[1]	1.26	73%	73%	-	-	-	-
All other restrooms	0.63	73%	73%	-	-	-	-
-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-

C409.3.2 Compliance Calculations.

The *proposed lighting system performance* and *reference lighting system performance* shall be calculated using the same

- 1.

  Calculation tool
- 2.

  Hours of operation, and
- 3.

  Exterior lighting zone from Table C405.4.2(1).

C409.3.3 General Project Requirements.

Building types, space types, daylight areas and operating hours used to calculate the proposed lighting system performance and the reference lighting system performance shall be in accordance with Sections C409.3.3.1 through C409.3.3.3

Table C409.3.3(1) Interior and Exterior Lighting Annual Operating Hours

Building Type	**Annual Interior Building Operating Hours**	**Before Midnight Operating Hours (BMOH)**	**After Midnight Operating Hours (AMOH)**
Automotive Facility	3,289	0	0
Convention Center	3,357	1,508	-
Courthouse	2,938	0	0
Dining: Bar Lounge/Leisure	5,073	2,184	0
Dining: Cafeteria / fast food	5,073	2,184	0

Dining: Family	5,073	2,184	0
Dormitory	2,876	2,196	2,184
Exercise Center	3,357	1,508	0
Fire station	5,439	2,196	2,184
Gymnasium	4,193	780	0
Healthcare Clinic	5,439	2,196	2,184
Hospital	5,439	2,196	2,184
Hotel	3,589	2,196	2,184
Library	3,585	1,300	0
Manufacturing Facility	3,289	0	0
Motel	3,589	2,196	2,184

Motion Picture Theater	3,357	1,508	0
Multiple family	2,876	2,196	2,184
Museum	3,585	1,300	0
Office	2,938	0	0
Parking Garage	6,734	0	0
Penitentiary	3,589	2,196	2,184
Performing Arts Theater	3,357	1,508	0
Police Station	5,439	2,196	2,184
Post Office	2,938	0	0
Religious Building	3,357	1,508	0
Retail	3,585	1.300	0

School / University	4,193	0	0
Sports Arena	3,357	1,508	0
Town Hall	2,938	0	0
Transportation	5,439	2,196	2,184
Warehouse	2,837	0	0
Workshop	3,289	0	0

Table 409.3.3(2) Interior and Exterior Lighting Control Types

Code	**Name**	**Description**
Interior Lighting Control Types	-	-
NC	No Control	-
MS	Manual Switch	-
MD	Manual Dimmer	-

VS	Vacancy Sensor	-
OS	Occupancy Sensor	-
DD	Daylight Dimming	-
IT	Institutional Tuning	-
Sch	Schedule	-
Exterior Lighting Control Types	-	-
NC	No Control	No exterior lighting control
PC	Photocell	Dusk to dawn photocell with full off control
ES	Exterior Occupancy Sensor	-
TS_{PWRRED}	Timeswitch - 50% Power Reduction	Timeswitch that reduces fixture power by 50% between the hours of 12AM and 6AM.
TS_{ALLOFF}	Timeswitch - full off	Timeswitch that turns fixtures off between the hours of

		12AM and 6AM.
TC	Timeclock	Astronomical time clock

C409.3.3.1 Building and Space Types.

- 1.

  types shall be selected from Table C405.3.2(1) and the associated area of each applicable type shall be determined.

  Building

- 2.

  All interior spaces and subspaces, in the proposed design, determined in accordance with Section C405.5.1.1 shall be included in the Lighting System Performance calculation. The appropriate space type for each space and sub-space shall be determined from Table C405.3.2(2).

- 3.

  Each space or subspace shall be assigned one of the building types determined in accordance with Section C405.5.1.1(a). The sum of the areas of spaces and/or subspaces assigned to a building type shall not exceed the user-defined area of that building type.

- 4. .

  For each space or subspace users shall enter the required information in Section C409.1.2 for each applicable daylighting type: sidelighting, toplighting with skylights and toplighting with roof monitors.

- 5.

  For each space or subspace with toplighting via skylights users shall enter the required information for the skylight effective aperture

C409.3.3.2 Daylight Area.

For each *space* or subspace the *daylight area* of each applicable daylighting type shall be the smaller of:

- 1.

  The maximum daylight area determined in accordance with Section C409.3.3.2.1, or

- 2.

  determined in accordance with Sections C405.2.4.2, C405.2.4.3, or C405.2.4.4 3, or

  The user defined value for daylight area

- 3.

The user-defined floor area of a space or subspace.

C409.3.3.2.1 Calculated Daylight Area.

The maximum *daylight area* of each applicable daylighting type in a *space* or subspace shall be determined using Equations 4-16 through 4-21 and the following requirements:

- 1.

  The maximum primary sidelighted area shall be the smaller of the values calculated using Equations 4-16 and 4-17.

- 2.

  The maximum secondary sidelighted area shall be the smaller of the values calculated using Equations 4-18 and 4-19.

- 3.

  The calculated daylight area under skylights shall be determined by Equation 4-20 and shall assume that there are no interior obstructions.

- 4.

  The calculated daylight area under roof monitors shall be determined by Equation 4-21 and shall assume that there are no interior obstructions.

$PSA_{MAX} = (FL_{HOR} + NumWin \times HH) \times HH$
(Equation 4-16)

where:

PSA_{MAX} = Maximum *primary sidelighted area* in ft^2 (m^2)

FL_{HOR} = The user-defined total fenestration horizontal length in ft (m) in a space or subspace

HH = The user-defined head height in ft (m) of fenestration in a space or subspace

NumWin = The user-defined number of windows in a space or subspace. Fenestration separated by an opaque exterior wall assembly shall be considered separate windows.

$PSA_{MAX} = (EWL_{HOR} + NumWin \times HH) \times HH$
(Equation 4-17)

where:

PSA_{MAX} = Maximum primary sidelighted area in ft^2 (m^2)

EWL_{HOR} = The user-defined exterior wall horizontal length in ft (m) a space or subspace

HH = The user-defined head height in ft (m) of fenestration in a space or subspace

NumWin = The user-defined number of windows in a space or subspace. Fenestration separated by an opaque exterior wall assembly shall be considered separate windows.

SSA_{MAX}= (FL_{HOR} + NumWin x HH) x HH
(Equation 4-18)

where:

SSA_{MAX} = Maximum secondary sidelighted area in ft^2 (m^2) FL_{HOR} = The user-defined total fenestration horizontal length in ft (m) in a space or subspace HH = The user-defined head height in ft (m) of fenestration in a space or subspace NumWin = The user-defined number of windows in a space or subspace. Fenestration separated by an opaque exterior wall assembly shall be considered separate windows.
SSA_{MAX}= (EWL_{HOR} + NumWin x HH) x HH
(Equation 4-19)

where:

SSA_{MAX} = Maximum secondary sidelighted area in ft^2 (m^2)

EWL_{HOR} = The user-defined exterior wall horizontal length in ft (m) a space or subspace

HH = The user-defined head height in ft (m) of fenestration in a space or subspace

NumWin = The user-defined number of windows in a space or subspace. Fenestration separated by an opaque exterior wall assembly shall be considered separate windows.

TSD_{max}= SkyNum x π x [(0.7 x CH) + average (square root (ASky/π,square root 2 x square root (Asky)/2]^2
(Equation 4-20)
where:TSDmax = Maximum toplighted area from skylight area in ft^2 (m^2)SkyNum = The user-defined number of skylights in a space or subspaceASky = The user-defined area of a single skylight ft^2 (m^2) in a space or subspaceCH = The user-defined ceiling height in ft (m) of a space or subspace

TDM_{max} = NumMon x MonWidth x SH
(Equation 4-21)

where:

TDMmax = Maximum toplighted area from roof monitors in ft^2 (m^2)

NumMon = The user-defined number of roof monitors in a space or subspace

MonWidth = The user-defined width of the roof monitors in a space or subspace

SH = The user-defined sill height of the roof monitors in a space or subspace

C409.3.3.3 Operating Hours.

- 1.

  The annual operating hours of each space, subspace, or lighting control zone shall be determined using Table C409.3.3(1) and the corresponding building type in the proposed lighting system assigned to that space, subspace or lighting control zone.

- 2.

  The identified building type in the proposed lighting system with the largest number of nighttime operating hours shall be selected as the basis for all exterior lighting calculations in Sections C409.3.4.2

and C409.3.5.2. The nighttime operating hours for each building type shall be the sum of the before midnight operating hours (BMOH) and the after midnight operating hours (AMOH) from Table C409.3.3 Item 1.

C409.3.4 Calculation of Proposed Lighting Performance.

The *proposed lighting system performance* shall be calculated in accordance with Sections C409.3.4.1 through C409.3.4.3

Table C409.3.4(1) Allowable Interior Lighting Control configurations

Lighting Control Code	**Weighting Factor by Control Type**	**Lighting Control Code**	**Weighting Factor by Control Type**
1 Interior Lighting Control	-	-	-
MS	MS: 100%	DD	DD: 100%
MD	MD: 100%	IT	IT: 100%
VS	VS: 100%	SCH	Sch: 100%
OS	OS: 100%	NC	NC: 0%
Allowable combinations of 2 different Interior Lighting Controls	-	-	-
MS-VS	MS:0%, VS:100%	VS-IT	VS:83%, IT:100%

MS-DD	MS:100%, DD:95%	VS-SCH	VS:100%, SCH:100%
MS- SCH	MS:100%, Sch:100%	OD-DD	OS:75%, DD:65%
MD-VS	MD:100%, VS:83%	OS-IT	OS:83%, IT:100%
MD-DD	MD:100%, DD:71%	OS-SCH	OS:100%, SCH:100%
MD-IT	MD:80%, IT:100%	DD-IT	DD:78%, IT:100%
MD-SCH	MD:100%, Sch:100%	DD-SCH	DD:100%, SCH:100%
VS-DD	VS:70%, DD:65%	IT-SCH	IT:100%, SCH:100%
Allowable combinations of 3 different Interior Lighting Controls	-	-	-
MS-VS-DD	MS: 0%, VS: 70%, DD: 65%	MD-DD-SCH	MD: 100%, DD: 71%, SCH: 100%
MS-VS-IT	MS: 0%, VS: 83%, IT: 100%	MD-IT- SCH	MD: 80%, IT: 100%, SCH: 100%
MS-VS- SCH	MS: 0%, VS: 100%, SCH: 100%	VS-DD-IT	VS: 56%, DD: 52%, IT: 100%

MS-DD-IT	MS: 100%, DD: 78%, IT: 100%	VS-DD- SCH	VS: 70%, DD: 65%, SCH: 100%
MS-DD- SCH	MS: 100%, DD: 95%, SCH: 100%	VS-IT- SCH	VS: 83%, IT: 100%, SCH: 100%
MS-IT- SCH	MS: 80%, IT: 100%, SCH: 100%	OS-DD-IT	OS: 65%, DD: 56%, IT: 100%
MD-VS-DD	MD: 80%, VS: 70%, DD: 65%	OS-DD- SCH	OS: 75%, DD: 65%, SCH: 100%
MD-VS-IT	MD: 80%, VS: 63%, IT: 100%	OS-IT- SCH	OS: 83%, IT: 100%, SCH: 100%
MD-VS- SCH	MD: 100%, VS: 83%, SCH: 100%	DD-IT- SCH	DD: 78%, IT: 100%, SCH: 100%
MD-DD-IT	MD: 65%, DD: 55%, IT: 100%	-	-
Allowable combinations of 4 different Interior Lighting Controls	-	-	-
MS-VS-DD-IT	MS: 0%, VS: 56%, DD: 52%, SCH: 100%	-	-

MS-VS-DD- SCH	MS: 0%, VS: 70%, DD: 65%, SCH: 100%	-	-
MS-VS-IT- SCH	MS: 0%, VS: 83%, IT: 100%, SCH: 100%	-	-
MS-DD-IT- SCH	MS: 100%, DD: 78%, IT: 100%, SCH: 100%	-	-
MD-VS-DD-IT	MD: 68%, VS: 59%, DD: 55%, IT: 100%	-	-
MD-VS-DD- SCH	MD: 80%, VS: 70%, DD: 65%, SCH: 100%	-	-
MD-DD-IT- SCH	DD: 65%, DD: 55%, IT: 100%, SCH: 100%	-	-
VS-DD-IT- SCH	VS: 56%, DD: 52%, IT: 100%, SCH: 100%	-	-
OS-DD-IT- SCH	OS: 65%OS, DD: 56%, IT: 100%, SCH: 100%	-	-
Allowable combinations of 5 different Interior Lighting Controls	-	-	-
		-	-

MS-VS-DD-IT- SCH	MS: 0%, VS: 56%, DD: 52%, IT: 100%, SCH: 100%		
MD-VS-DD-IT- SCH	MD: 68%, VS: 59% DD: 55%, IT: 100%, SCH: 100%	-	-

Table C409.3.4(2) Lighting Controls Savings Value by Lighting Control Type and Space Type

Common *Space* Types	**MS**	**MD**	**VS**	**OS**	**DD**	**IT**	**SCH**
-	**Lighting Control Savings Values**	-	-	-	-	-	-
Atrium	-	-	-	-	-	-	-
Atrium: <0 ft in height	2%	20%	24%	24%	28%	20%	0%
Atrium: >40 ft in height	2%	20%	24%	24%	28%	20%	0%
Audience Seating Area	-	-	-	-	-	-	-
Auditorium	50%	50%	6%	6%	28%	20%	0%
Gymnasium	50%	50%	6%	6%	28%	20%	0%

Motion picture theater	50%	50%	6%	6%	28%	20%	0%
Penitentiary	50%	50%	6%	6%	28%	20%	0%
Performing arts theater	50%	50%	6%	6%	28%	20%	0%
Religious facility	50%	50%	6%	6%	28%	20%	0%
Sports arena	50%	50%	6%	6%	28%	20%	0%
Otherwise	50%	50%	6%	6%	28%	20%	0%
Banking Activity Area	10%	20%	34%	24%	28%	20%	0%
Breakroom (See Lounge/Breakroom)	-	-	-	-	-	-	-
Classroom/Lecture Hall/Training Room	-	-	-	-	-	-	-
Penitentiary	5%	20%	29%	24%	28%	20%	0%
Otherwise	5%	20%	29%	24%	28%	20%	0%
Computer room, data center	XX%	XX%	XX%	XX%	XX%	XX%	XX%

Conference/Meeting/ Multipurpose Room	20%	20%	50%	40%	28%	20%	0%
Confinement Cells	10%	20%	0%	0%	28%	20%	0%
Copy/Print Room	5%	20%	29%	24%	28%	20%	0%
Corridor	-	-	-	-	-	-	-
Facility for the visually impaired (and not used primarily by the staff)[1]	0%	20%	30%	30%	28%	20%	0%
Hospital	0%	20%	30%	30%	28%	20%	0%
Otherwise	0%	20%	40%	40%	28%	20%	0%
Courtroom	0%	20%	24%	24%	28%	20%	0%
Computer Room	0%	20%	24%	24%	28%	20%	0%
Dining Area	-	-	-	-	-	-	-
In bar/lounge or leisure dining	0%	20%	6%	6%	28%	20%	0%

In ccafeteria or fast food dining	0%	20%	6%	6%	28%	20%	0%
In facility for the visually impaired (and not used primarily by the staff)[1]	0%	20%	6%	6%	28%	20%	0%
In Family dining	0%	20%	6%	6%	28%	20%	0%
In ppenitentiary	0%	20%	6%	6%	28%	20%	0%
Otherwise	0%	20%	6%	6%	28%	20%	0%
Electrical/Mechanical Room	50%	20%	49%	40%	28%	20%	0%
Emergency Vehicle Garage	5%	20%	29%	24%	28%	20%	0%
Food Preparation Area	0%	20%	24%	24%	28%	20%	0%
Guest Room	See Section C405.1.1.	-	-	-	-	-	-
Laboratory	-	-	-	-	-	-	-
In or as a classroom	0%	20%	24%	24%	28%	20%	0%

Otherwise	0%	20%	24%	24%	28%	20%	0%
Laundry/Washing Area	0%	20%	24%	24%	28%	20%	0%
Loading Dock, Interior	0%	20%	24%	24%	28%	20%	0%
Lobby	-	-	-	-	-	-	-
For an eelevator	0%	20%	24%	24%	28%	20%	0%
In a facility for the visually impaired (and not used primarily by the staff)[1]	0%	20%	24%	24%	28%	20%	0%
In a hotel	0%	20%	24%	24%	28%	20%	0%
In a mootion picture theater	0%	20%	24%	24%	28%	20%	0%
In a performing arts theater	0%	20%	24%	24%	28%	20%	0%
Otherwise	0%	20%	24%	24%	28%	20%	0%
Locker Room	5%	20%	29%	24%	28%	20%	0%
	-	-	-	-	-	-	-

Lounge/Breakroom							
In a healthcare facility	0%	20%	24%	24%	28%	20%	0%
Otherwise	0%	20%	24%	24%	28%	20%	0%
Office	-	-	-	-	-	-	-
Enclosed	5%	20%	29%	24%	28%	20%	0%
Open	0%	20%	24%	24%	28%	20%	0%
Parking Area, Interior	0%	20%	0%	50%	28%	20%	0%
Pharmacy Area	0%	20%	24%	24%	28%	20%	0%
Restroom	-	-	-	-	-	-	-
In a facility for the visually impaired (and not used primarily by the staff)[1]	0%	20%	73%	73%	28%	20%	0%
Otherwise	0%	20%	73%	73%	28%	20%	0%

Sales Area	0%	20%	24%	24%	28%	20%	0%
Seating Area, General	50%	20%	6%	6%	28%	20%	0%
Stairwell	0%	20%	30%	30%	28%	20%	0%
Storage Room	40%	20%	52%	24%	28%	20%	0%
Vehicular Maintenance Area	0%	20%	24%	24%	28%	20%	0%
Workshop	0%	20%	24%	24%	28%	20%	0%
Automotive (See "Vehicular Maintenance Area")	-	-	-	-	-	-	-
Convention Center—Exhibit *Space*	0%	20%	24%	24%	28%	20%	0%
Dormitory—Living Quarters	80%	20%	80%	24%	28%	20%	0%
Facility for the visually impaired[1]	-	-	-	-	-	-	-
Recreation room/common living room (and not used primarily by staff)	0%	20%	24%	24%	28%	20%	0%

-	-	-	-	-	-	-	-
Fire Station—Sleeping Quarters	80%	20%	80%	24%	28%	20%	0%
Gymnasium/Fitness Center	-	-	-	-	-	-	-
In an exercise area	0%	20%	24%	24%	28%	20%	0%
In a laying area	0%	20%	24%	24%	28%	20%	0%
Healthcare Facility	-	-	-	-	-	-	-
Exam/treatment room	2%	20%	24%	24%	28%	20%	0%
Imaging room	2%	20%	24%	24%	28%	20%	0%
Medical supply room	10%	20%	34%	24%	28%	20%	0%
Nursery	2%	20%	24%	24%	28%	20%	0%
Nurse’s station	2%	20%	24%	24%	28%	20%	0%
Operating room	2%	20%	24%	24%	28%	20%	0%

Patient room	2%	20%	24%	24%	28%	20%	0%
Physical therapy room	2%	20%	24%	24%	28%	20%	0%
Recovery room	2%	20%	24%	24%	28%	20%	0%
Library	-	-	-	-	-	-	-
Reading area	0%	20%	24%	24%	28%	20%	0%
Stacks	0%	20%	24%	24%	28%	20%	0%
Manufacturing Facility	-	-	-	-	-	-	-
Detailed manufacturing area	0%	20%	24%	24%	28%	20%	0%
Equipment room	0%	20%	24%	24%	28%	20%	0%
Extra high bay area	-	-	-	-	-	-	-
(>50 ft *floor*-to-ceiling height)	0%	20%	24%	24%	28%	20%	0%

High bay area	-	-	-	-	-	-	-
(>25 to 50 ft *floor*-to-ceiling height)	0%	20%	24%	24%	28%	20%	0%
Low bay area	-	-	-	-	-	-	-
(<25 ft *floor*-to-ceiling height)	0%	20%	24%	24%	28%	20%	0%
Museum	-	-	-	-	-	-	-
General exhibition area	0%	20%	24%	24%	28%	20%	0%
Restoration room	0%	20%	24%	24%	28%	20%	0%
Performing Arts Theater—Dressing Room	10%	20%	34%	24%	28%	20%	0%
Post Office—Sorting Area	0%	20%	24%	24%	28%	20%	0%
Religious Facility	-	-	-	-	-	-	-
Fellowship hall	10%	20%	24%	24%	28%	20%	0%

Worship/pulpit/choir area	20%	20%	24%	24%	28%	20%	0%
Retail Facilities	-	-	-	-	-	-	-
Dressing/fitting room	0%	20%	24%	24%	28%	20%	0%
Mall concourse	0%	20%	0%	24%	28%	20%	0%
Sports Arena—Playing Area[2]	-	-	-	-	-	-	-
Class I facility	20%	20%	0%	0%	28%	20%	0%
Class II facility	20%	20%	0%	0%	28%	20%	0%
Class III facility	20%	20%	0%	0%	28%	20%	0%
Class IV facility	20%	20%	0%	0%	28%	20%	0%
Transportation Facility	-	-	-	-	-	-	-
Baggage/carousel area	0%	20%	24%	24%	28%	20%	0%
Airport concourse	0%	20%	24%	24%	28%	20%	0%

Ticket counter	0%	20%	24%	24%	28%	20%	0%
Warehouse—Storage Area	-	-	-	-	-	-	-
Medium to bulky, palletized items	0%	20%	24%	24%	28%	20%	0%
Smaller, hand-carried items[3]	0%	20%	24%	24%	28%	20%	0%

Table C409.3.4(3) Allowable Exterior Lighting Control configurations and *Control Savings Factor*s

Exterior Lighting Control Codes	**Exterior Lighting Control Savings Factors**	**Exterior Lighting Control Codes**	-	**Exterior Lighting Control Savings Factors**
Single Exterior Lighting Control	-	-	-	-
NC	0%	TS_{PWRRED}	-	12%
PC	50%	TS_{ALLOFF}	-	25%
-	-	TC	-	50%
Allowable combinations of multiple exterior lighting controls	-	-	-	-

PC-ES	75%	TC-ES	-	75%
PC-TS$_{PWRRED}$	62%	TC-TS$_{PWRRED}$	-	62%
PC-TS$_{ALLOFF}$	75%	TC-TS$_{ALLOFF}$	-	75%
PC-ES-TS$_{PWRRED}$	80%	ES-TS$_{PWRRED}$	56%	-
PC-ES-TS$_{ALLOFF}$	85%	ES-TS$_{ALLOFF}$	-	62%

C409.3.4.1 Annual Interior Lighting Energy.

- 1.

  shall be calculated by summing the annual interior lighting energy of each *lighting control zone*.

  The annual interior lighting energy in kWh of the proposed lighting system

- 2.

  Each lighting control zone in the proposed lighting system shall be assigned to a space or subspace and one or more of the interior lighting control types from Table C409.3.3(2). Users shall only be able to select one of the approved interior lighting control code combinations from Table C409.3.4(1).

- 3.

  Calculate the lighting control savings factor for each *lighting control zone*. The lighting control savings factor shall be calculated by summing the weighted lighting control savings value of each lighting control type in the assigned lighting control code. The weighted lighting control savings value shall be calculated using Equation 4-22.

  WLCSV = LCSV x WF
  (Equation 4-22)
  where:

  WLCSV = Weighted Lighting Control Savings Value. WLCSV is calculated for each lighting control type in an approved lighting control code.

  LCSV = Lighting Control Savings Value selected from Table C409.3.4.2 based on *space* type and lighting control type

WF = Weighting Factor from Table C409.3.4(1) based on the lighting control type in an approved lighting control code.

- 4.

The annual interior lighting energy of each *lighting control zone* in the *proposed lighting system*shall be calculated using Equation 4-23. Each calculation shall only include one *space*/subspace and one *luminaire* type. Additional calculations shall be created for each *luminaire* type when a *lighting control zone* serves includes more than one *luminaire* type. All calculations created for the same *lighting control zone* shall use the same lighting control code from Table C409.3.4(1) when calculating the *lighting control savings factor*.

$AILE_{LCZ}$ = LumQty x LUMPwr x (1-$LCSF_{INT}$) x AOH/1000

(Equation 4-23)

where:

$AILE_{LCZ}$ = Annual interior lighting energy of a *lighting control zone* in kWh

LumQty = *Luminaire* quantity

LumPwr = *Luminaire* power in watts (W)

$LCSF_{INT}$ = Interior lighting control savings factor calculated in accordance with C409.3.4.1(c)

AOH = Annual operating hours from Table C409.3.3(1) determined in accordance with Section C409.3.3.3(a)

C409.3.4.2 Annual Exterior Lighting Energy.

- 1.

The annual exterior lighting energy of the *proposed lighting system*shall be calculated by summing the annual exterior lighting energy in kWh of each exterior *building* area or surface designed to be illuminated.

Exception to C409.3.4.2

Exterior lighting meeting the exception to Section C405.4 or the exception to Section C405.2.7 shall not be included in the calculation of the *proposed lighting system performance.*

- 2. .

shall be assigned one or more of the exterior lighting control types from Table C409.3.3(2). Users shall only be able to select one of the approved exterior lighting control code combinations from Table C409.3.4(3).

Each exterior building area or surface designed to be illuminated in the proposed lighting system

- 3.

The annual exterior lighting energy shall be calculated using Equation 4-24 for each exterior *building* area or surface designed to be illuminated in the *proposed lighting system*. Each calculation shall only include one luminaire type. Additional calculations shall be created for each *luminaire* type when an exterior *building* area or surface is illuminated by more than one *luminaire* type.

$AELE_{EBA}$ = LumQty x LumPwr x (1-LCS_{EXT}) x 8760 / 1000

(Equation 4-24)

where:

$AELE_{EBA}$ = Annual exterior lighting energy in kWh of an exterior *building* area or surface designed to be illuminated

LumQty = *Luminaire* quantity

LumPwr = *Luminaire* power in watts (W)

$LCSF_{EXT}$ = Exterior lighting control savings factor from Table C409.3.3(5) based on the proposed exterior lighting control code

C409.3.4.3 Proposed Lighting System Performance.

The *proposed lighting system performance* shall be calculated by summing the annual interior lighting energy and the annual exterior lighting energy of the *proposed design*.

C409.3.5 Calculation of Reference Lighting System Performance.

Reference lighting system performance shall be calculated by summing the total reference annual interior lighting energy determined in accordance with Section C409.3.5.1 and the total reference exterior lighting energy determined in accordance with C409.3.5.2.

C409.3.5.1 Annual Interior Lighting Energy.

- 1.

  The total reference annual interior lighting energy shall be the sum of the reference annual interior lighting energy ($AILE_{REF}$) of each *space* or subspace. The reference annual interior lighting energy ($AILE_{REF}$) of each *space* or subspace shall be calculated using Equation 4-25.

  $AELE_{REF}$ = [(LP - LP_{DA}) x (1-CSF_{NDL}) + (LP_{DA}) x (1-CSF_{DL}) x AOH / 1000

  (Equation 4-25)

  where:

  $AILE_{REF}$ = Reference design case annual internal lighting energy in kWh of a *space* or subspace

  LP = reference lighting power of a *space* or subspace

  LP_{DA} = reference *daylight area* lighting power of a *space* of subspace determined in accordance with Section C409.3.5.1

  CSF_{NDL} = non-daylighting *control savings factor* of a *space* or subspace from Table C409.3.5.1(1)

  CSF_{DL} = daylighting *control savings factor* of a *space* or subspace from Table C409.3.5(1)

  AOH = Annual operating hours from Table C409.3.3(1) determined in accordance with Section C409.3.3.3 Item 1

  If a lighting control is not selected for the lighting control zone, the AOH defaults to 8,760 hours.

- 2.

  For each *space* or subspace:

– 2.1.

The reference lighting power (LP)is determined by multiplying the user-provided area by the lighting power density from Table C409.3.5.1(1). for the given space type.

– 2.2.

The non-daylighting control savings factor (CSFNDL) and the daylighting control savings factor (CSFDL) shall be determined from Table C409.3.5.1(1) for the given space type.

– 2.3.

The daylight area lighting power (LPDA) shall be the largest of the following:

- 2.3.1.

  Equals the product of the *primary sidelit area* in ft^2 (m^2) and the *lighting power density* inW/ft^2 (W/m^2) for the given *space* type. If the product is less than or equal to 75W the *primary sidelit area* lighting power shall be set to 0W.

  Primary sidelit area lighting power (C405.2.4 Item 1):

- 2.3.2.

  Equals the product of the *lighting power density* inW/ft^2 (W/m^2) for the given *space* type and the sum of the *primary sidelit area* and the *secondary sidelight area* in ft^2 (m^2). If the product is less than or equal to 150W the Sidelighted area lighting power shall be set to 0W.

  Sidelit area lighting power (C405.2.4 Item 2):

- 2.3.3.

  Equals the product of the *daylight area under skylights*in ft^2 (m^2) and the *lighting power density* inW/ft^2 (W/m^2) for the given *space* type. If the product is less than or equal to 75 W the *daylight area under skylight* lighting power shall be set to 0W.

  Daylight area under toplight lighting power (C405.2.4 Item 3):

C409.3.5.2 Annual Exterior Lighting Energy.

- 1.

  Total Reference exterior lighting power shall be the sum of the annual site lighting power plus the Reference annual exterior lighting energy ($AELE_{REF}$) for each exterior building area or surface designed to be illuminated in the *proposed lighting system*and as permitted in Tables C405.4.2(2) and C405.4.2(3) for the applicable lighting zone in Table C405.4.2(1).

- 2.

  Exception to C409.3.5.2 Item 2

Luminaires, in the *proposed design*, assigned to uncovered parking areas with a rated input wattage of greater than 78W and a mounting height of 24ft (7.3m) or less above the ground shall be assigned exterior control strategy D and use Equation 4-29 when calculating $AELE_{REF}$

Control Strategy A:

$AELE_{REF}$ = 4,380 x LP / 1000
(Equation 4-26)
where:

$AELE_{REF}$ = Reference design case annual external lighting energy in kWh of a *space* or subspace

LP = reference lighting power of the site allowance, or any tradeable or non-tradeable exterior building area or surface determined by multiplying the user-provided units (e.g., area, length, or quantity) of an exterior building area or surface by the corresponding lighting power allowancefrom Tables C405.4.2(2) and C405.4.2(3).

Control Strategy B:

$AELE_{REF}$ = (2,196 + AMOH) x LP / 1000
(Equation 4-27)
where:

$AELE_{REF}$ = Reference design case annual external lighting energy in kWh of a *space* or subspace

LP = reference lighting power of the site allowance, or any tradeable or non-tradeable exterior building area or surface determined by multiplying the user-provided units (e.g., area, length, or quantity) of an exterior building area or surface by the corresponding lighting power allowancefrom Tables C405.4.2(2) and C405.4.2(3).

AMOH = after midnight operating hours from Table C409.3.3(1) as determined by Section C409.3.3.3(b).
Control Strategy C:

$AELE_{REF}$ = [(2,196 + AMOH) x LP + (2,184 - AMOH) x 0.5 x LP / 1000
(Equation 4-28)
where:

$AELE_{REF}$ = Reference design case annual external lighting energy in kWh of a *space* or subspace

LP = reference lighting power of the site allowance, or any tradeable or non-tradeable exterior building area or surface determined by multiplying the user-provided units (e.g., area, length, or quantity) of an exterior building area or surface by the corresponding lighting power allowancefrom Tables C405.4.2(2) and C405.4.2(3).

AMOH = after midnight operating hours from Table C409.3.3 Item 1 as determined by Section C409.3.3.3 Item 2.
Control Strategy D:

$AELE_{REF}$ = 4,380 x 0.5 x LP / 1000
(Equation 4-29)

where:

$AELE_{REF}$ = Reference design case annual external lighting energy in kWh of a *space* or subspace

LP = reference lighting power of the site allowance, or any tradeable or non-tradeable exterior building area or surface determined by multiplying the user-provided units (e.g., area, length, or quantity) of an exterior building area or surface by the corresponding lighting power allowance from Tables C405.4.2(2) and C405.4.2(3).

AMOH = after midnight operating hours from Table C409.3.3(1) as determined by Section C409.3.3.3 Item 2.

BMOH = before midnight operating hours from Table C409.3.3(1) as determined by Section C409.3.3.3 Item 2.

AELEREF shall be calculated using Equations 4-26 through 4-29 based on the applicable exterior lighting control strategy from Table C409.3.5.2(2) for each exterior building area and for the site.

Table C409.3.5.2(2) Reference Lighting Control Strategies for Building Exteriors

Lighting Power Allowances for Building Exteriors	**Exterior Lighting Control Strategy**	**Non-Tradeable Exterior Surfaces**	**Exterior Lighting Control Strategy**
Base Site Allowance	A	Building façade (area)	B
Parking areas and drives	C	ATM and night depository	A
Walkways and ramps <10' wide	C	Additional ATM	A
Walkways and ramps >10' or greater, plaza areas, special features areas	C	Uncovered entrances and gatehouse inspection stations at guarded facilities	A
Dining Areas	C	Uncovered loading areas for law enforcement, fire, and other emergency	C

Stairways	A	Drive-through windows / doors	C
Pedestrian Tunnels	A	Parking near 24-hour retail entrance	A
Landscaping	B	-	-
Pedestrian and Vehicle Entrance / Exit	C	-	-
Entry Canopies	C	-	-
Loading Docks	C	-	-
Free-Standing and attached Sales Canopy	C	-	-
Open Area Sales	C	-	-
Street Frontage	C	-	-

C405.5.1.1 Existing Buildings.

All components of the proposed *lighting system* shown on architectural drawings or installed in *existing buildings* shall be modeled when calculating the *proposed lighting system performance.*

C405.5.1.2 Trade-Offs Limited to Building Permit.

When the *building* permit being sought applies to less than the whole *building*, parameters relating to unmodified existing conditions or to future *building* components shall be identical for both the *proposed* *lighting system performance* and the *reference lighting system performance*. Future building components shall meet the prescriptive requirements of Section C405.2 and C405.3.

C405.5.1.3 Performance and Reference Designs.

The proposed lighting system performance and *reference lighting system performance* shall be calculated in accordance with Section C405.5.1 using the procedures of Sections C405.5.2 – C405.5.8.

Reason:

This represents an alternate compliance path to the prescriptive requirements in the IECC for lighting controls and lighting power. Currently lighting fixtures and controls are treated independently but Lighting System Performance takes their interdependence into account and allows a designer to establish trade-offs between lighting power and the benefits of lighting controls. The proposal develops a reference design based on meeting the prescriptive compliance requirements. The reference design calculates the energy use of the system (reference lighting design power x operating hours x controls factor = reference energy [kWh]). If the proposed design annual lighting energy consumption is equal to or less than the annual lighting consumption of the reference design, the project meets this compliance path. This option provides more flexibility for practitioners. ANSI/ASHRAE/IES Standard 90.1 and some municipalities are considering this alternate compliance path.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is an alternate compliance path and therefore has no direct impact on the cost of construction. The Reference Design case used as the basis of comparison for a Proposed Design is compliant with all mandatory and prescriptive lighting system criteria in the 2021 IECC. Participating projects would have to demonstrate their project used the same amount or less energy than a design meeting prescriptive requirements. This option allows for practitioner flexibility by allowing them to balance the benefits of [lighting controls against the benefits of low power lighting fixtures.

CEPI-187-21

IECC®: C405.5.1, C405.3.1, C405.2

Proponents:

Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:
C405.5.1 Total connected exterior building exterior lighting power.

The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting <u>that is normally off </u>~~automatically off during normal business operation~~.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. Theatrical purposes, including performance, stage, film production and video production.
8. Athletic playing areas.
9. Temporary lighting.
10. Industrial production, material handling, transportation sites and associated storage areas.
11. Theme elements in theme/amusement parks.
12. Used to highlight features of art, public monuments and the national flag.
13. Lighting for water features and swimming pools.
14. Lighting controlled from within dwelling units, where the lighting complies with Section R404.1.

C405.3.1 Total connected interior lighting power.

The total connected interior lighting power shall be determined in accordance with Equation 4-10.

$TCLP = [LVL + BLL + LED + TRK + \text{Other}]$
(Equation 4-10)

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).

2. The wattage limit of the permanent current-limiting devices protecting the system.

3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

1. Television broadcast lighting for playing areas in sports arenas.

2. Emergency lighting that is normally off ~~automatically off during normal building operation~~.

3. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.

4. Casino gaming areas.

5. Mirror lighting in dressing rooms.

6. Task lighting for medical and dental purposes that is in addition to general lighting.

7. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.

8. Lighting for theatrical purposes, including performance, stage, film production and video production.

9. Lighting for photographic processes.

10. Lighting integral to equipment or instrumentation and installed by the manufacturer.

11. Task lighting for plant growth or maintenance.

12. Advertising signage or directional signage.

13. Lighting for food warming.

14. Lighting equipment that is for sale.

15. Lighting demonstration equipment in lighting education facilities.

16. Lighting approved because of safety considerations.

17. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.

18. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.

19. Exit signs.

20. Antimicrobial lighting used for the sole purpose of disinfecting a space.

C405.2 Lighting controls.

Lighting systems shall be provided with controls that comply with one of the following.

1. Lighting controls as specified in Sections C405.2.1 through C405.2.8.
2. Luminaire level lighting controls (LLLC) and lighting controls as specified in Sections C405.2.1, C405.2.5 and C405.2.6. The LLLC luminaire shall be independently capable of:
   2.1. Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
   2.2. Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.
   2.3. For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeouts, dimming fade rates, sensor sensitivity adjustments, and wireless zoning configurations.

Exceptions: Lighting controls are not required for the following:

1. Areas designated as security or emergency areas that are required to be continuously lighted.

2. Interior exit stairways, interior exit ramps and exit passageways.

3. Emergency ~~egress~~ lighting that is normally off.

Reason Statement:

All three of these sections are trying to describe the same lighting, but each section uses different terminology.

The language proposed here clarifies that this is emergency lighting, not egress lighting, and leaves out the language about "business operation".

Per IBC, emergency lighting can be off at all times when there is no emergency, but egress lighting must be on whenever the space it is serving is occupied.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed change is entirely editorial.

CEPI-187-21

CEPI-188-21

IECC®: C405.5.1

Proponents:

Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2021 International Energy Conservation Code

Revise as follows:
C405.5.1 Total connected exterior building exterior lighting power.

The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting automatically off during normal business operation.
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. Theatrical purposes, including performance, stage, film production and video production.
8. Athletic playing areas.
9. Temporary lighting.
10. Industrial production, material handling, transportation sites and associated storage areas.
11. Theme elements in theme/amusement parks.
12. Used to highlight features of art, public monuments and the national flag.
13. Lighting for water features and swimming pools.
14. Lighting controlled from within dwelling units~~, where the lighting complies with Section R404.1.~~

Reason Statement:

This reference to R404.1 made sense in the 2018 code, where the commercial section referred to R404.1 for efficiency requirements in dwelling units. But now that the commercial chapter has its' own efficiency requirements for dwelling units, this requirement to also comply with R404.1 is confusing and irrelevant.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The change is editorial in nature.

CEPI-188-21

CEPI-189-21

IECC®: C405.5.1, TABLE C405.5.2(3)

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Revise as follows:
C405.5.1 Total connected exterior building exterior lighting power.

The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.

2. Emergency lighting automatically off during normal business operation.

~~3.~~ ~~Exit signs.~~

~~4.~~3. Specialized signal, directional and marker lighting associated with transportation.

~~5.~~4. Advertising signage or directional signage.

~~6.~~5. Integral to equipment or instrumentation and installed by its manufacturer.

~~7.~~6. Theatrical purposes, including performance, stage, film production and video production.

~~8.~~7. Athletic playing areas.

~~9.~~8. Temporary lighting.

~~10~~9. Industrial production, material handling, transportation sites and associated storage areas.

~~11~~10. Theme elements in theme/amusement parks.

~~12~~11. Used to highlight features of art, public monuments and the national flag.

~~13~~12. Lighting for water features and swimming pools.

~~14~~13. Lighting controlled from within dwelling units, where the lighting complies with Section R404.1.

TABLE C405.5.2(3) INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

LIGHTING ZONES				
	Zone 1	Zone 2	Zone 3	Zone 4
Building facades	No allowance	0.075 W/ft^2 of gross above-grade wall area	0.113 W/ft^2 of gross above-grade wall area	0.15 W/ft^2 of gross above-grade wall area
Automated teller machines (ATM) and night depositories	~~135~~89.9 W per location plus ~~45~~34.9 W per additional ATM per location			
Uncovered entrances and gatehouse inspection stations at guarded facilities	~~0.50~~ 0.1439 W/ft^2 of area	~~0.50~~0.2519 W/ft^2 of area	~~0.50~~0.3599 W/ft^2 of area	~~0.50~~0.5039 W/ft^2 of area
Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles	~~0.35~~ 0.1039 W/ft^2 of area	~~0.35~~0.1819 W/ft^2 of area	~~0.35~~0.2599 W/ft^2 of area	~~0.35~~0.3639 W/ft^2 of area
Drive-up windows and doors	~~200~~52.9 W per drive through	~~200~~91.9 W per drive through	~~200~~ 131.9 W per drive through	~~200~~184.9 W per drive through
Parking near 24-hour retail entrances.	~~400~~79.9 W per main entry	~~400~~139.9 W per main entry	~~400~~199.9 W per main entry	~~400~~279.9 W per main entry

For SI: For SI: 1 watt per square foot = W/0.0929 m^2.

W = watts.

Reason Statement:

Many elements in exterior lighting have changed since this section was last modified in the 2018 version. In 2018, lighting fixture device efficacy ranged ranged 80 - 100 lm/W. Since 2018, exterior lighting device efficacy has increased by 20 - 40%. Many exterior lighting devices now exceed 120 lm/W. It is very hard to purchase equipment with efficacy values that low. As a result, the lighting power density values can be reduced in response to the current technology available.

Design practices and research also changed since 2018. In 2018, lighting knowledge about LEDs was still somewhat unknown. At the time, practices were assuming significant degradation assumption in the calculations. Now, industry assumes a degradation of about 15%. This also allows for a reduction in lighting power density through newer guidance on design calculations.

In 2019, the Illuminating Engineering Society (IES) conducted research post 2018 related to exterior lighting. This proposal reflects the revised guidance developed from this new IES research. As a result of the new lighting guidance, certain levels that were previously recommended were now no longer recommended. This proposal aligns with new research from the IES and allows for lower lighting power density values.

Finally, this version first addresses lighting zones. The concept of a lighting zone is that less light is needed because of the adaption state of the eye. Lighting zone 1 is national parks, forest land, rural areas, etc. Lighting Zone 4 is heavy commercial districts like Times Square and the Las Vegas strip. More light is needed in lighting zone 4 than 1 to account for the ambient brightness of the environment. These changes provide values per lighting zone. For example, the previous version had the same value for drive-up windows independent of lighting zone. However, if following good lighting practices, less light (and thus less power) should be provided in lighting zone 1 than 4. This proposed change makes sure that the values ascend based on lighting zone.

This proposal also reflects changes in both lighting technology and practices that allow for lower lighting power density values. The proposed values are similar to those considered in ANSI/ASHRAE/IES Standard 90.1-2022 as well as Washington State Energy Code.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal is similar to an ANSI/ASHRAE/IES Standard 90.1 addendum. The 90.1 addendum met the Std. 90.1 scalar ratio. Exterior lighting fixture prices were surveyed. Prices were supplied by a third party and have remained relatively flat related over the last 5 years independent of the efficacy of the fixtures. Prices have remained flat while efficacy improved. Therefore, costs will not increase in response to this proposal.

CEPI-189-21

CEPI-190-21

IECC®: TABLE C405.5.2(2)

Proponents: Marty Salzberg, representing self

2021 International Energy Conservation Code

Revise as follows:

TABLE C405.5.2(2) LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

Portions of table not shown remain unchanged.

	LIGHTING ZONES			
	Zone 1	Zone 2	Zone 3	Zone 4
Building Grounds				
Walkways and ramps less than 10 feet wide	~~0.50~~ 0.57 W/linear foot	~~0.50~~ 0.57 W/linear foot	~~0.60~~ 0.69 W/linear foot	~~0.70~~ 0.85 W/linear foot

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m^2.

W = watts.

Reason: Another proposal changes the metric used for this area from Watts per linear foot to Watt/ft^2. A walkway that is 4' wide requires the same lighting as a walkway that is 6' wide, but would get 2/3 the allowance. This proposal would restore the metric to Watts per linear foot. Additionally, design experience has shown that this allowance often falls short, so the proposal increases the allowance. Technology has become more efficient, but, the allowance was always scanty.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The addendum is cost effective because it will allow a broader range of fixture options. Fixture costs have not increased significantly over the time period from the previous code update. Suply chain and inflation are the main cost issues.

CEPI-191-21

IECC®: C405.7, TABLE C405.7

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
C405.7 Electrical transformers.

Low-voltage dry-type distribution electric transformers shall meet the minimum efficiency requirements of Table C405.7 as tested and rated in accordance with the test procedure listed in DOE 10 CFR 431.193. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the transformer manufacturer.

Exceptions: The following transformers are exempt:

1. Transformers that meet the ~~*Energy Policy Act of 2005*~~ exclusions based on the DOE 10 CFR 431.192 definitions ~~of special purpose applications~~.

~~2.~~ ~~Transformers that meet the *Energy Policy Act of 2005* exclusions that are not to be used in general purpose applications based on information provided in DOE 10 CFR 431.~~

~~3.~~2. Transformers ~~that meet the *Energy Policy Act of 2005* exclusions~~ with tap range of 20 percent or more ~~multiple voltage taps where the highest tap is not less than 20 percent more than the lowest tap.~~

~~4.~~3. Drive (isolation) transformers.

~~5.~~4. Rectifier transformers.

~~6.~~5. Auto-transformers.

~~7.~~6. Uninterruptible power supply ~~system~~ transformers.

~~8.~~7. Special ~~I~~ impedance transformers.

~~9.~~8. Regulating transformers.

~~10.~~9. Sealed ~~and nonventilating~~ transformers.

~~11.~~10. Machine tool (control) transformers.

~~12.~~11. Welding transformers.

~~13.~~12. Grounding transformers.

~~14.~~13. Testing transformers.

14. Nonventilated Transformers

TABLE C405.7 MINIMUM NOMINAL EFFICIENCY LEVELS FOR DOE 10 CFR 431 LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMERS

SINGLE-PHASE TRANSFORMERS		THREE-PHASE TRANSFORMERS	
kVA[a,c]	Efficiency (%)[b]	kVA[a,c]	Efficiency (%)[b]
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	300	99.02
333	98.90	500	99.14
—	—	750	99.23
—	—	1000	99.28

a. kiloVolt-Amp rating.

b. Nominal efficiencies shall be established in accordance with the DOE 10 CFR 431.193 test procedure for low-voltage dry-type transformers.

c. A low-voltage dry-type distribution transformer with a kVA rating not listed in the table shall have its minimum efficiency level determined by linear interpolation of the kVA and efficiency values listed in the table immediately above and below its kVA rating. Extrapolation shall not be used below the minimum values or above the maximum values shown for single-phase transformers and three-phase transformers.

Reason Statement:

This section shows minimum efficiency requirements for low-voltage dry-type transformers that are used in commercial buildings. Federal efficiency standards were updated in 2016, and the revised values were incorporated into the Table.

However, in the federal requirements, there is language that provides information on the efficiency levels for transformers with kVA ratings that are not shown in the table. See the following web site links for the language:

https://www.govinfo.gov/content/pkg/CFR-2016-title10-vol3/pdf/CFR-2016-title10-vol3-part431-subpartK.pdf Section 431.196, file page 4 of 18, document page 716

https://www.ecfr.gov/cgi-bin/text-idx?node=pt10.3.431&rgn=div5#se10.3.431_1196

This addendum updates the table to include this language in a footnote, along with language that is needed to show that there are no requirements for transformers below minimum kVA ratings or above maximum kVA ratings shown in the table.

As an example, for a single-phase dry-type transformer, the minimum efficiency requirement for a 15 kVA unit is 97.7% and the minimum efficiency requirement for a 25 kVA unit is 98.0%. If someone purchased a 20 kVA unit, then the minimum efficiency required for that transformer, using linear interpolation, would be 97.85%.

This addendum also updates the language in several places in section 8.4.4 to reference the Code of Federal Regulations (CFR) rather than the Energy Policy Act of 2005 and to align the list of exceptions to distribution transformers with the current regulatory language.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is just an update to match the existing table of US federal minimum efficiency requirements that have been in place since 2016. It does not change any efficiency requirements, and therefore has no impact on construction costs.

CEPI-191-21

CEPI-192-21

IECC®: C405.7, TABLE C405.7

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:
C405.7 Electrical transformers.

Low-voltage dry-type distribution electric transformers shall meet the minimum efficiency requirements of Table C405.7 as tested and rated in accordance with the test procedure listed in DOE 10 CFR 431. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the transformer manufacturer.

Exceptions: The following transformers are exempt in accordance with the DOE definition of Distribution Transformers found in 10 CFR 431.192:

~~1.~~ ~~Transformers that meet the *Energy Policy Act of 2005* exclusions based on the DOE 10 CFR 431 definition of special purpose applications.~~

~~2.~~ ~~Transformers that meet the *Energy Policy Act of 2005* exclusions that are not to be used in general purpose applications based on information provided in DOE 10 CFR 431.~~

~~3.~~1. Transformers ~~that meet the *Energy Policy Act of 2005* exclusions with multiple voltage taps where the highest tap is not less than~~ with tap range of 20 percent or more ~~than the lowest tap~~.

~~4.~~2. Drive (isolation) transformers.

~~5.~~3. Rectifier transformers.

~~6.~~4. Auto-transformers.

~~7.~~5. Uninterruptible power supply~~system~~ transformers.

~~8.~~6. Special i~~I~~mpedance transformers.

~~9.~~7. Regulating transformers.

~~10.~~8. Sealed ~~and nonventilating~~ transformers.

~~11.~~9. Machine- tool (control) transformers.

~~12.~~10. Welding transformers.

~~13.~~11. Grounding transformers.

~~14.~~12. Testing transformers.

13. Nonventilated transformers.

TABLE C405.7 MINIMUM NOMINAL EFFICIENCY LEVELS FOR DOE 10 CFR 431 LOW-VOLTAGE DRY-TYPE DISTRIBUTION TRANSFORMERS

Portions of table not shown remain unchanged.

SINGLE-PHASE TRANSFORMERS[a]		**THREE-PHASE TRANSFORMERS[a]**	
kVA~~a~~[b]	**Efficiency (%)~~b~~[c]**	**kVA~~a~~[b]**	**Efficiency (%)~~b~~[c]**
15	97.70	15	97.89
25	98.00	30	98.23
37.5	98.20	45	98.40
50	98.30	75	98.60
75	98.50	112.5	98.74
100	98.60	150	98.83
167	98.70	225	98.94
250	98.80	300	99.02
333	98.90	500	99.14
—	—	750	99.23
—	—	1000	99.28

a. A low-voltage dry-type distribution transformer with a kVA rating not listed in the table shall have its minimum efficiency level determined by linear interpolation of the kVA and efficiency values listed in the table immediately above and below its kVA rating. Extrapolation shall not be used below the minimum values or above the maximum values shown for single-phase transformers and three-phase transformers.

~~a.~~b. kiloVolt-Amp rating.

~~b.~~c. Nominal efficiencies shall be established in accordance with the DOE 10 CFR 431 test procedure for low-voltage dry-type transformers.

Reason Statement:

This section shows minimum efficiency requirements for low-voltage dry-type transformers that are used in commercial buildings. Federal efficiency standards were updated in 2016, and the revised values were incorporated into the Table.

However, in the federal requirements, there is language that provides information on the efficiency levels for transformers with kVA ratings that are not shown in the table. See the following web site links for the language: https://www.govinfo.gov/content/pkg/CFR-2016-title10-vol3/pdf/CFR-2016-title10-vol3-part431-subpartK.pdf Section 431.196, file page 4 of 18, document page 716

https://www.ecfr.gov/cgi-bin/text-idx?node=pt10.3.431&rgn=div5#se10.3.431_1196

This addendum updates the table to include this language in a footnote, along with language that is needed to show that there are no requirements for transformers below minimum kVA ratings or above maximum kVA ratings shown in the table.

As an example, for a single-phase dry-type transformer, the minimum efficiency requirement for a 15 kVA unit is 97.7% and the minimum efficiency requirement for a 25 kVA unit is 98.0%. If someone purchased a 20 kVA unit, then the minimum efficiency required for that transformer, using linear interpolation, would be 97.85%.

This addendum also updates the language in several places in section 8.4.4 to reference the Code of Federal Regulations (CFR) rather than the Energy Policy Act of 2005 and to align the list of exceptions to distribution transformers with the current regulatory language.

Bibliography:

ANSI/ASHRAE/IES Standard 90.1-2019, Energy Standard for Buildings Except Low-Rise Residential Buildings, Addendum ae.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is just an update to match the existing table of US federal minimum efficiency requirements that have been in place since 2016. It does not change any efficiency requirements, and therefore has no impact on construction costs.

CEPI-192-21

CEPI-193-21

IECC®: SECTION C406, SECTION 406 (New), C406.1 (New), C406.1.1 (New), Table C406.1.1 (New), C406.1.1.1 (New), C406.1.2 (New), Table C406.1.2 (New), C406.1.3 (New), C406.1.4 (New), Table C406.1.4(1) (New), Table C406.1.4(2) (New), Table C406.1.4(3) (New), Table C406.1.4(4) (New), Table C406.1.4(5) (New), Table C406.1.4(6) (New), Table C406.1.4(7) (New), Table C406.1.4(8) (New), Table C406.1.4(9) (New), C406.2 (New), C406.2.1 (New), C406.2.1.1 (New), C406.2.1.2 (New), C406.2.1.3 (New), C406.2.1.3.1 (New), C406.2.1.3.2 (New), C406.2.1.3.3 (New), C406.2.1.4 (New), C406.2.1.4.1 (New), C406.2.1.4.2 (New), C406.2.1.5 (New), C406.2.1.5.1 (New), C406.2.1.5.2 (New), C406.2.1.6 (New), Table C406.2.1.6 (New), C406.2.2 (New), C406.2.2.1 (New), C406.2.2.2 (New), C406.2.2.3 (New), C406.2.2.4 (New), C406.2.2.5 (New), C406.2.3 (New), C406.2.3.1 (New), C406.2.3.3 (New), C406.2.3.4 (New), C406.2.3.5 (New), Table C406.2.3.5 (New), C406.2.3.6 (New), C406.2.4 (New), C406.2.5 (New), C406.2.5.1 (New), C406.2.5.2 (New), C406.2.5.3 (New), C406.2.5.4 (New), TABLE C406.2.5.4 (New), C406.2.5.5 (New), C406.2.5.6 (New), C406.2.7 (New), C406.2.7.1 (New), C406.2.7.2 (New), Table C406.2.7.2(1) (New), Table C406.2.7.2(2) (New), TABLE C406.2.7.2(3) (New), Table C406.2.7.2(4) (New), C406.2.7.3 (New), C406.2.7.4 (New), C406.3 (New), Table C406.3(1) (New), Table C406.3(2) (New), Table C406.3(3) (New), Table C406.3(4) (New), Table C406.3(5) (New), Table C403.6(6) (New), Table C406.3(7) (New), Table C406.3(8) (New), Table C406.3(9) (New), C406.3.1 (New), Table 406.3.1 (New), Table C406.3.1 (New), C406.3.2 (New), G406.3.3 (New), C406.3.4 (New), C406.3.5 (New), C403.6.6 (New), G406.3.7 (New), C406.3.8 (New), C407.2, TABLE C407.2, APPENDIX CD (New), CD101 (New), CD101.1 (New), CD101.2 (New), CD102 (New), CD102.1 (New), Table CD102.1 (New), ANSI Chapter 06 (New), IEC (New), IEC (New), OpenADR (New)

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Delete without substitution:
~~SECTION C406 ADDITIONAL EFFICIENCY REQUIREMENTS~~
Add new text as follows:
SECTION 406 ADDITIONAL EFFICIENCY, RENEWABLE, and LOAD MANAGEMENT REQUIREMENTS
C406.1 Compliance.

New buildings and changes in space conditioning, change of occupancy and building additions in accordance with Chapter 5 exceeding 500 square feet (46.5 m^2) of floor area shall comply with the requirements of Section C406.1.1. Alterations shall comply with C406.1.3.

C406.1.1 Additional energy efficiency credit requirements.

Projects shall comply with sufficient measures from C406.2 to achieve the minimum number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone. Projects with multiple *occupancies*, unconditioned parking garages, alterations, and buildings with separate shell-and-core and initial build-out *construction* permits shall comply as follows:

1. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required.
2. Where separate permits are used for *building* core/shell and initial build-out construction then compliance shall be in accordance with Section C406.1.1.1.
3. Substantial *alterations* as described in Section C406.1.3 that are not initial build-out *construction* shall achieve half the credits required for the *building* occupancy.
4. Unconditioned parking garages shall achieve half the credits required for use groups S-1 and S-2 in Table C406.1.1.

Exceptions:

1. Utility buildings, and miscellaneous use buildings up to 1000 ft^2 (90 m^2) that are not occupied except for maintenance.
2. Industrial and manufacturing portions of factory use areas within buildings, not including office areas.
3. Where the core/shell complied in accordance with C407, the initial build-out alterations do not need to achieve any energy credits.

Table C406.1.1 Energy Credit Requirements by Building Occupancy Group

Table C406.1.1 Energy Credit Requirements by Building Occupancy Group

Building Occupancy Group	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4, and I-1	85	85	91	100	100	100	100	100	100	94	100	100	93	100	100	100	100	100	100
I-2	50	49	47	46	46	48	44	44	45	48	48	49	54	55	56	55	56	58	59
R-1	59	57	60	60	62	62	65	67	68	67	70	73	78	75	82	86	82	94	100
B	66	63	65	68	64	63	67	68	68	70	73	74	83	83	84	95	92	94	100
A-2	74	74	75	76	79	79	77	80	87	73	78	82	100	98	100	100	100	100	100
M	95	94	95	93	94	97	87	85	97	82	75	68	79	94	83	100	98	100	87
E	67	68	68	70	72	71	72	76	77	77	83	79	83	86	89	90	89	88	89
S-1 and S-2	90	89	95	92	93	91	66	83	95	38	62	90	100	93	87	100	100	100	98
All Other	37	36	37	38	38	39	37	38	41	34	37	39	42	43	44	47	46	47	47

C406.1.1.1 Building Core/Shell and Initial Build-Out Construction.

Where separate permits are used for *building* core/shell and initial build-out construction compliance shall be in accordance with the following requirements.

1. The building core and shell permit(s) shall achieve at least half the energy credits required in Table C406.1.1.
2. The *building envelope*, *equipment,* and *systems* in initial build-out construction exceeding 500 square feet (46.5 m^2) of floor area in *buildings* where the *alteration* did not have final lighting or HVAC systems installed under a prior building permit shall be deemed to comply with Section C406.1 where either:

   2.1 The energy credits achieved under the project plus the energy credits achieved under a prior core and shell permit total at least the credits required in Table C406.1.1. Credits achieved under 2021 IECC Section C406 shall be multiplied by 2.5 for application to this code.

   2.2 The project achieves not less than one half of the credits required in Table C406.1.1.

C406.1.2 Additional renewable and load management credit requirements.

Projects in new buildings and *additions* that are greater than 5000 square feet (465 m^2) shall comply with sufficient measures from C406.3 to achieve the minimum number of required renewable and load management credits from Table C406.1.2 based on building occupancy group and climate zone.

Table C406.1.2 Renewable and Load Management Credit Requirements by Building Occupancy Group

Building Occupancy Group	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8

R-2, R-4, and I-1	64	59	70	69	73	89	76	91	96	63	93	70	51	79	66	52	63	50	47
I-2	31	32	33	32	33	40	36	40	34	32	44	32	29	37	34	34	33	28	24
R-1	41	44	48	49	49	63	55	66	68	50	66	52	42	60	51	46	52	41	36
B	63	64	78	75	78	89	87	100	100	77	100	86	69	93	83	72	86	73	59
A-2	8	8	9	9	9	11	9	11	11	8	11	9	8	9	9	8	9	8	5
M	71	70	84	84	95	100	100	100	100	87	100	99	83	100	96	83	90	78	61
E	50	56	64	61	69	87	77	96	97	72	100	79	62	90	79	70	77	65	52
S-1 and S-2	100	100	100	100	100	100	100	100	100	98	100	100	78	100	100	69	94	70	60
All Other	55	55	66	63	69	81	72	87	89	61	87	69	53	75	67	54	63	52	43

C406.1.3 Substantial Alterations to Existing Buildings.

The *building envelope*, *equipment*, and *systems* in *alterations* to *buildings* exceeding 5000 square feet (46.5 m^2) of *gross conditioned floor area* shall comply with the requirements of Section C406.1.1 and C406.1.2 where the alteration includes replacement of two or more of the following:

1. HVAC unitary systems or HVAC central heating or cooling equipment serving the alteration area, not including ductwork or *piping*
2. 80% or more of the lighting fixtures in the *alteration* area
3. Building envelope components in the *alteration* area including new exterior cladding, fenestration, or insulation.

C406.1.4 Energy Credits Achieved.

Energy credits achieved for the project shall be the sum of measure energy credits for individual measures included in the project. Credits are available for the measures listed in Section C406.2. Base energy credits are shown in Tables C406.1.4(1) through C406.1.4(9) based on building occupancies and climate zones. Measure energy credits achieved shall be determined in one of three ways, depending on the measure:

1. The measure energy credit shall be the base energy credit for the measure where no adjustment factor or formula is shown in the measure description in Section C406.2.
2. The measure energy credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the measure description in Section C406.2. Where adjustments are applied, each measure energy credit shall be rounded to the nearest whole number.
3. The measure energy credit shall be by direct formula as stated in the measure description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.

Table C406.1.4(1) Base Energy Credits for Group R-2, R-4, and I-1 Occupancies

ID	Energy Credit Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		

E02	UA reduction (15%)	C406.2.1.2	8	13	7	11	6	8	9	6	1	24	8	9	30	15	5	32	28	31	36
E03	Envelope leak reduction	C406.2.1.3	15	10	12	8	6	16	13	5	1	47	7	9	65	16	x	73	43	52	26
E04	Add R-5 Roof Insulation	C406.2.1.4	1	0	0	1	1	1	2	2	1	3	2	2	3	3	0	4	4	3	4
E05	Add R-10 Roof Insulation	C406.2.1.4	1	1	1	1	1	1	4	3	1	5	3	4	6	5	0	7	7	6	8
E06	Add R-2.5ci Wall Insulation	C406.2.1.5	6	6	3	5	3	4	5	2	1	5	2	2	6	4	0	8	7	7	7
E07	Add R-5.0ci Wall Insulation	C406.2.1.5	10	10	6	8	5	6	8	4	1	8	3	4	11	7	0	14	12	13	13
E08	Fenestration U-0.45	C406.2.1.6	0	0	0	0	14	17	x	x	x	x	x	x	x	x	x	x	x	x	x
E09	Fenestration U-0.33	C406.2.1.6	x	x	x	x	7	9	15	6	0	0	7	2	x	x	x	x	x	x	x
E10	Fenestration U-0.31	C406.2.1.6	x	x	x	x	x	x	x	x	x	5	0	1	16	0	0	16	10	x	x
E11	Fenestration U-0.26	C406.2.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	42	35	25	14
H01	HVAC Performance	C406.2.2.1	20	19	16	17	14	13	11	11	5	13	10	8	15	12	7	18	14	17	19
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	3	1	1	6	2	3	10	5	2	14	10	13	16
H03	Cooling efficiency	C406.2.2.3	7	6	4	4	3	3	1	1	1	1	1	1	1	1	x	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	9	10	8	22	20	25	16	17	32	21	24	17	23	27	16	21	24	18	18
H05	DOAS/fan control	C406.2.2.5	32	31	27	28	23	23	28	21	12	42	24	24	56	36	19	73	54	70	79
W01	SHW preheat recovery	C406.2.3.1 a	61	63	74	74	85	88	101	100	121	103	109	122	102	111	130	93	106	99	96
W02	Heat pump water heater	C406.2.3.1 b	50	52	62	61	72	74	86	85	104	88	94	106	88	96	112	81	92	87	84
W03	Efficient gas water heater	C406.2.3.1 c	38	39	46	46	53	55	63	62	76	64	68	76	64	69	81	58	66	62	60
W04	SHW pipe insulation	C406.2.3.2	7	7	8	7	8	8	8	9	10	8	9	9	7	8	9	6	7	6	6
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	3	3	3	3	3	3	3	3	4	3	3	4	3	3	4	3	3	3	2
W07	SHW heat trace system	C406.2.3.3 c	12	12	13	13	14	15	15	15	18	14	15	16	13	14	16	11	13	11	10

W08	SHW submeters	C406.2.3.4	11	11	13	13	15	16	18	18	22	19	20	22	19	20	24	17	20	18	18
W09	SHW distribution sizing	C406.2.3.5	45	46	55	54	63	65	74	73	89	75	80	89	74	81	95	68	77	72	70
W10	Shower heat recovery	C406.2.3.6	15	16	19	19	22	23	26	26	32	27	29	32	27	29	34	25	28	27	26
P01	Energy monitoring	C406.2.4	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
L03	Increase occp. sensor	C406.2.5.3	3	3	4	4	4	4	3	4	3	2	3	2	1	2	2	1	1	1	1
L04	Increase daylight area	C406.2.5.4	5	5	5	5	5	5	4	4	4	4	4	3	3	4	3	2	3	3	2
L05	Residential light control	C406.2.5.5	8	8	9	9	9	9	8	8	10	6	8	7	4	6	8	3	5	4	3
L06	Light power reduction	C406.2.5.7	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	1	1	1	1
Q01	Efficient elevator	C406.2.7.1	4	4	4	4	5	5	5	5	5	4	5	5	4	4	5	4	4	4	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	15	15	17	16	17	18	17	18	20	16	17	18	15	16	18	13	15	13	12
Q04	Fault detection	C406.2.7.4	3	3	2	3	2	2	2	2	1	2	2	1	2	2	1	3	2	3	3

x indicates measure is not available for building occupancy in that climate zone

Table C406.1.4(2) Base Energy Credits for Group I-2 Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	6	11	6	11	7	9	6	6	2	3	3	3	4	3	7	5	5	17	3
E03	Envelope leak reduction	C406.2.1.3	5	3	4	3	5	8	8	3	2	6	2	2	7	3	1	9	7	19	5
E04	Add R-5 Roof Insulation	C406.2.1.4	0	0	0	1	1	1	1	1	0	1	0	0	1	1	0	1	1	1	2

E05	Add R-10 Roof Insulation	C406.2.1.4	1	1	0	1	1	1	1	1	0	1	1	1	2	1	0	2	1	2	3
E06	Add R-2.5ci Wall Insulation	C406.2.1.5	0	3	0	2	1	2	8	3	1	3	0	1	2	1	0	2	1	2	2
E07	Add R-5.0ci Wall Insulation	C406.2.1.5	0	3	0	3	2	2	9	4	1	4	1	1	3	0	0	3	3	3	3
E08	Fenestration U-0.45	C406.2.1.6	0	0	0	0	1	2	x	x	x	x	x	x	x	x	x	x	x	x	x
E09	Fenestration U-0.33	C406.2.1.6	x	x	x	x	2	3	2	3	1	0	1	0	x	x	x	x	x	x	x
E10	Fenestration U-0.31	C406.2.1.6	x	x	x	x	x	x	x	x	x	3	1	2	2	1	1	1	0	x	x
E11	Fenestration U-0.26	C406.2.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	6	5	1	0
H01	HVAC Performance	C406.2.2.1	23	22	21	21	20	19	19	18	16	19	18	16	19	18	18	21	21	24	26
H02	Heating efficiency	C406.2.2.2	x	x	x	x	2	3	4	3	7	6	4	6	8	6	10	11	12	15	19
H03	Cooling efficiency	C406.2.2.3	6	6	4	4	3	3	2	2	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	8	8	6	18	16	17	11	12	23	13	16	13	14	17	17	13	19	15	17
H05	DOAS/fan control	C406.2.2.5	41	41	40	40	42	36	42	37	39	49	40	46	56	46	61	65	68	82	93
W01	SHW preheat recovery	C406.2.3.1 a	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6	5	5	5
W02	Heat pump water heater	C406.2.3.1 b	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
W03	Efficient gas water heater	C406.2.3.1 c	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W04	SHW pipe insulation	C406.2.3.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
W07	SHW heat trace system	C406.2.3.3 c	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW distribution sizing	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

P01	Energy monitoring	C406.2.4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	5	5	5	6	5	6	6	5	6	6	5	5	5	4	4	3	2
L03	Increase occp. sensor	C406.2.5.3	5	5	5	5	5	5	5	5	6	5	5	6	5	5	5	4	4	3	2
L04	Increase daylight area	C406.2.5.4	7	7	7	7	7	7	7	7	8	6	6	6	6	6	5	5	5	5	4
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	7	7	7	7	7	7	7	7	9	7	7	8	6	7	7	5	5	4	3
Q01	Efficient elevator	C406.2.7.1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3	4	4

x indicates measure is not available for building occupancy in that climate zone.

Table C406.1.4(3) Base Energy Credits for Group R-1 Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	8	12	7	12	6	8	6	7	13	8	5	3	9	7	3	13	12	18	26
E03	Envelope leak reduction	C406.2.1.3	15	9	12	8	6	16	7	5	10	14	3	1	19	5	x	28	16	28	18
E04	Add R-5 Roof Insulation	C406.2.1.4	0	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	2
E05	Add R-10 Roof Insulation	C406.2.1.4	1	1	1	2	2	1	2	1	1	2	1	2	2	1	2	3	2	2	3
E06	Add R-2.5ci Wall Insulation	C406.2.1.5	14	19	8	19	2	3	3	2	0	4	1	3	4	2	2	5	3	4	3
E07	Add R-5.0ci Wall Insulation	C406.2.1.5	18	26	11	25	3	4	5	3	0	6	2	4	7	4	4	8	6	8	5
E08	Fenestration U-0.45	C406.2.1.6	2	2	1	2	2	3	x	x	x	x	x	x	x	x	x	x	x	x	x

E09	Fenestration U-0.33	C406.2.1.6	x	x	x	x	2	3	4	3	1	1	6	3	x	x	x	x	x	x	x
E10	Fenestration U-0.31	C406.2.1.6	x	x	x	x	x	x	x	x	x	4	1	3	6	1	3	6	4	x	x
E11	Fenestration U-0.26	C406.2.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	13	8	5	2
H01	HVAC Performance	C406.2.2.1	21	20	17	18	16	13	12	12	11	11	11	8	11	11	8	13	11	14	16
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	1	1	6	2	1	1	3	2	2	6	4	8	11
H03	Cooling efficiency	C406.2.2.3	7	6	4	4	3	2	1	2	1	1	2	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	8	8	6	31	28	36	19	23	54	21	31	22	22	30	21	19	24	18	19
H05	DOAS/fan control	C406.2.2.5	32	30	26	28	25	23	24	22	28	26	22	20	30	26	19	41	34	48	62
W01	SHW preheat recovery	C406.2.3.1 a	18	19	22	22	25	27	31	31	32	34	34	38	37	36	40	36	37	36	35
W02	Heat pump water heater	C406.2.3.1 b	14	15	18	17	20	22	25	25	27	29	29	32	31	31	34	30	32	31	30
W03	Efficient gas water heater	C406.2.3.1 c	11	12	14	14	16	17	19	19	20	21	21	24	23	23	25	22	23	23	22
W04	SHW pipe insulation	C406.2.3.2	3	3	4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4	3
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2	1	1
W07	SHW heat trace system	C406.2.3.3 c	5	6	6	6	6	7	7	7	7	7	7	8	7	7	8	7	7	6	6
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW distribution sizing	C406.2.3.5	13	14	16	16	18	20	22	22	23	25	25	28	27	26	29	26	27	26	25
W10	Shower heat recovery	C406.2.3.6	4	5	5	5	6	7	8	8	8	9	9	10	10	9	10	9	10	10	9
P01	Energy monitoring	C406.2.4	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

L03	Increase occp. sensor	C406.2.5.3	3	3	3	3	3	3	3	3	4	2	3	3	2	2	3	2	2	1	1
L04	Increase daylight area	C406.2.5.4	4	5	5	4	5	5	4	4	5	4	4	4	3	4	3	3	3	3	2
L05	Residential light control	C406.2.5.5	7	7	8	8	8	8	8	8	9	6	7	7	5	7	7	4	5	4	3
L06	Light power reduction	C406.2.5.7	1	1	2	2	2	2	2	2	2	1	2	2	1	1	2	1	1	1	1
Q01	Efficient elevator	C406.2.7.1	2	2	2	2	2	2	2	3	3	3	3	3	3	3	3	2	2	2	2
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	9	9	10	10	10	11	11	11	11	11	11	12	11	11	12	10	11	10	9
Q04	Fault detection	C406.2.7.4	3	3	3	3	2	2	2	2	2	2	2	1	2	2	1	2	2	2	2

x indicates measure is not available for building occupancy in that climate zone

Table C406.1.4(4) Base Energy Credits for Group B Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	4	7	4	7	3	4	7	2	0	7	2	3	10	6	4	12	9	19	11
E03	Envelope leak reduction	C406.2.1.3	5	3	4	2	2	2	5	1	0	8	0	2	13	4	0	18	9	18	7
E04	Add R-5 Roof Insulation	C406.2.1.4	1	1	1	1	1	1	2	1	0	2	1	1	2	2	1	3	3	4	5
E05	Add R-10 Roof Insulation	C406.2.1.4	2	2	2	2	2	2	3	2	1	3	1	2	3	2	2	3	3	2	3
E06	Add R-2.5ci Wall Insulation	C406.2.1.5	9	9	5	7	2	2	4	2	0	3	1	2	3	2	2	5	4	6	4
E07	Add R-5.0ci Wall Insulation	C406.2.1.5	13	14	8	11	4	4	7	4	0	5	2	4	6	4	3	9	7	10	8
E08	Fenestration U-0.45	C406.2.1.6	1	1	2	2	7	7	x	x	x	x	x	x	x	x	x	x	x	x	x
E09	Fenestration U-0.33	C406.2.1.6	x	x	x	x	4	4	8	3	0	0	0	0	x	x	x	x	x	x	x
E10	Fenestration U-0.31	C406.2.1.6	x	x	x	x	x	x	x	x	x	5	1	3	7	1	3	7	4	x	x
E11	Fenestration U-0.26	C406.2.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	21	17	8	0

H01	HVAC Performance	C406.2.2.1	22	22	19	20	17	17	15	15	11	15	15	11	16	15	11	19	17	18	20
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	1	1	0	3	2	2	5	4	3	9	7	8	12
H03	Cooling efficiency	C406.2.2.3	7	6	4	5	3	3	1	2	1	1	2	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	8	9	7	9	7	8	5	7	7	7	9	6	9	11	7	11	12	8	10
H05	DOAS/fan control	C406.2.2.5	31	31	27	29	25	25	28	26	18	35	28	28	47	38	29	64	53	58	74
W01	SHW preheat recovery	C406.2.3.1 a	8	9	10	9	11	11	12	12	14	13	13	14	13	13	15	12	13	14	14
W02	Heat pump water heater	C406.2.3.1 b	3	3	3	3	4	4	5	4	5	5	5	6	5	5	6	5	5	6	6
W03	Efficient gas water heater	C406.2.3.1 c	5	5	6	6	7	7	8	7	8	8	8	9	8	8	9	8	8	9	8
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	4	5	4	4	5	4	4	5	4	4	4	4
W05	Point of use water heaters	C406.2.3.3 a	12	15	17	16	18	18	19	19	22	20	20	22	20	20	22	18	19	20	19
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	4	5	5	5	5	6	5	5	6	5	5	6	5	5	5	5
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW distribution sizing	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P01	Energy monitoring	C406.2.4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	6	6	6	6	6	6	7	6	6	6	5	5	6	4	5	3	2
L03	Increase occp. sensor	C406.2.5.3	5	6	6	6	6	6	6	6	8	6	6	6	5	5	6	4	5	4	3
L04	Increase daylight area	C406.2.5.4	7	7	8	8	8	8	8	8	9	6	7	7	6	6	6	6	6	7	5
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	7	7	8	8	8	8	8	8	9	7	8	8	6	7	8	5	6	5	3

Q01	Efficient elevator	C406.2.7.1	4	4	4	4	5	5	5	5	5	5	5	5	5	5	5	4	5	4	4
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	3	3	3	3

x indicates measure is not available for building occupancy in that climate zone

Table C406.1.4(5) Base Energy Credits for Group A-2 Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	1	1	1	1	2	2	9	2	0	19	4	5	26	7	3	33	23	29	13
E03	Envelope leak reduction	C406.2.1.3	2	1	1	1	2	3	11	2	0	24	4	6	33	9	3	42	29	36	16
E04	Add R-5 Roof Insulation	C406.2.1.4	0	0	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	1	1
E05	Add R-10 Roof Insulation	C406.2.1.4	1	1	0	1	1	1	2	1	1	1	1	1	2	2	1	2	2	1	2
E06	Add R-2.5ci Wall Insulation	C406.2.1.5	1	1	0	1	1	1	2	2	0	1	0	1	2	1	1	1	1	1	1
E07	Add R-5.0ci Wall Insulation	C406.2.1.5	1	1	0	1	1	2	3	3	1	2	1	2	2	2	2	2	2	2	2
E08	Fenestration U-0.45	C406.2.1.6	0	0	0	0	1	1	x	x	x	x	x	x	x	x	x	x	x	x	x
E09	Fenestration U-0.33	C406.2.1.6	x	x	x	x	1	2	3	2	1	0	0	0	x	x	x	x	x	x	x
E10	Fenestration U-0.31	C406.2.1.6	x	x	x	x	x	x	x	x	x	1	0	1	2	0	1	2	1	x	x
E11	Fenestration U-0.26	C406.2.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	4	4	0	0
H01	HVAC Performance	C406.2.2.1	18	17	13	15	13	10	12	10	6	14	11	10	16	14	11	20	17	22	25
H02	Heating efficiency	C406.2.2.2	x	x	x	x	1	1	6	3	3	10	6	8	15	11	10	19	15	23	28
H03	Cooling efficiency	C406.2.2.3	6	5	3	4	3	2	1	1	1	1	1	1	1	1	1	x	x	x	x

H04	Residential HVAC control	C406.2.2.4	7	7	5	24	23	29	20	21	39	26	34	24	30	38	25	27	32	26	28
H05	DOAS/fan control	C406.2.2.5	29	27	20	25	24	21	36	27	15	51	35	38	67	53	45	84	70	97	115
W01	SHW preheat recovery	C406.2.3.1 a	24	26	31	29	33	35	37	38	45	38	41	44	37	40	44	34	38	33	30
W02	Heat pump water heater	C406.2.3.1 b	15	16	19	18	21	23	25	25	29	26	28	30	26	28	31	25	27	24	22
W03	Efficient gas water heater	C406.2.3.1 c	15	16	19	18	21	22	23	24	28	24	25	27	23	25	27	21	24	21	18
W04	SHW pipe insulation	C406.2.3.2	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3	2	2	2	2
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	3	4	4	4	4	4	4	4	4	4	4	4	3	4	4	3	3	3	3
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW distribution sizing	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P01	Energy monitoring	C406.2.4	2	2	2	2	2	1	2	1	1	2	1	1	2	2	1	2	2	2	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	0
L03	Increase occp. sensor	C406.2.5.3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	0
L04	Increase daylight area	C406.2.5.4	3	3	3	3	3	3	2	2	2	2	2	2	1	2	1	1	1	1	1
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	2	1	1
Q01	Efficient elevator	C406.2.7.1	0	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0
Q02	Commercial kitchen equip.	C406.2.7.2	24	26	28	27	28	29	27	29	32	26	28	29	24	26	28	21	23	19	17
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Q04	Fault detection	C406.2.7.4	3	2	2	2	2	2	2	2	1	2	2	1	2	2	2	3	2	3	4

x indicates measure is not available for building occupancy in that climate zone

Table C406.1.4(6) Base Energy Credits for Group M Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	2	2	2	2	2	3	15	2	0	36	5	9	45	11	5	51	36	35	15
E03	Envelope leak reduction	C406.2.1.3	3	3	2	2	3	3	19	3	0	44	6	11	56	13	6	64	44	43	19
E04	Add R-5 Roof Insulation	C406.2.1.4	4	3	3	4	4	4	10	9	2	11	10	11	12	13	13	13	15	13	17
E05	Add R-10 Roof Insulation	C406.2.1.4	8	6	5	7	7	7	18	16	4	19	18	20	21	22	23	24	26	24	30
E06	Add R-2.5ci Wall Insulation	C406.2.1.5	46	47	34	45	8	9	14	11	3	16	13	16	15	14	14	13	14	14	9
E07	Add R-5.0ci Wall Insulation	C406.2.1.5	64	65	48	62	13	15	23	18	4	27	21	27	25	24	25	23	24	24	16
E08	Fenestration U-0.45	C406.2.1.6	0	0	0	0	0	0	x	x	x	x	x	x	x	x	x	x	x	x	x
E09	Fenestration U-0.33	C406.2.1.6	x	x	x	x	0	0	0	0	0	0	0	0	x	x	x	x	x	x	x
E10	Fenestration U-0.31	C406.2.1.6	x	x	x	x	x	x	x	x	x	5	4	5	4	3	5	4	3	x	x
E11	Fenestration U-0.26	C406.2.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	10	10	0	0
H01	HVAC Performance	C406.2.2.1	31	30	26	28	23	21	23	20	14	27	21	22	29	25	23	32	28	30	33
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	10	3	1	19	8	15	26	17	18	29	24	27	31
H03	Cooling efficiency	C406.2.2.3	10	9	7	7	5	4	2	2	1	1	2	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	11	12	9	18	15	17	19	15	19	31	27	26	35	38	27	31	35	25	27
H05	DOAS/fan control	C406.2.2.5	48	48	42	47	40	38	66	46	31	98	61	82	120	91	90	134	115	125	141
W01	SHW preheat recovery	C406.2.3.1 a	12	13	16	15	18	20	19	21	26	17	21	21	16	19	21	13	16	15	13
W02	Heat pump water heater	C406.2.3.1 b	3	3	4	3	4	5	5	5	7	5	6	6	4	5	6	4	4	4	4

W03	Efficient gas water heater	C406.2.3.1 c	6	7	8	8	10	10	10	11	14	9	11	11	8	10	11	7	8	8	7
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	4	5	4	4	5	4	4	5	4	4	4	4
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	4	5	5	5	5	6	5	5	6	5	5	6	5	5	5	5
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW distribution sizing	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P01	Energy monitoring	C406.2.4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	9	9	11	10	12	13	11	13	15	9	12	11	7	9	10	5	7	5	3
L03	Increase occp. sensor	C406.2.5.3	9	9	11	10	12	13	12	13	15	10	12	11	7	10	11	6	8	5	4
L04	Increase daylight area	C406.2.5.4	12	13	15	14	16	17	15	16	20	11	14	13	9	12	11	8	10	10	8
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	12	12	14	14	15	16	12	15	19	8	12	9	6	10	7	6	7	6	5
Q01	Efficient elevator	C406.2.7.1	3	3	4	3	4	4	4	4	5	3	4	4	3	4	4	3	3	3	2
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	2	2	2	2	2	2	2	1	2	2	1	2	2	2	3	2	3	4

x indicates measure is not available for building occupancy in that climate zone

Table C406.1.4(7) Base Energy Credits for Group E Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		

			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	9	22	8	20	9	12	5	11	3	4	9	2	3	6	0	4	3	4	3
E03	Envelope leak reduction	C406.2.1.3	4	3	3	3	2	5	2	1	0	0	0	0	1	0	0	2	0	1	1
E04	Add R-5 Roof Insulation	C406.2.1.4	4	5	2	5	2	5	8	4	0	7	4	6	11	7	11	13	14	12	15
E05	Add R-10 Roof Insulation	C406.2.1.4	8	8	4	9	5	7	16	7	0	14	7	10	18	13	13	23	25	22	28
E06	Add R-2.5ci Wall Insulation	C406.2.1.5	3	5	2	5	2	4	6	4	1	4	2	3	4	3	2	4	4	3	4
E07	Add R-5.0ci Wall Insulation	C406.2.1.5	5	7	4	8	3	6	8	6	2	6	3	6	5	5	6	7	6	7	8
E08	Fenestration U-0.45	C406.2.1.6	0	0	0	0	4	6	x	x	x	x	x	x	x	x	x	x	x	x	x
E09	Fenestration U-0.33	C406.2.1.6	x	x	x	x	1	5	15	8	0	1	2	4	x	x	x	x	x	x	x
E10	Fenestration U-0.31	C406.2.1.6	x	x	x	x	x	x	x	x	x	10	4	10	15	4	11	13	12	x	x
E11	Fenestration U-0.26	C406.2.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	34	29	12	10
H01	HVAC Performance	C406.2.2.1	30	28	25	26	23	21	20	18	15	19	18	17	19	20	15	23	20	25	29
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	4	3	3	5	5	10	9	11	6	15	11	18	26
H03	Cooling efficiency	C406.2.2.3	9	8	6	7	5	4	2	2	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	10	11	8	14	11	14	11	12	17	12	20	18	16	28	13	18	20	18	23
H05	DOAS/fan control	C406.2.2.5	45	42	37	41	36	34	41	39	30	43	46	58	57	65	40	79	63	88	117
W01	SHW preheat recovery	C406.2.3.1 a	7	7	9	8	10	11	13	13	15	14	15	15	15	14	17	13	15	14	12
W02	Heat pump water heater	C406.2.3.1 b	4	4	6	5	7	7	9	9	10	10	10	11	11	10	12	10	11	10	9
W03	Efficient gas water heater	C406.2.3.1 c	4	4	6	5	6	7	8	8	9	9	9	10	9	9	11	8	10	9	7
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	5	6	5	5	6	5	5	7	4	5	4	4
W05	Point of use water heaters	C406.2.3.3 a	3	4	4	4	4	5	5	5	6	5	5	5	5	5	6	4	5	4	3

W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	2	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	4	5	5	5	6	7	6	6	7	6	6	8	5	7	5	5
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW distribution sizing	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	2	2	2	2	3	3	3	3	4	3	3	4	3	3	4	3	3	3	3
P01	Energy monitoring	C406.2.4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	5	6	6	6	5	6	7	6	6	6	5	5	6	4	4	3	2
L03	Increase occp. sensor	C406.2.5.3	4	4	5	5	5	6	6	6	7	6	6	5	4	4	5	3	4	3	2
L04	Increase daylight area	C406.2.5.4	6	6	7	7	7	7	7	7	8	6	6	6	5	5	6	5	5	5	4
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	6	7	7	7	8	8	8	8	10	7	8	7	6	7	8	5	6	4	2
Q01	Efficient elevator	C406.2.7.1	3	4	4	4	4	5	5	5	5	5	5	5	5	5	5	4	5	4	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	4	4	4	4	3	3	3	3	2	3	3	3	3	3	2	4	3	4	4

x indicates measure is not available for building occupancy in that climate zone

Table C406.1.4(8) Base Energy Credits for Group S-1 and S-2 Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	1	2	1	1	1	2	25	2	0	62	11	14	74	21	6	75	57	56	21
E03	Envelope leak reduction	C406.2.1.3	2	2	1	2	1	3	31	3	x	77	14	17	92	25	8	95	71	69	26

E04	Add R-5 Roof Insulation	C406.2.1.4	8	7	6	6	6	7	12	10	4	8	11	10	8	12	13	5	8	7	11
E05	Add R-10 Roof Insulation	C406.2.1.4	13	12	10	11	10	11	18	17	7	14	19	18	14	20	22	10	14	12	19
E06	Add R-2.5ci Wall Insulation	C406.2.1.5	12	14	8	13	4	6	11	7	2	6	7	8	5	7	7	4	5	5	4
E07	Add R-5.0ci Wall Insulation	C406.2.1.5	19	23	13	21	7	10	15	12	3	10	12	13	9	12	12	7	9	9	8
E08	Fenestration U-0.45	C406.2.1.6	0	0	0	0	0	0	x	x	x	x	x	x	x	x	x	x	x	x	x
E09	Fenestration U-0.33	C406.2.1.6	x	x	x	x	0	0	0	0	0	0	0	0	x	x	x	x	x	x	x
E10	Fenestration U-0.31	C406.2.1.6	x	x	x	x	x	x	x	x	x	4	0	5	8	0	5	6	3	x	x
E11	Fenestration U-0.26	C406.2.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	3	3	10	12
H01	HVAC Performance	C406.2.2.1	20	21	14	18	12	13	20	13	6	31	21	22	36	30	20	39	34	38	38
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	16	3	1	33	17	22	41	31	21	44	38	43	43
H03	Cooling efficiency	C406.2.2.3	7	7	4	5	3	3	1	1	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	8	9	6	6	4	5	21	8	2	44	38	30	50	57	26	42	48	36	34
H05	DOAS/fan control	C406.2.2.5	35	37	26	33	24	27	77	35	14	141	83	96	168	132	90	180	157	177	178
W01	SHW preheat recovery	C406.2.3.1 a	8	7	9	8	10	10	8	10	12	5	8	8	4	6	9	3	4	3	3
W02	Heat pump water heater	C406.2.3.1 b	2	2	2	2	2	2	2	2	3	1	2	2	1	2	2	1	1	1	1
W03	Efficient gas water heater	C406.2.3.1 c	4	4	5	4	5	5	4	5	6	3	4	4	2	3	5	2	2	2	2
W04	SHW pipe insulation	C406.2.3.2	3	3	4	3	3	3	2	3	4	2	2	3	1	2	3	1	1	1	1
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	3	4	4	3	4	5	2	3	3	2	2	4	2	2	2	2
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW distribution sizing	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

W10	Shower heat recovery	C406.2.3.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
P01	Energy monitoring	C406.2.4	5	5	6	6	6	6	5	6	6	5	5	5	5	5	6	5	5	5	5
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	10	10	12	11	12	14	9	12	14	6	9	9	3	6	9	3	5	3	2
L03	Increase occp. sensor	C406.2.5.3	12	12	14	13	15	14	12	14	17	7	11	11	5	7	11	4	6	3	3
L04	Increase daylight area	C406.2.5.4	15	14	18	16	18	17	13	16	21	7	12	11	5	8	10	4	6	6	5
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	14	14	17	16	17	17	13	17	19	8	13	12	5	8	12	4	6	4	2
Q01	Efficient elevator	C406.2.7.1	15	14	18	16	18	18	15	18	21	9	14	14	7	10	14	5	7	5	5
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	3	2	3	2	2	3	2	1	5	3	3	5	4	3	6	5	6	6

x indicates measure is not available for building occupancy in that climate zone

Table C406.1.4(9) Base Energy Credits for Other[a] Occupancies

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	5	9	5	8	5	6	10	5	2	20	6	6	25	10	4	28	22	26	16
E03	Envelope leak reduction	C406.2.1.3	6	4	5	4	3	7	12	3	2	28	5	6	36	9	3	41	27	33	15
E04	Add R-5 Roof Insulation	C406.2.1.4	2	2	2	2	2	3	5	4	1	4	4	4	5	5	6	5	6	5	7
E05	Add R-10 Roof Insulation	C406.2.1.4	4	4	3	4	4	4	8	6	2	7	6	7	9	8	9	9	10	9	12
E06	Add R-2.5ci Wall Insulation	C406.2.1.5	11	13	8	12	3	4	7	4	1	5	3	5	5	4	4	5	5	5	4

E07	Add R-5.0ci Wall Insulation	C406.2.1.5	16	19	11	17	5	6	10	7	2	9	6	8	9	7	7	9	9	10	8
E08	Fenestration U-0.45	C406.2.1.6	0	0	0	1	4	5	x	x	x	x	x	x	x	x	x	x	x	x	x
E09	Fenestration U-0.33	C406.2.1.6	x	x	x	x	2	3	6	3	0	0	2	1	x	x	x	x	x	x	x
E10	Fenestration U-0.31	C406.2.1.6	x	x	x	x	x	x	x	x	x	5	1	4	8	1	4	7	5	x	x
E11	Fenestration U-0.26	C406.2.1.6	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	17	14	8	5
H01	HVAC Performance	C406.2.2.1	23	22	19	20	17	16	17	15	11	19	16	14	20	18	14	23	20	24	26
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	6	2	3	11	6	8	15	11	9	18	15	19	23
H03	Cooling efficiency	C406.2.2.3	7	7	5	5	4	3	1	2	1	x	x	x	x	x	x	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	9	9	7	18	16	19	15	14	24	22	25	20	25	31	19	23	27	21	22
H05	DOAS/fan control	C406.2.2.5	37	36	31	34	30	28	43	32	23	61	42	49	75	61	49	90	77	93	##
W01	SHW preheat recovery	C406.2.3.1 a	18	19	22	21	25	26	28	29	34	29	31	34	29	31	35	26	29	27	26
W02	Heat pump water heater	C406.2.3.1 b	12	12	15	14	17	17	20	20	24	21	22	25	21	23	26	20	22	21	20
W03	Efficient gas water heater	C406.2.3.1 c	11	11	13	13	15	16	17	17	21	18	19	21	18	19	22	16	18	17	16
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	4	5	4	4	5	4	4	5	3	4	3	3
W05	Point of use water heaters	C406.2.3.3 a	8	10	11	10	11	12	12	12	14	13	13	14	13	13	14	11	12	12	11
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	2	1	1	2	1	1	2	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	5	5	5	5	6	6	6	6	7	6	6	7	5	6	7	5	5	5	5
W08	SHW submeters	C406.2.3.4	11	11	13	13	15	16	18	18	22	19	20	22	19	20	24	17	20	18	18
W09	SHW distribution sizing	C406.2.3.5	29	30	36	35	41	43	48	48	56	50	53	59	51	54	62	47	52	49	48
W10	Shower heat recovery	C406.2.3.6	6	6	7	7	8	9	10	10	11	10	11	12	10	11	12	10	11	10	10
P01	Energy monitoring	C406.2.4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

L02	Lighting dimming & tuning	C406.2.5.2	5	5	5	5	6	6	5	6	7	5	5	5	4	4	5	3	4	3	2
L03	Increase occp. sensor	C406.2.5.3	5	6	6	6	7	7	6	7	8	5	6	6	4	5	6	3	4	3	2
L04	Increase daylight area	C406.2.5.4	7	8	9	8	9	9	8	8	10	6	7	7	5	6	6	4	5	5	4
L05	Residential light control	C406.2.5.5	8	8	9	9	9	9	8	8	10	6	8	7	5	7	8	4	5	4	3
L06	Light power reduction	C406.2.5.7	7	7	8	7	8	8	7	8	9	5	7	6	4	5	6	4	4	3	2
Q01	Efficient elevator	C406.2.7.1	4	4	5	4	5	5	5	5	6	4	5	5	4	4	5	3	4	3	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	3	3	3	3	2	3	2	2	3	3	2	3	3	2	4	3	4	4

x indicates measure is not available for building occupancy in that climate zone

[a] Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, and R.

C406.2 Additional Energy Efficiency Credit Measures.

Each energy efficiency credit measure used to meet credit requirements for the project shall include efficiency that is greater than the energy efficiency required for the building type and configuration requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.7 shall achieve the credits listed for the measure and occupancy type in Tables C406.1.4(1) through C406.1.4(9) or where calculations required by Sections C406.2.1 through C406.2.7 create or modify the table credits, the credits achieved shall be based upon the section calculations.

C406.2.1 More Efficient Building Envelope.
A project shall achieve credits for improved envelope performance through compliance with the requirements of one of the following:

1. Section C406.2.1.1 (E01)
2. Section C406.2.1.2 (E02)
3. Section C406.2.1.3 (E03)
4. Both EO2 and E03
5. Any combination of
    5.1 Section C406.2.1.3: E03A, E03B, or E03C
    5.2 Section C406.2.1.4: E04 or E05
    5.3 Section C406.2.1.5: E06 or E07
    5.4 Section C406.2.1.6: E08, E09, E10, or E11

C406.2.1.1 EO1 Improved envelope performance 90.1 Appendix C.

To achieve this credit, building envelope measures shall be installed to improve the energy performance of the project. The allowable energy credits shall be determined using Equation 4-13.

$EC_{env} = 1000 \text{ X } (EPF_B - EPF_P)/EPF_B$
(Equation #)

where:

EC_{ENV} = E01 measure energy credits

EPF_B= base envelope performance factorcalculated in accordance with ASHRAE 90.1-2019 Appendix C.

EPF_P = proposed envelope performance factor calculated in accordance with ASHRAE 90.1-2019 Appendix C.

C406.2.1.2 E02 Total UA envelope reduction.

Energy credits shall be achieved where the total UA of the building thermal envelope as designed is not less than 15 percent below the total UA of the building thermal envelope in accordance with Section C402.1.5.

C406.2.1.3 E03 Reduced air infiltration.

Energy credits shall be achieved for tested air leakage less than thresholds in either section C406.2.1.3.1, C406.2.1.3.2, or C406.2.1.3.3 where tested in accordance with the following:Air infiltration shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air-leakage rate of the project envelope shall not exceed the required cfm/ft^2 (L/s · m^2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade project envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Alternate testing method: For projects having over 50,000 square feet (4645 m^2) of conditioned floor area, air-leakage testing need not be conducted on the whole project where testing is conducted on representative above-grade sections of the project. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section
C406.2.1.3.1 E03A Reduced air leakage to 0.25.

The measured air-leakage rate of the project envelope shall not exceed 0.25 cfm/ft^2 (1.3 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), Multiply E03 Credits times 1.0.

C406.2.1.3.2 E03B Reduced air leakage to 0.15.
The measured air-leakage rate of the project envelope shall not exceed 0.15 cfm/ft^2 (0.8 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), Multiply E03 Credits times 1.2.
C406.2.1.3.3 E03C Reduced air leakage to 0.08.
The measured air-leakage rate of the project envelope shall not exceed 0.08 cfm/ft^2 (0.4 L/s × m^2) under a pressure differential of 0.3 inches water column (75 Pa), Multiply E03 Credits times 2.0.
C406.2.1.4 Improved Roof Insulation.

Energy credits shall be achieved for improved insulation of all roof areas in the project meeting the requirements in either section C406.2.1.6.1 or C406.2.1.6.2. Such insulation shall be in addition to the required insulation in Table C402.1.3.

C406.2.1.4.1 E04 Add R-5 Roof Insulation.

All roof area shall have additional R-5 continuous insulation included in the roof assembly. This can be achieved with 0.75 inches (19mm) of polyisocyanurate, 1.25 inches (32 mm) of expanded polystyrene (EPS), or other insulation rated at R-10. For attics this is permitted to be achieved with fill or batt insulation rated at R-5 that is continuous and not interrupted by ceiling or roof joists. Where interrupted by joists, the added insulation shall be R-8 or more.

C406.2.1.4.2 E05 Add R-10 Roof Insulation.

All roof area shall have additional R-10 continuous insulation included in the roof assembly. This can be achieved with 1.5 inches (38 mm) of polyisocyanurate or 2.5 inches (64 mm) of EPS or other insulation rated at R-10. For attics this is permitted to be achieved with fill or batt insulation rated at R-10 that is continuous and not interrupted by ceiling or roof joists. Where interrupted by joists, the added insulation shall be R-13 or more.

C406.2.1.5 Improved Wall Insulation.

Energy credits shall be achieved for improved insulation applied to at least 90% of all opaque walls in the project meeting the requirements in either section C406.2.1.5.1 or C406.2.1.5.2. Such insulation shall be in addition to the required insulation in Table C402.1.3.

C406.2.1.5.1 E06 Add R-2.5 to Walls.

Opaque walls shall have additional R-2.5 continuous insulation included in the wall assembly. This can be achieved with 0.375 inches of polyisocyanurate, 0.625 inches of EPS, or other continuous wall insulation rated at R-2.5.

C406.2.1.5.2 E07 Add R-5 to Walls.

Opaque walls shall have additional R-5 continuous insulation included in the wall assembly. This can be achieved with 0.75 inches of polyisocyanurate or 1.25 inches of EPS, or other continuous wall insulation rated at R-5.

C406.2.1.6 E08- E11 Improved fenestration..

Energy credits for one selected fenestration energy credit ID shall be achieved for improved energy characteristics of all vertical fenestration in the project meeting the requirements in one of the rows of Table C406.2.1.6. The area-weighted average U-factor and SHGC of all vertical fenestration shall be equal to or less than the value shown in the selected table row. The area-weighted average visible transmittance (VT) of all vertical fenestration shall be equal to or greater than the value shown in the selected table row.

Table C406.2.1.6 Vertical Fenestration Requirements for Energy Credits

Energy Credit ID	**Applicable Climate Zones**	**Maximum U-Factor**	**Maximum SHGC**	**Minimum VT**
E08	0-2	0.45	0.21	0.230
E09	2-4	0.33	0.23	0.253
E10	4-6	0.31	0.36	0.396
E11	6-7	0.26	0.38	0.418

C406.2.2 More Efficient HVAC Equipment Performance.

All heating and cooling systems shall meet the minimum requirements of Section C403 and efficiency improvements shall be referenced to minimum efficiencies listed in Tables referenced by Section C403.3.2. Where multiple efficiency requirements are listed, equipment shall meet the seasonal efficiencies including SEER, EER/integrated energy efficiency ratio (IEER), integrated part load value (IPLV), or AFUE. Equipment that is larger than the maximum capacity range indicated in Tables referenced by Section C403.3.2 shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table. Where multiple individual heating or cooling systems serve the project, the improvement shall be the weighted average improvement based on individual system capacity.

Systems are permitted to achieve HVAC energy credits by meeting the requirements of either:

1. C406.2.2.1 H01
2. C406.2.2.2 H02
3. C406.2.2.3 H03
4. C406.2.2.4 H04
5. C406.2.2.5 H05
6. Any combination of H02, H03, H04 and H05
7. The combination of H01 and H04

C406.2.2.1 H01 HVAC Performance (TSPR).

For systems required to comply with Section C403.1.1, HVAC total system performance ratio, the TSPR shall exceed the minimum requirement by 5 percent. If improvement is greater, base energy credits from Table C406.1.2(1) through C406.1.2(9) are permitted to be prorated up to a 20 percent improvement using Equation 4-14. Energy credits for H01 may not be combined with energy credits from HVAC measures H02, H03 and H05.

H01 energy credit = H01 base energy credit x TSPR% / 5%
(Equation 4-14)

where:

TSPR% = percentage by which TSPR of proposed design exceeds minimum TSPR requirement. The value of TSPR% cannot exceed 20% for purposes of calculating H01 energy credits.

C406.2.2.2 H02 More efficient HVAC equipment heating performance.

No less than 90 percent of the total HVAC capacity serving the total *conditioned floor area* of the entire building, or tenant space in accordance with Section C406.1.1, shall comply with the requirements of this Section.

1. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2 or air-to-water heat pumps. Electric resistance heating shall be limited to 20 percent of system capacity, with the exception of heat pump supplemental heating.

2. Equipment shall exceed the minimum heating efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum annual heating efficiency requirements by more than 5 percent, energy efficiency credits for heating shall be determined using Equation 4-14 rounded to the nearest whole number.

$EEC_{HEH} = EEC_{H5} \times (HEI / 5\%)$
(Equation #)

where:

EEC_{HEH} = energy efficiency credits for heating efficiency improvement

EEC_5 = C406.2.2.2 credits from Tables C406.1.2(1) through C406.1.2(9)

HEI = the lesser of: the improvement above minimum heating efficiency requirements, or 20 percent. Where heating efficiency varies by system, use the capacity weighted average percentage for all heating equipment combined.

Exception: In low energy spaces complying with Section C402.1.1, no less than 90 percent of the installed heating capacity is provided by electric infrared or gas-fired radiant heating equipment for localized heating applications. Such spaces shall only achieve energy credits for EEC_5.

C406.2.2.3 H03 More efficient HVAC equipment cooling and fan performance..

No less than 90 percent of the total HVAC capacity serving the total *conditioned floor area* of the entire building, or tenant space in accordance with Section C406.1.1, shall comply with all of the requirements of this section. Where individual equipment efficiencies vary, weight them based on rated capacity.

1. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2 or air-to-water heat pumps. Air-to-water heat pumps do not have a requirement for minimum efficiency.

2. Equipment shall exceed the minimum cooling efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum annual cooling efficiency and heat rejection efficiency requirements by more than 5 percent, energy efficiency credits for cooling shall be determined using Equation 4-15, rounded to the nearest whole number.

   $EEC_{HEC} = EEC_5 \times (CEI / 5\%)$
   (Equation #)

   where:

   EEC_{HEC} = energy efficiency credits for cooling efficiency improvement

   EEC_5 = C406.2.2.2 base energy credits from Tables C406.1.2(1) through C406.1.2(9)

   CEI = the lesser of: the improvement above minimum cooling and heat rejection efficiency requirements, or 20 percent. Where cooling efficiency varies by system, use the capacity weighted average percentage for all cooling equipment combined.

   Where fan energy is not included in packaged equipment rating or it is and the fan size has been increased from the as-rated equipment condition, fan power or horsepower shall be less than 95 percent of the allowed fan power in Section C403.8.1.

C406.2.2.4 H04 Residential HVAC control..

HVAC systems serving *dwelling units* or *sleeping units* shall be controlled with a programmable thermostat that is configured to automatically activate a setback condition of at least 5°F (3°C) for both heating and cooling. The programmable thermostat shall be configured to provide setback during occupied sleep periods. The unoccupied setback mode shall be configured to operate in conjunction with one of the following:

1. A manual main control device by each *dwelling unit* main entrance that initiates setback and non-ventilation mode for all HVAC units in the dwelling unit and is clearly identified as “Heating/Cooling Master Setback.”
2. Occupancy sensors in each room of the *dwelling unit* combined with a door switch to initiate setback and non-ventilation mode for all HVAC units in the dwelling within 20 minutes of all spaces being vacant immediately after a door switch operation. Where separate room HVAC units are used, an individual occupancy sensor on each unit that is configured to provide setback shall meet this requirement.
3. An advanced learning thermostat that senses occupant presence and automatically creates a schedule for occupancy and provides a dynamic setback schedule based on when the spaces are generally unoccupied.
4. An automated control and sensing system that uses geographic fencing connected to the dwelling unit occupants’ cell phones and initiates the setback condition when all occupants are away from the building.

C406.2.2.5 H05 Dedicated Outdoor Air System.

To achieve this credit, where single zone HVAC units are not required to have modulating fan control in accordance with Section C403.8.6.1, the base energy credits shown in Table 406.2 shall be prorated proportionately to the *conditioned floor area* served by single zone HVAC units with constant speed fans. HVAC controls and *ventilation* systems shall include all of the following:

1. Zone controls shall cycle the indoor fans with the load.
2. Outdoor air shall be supplied by an independent ventilation system designed to provide no more than 110% of the minimum outdoor air to each individual occupied zone, as specified by the *International Mechanical Code*.
3. The ventilation system shall have energy recovery with an *enthalpy recovery ratio* of 65% or more at heating design conditions in climate zones 3 through 8 and an enthalpy recovery ratio of 65% or more at cooling design conditions in climate zones 0, 1, 2, 3A, 3B, 4A, 4B, 5A, and 6A. In “A” climate zones, energy recovery shall include latent recovery.
4. Where the ventilation system serves multiple zones, an outdoor air bypass or wheel speed control shall automatically do one of the following:
   - 4.1 Set the energy recovery leaving-air temperature 55°F (13°C) or 100% outdoor air bypass when a majority of zones require cooling and outdoor air temperature is below 70°F (21°C).
   - 4.2 The HVAC system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.
5. Ventilation systems providing mechanical dehumidification shall use recovered energy for reheat.

C406.2.3 Reduced Energy Use In-service Water Heating.

Projects with service water-heating equipment that serves the whole building, a building addition or a tenant space shall achieve credits through compliance with the requirements of this section. Systems are permitted to achieve energy credits by meeting the requirements of either:

1. C406.2.6.1 by selecting one allowed measure W01, W02 or W03
2. C406.2.6.2
3. C406.2.6.3 by selecting one allowed measure W05, W06, or W07
4. C406.2.6.4 W08
5. C406.2.6.5 W09
6. C406.2.6.6 W10
7. Any combination of measures in C402.2.6.1 through C402.2.6.6 as long no more than one allowed measure from C406.2.6.1 and C406.2.6.3 are selected.

C406.2.3.1 Service water-heating system efficiency.

A project is allowed to claim energy credits from only one of the following water-heating system efficiency measures.

W01 Recovered or renewable water heating. The building service water-heating system shall have one or more of the following that are sized to provide not less than 30 percent of the building's annual hot water requirements, or sized to provide 70 percent of the building's annual hot water requirements if the building is required to comply with Section C403.10.5:

1.

1.1 Waste heat recovery from SHW, heat recovery chillers, building equipment, or process equipment.

1.2 A water-to-water heat pump that precools chilled water return for building cooling.

1.3 On-site renewable energy water-heating systems.

W02 Heat pump water heater. To achieve this credit, air-source heat pump *water heater*s shall not draw conditioned air from within the *building*, except exhaust air that would otherwise be exhausted to the exterior. Any *recirculating system* and final heating shall be met with a separate non-heat pump heating source. Requirements shall be in accordance with one of the following:

2.

2.1 For multifamily, dormitories, and health care occupancies with a *recirculating system*, at least 30% of design end-use *service water-heating* requirements shall be met using heat pump preheat with a coefficient of performance (COP) of not less than 4.0 tested at 50°F (10°C) entering air and 70°F (21°C) entering water in accordance with AHRI Standard 1300. A preheat storage tank equal to 25% of peak demand shall be included in design.

2.2 For office, restaurant and school *occupancies* with *piping* temperature maintenance, at least 30% of design end-use *service water-heating* requirements shall be met using heat pump preheat with a combined input-capacity-weighted-average UEF of 3.0 with a medium draw pattern for unitary *equipment* with either a *heat trace system* or a separate *water heater* in series for *recirculating system* and final heating.

2.3 For retail, small office, and warehouse *occupancies* with no *recirculating system*, at least 30% of design end-use *service water-heating* requirements shall be met using the heat pump portion of a hybrid *water heater* with a combined input-capacity-weighted-average UEF of 3.0 with a medium draw pattern for unitary *equipment*, including *electric resistance* heating to meet peak loading.

Where the heat pump capacity at 50°F (10°C) entering air and 70°F (21°C) entering water exceeds 50% of the design end-use load excluding *recirculating system* losses, the base credits from the Section C406.1 tables shall be prorated based on Equation 4-16.

WO2 credit = base W02 table credit X (HP_{LF} / 50%)
(Equation 4-16)

where:

HP_{LF} = Heat pump capacity as a fraction of the design end-use SHW requirements excluding recirculating system losses, not to exceed 80%.

3. **W03 Efficient fossil fuel water heater**. The combined input-capacity-weighted-average equipment rating of all fossil fuel water-heating equipment in the building shall be not less than 95% Et or 0.95 EF. This measure shall receive only half the listed energy credits for projects required to comply with C404.2.1.

<u>C406.2.3.3</u> <u>Water-heating distribution temperature maintenance</u>.

<u>A project is allowed to claim energy credits from only one of the following SHW distribution temperature maintenance measures.</u>

W05 Point of use water heaters. Credits are available for office or school buildings larger than 10,000 ft^2 (930 m^2). Fixtures requiring hot water shall be supplied from a localized source of hot water with no recirculating system or heat trace piping. Supply piping from the water heater to the termination of the fixture supply pipe shall be insulated to the levels shown in Table C403.12.3 without exception. The volume from the water heater to the termination of the fixture supply pipe shall be limited as follows:

1.

1.1 Non-residential lavatories: not more than 2 oz (60 mL)

1.2 All other plumbing fixtures or appliances: not more than 0.25 gallons (0.95 L)

Exception: Where all remotely located hot water uses meet the requirements for measure W05, separate water heaters serving commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping.

2. **W06 Thermostatic balancing valves.** Credits are available where service water heating is provided centrally and distributed throughout the building. Each recirculating system branch return connection to the main SHW supply piping shall have an automatic thermostatic balancing valve set to a minimal return water flow when the branch return temperature is greater than 115°F

(46°C).

3. **W07 Heat trace system.** Credits are available for projects with gross floor area greater than 10,000 square feet and a central water-heating system. The energy credits achieved shall be from Tables C406.1.2(1) through C406.1.2(9). This system shall include self-regulating electric heat cables, connection kits, and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.

C406.2.3.4 W08 Water-heating system submeters.

To achieve this credit, each individual *dwelling unit* in a Group R-2 occupancy served by a central service water-heating system shall be provided with a SHW meter connected to a reporting system that provides individual *dwelling unit* reporting of actual domestic hot water use. Preheated water serving the cold water inlet to showers need not be metered. Where other codes or regulations require individual *dwelling unit* hot water metering, energy credits for this measure shall not be allowed.

C406.2.3.5 W09 Water heating distribution sizing.

To achieve this credit, where Group R-1 and R-2 occupancies are served by a central SHW system, the distribution system serving dwelling units and guest rooms shall be sized using IAPMO/ANSI WE●Stand – 2017 Water Efficiency and Sanitation Standard for the Built Environment. Plumbing fixtures in residential spaces that are connected to the service water-heating system shall have a flow or consumption rating ≤ the values shown in Table C406.2.3.5. Where other codes or regulations require fixture flows to be equal to or less than listed in Table C406.2.3.5 only half the base energy credits shall be achieved for this measure.

Table C406.2.3.5

Maximum Flow Rating for Residential Plumbing Fixtures with Heated Water

Plumbing Fixture	**Maximum Flow Rate**
Faucet for private lavatory,[a] hand sinks, or bar sinks	1.50 gpm at 60 psi (0.095 L/s at 410 kPa)
Faucet for residential kitchen sink [a,b, c]	1.8 gpm at 60 psi 0.11 L/s at 410 kPa)
Shower head (including hand-held shower spray) [a, b, d]	2.0 gpm at 80 psi (0.13 L/s at 550 kPa)

a. Showerheads, lavatory faucets and kitchen faucets are subject to U.S. Federal requirements listed in 10 CFR 430.32(o)-(p).

b. Maximum flow allowed is less than required by flow rates listed in U.S. 10 CFR 430.32(o)-(p) for showerheads and kitchen faucets.

c. Residential kitchen faucet may temporarily increase the flow above the maximum rate, but not above 2.2 gallons per minute at 60 psi (0.14 L/s at 410 kPa) and must default to the maximum flow rate listed.

d. When a shower is served by multiple shower heads, the combined flow rate of all shower heads controlled by a single valve shall not exceed the maximum flow rate listed or the shower shall be designed to allow only one shower head to operate at a time.

C406.2.3.6 W10 Shower drain heat recovery.

To achieve this credit, cold water serving building showers shall be preheated by shower drain heat recovery units that comply with CSA B55.2. Potable waterside pressure loss shall be less than 10 psi (69 kPa) at maximum design flow. The efficiency of drain heat recovery units shall be 54% or greater measured in accordance with CSA B55.1. Full credits are applicable to the following building use types: health clinic, hospital, hotel, motel, multifamily, retirement facility, dormitory, and schools with more than eight showers. Partial credits are applicable to buildings where all but ground floor showers are served where the base energy credit from Tables C406.1.2(1) through C406.1.2(9) is adjusted by Equation 4-17.

W10 credit = W10 base energy credit X (showers with drain heat recovery / total showers in building) **(Equation 4.17)**

C406.2.4 P01 Energy Monitoring.

A project not required to comply with C405.12 can claim energy credits for installing an energy monitoring system that complies with all the requirements of C405.12.1 through C405.12.

C406.2.5 Energy Savings in Lighting Systems.

Projects are permitted to achieve energy credits for increased lighting system performance by meeting the requirements of either:

1. C406.2.5.2 L02
2. C406.2.5.3 L03
3. C406.2.5.4 L04
4. C406.2.5.5 L05
5. C406.2.5.6 L06
6. Any combination of L03, L04, L05 and L06
7. Any combination of L02, L03 and L04

C406.2.5.1 L01 Lighting system performance (reserved).

Reserved for future use

C406.2.5.2 L02 Enhanced digital lighting controls..

Measure credits shall be achieved where no less than 50 percent of the gross floor area within the project shall comply with the requirements of this section.

1. Lighting controls function. Interior general lighting shall be located, scheduled and operated in accordance with Section C405.2 and shall be configured with the following enhanced control functions:
   - 1.1 Luminaires shall be configured for continuous dimming.
   - 1.2 Each luminaire shall be individually addressed.

     Exceptions:

     1. Multiple luminaires mounted on no more than 12 linear feet of a single lighting track and addressed as a single luminaire.
     2. Multiple linear luminaires that are ganged together to create the appearance of a single longer fixture and addressed as a single luminaire, where the total length of the combined luminaires is not more than 12 feet.
   - 1.3 No more than eight luminaires within a *daylight zone* are permitted to be controlled by a single *daylight responsive control*.
2. Luminaires shall be controlled by a digital control system configured with the following capabilities:
   - 2.1 Scheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.
   - 2.2 Load shedding.
   - 2.3 In open and enclosed offices, the illumination level of overhead general illumination luminaires are configured to be individually adjusted by occupants.
   - 2,4 Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.
3. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.
4. High-end trim. Luminaires shall be initially configured with the following:
   - 4.1 High-end trim, setting the maximum light output of individual luminaires or groups of luminaires to support visual needs of a space or area, shall be implemented and construction documents shall state that maximum light output or power of controlled lighting shall be initially reduced by at least 15 percent from full output. The average maximum light output or power of the controlled lighting shall be documented without high-end trim and with high-end trim to verify reduction of light output or power by at least 15 percent when tuned.
   - 4.2 Where lumen maintenance control is used, controls shall be configured to limit the initial maximum lumen output or maximum lighting power to 85 percent or less of full light output or full power draw and lumen maintenance controls shall be limited to increasing lighting power by 1 percent per year.
   - 4.3 High-end trim and lumen maintenance controls shall be accessible only to authorized personnel.

Where *general lighting* in more than 50 percent of the *gross lighted floor area* receives *high-end trim*, the base credits from Tables C406.1.2(1) through C406.1.2(9) shall be prorated as follows:

[Tuned lighted floor area,%] × [Base energy credits for C406.2.5.2] / 50%

C406.2.5.3 L03 Increase occupancy sensor.

To achieve this credit, automatic partial OFF or automatic full OFF occupancy sensors shall be installed in all space types not required by C405.2.1 and shall be installed as follows:

1. Automatic shutoff or light reduction shall occur within 15 minutes of all occupants leaving each control zone.
2. For spaces with multiple control zones or automatic partial OFF control, automatic full shutoff shall occur within 15 minutes of all occupants leaving the space.
3. For spaces with one control zone, automatic full OFF control shall be used.
4. All areas of the project with automatic partial OFF or automatic full OFF control shall have one control device for every 600 ft^2 (60 m^2) of gross lighted area.

Exception: to automatic full OFF control requirement: Stairwells.

C406.2.5.4 L04 Increase daylight area.

To achieve this credit, the total daylight area of the project (DLA_{BLDG}) with continuous daylight dimming meeting the requirements of C405.2.4 shall be at least 5% greater than the typical daylit area (DLA_{TYP}). Where the actual daylight area includes additional daylit areas beyond the primary sidelighted areas, secondary sidelighted areas, daylight area under skylights, or daylight area under roof monitor then:

1. An analysis based on IES LM83 shall be submitted demonstrating that the spatial daylight autonomy (sDA) is at least 200, 60% for the additional actual daylight area (DLA_{BLDG}).
2. Additional daylit areas shall be separately controlled by automatic daylighting controls.

Credits for measure L04 shall be determined based on Equation 4-18:

$EC_{DL} = EC_{DL5} \times 20 \times [(DLA_{BLDG}/GLFA) - DLA_{TYP}]$
(Equation #)

where:

EC_{DL} = C406.2.5.4 L04 measure base energy credits

DLA_{BLDG} = The lesser of actual daylight area of the project with continuous daylight dimming, ft^2 or m^2 and DLA_{max} in Table C406.2.5.4

GLFA = Project gross lighted floor area, ft^2 or m^2

DLA_{TYP} = Typical % of building area with daylight control (as a fraction) from Table C406.2.5.4:

EC_{DL5} = C406.2.5.4 L04 base energy credits from Tables C406.1.2(1) through C406.1.2(9)

TABLE C406.2.5.4

ADDED DAYLIGHTING PARAMETERS

***Building* use type**	**DLA_{TYP}**	**DLA_{max}**
Small Office ≤ 5000 ft^2 (460 m^2)	10%	20%
Office > 5000 ft^2 (460 m^2)	21%	31%
Single-floor retail ≤ 3000 ft^2 (280 m^2) or retail with ≤ 1000 ft^2 (900 m^2) *roof* area	0%	20%

Retail >3000 ft^2 (280 m^2) of single-floor area	60%	80%
School	42%	52%
Warehouse and semiheated	50%	70%
Medical, hotel, multifamily, dormitory, and other	NA	NA

C406.2.5.5 L05 Residential light control.

To achieve this credit, in buildings with nontransient residential spaces interior lighting systems shall comply with the following:

1. Restrooms, laundry rooms, storage rooms, utility rooms, and interior parking areas shall have automatic full OFF occupancy sensor controls that comply with the requirements of C405.2.1.1. Each additional control device shall control no more than 5,000sq.ft.
2. Stairwells, lobbies, and corridors shall have automatic partial OFF occupancy sensor controls that shall reduce general lighting power in the space by at least 66% of full lighting power within 15 minutes of all occupants leaving the space.
3. Each *dwelling unit* shall have a main control by the main entrance that turns off all the lights and all switched receptacles in the *dwelling unit*. Two switched receptacles shall be provided in living and sleeping rooms or areas and clearly identified. All switched receptacles shall be located within 12 inches (30 cm) of an unswitched receptacle. The main control shall be permitted to have two controls, one for permanently wired lighting and one for switched receptacles. The main controls should be clearly identified as "lights master off" and "outlets master off."

Where item 2 is not practicable, it is permitted to be excluded and measure credits shall be 85% of base credits from Tables C406.1.2(1) through C406.1.2(9) or EC_{rl} calculated using Equation 4-19.

Where automatic lighting controls similar to item 3 are required in some *dwelling units* by C405.2, base credits shall be prorated using Equation 4-19.

$EC_{rl} = EC_t \times [\,0.8 \times (1 - Area_{durl}/Area_{du}) + 0.2\,]$
(Equation #)

where:

EC_{rl} = Residential lighting control measure energy credit achieved for the project

EC_t = C406.2.5.5 L05 base energy credit for building use type and Climate Zone

$Area_{durl}$ = Dwelling unit gross lighted floor area where similar controls are required by Section C405.2

$Area_{du}$ = Total project dwelling unit gross lighted floor area

C406.2.5.6 L06 Reduced lighting power..

Interior lighting within the whole project shall achieve energy credits by complying with all the requirements of this section.

1. The net connected interior lighting power (LPn) shall be 95% or less than the net interior lighting power allowance (LPAn) determined in accordance with Section C405.3.2.2. In R-1 and R-2 occupancies the credit is calculated for all common areas other than dwelling units and sleeping units. Energy credits shall be determined based on one of the following:
   1.1 Where $LP_n \leq 80\%$ of LPA_n, four times the C406.2.5.6 credits from Tables C406.1.2(1) through C406.1.2(9).
   1.2 Where $LP_n > 80\%$ of LPA_n and $LP_n \leq 95\%$ of LPA_n energy credits shall be determined using Equation 4-20 .
   $EC_{LPA} = EC_5 \times 20 \times (LPA_n - LP_n)/LPA_n$
   (Equation 4-20

   where:

   EC_{LPA} = additional energy credit for lighting power reduction

LP_n = net connected interior lighting power calculated in accordance with SectionC405.3.1, watts, less any additional lighting power allowed in Section C405.3.2.2.1

LPA_n = interior lighting power allowance calculated in accordance with the requirements of Section C405.3.2.2, watts, less any additional interior lighting power allowed in Section C405.3.2.2.1

EC_5 = L06 base credit from Tables C406.1.2(1) through C406.1.2(9)

2. No less than 95 percent of the permanently installed light fixtures in *dwelling units* and *sleeping units* shall be provided by high efficacy lamps with a minimum efficacy of 90 lumens per watt.

C406.2.7 Efficient Equipment Credits.

Projects are permitted to achieve energy credits using any combination of Efficient Equipment Credits Q01 through Q04.

C406.2.7.1 Q01 Efficient Elevator Equipment.

Qualifying elevators in the building shall be Energy efficiency class A per ISO 25745-2, Table 7. Only buildings 3 or more floors above grade may use this credit. Credits shall be prorated based on Equation 4-22, rounded to the nearest whole credit. Projects with a compliance ratio below 0.5 do not qualify for this credit.

$EC_e = EC_t \times CR_e$
(Equation #)

where:

EC_e = Elevator energy credit achieved for Building

EC_t = C406.2.7.1 Table energy credit

CR_e = Compliance Ratio = (F_A / F_B)

F_A = Sum of floors served by class A elevators

F_B = Sum of floors served by all building elevators and escalators

C406.2.7.2 Q02 Efficient Commercial Kitchen Equipment..

For buildings and spaces designated as Group A-2, or facilities whose primary business type involves the use of a commercial kitchen with at least one gas or electric fryer, all fryers, dishwashers, steam cookers and ovens shall comply with all of the following:

1. Achieve performance levels in accordance with the equipment specifications listed in Tables C406.12 (1) through C406.12 (4) when rated in accordance with the applicable test procedure.
2. Be installed before the issuance of the Certificate of Occupancy.
3. Have associated performance levels listed on the construction documents submitted for permitting.

Table C406.2.7.2(1) Minimum Efficiency Requirements: Commercial Fryers

	Heavy-Load Cooking Energy Efficiency	**Idle Energy Rate**	**Test Procedure**
Standard Open Deep-Fat Gas Fryers	≥ 50%	≤ 9,000 Btu/hr	ASTM F1361
Standard Open Deep-Fat Electric Fryers	≥ 83%	≤ 800 watts	
Large Vat Open Deep-Fat Gas Fryers	≥ 50%	≤ 12,000 Btu/hr	ASTM F2144
Large Vat Open Deep-Fat Electric Fryers	≥ 80%	≤ 1,100 watts	

For SI: BTU/h = 0.293W

Table C406.2.7.2(2) Minimum Efficiency Requirements: Commercial Steam Cookers

Fuel Type	**Pan Capacity**	**Cooking Energy Efficiency[a]**	**Idle Energy Rate**	**Test Procedure**
Electric Steam	3-pan	50%	-	ASTM F1484
	4-pan	50%	-	
	5-pan	50%	-	
	6-pan and larger	50%	-	
Gas Steam	3-pan	38%	-	
	4-pan	38%	-	
	5-pan	38%	-	
	6-pan and larger	38%	-	

a. Cooking Energy Efficiency is based on heavy-load (potato) cooking capacity

TABLE C406.2.7.2(3)

MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL DISHWASHERS

Machine Type	**High Temperature Efficiency Requirements**		**Low Temperature Efficiency Requirements**		**Test Procedure**	
	Idle Energy Rate[a]	Water Consumption[b]	Idle Energy Rate[a]	Water Consumption[b]		
Under Counter	≤ 0.50 kW	≤ 0.86 GPR	≤ 0.50 kW	≤ 1.19 GPR	ASTM F1696 ASTM F1920	
Stationary Single Tank Door	≤ 0.70 kW	≤ 0.89 GPR	≤ 0.60 kW	≤ 1.18 GPR		
Pot, Pan , and Utensil	≤ 1.20 kW	≤ 0.58 GPR	≤ 1.00 kW	≤ 0.58 GPSF		
Single Tank Conveyor	≤ 1.50 kW	≤ 0.70 GPR	≤ 1.50 kW	≤ 0.79 GPR		
Multiple Tank Conveyor	≤ 2.25 kW	≤ 0.54 GPR	≤ 2.00 kW	≤ 0.54 GPR		
Single Tank Flight Type	Reported	GPH ≤ 2.975x + 55.00	Reported	GPH ≤ 2.975x + 55.00		

Multiple Tank Flight Type	Reported	GPH ≤ 4.96x + 17.00	Reported	GPH ≤ 4.96x + 17.00		

a. Idle results should be measured with the door closed and represent the total idle energy consumed by the machine including all tank heaters and controls. Booster heater (internal or external) energy consumption shall not be part of this measurement unless it cannot be separately monitored.

b. GPR = gallons per rack, GPSF = gallons per square foot of rack, GPH = gallons per hour, x = maximum conveyor belt speed (feet/minute) x conveyor belt width (feet)

Table C406.2.7.2(4) Minimum Efficiency Requirements: Commercial Ovens

Fuel Type	**Classification**	**Idle Rate**	**Cooking Energy Efficiency, %**	**Test Procedure**
Convection Ovens				
Gas	Full-Size	≤ 12,000 Btu/h	≥ 46	ASTM F1496
Electric	Half-Size	≤ 1.0 Btu/h	≥ 71	
	Full-Size	≤ 1.60 Btu/h		
Combination Ovens				
Gas	Steam Mode	≤ 200*P*[a] + 6,511 Btu/h	≥ 41	ASTM F2861
	Convection Mode	≤ 150*P*[a] + 5,425 Btu/h	≥ 56	
Electric	Steam Mode	≤ 0.133*P*[a] + 0.6400 kW	≥ 55	
	Convection Mode	≤ 0.080*P*[a] + 0.4989 kW	≥ 76	
Rack Ovens				
Gas	Single	≤ 25,000 Btu/h	≥ 48	ASTM F2093
	Double	≤ 30,000 Btu/h	≥ 52	

P = Pan Capacity: the number of steam table pans the combination oven is able to accommodate in accordance with ASTM F1495

C406.2.7.3 Q03 Efficient Residential Kitchen Equipment. .

For projects with Group R-1 and R-2 occupancies, energy credits shall be achieved where all dishwashers, refrigerators, and freezers comply with all of the following:

1. Achieve the Energy Star Most Efficient 2021 label in accordance with the specifications current as of:

   1.1 Refrigerators and freezers 5.0, 9/15/2014

   1.2 Dishwashers 6.0, 1/29/2016

2. Be installed before the issuance of the certificate of occupancy.

For Group R-1 where only some guest rooms are equipped with both refrigerators and dishwashers, the table credits shall be prorated as follows:

[Tables C406.1.2(1) through C406.1.2(9) base credits] × [floor area of guest rooms with kitchens] / [total guest room floor area]

C406.2.7.4 Q04 Fault detection and diagnostics system. .

A project not required to comply with C403.2.3 can claim energy credits for installing a fault detection and diagnostics system to monitor the HVAC system's performance and automatically identify faults. The installed system shall comply with items 1 through 6 in Section C403.2.3.

C406.3 Renewable and Load Management Credits..

Renewable energy and load management measures installed in the building that meet the requirements in Sections C406.3.1 through C406.3.8 shall achieve the credits listed for the occupancy group in Tables C406.3(1) through C406.3(9) or where calculations required in Sections C406.3 create credits or modify the table credits, the credits achieved shall be based upon the Section C406.3 calculations.

The load management measures in Sections C406.3.2 through C406.3.7 require load management control sequences that are capable of and configured to automatically provide the load management operation specified based on a demand response signal from the controlling entity, such as a utility or service operator. When communications are disabled or unavailable, all demand responsive controls shall continue to perform all other control functions provided by the control and shall continue backup demand response based on a local schedule or building demand monitoring. The local building schedule shall be adjustable without programming and reflect the electric rate peak period dates and times The load management control sequences shall be activated by either:

1. A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification, or
2. A device certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b VEN by automatically implementing the control functions requested by the VEN for the equipment it controls, or
3. A device that complies with IEC 62726-10-1, an international standard for the open automated demand response system interface between the smart appliance, system, or energy management system and the controlling entity, or
4. An interface that complies with the communication protocol required by a controlling entity, to participate in an automated demand response program, or
5. Where the controlling entity does not have a demand response program or protocol available, local demand response control shall be provided based on either building demand management controls that monitor building electrical demand, or a local building schedule that reflects the electric rate peak period dates and times. In this case binary input(s) to the control system shall be provided that activate the demand response sequence when connected in the future to an interface that receives a controlling entity demand response signal.

Table C406.3(1) Renewable and Load Management Credits for Multifamily/Dormitory

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R01	On-Site Renewable Energy	C406.3.1	9	15	11	17	18	20	19	21	13	10	13	9	9	11	10	9	10	9	7
G01	Lighting load management	C406.3.2	16	7	9	12	12	16	11	14	12	11	16	14	8	11	14	5	7	7	11
G02	HVAC load management	C406.3.3	42	41	21	35	23	37	30	28	28	17	33	24	20	22	23	10	13	15	17
G03	Automated shading	C406.3.4	11	x	7	18	10	13	5	13	12	2	14	7	10	13	11	1	8	8	16

G04	Electric energy storage	C406.3.5	10	10	10	11	10	13	13	14	17	16	13	17	14	13	17	14	14	14	15
G05	Cooling energy storage	C406.3.6	28	6	31	13	22	21	21	37	11	12	22	11	9	17	9	7	17	2	3
G06	SHW energy storage	C406.3.7	17	17	19	18	19	19	20	20	22	19	19	21	19	19	20	18	19	18	17
G07	Building thermal mass	C406.3.8	7	2	11	5	16	28	22	27	60	19	43	46	32	58	37	27	45	40	19

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(2) Renewable and Load Management Credits for Health Care Buildings

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	On-Site Renewable Energy	C406.3.1	6	6	6	6	6	8	7	9	8	6	8	6	6	7	7	6	7	5	4
G01	Lighting load management	C406.3.2	11	12	13	13	13	12	12	12	6	13	16	12	13	14	15	14	14	12	12
G02	HVAC load management	C406.3.3	10	11	10	10	8	21	10	10	13	11	18	11	12	14	13	12	11	9	7
G03	Automated shading	C406.3.4	1	1	1	1	x	x	x	1	x	x	2	x	x	2	x	x	1	1	x
G04	Electric energy storage	C406.3.5	13	13	13	13	14	15	14	15	15	14	15	15	14	15	15	13	14	13	12
G05	Cooling energy storage	C406.3.6	25	6	33	14	25	19	27	37	27	16	22	19	14	18	11	11	20	2	3
G06	SHW energy storage	C406.3.7	4	4	4	4	4	4	4	4	4	4	4	5	4	4	4	4	4	4	4
G07	Building thermal mass	C406.3.8	6	2	10	4	15	25	20	24	57	18	39	44	31	53	33	26	40	34	14

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(3) Renewable and Load Management Credits for Hotel/Motel

ID	Energy Credit Abbreviated Title	Section	Climate Zone																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	On-Site Renewable Energy	C406.3.1	9	8	12	9	11	11	10	12	13	9	12	8	9	11	9	8	9	7	5
G01	Lighting load management	C406.3.2	12	12	11	12	12	14	14	13	15	14	13	11	10	11	14	9	11	8	8
G02	HVAC load management	C406.3.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

G03	Automated shading	C406.3.4	2	2	2	3	1	2	3	2	4	3	2	1	0	1	3	1	2	0	0
G04	Electric energy storage	C406.3.5	9	9	10	10	9	13	13	15	13	14	13	14	14	12	16	13	12	12	13
G05	Cooling energy storage	C406.3.6	31	7	38	17	29	24	31	44	26	18	26	16	15	21	11	12	24	2	4
G06	SHW energy storage	C406.3.7	25	25	28	26	28	29	29	30	31	29	30	31	28	29	31	26	28	25	24
G07	Building thermal mass	C406.3.8	6	1	10	4	14	24	19	23	53	17	38	41	30	52	33	26	42	37	17

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(4) Renewable and Load Management Credits for Office Buildings

ID	**Energy Credit Abbreviated Title**	**Section**	**Climate Zone**																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	On-Site Renewable Energy	C406.3.1	14	14	17	15	17	19	18	22	24	17	22	16	14	18	18	14	17	14	11
G01	Lighting load management	C406.3.2	10	11	11	12	11	11	11	12	9	10	11	10	10	11	10	10	11	10	9
G02	HVAC load management	C406.3.3	x	10	10	9	9	3	8	12	7	12	8	11	9	10	12	8	9	10	2
G03	Automated shading	C406.3.4	4	7	7	8	7	8	5	6	6	4	6	5	4	5	5	5	5	4	7
G04	Electric energy storage	C406.3.5	14	15	14	14	16	16	17	16	18	17	16	18	17	17	18	16	15	17	18
G05	Cooling energy storage	C406.3.6	28	7	36	16	27	24	28	45	27	17	27	15	15	20	9	12	25	2	4
G06	SHW energy storage	C406.3.7	5	5	6	6	6	6	7	7	8	7	7	7	7	7	8	6	7	6	6
G07	Building thermal mass	C406.3.8	3	1	5	2	6	9	6	7	14	4	11	8	9	15	5	8	12	15	7

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(5) Renewable and Load Management Credits for Restaurant Buildings

ID	**Energy Credit Abbreviated Title**	**Section**	**Climate Zone**																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	On-Site Renewable Energy	C406.3.1	2	2	2	2	2	2	2	3	4	2	3	2	2	3	2	2	2	2	1
G01	Lighting load management	C406.3.2	4	4	5	5	4	5	5	5	5	4	5	5	4	4	5	4	5	4	1
G02	HVAC load management	C406.3.3	32	26	37	28	31	26	27	22	23	20	17	14	19	14	10	16	14	14	1

G03	Automated shading	C406.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
G04	Electric energy storage	C406.3.5	4	4	4	4	5	5	5	5	4	4	4	4	3	4	4	4	3	3	2
G05	Cooling energy storage	C406.3.6	15	4	17	8	12	10	10	16	6	5	7	3	3	4	1	2	4	0	0
G06	SHW energy storage	C406.3.7	13	13	15	14	15	16	16	17	19	16	17	19	16	17	18	15	16	14	13
G07	Building thermal mass	C406.3.8	3	1	5	2	7	12	8	10	21	6	15	14	8	18	10	6	12	8	3

x = Credits excluded from this *building* use type and climate zone.

Table C403.6(6) Renewable and Load Management Credits for Retail Buildings

ID	**Energy Credit Abbreviated Title**	**Section**	**Climate Zone**																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	On-Site Renewable Energy	C406.3.1	8	8	12	9	11	12	12	17	17	11	13	9	10	11	10	9	10	9	6
G01	Lighting load management	C406.3.2	16	16	18	19	17	19	19	21	17	18	21	21	18	21	22	18	22	18	16
G02	HVAC load management	C406.3.3	x	15	16	15	15	6	15	21	13	23	15	23	17	19	26	14	17	18	3
G03	Automated shading	C406.3.4	7	11	11	12	11	13	10	11	11	7	11	11	8	10	11	8	9	8	12
G04	Electric energy storage	C406.3.5	6	10	8	10	11	12	11	10	14	11	10	12	10	11	12	11	9	10	8
G05	Cooling energy storage	C406.3.6	40	9	51	22	35	31	34	53	21	17	28	10	11	19	4	9	18	2	2
G06	SHW energy storage	C406.3.7	3	3	4	3	4	4	4	4	5	4	4	5	4	4	5	4	4	4	3
G07	Building thermal mass	C406.3.8	5	1	6	3	8	12	10	10	20	7	17	15	14	24	10	13	20	24	12

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(7) Renewable and Load Management Credits for School/Education Buildings

ID	**Energy Credit Abbreviated Title**	**Section**	**Climate Zone**																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	On-Site Renewable Energy	C406.3.1	10	11	13	12	13	16	15	21	22	15	19	15	14	17	16	13	16	12	10
G01	Lighting load management	C406.3.2	7	12	12	13	13	15	14	16	13	12	16	16	10	14	18	16	13	14	14

G02	HVAC load management	C406.3.3	18	22	32	23	25	31	26	26	20	23	31	24	20	31	12	18	27	16	9
G03	Automated shading	C406.3.4	7	13	16	12	18	17	17	18	13	12	17	17	10	15	13	14	10	16	17
G04	Electric energy storage	C406.3.5	16	16	18	17	19	21	21	23	26	22	24	24	23	24	24	20	22	19	19
G05	Cooling energy storage	C406.3.6	36	9	46	21	36	32	39	62	39	24	37	22	20	28	13	16	31	3	4
G06	SHW energy storage	C406.3.7	5	5	6	5	6	6	7	7	8	7	7	8	7	7	8	7	7	7	6
G07	Building thermal mass	C406.3.8	7	2	11	5	17	28	23	27	63	21	44	48	37	60	38	31	50	47	21

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(8) Renewable and Load Management Credits for Warehouse and Semiheated Building Areas

ID	**Energy Credit Abbreviated Title**	**Section**	**Climate Zone**																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	On-Site Renewable Energy	C406.3.1	38	37	55	45	53	53	49	58	66	36	56	38	29	41	36	24	32	23	16
G01	Lighting load management	C406.3.2	13	26	32	28	32	35	36	33	36	31	27	37	32	23	28	36	22	25	22
G02	HVAC load management	C406.3.3	18	46	37	37	28	36	29	26	22	23	17	12	16	13	5	14	8	10	3
G03	Automated shading	C406.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
G04	Electric energy storage	C406.3.5	40	40	47	41	47	44	40	44	42	30	38	31	21	31	26	24	29	23	21
G05	Cooling energy storage	C406.3.6	20	5	21	11	14	14	11	21	5	5	9	2	2	5	1	1	3	x	x
G06	SHW energy storage	C406.3.7	3	3	3	3	4	3	4	4	4	3	4	4	3	3	4	2	2	2	2
G07	Building thermal mass	C406.3.8	7	2	12	5	17	29	23	28	66	18	44	47	28	56	37	20	39	29	13

x = Credits excluded from this *building* use type and climate zone.

Table C406.3(9) Renewable and Load Management Credits for Other Buildings

ID	**Energy Credit Abbreviated Title**	**Section**	**Climate Zone**																		
			0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R01	On-Site Renewable Energy	C406.3.1	12	13	16	14	16	18	17	20	21	13	18	13	12	15	14	11	13	10	8

G01	Lighting load management	C406.3.2	11	13	14	14	14	16	15	16	14	14	16	16	13	14	16	14	13	12	12
G02	HVAC load management	C406.3.3	24	24	23	22	20	23	21	21	18	18	20	17	16	18	14	13	14	13	6
G03	Automated shading	C406.3.4	5	6	7	9	8	9	7	9	8	5	9	7	5	8	7	5	6	6	9
G04	Electric energy storage	C406.3.5	14	15	16	15	16	17	17	18	19	16	17	17	15	16	17	14	15	14	14
G05	Cooling energy storage	C406.3.6	28	7	34	15	25	22	25	39	20	14	22	12	11	17	7	9	18	2	3
G06	SHW energy storage	C406.3.7	9	9	11	10	11	11	11	12	13	11	12	13	11	11	12	10	11	10	9
G07	Building thermal mass	C406.3.8	6	2	9	4	13	21	16	20	44	14	31	33	24	42	25	20	33	29	13

x = Credits excluded from this *building* use type and climate zone.

C406.3.1 R01 On-Site Renewable Energy.

Where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation equal or greater than 1.1 kBtu/ft²·day (3.5 kWh/m²·day), projects installing *on-site renewable energy* systems with a capacity of at least 0.1 watts per gross square foot (1.08 W/m^2) of *building* area shall achieve energy credits for this measure, calculated as follows:

$AEC_{RRa} = AEC_{0.1} \times (RR_t - RR_e)/(0.1 \times PGFA)$
(Equation 4-23)

where:

AEC_{RRa} = C406.3.1 R01 energy credits achieved for this project

RR_t = actual total rating of on-site renewable energy systems (W)

PGFA = Project gross floor area, ft^2

$AEC_{0.1}$ = C406.3.1 R01 base credits from Tables C406.3(1) through C406.3(9)

RR_e = rating (W) of *on-site renewable energy* systems excluded from credit calculated as follows:

$RR_e = RR_r$ + greater of [0 or (RR_t - PFGA x RA_L - ESC/3)}
(Equation 4-24)

where:

RR_r = rating of *on-site renewable energy* systems required by other Sections of this code (W) plus the rating of any *on-site renewable energy* systems used to qualify for exceptions elsewhere in this code.

PGFA = Project gross floor area, ft^2 (m^2)

RA_L = Limit of *on-site renewable energy* systems rating per gross floor area that exceed the rating per gross floor area in Table C406.3.1 without electrical storage installed in accordance with Section C406.3.5. For office and residential buildings, see RA_L adjustments in table footnotes.

ESC Electric Storage Capacity in Watt·hours installed in the project in accordance with Section C406.3.5

Table 406.3.1 Renewable Capacity Limits (RA_L) without Electric Storage, W/ft^2

Building Occupancy Group	Climate Zone																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
RA_{L1}: R-2, R-4, and I-1 with gas water heat [a]	1.3	1.3	1.0	1.0	1.0	0.9	0.9	0.8	0.7	0.9	0.8	0.9	0.9	0.9	0.9	1.0	0.9	1.0	1.3
RA_{L2}: R-2, R-4, and I-1 with electric or solar water heat [a]	7.6	6.8	5.9	5.1	4.2	4.2	4.2	3.4	2.5	4.2	3.4	3.4	3.4	3.4	3.4	4.2	3.4	4.2	5.1
I-2	10.3	9.7	8.2	8.2	8.2	7.3	7.2	6.2	6.2	7.5	6.2	7.3	7.5	6.5	7.3	7.3	7.2	7.2	8.8
R-1	4.1	3.8	3.4	2.9	3.1	2.7	2.6	2.3	2.2	2.7	2.0	2.7	2.7	2.1	1.9	2.6	2.2	2.7	3.2
RA_{L3}: B with IT & phone equip. > 0.5 W/ft^{2} [b]	5.2	5.2	4.6	4.6	4.3	4.0	4.0	3.8	3.5	3.8	3.8	4.0	4.0	4.0	4.0	4.0	4.0	4.3	5.2
RA_{L4}: B with IT & phone equip. ≤ 0.5 W/ft^{2} [b]	2.7	2.7	2.1	2.1	2.1	1.9	1.9	1.6	1.6	1.8	1.6	1.8	1.8	1.8	1.8	1.9	1.9	2.0	2.6
A-2	26.9	26.3	19.4	20.0	18.0	14.9	14.9	13.9	12.7	14.8	12.5	14.0	13.7	13.1	13.2	14.4	13.6	14.4	16.5
M	6.5	6.4	4.5	4.8	4.3	3.5	3.5	3.0	2.9	3.2	2.9	3.2	3.2	2.9	2.8	3.1	2.9	3.1	3.3
E	3.9	4.2	2.8	3.0	2.6	2.1	2.0	1.7	1.6	1.9	1.4	1.9	1.9	1.9	1.9	1.9	1.9	1.9	2.4
S-1 and S-2	1.3	1.3	1.0	1.0	0.7	0.7	0.7	0.7	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.9	0.9	0.9	1.0
All Other	3.4	3.3	2.6	2.5	2.9	2.7	2.7	2.1	2.3	2.6	2.3	2.7	2.7	2.5	3.1	3.1	2.8	3.2	3.2

a. For buildings that include residential occupancy (Group R-2, R-4 and I-1), RA_L shall be adjusted as follows:
   1. Where 70% or more of service water-heating capacity is gas, $RA_L = RA_{L1}$
   2. Where 70% or more of service water-heating capacity is electric resistance or solar water/pool heating is included with electric resistance backup, use RA_{L2}
   3. Where 70% or more of service water-heating capacity is heat pump water heating, adjust as follows: $RA_L = RA_{L1} + \{ (RA_{L2} - RA_{L1}) / 3 \}$
   4. Where solar water/pool heating is included with gas backup, prorate based on relative capacity as follows: RA_L = [% gas peak capacity] · RA_{L1} + [% solar peak capacity] · RA_{L2}
   5. Where electric water heating is mixed with gas water heating, prorate based on relative capacity as follows: RA_L = [% gas peak capacity] · RA_{L1} + [% electric peak capacity] · RA_{L2}

b. Office (Group B) IT & phone equipment density is calculated based on total building area, not just server and equipment room area, and power for distributed computers or terminals in office areas is not included. Where the total building density of IT & phone equipment is greater than 0.5 W/sf, $RA_L = RA_{L3}$, otherwise $RA_L = RA_{L4}$.

Table C406.3.1 Renewable Capacity LImits (RA_L) without Electric Storage, W/m^2

Building Occupancy Group	Climate Zone																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
RA_{L1}: R-2, R-4, and I-1 with gas water heat [a]	14	14	11	11	11	10	10	9	8	10	9	10	10	10	10	11	10	11	14
RA_{L2}: R-2, R-4, and I-1 with electric or solar water heat [a]	82	73	64	55	45	45	45	37	27	45	37	37	37	37	37	45	37	45	55
I-2	111	104	89	88	88	78	78	67	67	81	67	78	81	70	79	78	78	78	94
R-1	44	40	36	31	33	29	28	24	24	29	22	29	29	23	21	28	24	29	34
RA_{L3}: B with IT & phone equip. > 0.5 W/ft^{2}[b]	56	56	50	50	46	43	43	41	38	41	41	43	43	43	43	43	43	46	56
RA_{L4}: B with IT & phone equip. ≤ 0.5 W/ft^{2}[b]	29	29	23	23	23	20	20	17	17	19	17	19	19	19	19	20	20	22	27
A-2	289	283	209	215	193	160	160	150	136	159	135	150	147	141	142	155	147	155	178
M	70	68	48	51	46	38	38	32	31	35	31	35	35	31	30	34	31	33	36
E	42	45	31	32	28	23	22	18	17	21	15	21	21	21	20	21	20	20	26
S-1 and S-2	14	14	11	11	8	8	8	8	6	8	6	8	8	8	8	10	10	10	11
All Other	36	35	28	27	32	29	29	23	24	28	25	29	29	27	34	33	30	35	34

[same footnotes as IP version]

C406.3.2 G01 Lighting Load Management.

Luminaires shall have dimming capability and automatic load management controls that shall gradually reduce *general lighting* power during peak electric price periods coincident with high building loads. The load management controls shall reduce lighting power in 75% of the building area by at least 20% with *continuous dimming* over a period no longer than 15 minutes. F Where less than 75%, but at least 50% of the project *general lighting* is controlled, the credits from Tables C406.3 shall be prorated as follows:

[Area of building with lighting load management, %] x [table credits for C406.3.2] / 75%

Exception: Warehouse or retail storage building areas shall be permitted to achieve this credit by switching off at least 25% of lighting power in 75% of the building area without dimming.
G406.3.3 G02 HVAC Load Management.

Automatic load management controls shall be configured:

1. Where electric cooling is in use to gradually increase the cooling setpoint by at least 3°F over a minimum of three hours over the period coincident with high *building* electric load and high electric energy or demand price periods.

2. Where electric heating is in use to gradually decrease the heating setpoint by at least 3°F over a minimum of three hours over the period coincident with high building electric load and high electric energy or demand price periods.
3. Where HVAC systems are serving multiple zones and have less than 70% outdoor air required, include controls that provide excess *outdoor air* preceding the summer peak electric price period and reduce *outdoor air* by at least 30% during summer in the period of coincident high *building* load and summer peak electric price, in accordance with ASHRAE Standard 62.1 Section 6.2.5.2 Short Term Conditions.

C406.3.4 G03 Automated Shading Load Management.

Where fenestration on south and west exposures exceeds 20% of wall area, automatic controls shall be configured to operate movable exterior shading devices or dynamic glazing to reduce solar gain through sunlit fenestration on southern and western exposures by at least 50% during summer peak electric price periods.

C406.3.5 G04 Electric Energy Storage.

Electric storage devices shall be charged and discharged by automatic load management controls to store energy during non-peak periods and use stored energy during peak periods to reduce building demand. Electric storage devices shall have a minimum capacity of 1.5 Wh/ft^2 (87 Wh/m^2) of gross building area. Base credits in Tables C406.3-1 through C406.3-8 are based on installed electric storage of 5 Wh/ft^2 (54 Wh/m^2) and shall be prorated for actual installed storage capacity between 1.5 and 15 Wh/ft^2 (16 to 160 Wh/m^2), as follows:

[Installed electric storage capacity, Wh/ft^2 (Wh/m^2)]] / 5 (54) × [C406.3.5 Credits from Tables]

Larger energy storage shall be permitted however, credits are limited to the range of 1.5 to 15 Wh/ft^2 value.

C403.6.6 G05 Cooling Energy Storage.

Automatic load management controls shall be capable of activating ice or chilled water storage *equipment* to reduce demand during summer peak electric price periods. To achieve this credit,

1. the storage tank shall be certified by the manufacturer to have no more than 2% of storage capacity standby loss over a 24 hour period, or
2. have tank insulation values that meet or exceed the following:
   a. R-9 (RSI-1.5): ice storage tank
   b. R-3 (RSI-0.5): above-ground chilled water tank
   c. None: below-ground chilled water tanks

Base credits in Tables C406.3-1 through C406.3-8 are for storage capacity of 1.0 ton-hours per design day ton of cooling load with a 1.15 sizing factor. Credits shall be prorated for installed storage systems sized between 0.5 and 4.0 ton-hours per design day ton (kWh/*kW*) of cooling load rounded to the nearest whole credit. Larger storage shall be permitted but the associated credits are limited to the 4.0 ton-hours storage per ton of design day value. Energy credits shall be determined as follows:

ECs = EC1.0 x (1.44 X SR + 0.71) / 2.15
(Equation 4.25)

where:

ECs = Cooling Storage credit achieved for Project

EC1.0 = G05 base energy credit for building use type and climate zone based on 1.0 ton-hours storage per design day ton (kWh/kW) of cooling load

SR = Storage ratio in ton-hours storage per design day ton (kWh/kW) of cooling load where 0.5 ≤ SR ≤ 4.0

G406.3.7 G06 SWH Energy Storage.

To achieve this credit, where SHW is heated by electricity, automatic load management controls comply with ANSI/CTA-2045-B shall preheat stored SHW before the electric peak price period and suspend electric water heating during the period of peak prices coincident with peak building load. Storage capacity shall be provided by either:

1. Preheating water above 140°F (60°C) delivery temperature with at least 1.34 kWh of energy storage per kW of water-heating capacity. Tempering valves shall be provided at the water heater delivery location.
2. Providing additional heated water tank storage capacity above peak SHW demand with equivalent peak storage capacity to item 1. Where heat pump water heating is used, the credits achieved shall be 1/3 of the credits in Tables C406.3(1) through C406.3(9).

C406.3.8 G07 Building Thermal Mass.

The project shall have additional passive interior mass and a night flush control of the HVAC system. The credit is available to projects that have at least 80% of gross floor area unoccupied between midnight and 6:00 a.m.

1. Provide 10 pounds of passive thermal mass per square foot of building floor area. Locate the mass construction interior to the building, indoor-facing to the exterior wall or floor construction. Mass construction is allowed in direct contact with the air in conditioned spaces or directly attached to interior-facing gypsum board or interior-facing hard surface flooring. Mass with carpet or furred wallboard shall not be counted toward the building mass required. For integral insulated concrete block walls complying with ASTM C90 with an exterior face, only the mass of the interior face shall be counted toward the building mass required.
2. HVAC units that supply 80% or more of the airflow in the project shall be included in the night flush control sequence and be equipped with outdoor air economizers and fans that have variable or low speed capability to operate at 66% or lower design airflow.
3. Night flush controls shall be configured with the following sequence or alternative night flush strategy where the alternative sequence is demonstrated to be effective, avoids added morning heating, and is approved by the authority having jurisdiction.
   3.1 Summer mode shall be activated when outdoor air temperature exceeds 70°F (21°C) and shall continue uninterrupted until deactivated when outdoor air temperature falls below 45°F (7°C). During summer mode, the occupied cooling set point shall be reset 1°F (0.5°C) higher than normal and the occupied heating set point shall be reset 2°F (1.0°C) lower than normal.
   3.2. During active summer mode for hours that indoor average temperature is 5°F or more above outdoor temperature and between 10:00 p.m. and 6:00 a.m., automatic night flush controls shall operate outdoor air economizers at fan speed less than 66% design airflow during the unoccupied period until the average indoor air temperature falls to the occupied heating setpoint.

Revise as follows:

C407.2 Mandatory requirements.

Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to ~~80~~ the percentage of the annual energy cost (PAEC) of the *standard reference design* calculated in Equation 4-23.. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

Exception: Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

PAEC = 100 x (0.85 + 0.025 - ECr/1000)
(Equation 4-23)

where:

PAEC = *Percentage of annual energy cost applied to standard reference design*

EC_r = Energy efficiency credits required for the *building* in accordance with Section C406.1 (do not include load management and renewable credits)

TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION [a]	**TITLE**

Envelope	
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C406.1.2	Additional renewable and load management credit requirements
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Add new text as follows:

APPENDIX CD ENERGY CREDITS

CD101 General
CD101.1 Purpose.
This purpose of this Appendix is to supplement the *International Energy Conservation Code and* requires projects to comply with Advanced Energy Credit Package requirements.
CD101.2 Scope.

This Appendix applies to all buildings, in accordance with Section C406.1, required to comply with, either Section C406.1.1 or Section C406.1.3.

CD102 Advanced Energy Credit Package
CD102.1 Advanced Energy Credit Package requirements.

The requirements of this Section supercede the requirements of Section C406.1.1. Projects shall comply with sufficient measures from C406.2 to achieve the minimum number of required efficiency credits from Table CD102.1 based on building occupancy group and climate zone. Projects with multiple *occupancies*, unconditioned parking garages, alterations, and buildings with separate shell-and-core and initial build-out *construction* permits shall comply as follows:

1. Where a project contains multiple occupancies, credits in Table CD102.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required.
2. Where separate permits are used for *building* core/shell and initial build-out construction then compliance shall be in accordance with Section C406.1.1.1.
3. Substantial *alterations* as described in Section C406.1.3 that are not initial build-out *construction* shall achieve half the credits required for the *building* occupancy.
4. Unconditioned parking garages shall achieve half the credits required for use groups S-1 and S-2 in Table CD102.1

Exceptions to C102.1:

1. Utility buildings, and miscellaneous use buildings up to 1000 ft^2 (90 m^2) that are not occupied except for maintenance.

2. Industrial and manufacturing portions of factory use areas within buildings, not including office areas.
3. Where the core/shell complied in accordance with C407, the initial build-out alterations do not need to achieve any energy credits.

Table CD102.1 Energy Credit Requirements by Building Occupancy Group

Building Occupancy Groups	**Climate Zone**																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R-2, R-4, and I-1	179	174	188	197	200	200	200	200	200	200	200	200	193	200	200	200	200	200	200
I-2	78	75	73	71	80	90	100	85	90	97	83	90	99	90	96	107	106	130	117
R-1	106	100	110	105	109	122	123	125	131	137	129	136	157	139	147	171	158	180	176
B	114	110	112	115	108	107	116	111	114	126	118	123	135	125	125	152	142	153	141
A-2	83	81	82	82	86	86	108	91	97	126	99	111	147	117	113	160	143	163	151
M	113	113	121	118	123	127	116	116	133	109	100	92	99	134	125	171	146	150	137
E	91	95	91	100	96	100	105	104	101	113	110	110	120	117	122	131	132	126	131
S-1 and S-2	108	106	111	109	109	108	89	106	108	134	100	130	200	143	123	200	190	189	148
All Other	54	53	55	56	57	60	61	60	63	68	60	65	73	68	69	84	79	84	78

Add new standard(s) as follows:

ANSI American National Standards Institute 25 West 43rd Street, 4th Floor New York NY 10036

ANSI/CTA-2045-B – 2018 Modular Communications Interface for Energy Management

IEC IEC Regional Centre for North America 446 Main Street 16th Floor Worcester MA 01608

IEC International Electrotechnical Commission.

IEC 62746-10-1 - 2018 Systems interface between customer energy management system and the power management system - Part 10-1: Open automated demand response

OpenADR OpenADR Alliance 111 Deerwood Road Suite 200 San Roman CA 94583

OpenADR OpenADR Alliance.

OpenADR 2.0a and 2.0b – 2019: Profile Specification Distributed Energy Resources

Reason Statement:

In the 2021 IECC, energy credit measures were expanded from 8 alternate options to 15 measures that can be flexibly selected to achieve a 2.5% level of building energy cost savings. A similar package of measures has been proposed for ASHRAE Standard 90.1-2022, with 32 energy efficiency, renewable energy, and load management measures available. Building-type-specific targets were developed with a goal of 5% total energy cost savings.

This proposal includes 40 energy efficiency measures and builds on the former energy credit approaches with a base goal of around 7% energy savings. The energy efficiency credits here are based on site energy use and each credit represents 1/10 of 1% building energy use. Renewable and Load Management measures add cost savings based on grid cost impact represented by a time-of-use electric price structure. While measure goals vary by building type and climate zone, a national weighted goal is as follows:

- The package of cost effective measures achieves a weighted national average of 7.0% site energy savings
- The package of cost effective load management and renewable measures achieves an average of 7.3% utility cost savings

If these measures were adopted nationally into building codes, potential national savings for expected new construction using various metrics would be as given in Table 1 while the impact of renewable and selected load management measures is shown in Table 2.

Table 1. Impact of Energy Credit Measures

Metric[a]	Units	Base Package
National Annual Site Energy Savings	million Btu	7,760,000
Consumer Annual Energy Cost Savings	million $US	$154.0m
Annual Emission Reductions, CO_2	metric tons	995,000

(a) The values shown here are based on national average values. Custom results can be generated for states and local jurisdictions to support adoption of advanced code concepts.

Table 2. Impact of Renewable and Load Management Credit Measures

Metric	Units	Base Package
Consumer Annual Energy Cost Savings	million $US	$158.2m

1. The Code Approach

Energy codes include mandatory requirements that all buildings must fulfill prescriptive requirements that can be used without following a performance path, or whole-building performance paths where equivalent energy performance to the prescriptive path is demonstrated. To fit into the existing code structure, additional energy credits constitute a new prescriptive requirement; however, instead of all measures being required, the building designer can select from various options to achieve a defined level of energy performance. To maintain equivalent energy impact, whole-building performance paths must be adjusted to reflect the impact of the required energy credits.

2. Energy Credit Development Energy credits have been developed from typical measures used in green building programs, new construction utility incentive programs, and Advanced Energy Design Guidelines (ASHRAE 2019b). A detailed discussion of the methodology used to develop individual credits can be found in the published Energy Credit Tech Brief at https://www.energycodes.gov/stretch-codes

Referenced Standards.

ANSI/CTA-2045-B-2018 Modular COmmunications Interface for Energy Management: https://shop.cta.tech/products/modular-communications-interface-for-energy-management

OpenADR 2.0a and 2.0b – 2019: Profile Specification Distributed Energy Resources : https://www.openadr.org/specification-download

The following notes should be included in the Commentary:

Section C406.2.3.5 *Note to adopting jurisdictions, consider including the following commentary to clarify the requirements of C406.2.3.5 Where low water supply pressures are anticipated, user satisfaction may be enhanced if flow restrictors are specified to provide ≥80% of the rated flow at 20 psi (140 kPa).Where the distribution sizing protocol is applied to other than multifamily residential buildings, a variance to the plumbing code may be needed.*

Section C406.2.5.4 *Note to adopting jurisdictions, consider including the following informative note to clarify the requirements of*

C406.2.5.4. In IES LM83, spatial daylight autonomy (sDA) means the amount of daylight received in a space over a portion of operating hours each year. It is written as sDA###,YY% where the ### indicates the desired lux provided by the daylight. The YY% indicates the portion of operating hours per year to receive that daylight. It also includes an area requirement or statement. For example, sDA200,60% for 30% of regularly occupied spaces means that 30% of regularly occupied spaces receive at least 200 lux for at least 60% of the operating hours each year.

Section C406.3.1 *On-site renewable energy may include thermal service water heating or pool water heating in which case ratings in Btu/h can be converted to W where W = Btu/h / 3.413.*

Section C406.3.4 *This credit can be met by exterior roller, movable blind, or movable shutter shading devices; however fixed overhang, screen or shutter shading will not meet the requirement. Roller shades that reject solar gain but still allow a view are allowed as long as they provide an effective 50% reduction in net solar gain, e.g., have a shading coefficient of less than 0.5 for the shading material itself. Interior shading devices will not meet the requirement. Electrochromatic windows that achieve 50% of SHGC would qualify.*

Section C406.3.8 *The simplified night flush sequence described will operate in "Summer Mode" below the 70F OA trigger temperature down until OA of 45F is hit when the "Summer Mode" is deactivated until the OA rises above 70F again. Other strategies may be implemented that cool the space below the heating setpoint and adjust the morning heating setpoint to avoid morning reheating.*

Section C407.2 *The formula above allows adjustment for the current energy credits required in the IECC (2.5% or 0.025) and the new energy efficiency credit requirements that come from Section C406.1.1.*

Coordination with Proposal CEPI-76-21

This proposal includes language that coordinates with proposal CEPI-76-21 HVAC Total System Performance Ratio. Energy Credit H01 described in Section C406.2.2.1 allows projects using TSPR an easy way to document energy credits and is contingent on the approval of CEPI-76-21. The proposed coordinating language includes:

1. Section 406.2.2 numbered list items 1 and 7.

2. Section C406.2.2.1,

3. the base energy credits for H01 in Tables C406.1.4(1) through C406.1.4(9).

If Proposal CEPI-76-21 is not approved for publication in the 2024 IECC then the coordinating language for energy credit H01 needs to be removed from this proposal prior to publication.

Bibliography:

Hart, R, J. McNeil, M. Tillou, E. Franconi, C. Cejudo, C. Nambiar, H. Nagada, D. Maddox, J. Lerond, M. Rosenberg. 2021. Expanded Energy and Load Management Credits in Energy Codes. PNNL-32001, Pacific Northwest National Laboratory, Richland, WA. https://www.energycodes.gov/sites/default/files/2021-07/TechBrief_EnergyCredits_July2021.pdf

Cost Impact:

The code change proposal will increase the cost of construction.

While baseline prescriptive requirements usually undergo individual review for cost effectiveness, the approach to energy credit measures is different. Each measure can be selected for a particular building; however, not all measures are required, so the approach is to find at least one package of measures that are shown to be cost effective.

The energy credit requirements are justified based on a selection of a package of measures that meet the requirement and are cost effective for each building use type and climate zone. About one quarter of the measures were selected for inclusion in the cost effectiveness analysis, based on their general applicability and reliable savings. Two requirement packages were determined for evaluation of cost effectiveness:· The package included standard efficiency measures with a cap of 10% for required credits to allow for measure selection flexibility. While the energy credits are limited to 10% whole-building savings, in many cases the selected measures that were cost effective exceeded that savings level. Table 8 provides an overview of measures selected for inclusion in the package. Measures are selected with the goal of 7% savings or 70 credits for this package. Measure selection may be climate zone specific. For example, cooling efficiency only makes sense in warm climate zones. The climate zones (CZ) or application of measures is shown along with individual measure lives shown for determining cost effectiveness.

Based on this selection of measures, the scalar value or payback for each building type for the selected group of measures is given in Table 9. This represents the cost for all measures included in the package divided by the annual consumer energy cost savings. Note that for multifamily buildings and hotels, the SHW distribution redesign results in a significant cost reduction, so the overall package cost is less than the baseline and the “CE” indicates that the packages in those buildings are immediately cost effective. A scalar limit or threshold is developed for each combination of climate zone and building type based on the individual measure lives shown in Table 7, weighted by the measure cost savings. The measures included in the base package and therefore credits required are adjusted so that all building types in all climate zones have a consumer payback that is less than the scalar limit, indicating cost effectiveness for the efficiency credit requirements.

Table 7. Scalar Ratio Method Economic Parameters and Scalar Ratio Limit

Input Economic Variables	Heating (gas) SRh	Cooling (electricity) SRc
Economic Life – Years (example)	40	40
Down Payment - $	0.00	0.00
Energy Escalation Rate - %[(a)]	2.90	2.25
Nominal Discount Rate - %[(b)]	8.1	8.1
Loan Interest Rate - %	5.0	5.0
Federal Tax Rate - %[(b)]	NA[(b)]	NA[(b)]
State Tax Rate - %[(b)]	NA[(b)]	NA[(b)]
Heating – Natural Gas Price, $/therm	0.983	
Cooling - Electricity Price $/kWh		0.1099
Scalar Ratio Limit (weight: 0.25/0.75)	**25.4**	**22.0**

(a) The energy escalation rate used in the scalar calculation for 90.1-2022 includes inflation, so it is a nominal rather than a real escalation rate.
(b) Beginning with addenda for 90.1-2016, SSPC 90.1 eliminated tax analysis from the Scalar Method by using a pre-tax discount rate.

Table 8. Matrix of Base Package Efficiency Measures

ID	Energy Credit Abbreviated Title	Measure Life, yr	Multifamily /Dormitory	Health Care	Hotel/Motel	Office	Restaurant	Retail	School/ Education	Warehouse/ Semiheated
E01	Glazing U & SHGC reduction	40	CZ 0A-1A	all CZ	all CZ	all CZ			all CZ	
E02	UA Reduction (15%)	40						All CZ		
H02	Heating efficiency	18		CZ 5-8	CZ 5-8	CZ 5-8	CZ 5-8	CZ 5B-8	CZ 5-8	CZ 4C-8
H03	Cooling efficiency.	15	CZ 0-2	CZ 0-2	CZ 0-3B	CZ 0-3B	CZ 0-3B	CZ 0-3B	CZ 0-3B	CZ 0-3B
H04	Residential HVAC control.	15	CZ 0-3, 6-8							
W02	Heat pump water heater	19					30% all CZ	CZ0, 4B-5		
W03	Efficient gas water heater	15	all CZ	all CZ	all CZ	all CZ	70% all CZ		all CZ	
W06	Thermostatic balancing valves	15	all CZ	all CZ	all CZ	all CZ			all CZ	
W08	SHW distribution sizing	15	all CZ		all CZ					
L03	Increase occupancy sensor	15		all CZ						all CZ
L04	Increase daylighting area	15						CZ 0-5		all CZ
L06	Light power reduction	20	5% all CZ	15% all CZ	15% all CZ	15% all CZ	10% all CZ	10% all CZ	15% all CZ	10-15% all CZ
Q02	Efficient kitchen equipment	15	(a)		(a)		all CZ		(a)	
Q04	Fault detection	15		all CZ	all CZ	CZ 0-4			all CZ	

[a] Dining areas and kitchens in dormitories, hotels, and schools treated as a separate area where efficient kitchen equipment credits apply

Table 9. Scalar Ratios for Base Package Efficiency Measures by Climate Zone and Building Type

	Climate Zone																		
Building Use Type	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Multifamily/Domitory	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE
Health Care	3.0	3.3	3.3	3.3	3.2	3.6	2.7	2.8	2.4	2.5	2.6	2.3	2.6	2.6	2.0	2.6	2.5	2.3	2.3
Hotel/Motel	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE	CE
Office	11.7	12.1	13.1	12.7	13.2	13.6	13.3	13.1	12.6	11.0	10.7	11.7	10.9	10.7	11.8	9.6	10.0	9.8	9.1
Restaurant	3.2	3.5	4.2	3.9	4.3	4.7	4.9	4.9	4.9	4.7	4.7	4.7	3.5	3.8	4.0	3.1	3.4	2.8	2.4
Retail Buildings	4.0	4.3	4.8	4.6	5.4	5.5	6.1	6.2	4.9	4.4	5.0	5.3	4.3	4.6	5.2	3.4	4.5	5.1	5.0
School/Education	6.5	7.3	8.5	7.8	8.8	9.8	9.1	9.0	8.0	7.1	7.1	7.8	6.6	6.1	7.2	5.4	6.1	5.2	4.4
Warehouse	8.3	8.1	9.4	8.9	9.8	9.5	8.0	7.7	2.7	2.8	2.7	2.9	1.8	2.4	3.0	1.4	1.8	1.5	1.5

CEPI-193-21

CEPI-194-21

IECC®: C406.1

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:

C406.1 Additional energy efficiency credit requirements.

New buildings shall achieve a total of 25 ~~10~~ credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.

Reason Statement:

The purpose of this code change proposal is to improve the efficiency of commercial buildings by almost 4% by requiring that code users incorporate efficiency measures in the building to achieve 25 points (instead of the current 10 points) from the Additional Energy Efficiency Credit Requirements tables.

In the code development process for the 2021 *IECC*, proposal CE218-19 and similar proposals aimed to provide additional flexibility for code users to combine various improvements to achieve improved energy savings, while fine-tuning credits to commercial building occupancy types. These changes were based on an analysis carried out by PNNL that calculated the relative impact of these improvements across several building prototypes in multiple climate zones. *See* https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-28370.pdf. Each point represents approximately 0.25% energy cost savings over base code requirements. This points-based approach adds complexity to the code, but also additional flexibility for code users to achieve the energy savings target. It also provides a relatively straightforward means of improving the efficiency of the *IECC* from one code edition to the next and provides a framework for jurisdictions to increase energy savings by requiring additional points.

In the development of the 2021 *IECC*, additional points options were added to those in CE218-19, and we expect that even more options will become available in future editions of the code. Code users will continue to select options, or combinations of options, to achieve the required number of points; the only change intended by this proposal is to increase the total number of points required.

The number of additional points to require is a judgment call. We chose a modest level of 25 points to achieve an additional 3.75% energy savings. A more aggressive level, such as 30 or more points, would also be a reasonable choice to achieve more savings.

The nation is at a crossroads in its efforts to reduce energy use and the production of greenhouse gases, and it is clearer than ever before that the path to long-term energy security runs through efficient buildings. Buildings consume 42% of the nation's energy, including 54% of the nation's natural gas and 71% of its electricity. Each new building constructed today will either become part of the climate solution or part of the problem for decades. The ICC Board of Directors has revised the Scope and Intent provisions of the *IECC* to include more specific goals, including the requirement that each edition of the *IECC* will provide "increased energy savings over the prior edition." The proposal above makes a straightforward improvement in the efficiency of the 2024 *IECC* using the framework adopted in 2021. We urge the Committee to use the tools available today to lay the groundwork for a more sustainable built environment in the future.

Bibliography:

https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-28370.pdf

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal will increase the cost of construction by requiring additional efficiency measures. The cost impact will vary significantly depending on occupancy type, climate zone, the combination of credits selected, the design and features of the building, and other factors. In some cases, these measures may already be included in the design, and thus would result in no increase in construction cost. In other cases, the cost increase will only be the incremental difference between the efficiency of commonly-installed equipment or components and the efficiency requirement in the credits tables. The code user is in the best position to select the options that provide the most benefits at the lowest cost to the consumer, but each of the options will result in a substantial reduction in energy costs.

COST-EFFECTIVENESS

Section C406—with multiple tables of credit options for occupancy types—will result in a broad range of cost impacts depending on a series of choices made by the code user, such as the building design and combination of options selected, as well as the climate zone, local market conditions, and other variables. Other assumptions and estimates are also likely to vary significantly. In the end, it would be impossible for a cost-effectiveness analysis to anticipate the full range of options and choices made by a code user to meet the code, and an over-simplified analysis full of assumptions or a broad summary of cost-effectiveness would provide only limited value.

The ICC Board of Directors has determined that the 2021 IECC is the new baseline for the 2024 IECC Standard, without rollbacks. This means for purposes of analyzing code proposals, the existing provisions of the 2021 IECC are considered cost-effective and reasonable (since they are the starting point for analyses of code changes). This proposal does not introduce any new measures into the code, but rather requires code users to select more of the credits already included in the baseline code.

CEPI-194-21

CEPI-195-21

IECC®: C406.1, C406.12 (New), C408.4 (New), TABLE C406.1(1), TABLE C406.1(2), TABLE C406.1(3), TABLE C406.1(4), TABLE C406.1(5)

Proponents: Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Energy Conservation Code

Revise as follows:

C406.1 Additional energy efficiency credit requirements. New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.
12. Automated window shading to reduced solar heat gain and increase daylight responsive control energy savings installed in accordance with C406.12.

Add new text as follows:

C406.12 Automated window shading. Building with a window to wall ratio greater than 30% shall have vertical fenestration with automatically controlled shading devices capable of modulating in multiple steps the amount of solar gain and light transmitted into the space in response to daylight levels or solar intensity that comply with all of the following:

1. Exterior shading devices shall be capable of providing at least 90% coverage of the total fenestration area in the building.
2. Interior shading devices shall be capable of providing at least 90% coverage of the total fenestration area and have a minimum solar reflectance of 0.50 for the surface facing the fenestration.
3. A manual override located in the same enclosed space as the vertical fenestration shall override operation of automatic controls no longer than four hours.
4. Functional and performance testing (FPT) and commissioning shall be conducted as required by Section C408.

C408.4 Automated window shade functional testing . Where automated window shades are provided, verify that the shading devices automatically respond to changes in solar illumination or radiation intensity.

Revise as follows:

TABLE C406.1(1) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pumpwater heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced air infiltration	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	
C406.12: Automated window shading	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1

NA = Not Applicable.

TABLE C406.1(2) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406.2.2: 5% cooling efficiency improvement	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% cooling efficiency improvement	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3: Reduced lighting power	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C406.4: Enhanced digital lighting controls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: On-site renewable energy	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.2: Recovered or renewable water heating	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Reduced air infiltration	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3
C406.10: Energy monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.11: Fault detection and diagnostics system	1	1	1	1	1	1	NA	1	1	NA	1	1	NA	1	1	1	1
C406.12 Automated window shading	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA

NA = Not Applicable.

TABLE C406.1(3) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP E OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	4
C406.2.2: 5% cooling efficiency improvement	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	3	4	3	4	3	4	3	5	7
C406.2.4: 10% cooling efficiency improvement	7	8	7	6	5	4	3	4	3	1	2	2	1	2	2	2	1
C406.3: Reduced lighting power	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
C406.5: On-site renewable energy	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
C406.6: Dedicatedoutdoor air system	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.2: Recoveredor renewable water heating[a]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.7.3: Efficient fossil fuel water heater[a]	NA	1	1	1	1	1	1	2	2	3	2	3	2	3	3	3	5
C406.7.4: Heat pump water heater[a]	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1	1	1	1
C406.8: Enhanced envelope performance	3	7	3	4	2	4	1	1	3	1	2	3	NA	4	3	6	9
C406.9: Reduced air infiltration	1	1	1	2	NA	NA	NA	NA	NA	NA	1	NA	NA	4	1	4	3
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	2	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
C406.12 Automated window shading	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA

NA = Not Applicable.

a. For schools with showers or full-service kitchens.

TABLE C406.1(4) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP M OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	NA	1	1	2	2	2	2	3	2	3	4
C406.2.2: 5% cooling efficiency improvement	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	4	3	4	5	5	3	6	8
C406.2.4: 10% cooling efficiency improvement	9	12	9	8	6	6	3	4	4	1	2	3	NA	2	2	2	1
C406.3: Reduced lighting power	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12
C406.4: Enhanced digital lighting controls	3	3	4	3	4	3	4	4	4	3	3	3	3	4	4	3	3
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
C406.6: Dedicated outdoor air system	3	4	3	3	3	3	1	3	2	2	2	3	2	4	3	4	4
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pump water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	4	6	3	4	3	3	1	6	4	4	4	5	4	6	5	8	9
C406.9: Reduced air infiltration	1	1	1	2	1	1	NA	3	1	1	3	2	1	7	3	6	3
C406.10: Energy monitoring	4	5	5	5	5	4	4	4	4	3	3	4	3	4	4	4	3
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2
C406.12 Automated window shading	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA

NA = Not Applicable.

TABLE C406.1(5) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR OTHER[a] OCCUPANCIES

Portions of table not shown remain unchanged.

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	3
C406.2.2: 5% cooling efficiency improvement	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	3	3	3	3	4	3	5	5
C406.2.4: 10% cooling efficiency improvement	8	9	8	7	5	5	3	4	4	2	2	3	2	2	2	2	2
C406.3: Reduced lighting power	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	8	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	3	2	5	3	3	5	4	3	7	5	7	6
C406.7.2: Recovered or renewable water heating [b]	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater [b]	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater [b]	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	4	3	4	1	5	4	3	5	5	4	7	6	9	10
C406.9: Reduced air infiltration	3	2	2	4	4	2	NA	6	2	2	6	4	1	10	5	7	4
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	3	2	3	2	2	2	3	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.12 Automated window shading	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1

NA = Not Applicable.

a. Other occupancy groups include all groups except Groups B, E, I, M and R.

b. For occupancy groups listed in Section C406.7.1.

Reason: Automated window shades improve a buildings energy efficiency by reducing solar heat again (lowering cooling energy use) and maximizing daylight harvesting (increased energy savings from daylight responsive controls). Additionally, there are non-energy benefits. They protect against solar discomfort glare; increase access daylight; maintain views and connection to the outdoors; and reduce thermal discomfort (e.g., avoid discomfort from the radiant heat of a hot window). Manual shades have the potential to provide the same benefits, however, they are not actively controlled by users. Thus, automation is required to achieve the full benefits.
Many studies show (see bibliography) substantial energy savings from automated shading such as:

- 52% lighting and 26% HVAC energy savings is achieved with automated shading compared to the baseline. Full-scale experimental testing of integrated dynamically-operated roller shades and lighting in perimeter office spaces. Source: https://www.sciencedirect.com/science/article/abs/pii/S0038092X19304165
- 5 - 20% cooling energy savings achieved with automated shades compared open shades (for solar reflectance of 60% or greater). Plus, reduce daytime lighting energy use by 65% through the use of automated shades. Automated shades can increase lighting energy savings from daylight harvesting by 1.6kWh/sq.ft./yr. Source: Lutron commissioned study with Purdue University. https://www.lutron.com/TechnicalDocumentLibrary/Lutron_Energy_Savings_Claims.pdf
- 49% lighting energy savings and 23% HVAC shades with automated blinds compared to the baseline. Source: https://www.sciencedirect.com/science/article/abs/pii/S0360544220302978

Bibliography: Daylighting and energy analysis of private offices with automated interior roller shades - ScienceDirect www.sciencedirect.com/science/article/abs/pii/S0038092X11004270
https://www.sciencedirect.com/science/article/abs/pii/S0038092X19304165

Cost Impact: The code change proposal will increase the cost of construction.
The code change proposal will increase the cost of construction. However, cost savings from interior automated shading system are substantial over 30-year time horizon. The results show that the cost savings from interior automated shading system are substantial over a 30-year time horizon, when compared with common passive manual blinds ($25 versus $7.6 Net Present Value per SF glazing area). Source: https://www.sciencedirect.com/science/article/abs/pii/S0926580518300682

CEPI-196-21

IECC®: C406.1, C406.13 (New)

Proponents: Mike Fischer, representing Attachments Energy Ratings Council (mfischer@kellencompany.com)

2021 International Energy Conservation Code

Revise as follows:

C406.1 Additional energy efficiency credit requirements. New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.
12. Fenestration shading attachments in accordance with Section C406.13.

Add new text as follows:

C406.13 Fenestration shading attachments. Automated shading attachments shall reduce the sunlit area of exterior fenestration by not less than 50 percent of the total area. Shading attachments shall be automatically controlled and shall comply with AERC 1. Controls for shading attachments shall modulate the amount of solar gain and light transmitted into the space in multiple steps in response to daylight levels or solar intensity. Any manual control of the shading attachment shall not override automatic operation for longer than 4 hours.

Reason: The use of automated shading devices to reduce solar gain through exterior fenestration provides significant energy efficiency benefits. The proposal establishes a pathway for building designers to utilize shading strategies through the additional energy efficiency measures in Section C406.
The proposal sets a threshold of 50% of the exterior fenestration area, and includes performance criteria to ensure that shading attachments used for this measure will perform as intended. This measure provides flexibility in design, will save energy and improve comfort for building occupants. It should be noted that the 50% threshold, as well as the occupancy-based credits should be reviewed by the standards committee for consistency with other measures.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed measure is voluntary so has no direct impact on project cost.

CEPI-197-21

IECC®: SECTION 202 (New), C406.1, TABLE C406.1(1), TABLE C406.1(2), TABLE C406.1(3), TABLE C406.1(4), TABLE C406.1(5), C406.1.1

Proponents: Kimberly Newcomer, representing NBI (kim@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:

GRID-INTEGRATED CONTROL. An automatic control that can receive, automatically respond to demand response requests from and send information back to a utility, electrical system operator, or third-party demand response program provider.

BUILDING PEAK ELECTRIC DEMAND. The annual highest whole-building electrical power demand, net of on-site renewables, measured in kW.

Revise as follows:

C406.1 Additional energy efficiency credit requirements. New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple-use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.
12. Grid Integration Controls in accordance with Section C406.13.1 or Section C406.13.2.

TABLE C406.1(1) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1
C406.2.2: 5% cooling efficiency improvement	6	6	5	5	4	4	3	3	3	2	2	2	1	2	2	2	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	1	1	2	2	NA	1
C406.2.4: 10% cooling efficiency improvement	11	12	10	9	7	7	6	5	6	4	4	5	3	4	3	3	3
C406.3: Reduced lighting power	9	8	9	9	9	9	10	8	9	9	7	8	8	6	7	7	6
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1
C406.5: On-site renewable energy	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
C406.6: Dedicated outdoor air	4	4	4	4	4	3	2	5	3	2	5	3	2	7	4	5	3
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pumpwater heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	1	4	2	4	4	3	NA	7	4	5	10	7	6	11	10	14	16
C406.9: Reduced air infiltration	2	1	1	2	4	1	NA	8	2	3	11	4	1	15	8	11	6
C406.10: Energy monitoring	4	4	4	4	3	3	3	3	3	3	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.13.1: Grid integration controls	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.13.2: Enhanced grid integration controls	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1

NA = Not Applicable.

TABLE C406.1(2) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP R AND I OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	NA	1	1	1	1	2	1	2	2
C406.2.2: 5% cooling efficiency improvement	3	3	2	2	1	1	1	1	1	NA	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	NA	1	NA	NA	1	1	1	2	2	1	3	2	3	4
C406.2.4: 10% cooling efficiency improvement	5	5	4	3	2	3	1	2	2	1	1	1	1	1	1	1	1
C406.3: Reduced lighting power	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
C406.4: Enhanced digital lighting controls	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.5: On-site renewable energy	8	8	8	8	7	8	8	7	7	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	2	NA	6	3	4	8	5	5	10	7	11	12
C406.7.2: Recovered or renewable water heating	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	5	4	4	1	4	3	3	4	5	3	5	4	6	6
C406.9: Reduced air infiltration	6	5	3	11	6	4	NA	7	3	3	9	5	1	13	6	8	3
C406.10: Energy monitoring	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.11: Fault detection and diagnostics system	1	1	1	1	1	1	NA	1	1	NA	1	1	NA	1	1	1	1
C406.13.1: Grid integration controls	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0
C406.13.2: Enhanceed grid integration controls	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

TABLE C406.1(3) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP E OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	4
C406.2.2: 5% cooling efficiency improvement	4	4	3	3	2	2	2	2	1	1	1	1	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	3	4	3	4	3	4	3	5	7
C406.2.4: 10% cooling efficiency improvement	7	8	7	6	5	4	3	4	3	1	2	2	1	2	2	2	1
C406.3: Reduced lighting power	8	8	8	9	8	9	9	8	9	9	8	9	8	7	8	7	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1
C406.5: On-site renewable energy	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	5	5
C406.6: Dedicatedoutdoor air system	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.2: Recoveredor renewable water heating[a]	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.7.3: Efficient fossil fuel water heater[a]	NA	1	1	1	1	1	1	2	2	3	2	3	2	3	3	3	5
C406.7.4: Heat pump water heater[a]	NA	NA	NA	NA	NA	NA	NA	1	NA	NA	1	1	NA	1	1	1	1
C406.8: Enhanced envelope performance	3	7	3	4	2	4	1	1	3	1	2	3	NA	4	3	6	9
C406.9: Reduced air infiltration	1	1	1	2	NA	NA	NA	NA	NA	NA	1	NA	NA	4	1	4	3
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	2	2	3	2	2	2	2	2
C406.11: Fault detection and diagnostics system	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
C406.13.1: Grid integration controls	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
C406.13.2: Enhanced grid integration controls	1	2	2	2	2	1	2	2	2	2	2	2	2	2	2	1	1

NA = Not Applicable.

a. For schools with showers or full-service kitchens.

TABLE C406.1(4) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP M OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	**0B & 1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	NA	1	1	2	2	2	2	3	2	3	4
C406.2.2: 5% cooling efficiency improvement	5	6	4	4	3	3	1	2	2	1	1	2	NA	1	1	1	NA
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	4	3	4	5	5	3	6	8
C406.2.4: 10% cooling efficiency improvement	9	12	9	8	6	6	3	4	4	1	2	3	NA	2	2	2	1
C406.3: Reduced lighting power	13	13	15	14	16	14	17	15	15	14	12	14	14	16	16	14	12
C406.4: Enhanced digital lighting controls	3	3	4	3	4	3	4	4	4	3	3	3	3	4	4	3	3
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	6
C406.6: Dedicated outdoor air system	3	4	3	3	3	3	1	3	2	2	2	3	2	4	3	4	4
C406.7.2: Recovered or renewable water heating	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.3: Efficient fossil fuel water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.7.4: Heat pump water heater	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C406.8: Enhanced envelope performance	4	6	3	4	3	3	1	6	4	4	4	5	4	6	5	8	9
C406.9: Reduced air infiltration	1	1	1	2	1	1	NA	3	1	1	3	2	1	7	3	6	3
C406.10: Energy monitoring	4	5	5	5	5	4	4	4	4	3	3	4	3	4	4	4	3
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	2	2
C406.13.1: Grid integration controls	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.13.2: Enhanced grid integration controls	1	2	2	2	2	2	2	2	2	2	1	2	1	1	2	1	1

NA = Not Applicable.

TABLE C406.1(5) ADDITIONAL ENERGY EFFICIENCY CREDITS FOR OTHER[a] OCCUPANCIES

SECTION	CLIMATE ZONE																
	0A & 1A	0B & 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
C406.2.1: 5% heating efficiency improvement	NA	NA	NA	NA	1	1	1	1	1	2	1	2	1	2	2	3	3
C406.2.2: 5% cooling efficiency improvement	5	5	4	4	3	3	2	2	2	1	1	2	1	1	1	1	1
C406.2.3: 10% heating efficiency improvement	NA	NA	NA	1	1	1	1	2	2	3	3	3	3	4	3	5	5
C406.2.4: 10% cooling efficiency improvement	8	9	8	7	5	5	3	4	4	2	2	3	2	2	2	2	2
C406.3: Reduced lighting power	8	8	9	9	9	9	10	8	9	9	7	8	8	8	8	8	7
C406.4: Enhanced digital lighting controls	2	2	2	2	2	2	2	2	2	2	2	3	2	2	2	2	1
C406.5: On-site renewable energy	8	8	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7
C406.6: Dedicated outdoor air system	3	4	3	3	4	3	2	5	3	3	5	4	3	7	5	7	6
C406.7.2: Recovered or renewable water heating [b]	10	9	11	10	13	12	15	14	14	15	14	14	16	14	15	15	15
C406.7.3: Efficient fossil fuel water heater [b]	5	5	6	6	8	7	8	8	8	9	9	9	10	10	9	10	11
C406.7.4: Heat pump water heater [b]	6	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
C406.8: Enhanced envelope performance	3	6	3	4	3	4	1	5	4	3	5	5	4	7	6	9	10
C406.9: Reduced air infiltration	3	2	2	4	4	2	NA	6	2	2	6	4	1	10	5	7	4
C406.10: Energy monitoring	3	3	3	3	3	3	3	3	3	3	2	3	2	2	2	3	2
C406.11: Fault detection and diagnostics system	2	2	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
C406.13.1: Grid integration controls	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
C406.13.2: Enhanced grid integration controls	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

NA = Not Applicable.

a. Other occupancy groups include all groups except Groups B, E, I, M and R.

b. For occupancy groups listed in Section C406.7.1.

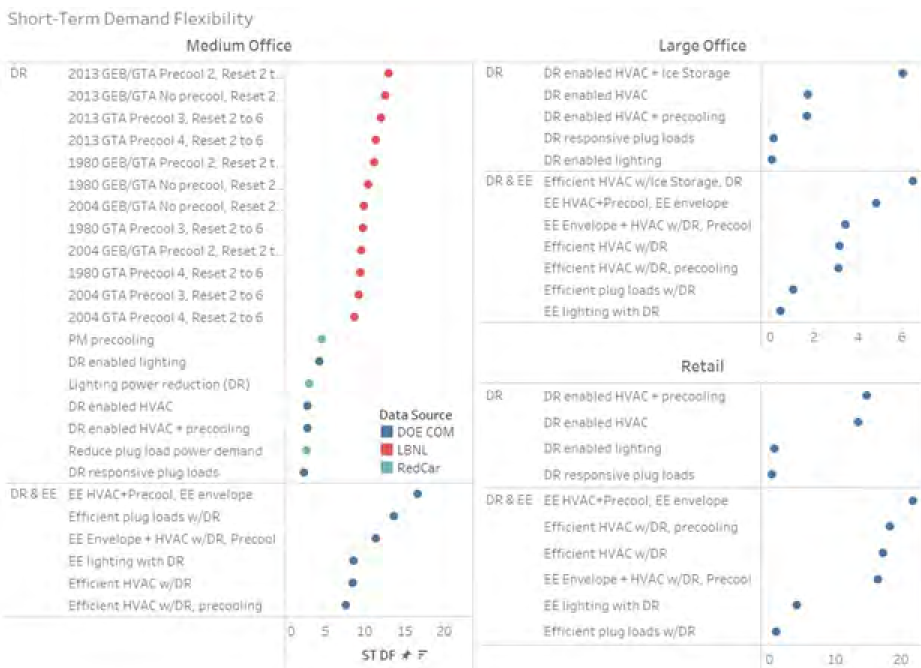
C406.1.1 Tenant spaces. Tenant spaces shall comply with sufficient options from Tables C406.1(1) through C406.1(5) to achieve a minimum number of 5 credits, where credits are selected from Section C406.2, C406.3, C406.4, C406.6, C406.7 or C406.10. Where the entire building complies using credits from Section C406.5, C406.8, ~~or~~ C406.9, or C406.13, tenant spaces shall be deemed to comply with this section.

Exception: Previously occupied tenant spaces that comply with this code in accordance with Section C501.

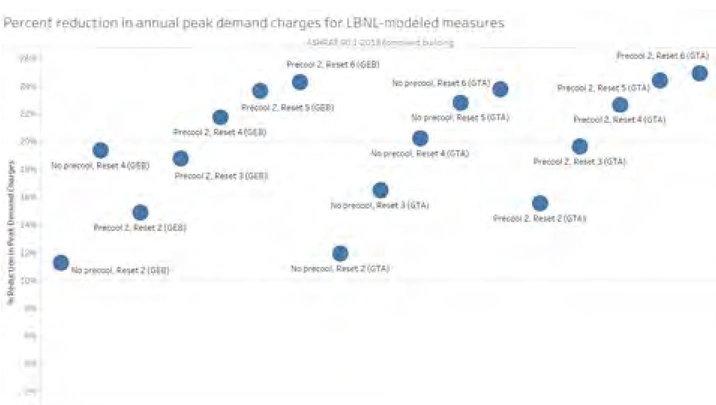
Reason: The electricity sector is currently undergoing fast and dramatic changes because of the accelerating adoption of variable renewable energy resources such as wind and solar energy. This proliferation of variable generating sources has significant effects at the building level, given that the electricity grid exists in large part to serve buildings (roughly three quarters of all electricity generated in the US goes to buildings). This variable supply is impacting buildings through rate structures, which are increasingly including time-of-use structures and demand charge components, as well as through local policy such as New York City's Local Law 97 greenhouse-gas-emissions-denominated building performance standard. This, along with other concurrent trends, is driving higher variability in greenhouse gas emissions intensity and electricity costs between regions and across time: from hour to hour.
Demand flexibility, or the ability of a building to shed load and/or shift loads over time, is a form of future-proofing. In many cases the goal is to be able to reduce energy consumption during expensive, typically high-emissions peak hours, and conversely take advantage of low-cost, clean energy when renewable energy makes up much of the electricity mix. A wide variety of strategies are possible, across every major end-use in buildings. Some of the most typical strategies include HVAC controls (for example, grid-integrated controls at the thermostat or centralized building management system level), water heater controls (for example, grid-integrated controls such as those enabled by CTA-2045B communications modules), and smart appliances. This proposal provides flexibility to designers and builders to determine how best to achieve this goal for the use case most common today: reducing demand during peak hours. Encouraging more demand flexibility reduces the risk that building owners will face in the future as rate structures and policies evolve with the broader energy system.

This proposal adds point values to the existing structure in C406. Point values are derived from the fractional energy cost savings for each building type-climate zone combination. To obtain the fractional energy cost savings, estimated total annual energy costs were calculated for each building type-climate zone combination by multiplying the ASHRAE 90.1-2019 energy cost intensities (ECI, dollars per square foot per year) by the square footage of the associated commercial building prototype. The hourly electricity consumption from each commercial building prototype model was used to identify the maximum demand (kW) in each summer month (May through September, inclusive). Today's demand charges are often only active during summer months, and these five months are typical. The maximum demand during each summer month was multiplied by an assumed demand charge of $5.83/kW (the average from NREL's 2017 national survey of demand charges), yielding an estimated baseline demand charge for each month. We applied the demand savings thresholds of 10% and 20% for grid-integrated controls to find the potential energy cost savings in each scenario. We then summed the monthly savings to obtain the estimated annual cost savings and divided this value by the total annual energy cost of each building type-climate zone combination. The resulting fractional energy cost savings were then decreased by a conservative combined 75% firmness, system capability, and controls drift adjustment factor (i.e., savings were multiplied by 0.25) to account for the fact that some demand flexibility resources may not actually respond or be available when needed and that controls capability can degrade or be reprogrammed over time.

Peak demand savings (both kW and cost) of 10%-25% are reasonable and achievable. Analysis by multiple national laboratories, especially LBNL, and PNNL, as well as by NBI in support of the GridOptimal Buildings Initiative, has clearly demonstrated that grid-integrated controls can reduce building peak demand through a variety of strategies. The following chart shows that a wide range of strategies can reduce building peak demand. LBNL's analysis shows that very simple, low-to-no cost measures such as precooling and thermostat adjustments alone can deliver 8%-13% whole-building peak demand savings. Other strategies modeled by LBNL to support DOE's GEB Roadmap show that multiple demand flexibility strategies are available to deliver peak demand savings in line with this proposal's thresholds, while demand flexibility paired with energy efficiency can deliver amplified impacts.



The chart below shows example cost impacts based on recent modeling by LBNL (the red dots in the above chart, and all the dots below). The building type is medium office, the climate zone is 3B, and the electricity rate is the Sacramento Municipal Utility District's Small Demand Service (GSS-T) rate structure, which includes a relatively moderate demand charge of $7.66/kW (reasonably close to the national average of $5.83/kW, according to NREL's 2017 national survey). The chart shows a selection of simple, low-to-no-cost HVAC measures: precooling (0-2° F) and temperature reset (2-6° F); even with these simple interventions, the potential demand charge related cost savings are substantial.



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SupplyHouse. “T3700 - Venstar T3700 - Explorer T3700 Residential Digital Thermostat (2 Heat, 1 Cool).” *SupplyHouse.com*, www.supplyhouse.com/Venstar-T3700-Explorer-T3700-Residential-Digital-Thermostat-2-Heat-1-Cool

SupplyHouse. “T1010 - Venstar T1010 –Single Day Programmable Digital Thermostat” *SupplyHouse.com,* https://www.supplyhouse.com/Venstar-T1010-Venstar-T1010-Single-Day-Programmable-Digital-Thermostat

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Since options presented in C406 are selected by the designer - there is not anticipated to be a change to construction cost for this measure, as it would be selected based on its relative cost and savings as part of a broader set of design decisions.

The cost premium to enable demand flexibility can vary widely depending on the strategy and technology used in the building: thermal energy storage systems cost much more than smart thermostats. However, the minimum cost is related to communications infrastructure. As stated in the reason statement, substantial benefits can be obtained through these low-to-no cost strategies. Some examples include ANSI/CTA-2045-B compliant communications modules for water heaters (incremental cost $60-$160: Advanced Water Heating Initiative research) and OpenADR-2.0-B compliant thermostats (incremental cost $40).

Given that smart thermostats are a very common, low-cost, and impactful way to achieve demand flexibility, further investigation of their costs and benefits of thermostat adjustment strategies is warranted. In multifamily buildings and smaller commercial buildings that install direct-attached thermostats, demand responsive thermostats (which were estimated in a 2011 study to cost $68 more than a programmable thermostat), were found to be extremely cost-effective. It was estimated that installing demand responsive thermostats in a 10,000 sf office building resulted in 83 kWh to 274 kWh of electricity savings and between 0.19 to 1.97 kW in demand savings in Climate Zones 2-4. A 2017 NREL national survey of demand charges showed an average demand charge of $5.83/kW. For the 10,000 sf medium office building, this would translate to a monthly potential savings from demand charge reduction between $1.10 and $11.49; if demand charges are present during only summer (five months is typical) this results in annual savings between $5 and $57; or 15-year savings between $80-$860 from demand charge reductions alone. Every dollar spent on demand responsive thermostats yielded between $1.20 to $7 in operating cost savings over a 15-year period for office buildings. Higher demand charges and time-of-use rate structures are on the rise in many utility territories nationwide, increasing potential savings. In the 10 years since the 2011 incremental cost estimate mentioned, the cost effectiveness has improved. Equipment prices have decreased, and current incremental costs are estimated to be only $40.

CEPI-198-21

IECC®: TABLE C406.12(3)

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C406.12(3) MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL DISHWASHERS

MACHINE TYPE	HIGH-TEMPERATURE EFFICIENCY REQUIREMENTS		LOW-TEMPERATURE EFFICIENCY REQUIREMENTS		TEST PROCEDURE
	Idle energy rate [a]	Water consumption[b]	Idle energy rate [a]	Water consumption [b]	
Under counter	≤ 0.50 kW	≤ 0.86 GPR	≤ 0.50 kW	≤ 1.19 GPR	ASTM F1696 ASTM F1920
Stationary single-tank door	≤ 0.70 kW	≤ 0.89 GPR	≤ 0.60 kW	≤ 1.18 GPR	
Pot, pan and utensil	≤ 1.20 kW	≤ 0.58 GPR	≤ 1.00 kW	≤ 0.58 GPSF	
Single-tank conveyor	≤ 1.50 kW	≤ 0.70 GPR	≤ 1.50 kW	≤ 0.79 GPR	
Multiple-tank conveyor	≤ 2.25 kW	≤ 0.54 GPR	≤ 2.00 kW	≤ 0.54 GPR	
Single-tank flight	Reported	GPH ≤ 2.975x + 55.00	Reported	GPH ≤ 2.975x + 55.00	
Multiple-tank flight	Reported	GPH ≤ 4.96x + 17.00	Reported	GPH ≤ 4.96x + 17.00	

a. Idle results shall be measured with the door closed and represent the total idle energy consumed by the machine, including all tank heaters and controls. Booster heater (internal or external) energy consumption shall not be part of this measurement unless it cannot be separately monitored.

b. GPR = gallons per rack, GPSF = gallons per square foot of rack, GPH = gallons per hour, x = maximum conveyor belt speed (feet/minute) × conveyor belt width (feet).

Reason: This proposal makes an editorial correction to the table (in the printed hard copy edition that I purchased, there is no decimal point in front of 50 kW or 70 kW for the idle energy rate in the first two table rows).

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is merely an editorial correction that does not change the actual efficiency requirements.

CEPI-199-21

IECC®: TABLE C406.12(3), TABLE C406.12(4), ASTM Chapter 06

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE C406.12(3) MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL DISHWASHERS

MACHINE TYPE	HIGH-TEMPERATURE EFFICIENCY REQUIREMENTS			LOW-TEMPERATURE EFFICIENCY REQUIREMENTS			TEST PROCEDURE
	Idle energy rate [a]	Washing Energy	Water consumption[b]	Idle energy rate [a]	Washing Energy	Water consumption [b]	
Under counter	≤ ~~.50~~ 0.30 kW	≤ 0.35 kWh/rack	≤ 0.86 GPR	≤ ~~0.50~~ 0.25 kW	≤ 0.15 kWh/rack	≤ 1.19 GPR	ASTM F1696 ASTM F1920
Stationary single-tank door	≤ ~~.70~~ 0.55 kW	≤ 0.35 kWh/rack	≤ 0.89 GPR	≤ ~~0.60~~ 0.30 kW	≤ 0.15 kWh/rack	≤ 1.18 GPR	
Pot, pan and utensil (PPU)	≤ ~~1.20~~ 0.90 kW	≤ 0.55+0.05 x SF_{rack}[c]	≤ 0.58 GPR	~~≤ 1.00 kW~~ N/A	N/A	~~≤ 0.58 GPSF~~N/A	
Single-tank conveyor	≤ ~~1.50~~ 1.20 kW	≤ 0.36 kWh/rack	≤ 0.70 GPR	≤ ~~1.50~~ 0.85 kW	≤ 0.16 kWh/rack	≤ 0.79 GPR	
Multiple-tank conveyor	≤ ~~2.25~~ 1.85 kW	≤ 0.36 kWh/rack	≤ 0.54 GPR	≤ ~~2.00~~ 1.00 kW	≤ 0.22 kWh/rack	≤ 0.54 GPR	
Single-tank flight	Reported	Reported	GPH ≤ 2.975x + 55.00	~~Reported~~ N/A	N/A	~~GPH ≤ 2.975x + 55.00~~ N/A	
Multiple-tank flight	Reported	Reported	GPH ≤ 4.96x + 17.00	~~Reported~~ N/A	N/A	~~GPH ≤ 4.96x + 17.00~~ N/A	

a. Idle results shall be measured with the door closed and represent the total idle energy consumed by the machine, including all tank heaters and controls. The most energy consumptive configuration in the product family shall be selected to test the idle energy rate. Booster heater (internal or external) energy consumption shall be measured and reported separately, if possible, per ASTM F1696 and ASTM F1920 Sections 10.8 and 10.9, respectively. However, if booster energy cannot be measured separately it will be included in the idle energy rate measurements. ~~not be part of this measurement unless it cannot be separately monitored.~~

b. GPR = gallons per rack, GPSF = gallons per square foot of rack, GPH = gallons per hour, x = maximum conveyor belt speed (feet/minute) × conveyor belt width (feet).

c. PPU Washing Energy is still in format kWh/rack when evaluated; SF_{rack} is Square Feet of rack area, same as in PPU water consumption metric.

TABLE C406.12(4) MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL OVENS

FUEL TYPE	CLASSIFICATION	IDLE RATE	COOKING-ENERGY EFFICIENCY, %	TEST PROCEDURE
Convection ovens				
Gas	Full-size	≤ 12,000 Btu/h	≥ 46	ASTM F1496
Electric	Half-size	≤ 1.0 ~~Btu/h~~ kW	≥ 71	
	Full-size	≤ 1.60 ~~Btu/h~~ kW		
Combination ovens				
Gas	Steam mode	≤ 200P [a] + 6,511 Btu/h	≥ 41	ASTM F2861
	Convection mode	≤ 150P [a] + 5,425 Btu/h	≥ 56	
Electric	Steam mode	≤ 0.133P [a] + 0.6400 kW	≥ 55	
	Convection mode	≤ 0.080P [a] + 0.4989 kW	≥ 76	
Rack ovens				
Gas	Single	≤ 25,000 Btu/h	≥ 48	ASTM F2093
	Double	≤ 30,000 Btu/h	≥ 52	

For SI: 1 Btu/h = 0.293/W.

a. *P* = Pan Capacity: the number of steam table pans the combination oven is able to accommodate in accordance with ASTM F1495.

ASTM

ASTM International
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959

F1696—~~2018~~ 2020 Standard Test Method for Energy Performance of Stationary-Rack, Door-Type Commercial Dishwashing Machines

F1920—~~2015~~ 2020 Standard Test Method for Performance of Rack Conveyor Commercial Dishwashing Machines

Reason: Fixes an editorial issue in commercial oven table that listed Btu/hr instead of kW for electric ovens. Also changes to the specification for dishwashers brings the current testing and reporting requirements in line with the market for efficient dishwashers. Furthermore, they align with ASTM testing criteria for high temp and low temp dishwashers.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is an optional efficiency package and therefore not a required cost to implement. Changes to the dishwasher performance will not increase costs as they are now aligned with efficient dishwashers in the market.

CEPI-200-21

IECC®: TABLE C406.12(4)

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C406.12(4) MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL OVENS

FUEL TYPE	CLASSIFICATION	IDLE RATE	COOKING-ENERGY EFFICIENCY, %	TEST PROCEDURE
Convection ovens				
Gas	Full-size	≤ 12,000 Btu/h	≥ 46	ASTM F1496
Electric	Half-size	≤ 1.0 kW ~~Btu/h~~	≥ 71	
	Full-size	≤ 1.60 kW ~~Btu/h~~		
Combination ovens				
Gas	Steam mode	≤ 200P[a] + 6,511 Btu/h	≥ 41	ASTM F2861
	Convection mode	≤ 150P[a] + 5,425 Btu/h	≥ 56	
Electric	Steam mode	≤ 0.133P[a] + 0.6400 kW	≥ 55	
	Convection mode	≤ 0.080P[a] + 0.4989 kW	≥ 76	
Rack ovens				
Gas	Single	≤ 25,000 Btu/h	≥ 48	ASTM F2093
	Double	≤ 30,000 Btu/h	≥ 52	

For SI: 1 Btu/h = 0.293/W.

a. P = Pan Capacity: the number of steam table pans the combination oven is able to accommodate in accordance with ASTM F1495.

Reason: This proposal fixes the idle rate errors in the current table. It changes the units from Btu/h to kW for electric half-size and full-size convection ovens to be consistent with the US EPA Energy Star criteria for commercial ovens that can be accessed at: https://www.energystar.gov/products/commercial_food_service_equipment/commercial_ovens/key_product_criteria

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposed change merely fixes a table error to show the actual idle rate efficiency metric for electric convection ovens. It does not change construction costs.

CEPI-201-21

IECC®: C406.13 (New), C406.13.1 (New), C406.13.2 (New), SECTION C202, SECTION 202 (New)

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Add new text as follows:
C406.13 Electric Vehicle Charging Infrastructure.

Where applicable, electric vehicle charging stations shall meet at least one of the following requirements:

C406.13.1 EVSE-installed spaces..

Where 25 or more parking spaces and lighting for parking areas are installed at buildings, at least one parking space shall be an *EVSE-installed space* rated at 208 Volts or greater and 40 Amps or greater. Where more than one parking facility is provided on a *site*, the number of *EVSE-installed spaces* shall be calculated separately for each parking facility. Where 25 or more parking spaces and lighting are added to an existing parking area or *site*, only the new parking spaces being added are subject to these requirements. Where permanent lighting fixtures are added to existing parking areas with 25 or more parking spaces, this section shall apply.

C406.13.2 Energy Star Certified Electric Vehicle Chargers.

Where 10 or more electric vehicle charging stations rated at 208/240 Volts are installed at a parking facility, at least one of the charging stations shall be Energy Star certified.

SECTION C202 GENERAL DEFINITIONS
Add new definition as follows:
ELECTRIC VEHICLE (EV).

An automotive-type vehicle for on-road use primarily powered by an electric motor that draws current from a building electrical service or another source of electric current to recharge.

ELECTRIC VEHICLE CHARGING STATION.

One or more vehicle spaces served by *electric vehicle* charging system equipment.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE).. An apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle*.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE)-INSTALLED SPACE. A designated parking space with dedicated *electric vehicle supply equipment*.

Reason Statement:

There are a significant number of jurisdictions that now require the installation of EV charging stations. See https://docs.google.com/spreadsheets/d/1lgppSv7HvU4ExH8TJarE23o8-Y-q9oLV0TaBPBMKaiE/edit#gid=27292754 for a list of requirements by city.

This proposal creates a reasonable baseline for those owners/developers that have made the decision to install a larger parking lot and permanent lighting fixtures (which are likely to be rated at 277 Volts, single phase).According to the US EPA, more than 50 state and local governments in the United States have enacted building and zoning codes amendments to ensure EV readiness. For example, the City of Los Angeles requires all newly constructed high-rise non-residential buildings to include EV charging outlets in at least 5 percent of the total parking spaces. Boulder County requires EV charging outlets in all new commercial, industrial, and multi-family residential buildings, as well as with significant additions or alterations. (see https://www.energystar.gov/sites/default/files/asset/document/Comm%20Buildings%20and%20EV%20Charging.pdf May 2019)

While there are no federal efficiency standards for EV charging stations, the US EPA has developed and implemented an Energy Star program for electric vehicle supply equipment. Version 1.0 of this specifications was released in December 2016 and updated in April 2017. Version 1.1 of the specifications was released on March 31, 2021. As of September 2021, there are 53 models of “Level 2” charging stations produced by over 15 manufacturers that are available on the market in the US and Canada.

Data provided by the US EPA for qualifying models shows that in the “no vehicle” mode, qualified charging stations reduce standby energy usage by an average of 25.7%. In the “partial on” mode, the qualified charging stations reduce standby energy usage by an average of 24.2%. In the “idle” mode, the charging stations that are qualified reduce standby energy usage by an average of 68.0%.

According to the US EPA, electric vehicle charging stations that have earned the Energy Star label use an average of 40% less energy than a standard EV charger when the charger is in a “standby” mode (e.g., “no vehicle” connected mode or “partial on” / “idle” modes when connected but not actively charging a vehicle). The US EPA estimates that EV chargers are typically in a standby mode for about 85% of the lifetime of the product.

In addition, two state (Rhode Island H5966 and Massachusetts S2955) have enacted state laws that require 208/240 Volt EV charging stations to meet the Energy Star specifications.

Bibliography:

US EPA, *ENERGY STAR® Program Requirements for Electric Vehicle Supply Equipment* Version 1.1, March 2021, Washington DC. https://www.energystar.gov/productfinder/product/certified-evse/results

Cost Impact:

The code change proposal will increase the cost of construction.

For a 208/240 Volt charging station, the cost of the equipment and labor will range from $500 to $1,500 depending on the features installed.

EV charging stations have a rated service life of 10-15 years. There have been many studies published about the costs to install a Level 2 EV charging station at a commercial building. See https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

https://theicct.org/sites/default/files/publications/ICCT_EV_Charging_Cost_20190813.pdf

Based on data provided by manufacturer websites and the US EPA, the incremental cost of an Energy Star EV charging station (compared to a non-Energy Star EV charging station) is approximately $10. (It should also be noted that EPA did a rudimentary analysis to identify models with similar attributes such as amperage, cable length, and Wi-Fi capability and compared Energy Star models to standard models. EPA found that the Energy Star models were not associated with a higher cost. This was not a comprehensive review of the market, but just an examination of a sub-set of products eligible for Energy Star certification).

With an estimated savings of 40% in standby mode, a typical Energy Star EV charging station will save approximately 30 kWh per year. Using a conservative 10-year service life and an average commercial electric costs of $0.1099 per kWh, the simple payback to install an Energy Star EV Charging Station is about 3.03 years.

CEPI-201-21

CEPI-202-21

IECC®: C406.3.3

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
C406.3.3 Lamp efficacy.

Not less than 95 percent of the permanently installed lighting, excluding kitchen appliance light fixtures, serving dwelling units and sleeping units shall be provided by lamps with an efficacy of not less than 65 lumens per watt or luminaires with an efficacy of not less than ~~45~~ 50 lumens per watt.

Reason Statement:

This proposal increases the minimum efficacy for fixtures to align with the latest US EPA Energy Star specifications for luminaires (version 2.2, August 2019). It will also be consistent with other proposals in the Commercial and Residential Energy Codes that also increase the fixture efficacy from 45 to 50 lumens/Watt.

A review of Sections 9.1 and 9.2 of the updated Energy Star specifications (available

at https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf) shows that the range of specifications for Energy Star luminaires is from 50 to 70 lumens/Watt depending on the type of luminaire and the lighting technology being used (fluorescent or LED).

Bibliography:

US EPA, ENERGY STAR® Program Requirements for Luminaires, Washington DC, August 25, 2019 (available at https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf)

Cost Impact:

The code change proposal will increase the cost of construction.

According to the EPA Energy Star web site (https://www.energystar.gov/productfinder/product/certified-light-fixtures/results), there are over 27,000 indoor luminaires that meet the most recent specifications, including:

Accent/Track Lighting (729 products)

Bath Vanity Lights (422 products)

Ceiling Fan Light Kits (75 products)

Ceiling Mount and Pendants (11,825 products)

Chandeliers (40 products)

Portable Lighting (table/desk/floor lamps) (169 products)

Post Lights (34 products)

Recessed Lighting (14,987 products)

In many cases, there will be no cost increase from going from 45 lumens/Watt to 50 lumens/Watt. However, there may be a $1 or $2 cost increase.

If a fixture has a light output of 900 lumens, then under the current language, the maximum Wattage is 20 Watt to meet the 45 lumen/Watt requirement. Under the proposed requirements, the maximum Wattage is 18 Watts (50 lumens/Watt).

If the fixture operates for 2 hours per day, the savings are as follows:

2 hours * 365 Days * 2 Watts saved = 1,460 Watt-hours = 1.46 kWh

1.46 kWh * $0.133 / kWh (US national average residential electricity cost in 2020, according to DOE) = $0.1942 saved per year

Simple payback:
$1 / $0.1942 = 5.15 years

$2 / $0.1942 = 10.30 years

CEPI-202-21

CEPI-203-21

IECC®: C407.2

Proponents:

Helen Sanders, Facade Tectonics Institute/Technoform North America, representing Facade Tectonics Institute

2021 International Energy Conservation Code

Revise as follows:
C407.2 Mandatory requirements.

Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to 80 percent of the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

   Exception: Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.
3. Energy use intensity (EUI) shall be publicly declared for all buildings that are equal to or greater than 50,000 SF (4645 m^2) after 12 months of continuous occupied building use within the first 36 months of occupancy. These EUI declarations, based on actual measured energy consumption, will need to be displayed publicly on the building and accessible online. The EUI declaration shall provide the information as defined in sections 3.1 to 3.4 for the building.
   - 3.1 Property information for each building, including:
     - 3.1.1. Property name
     - 3.1.2. Property address
     - 3.1.3. Property type
     - 3.1.4. Total gross floor area
     - 3.1.5. Year built / planned for construction completion
     - 3.1.6. Occupancy
   - 3.2. Predicted energy use as calculated for the *proposed design* using code-approved compliance software tools per Section C407.5.
   - 3.3. Total building site energy use as documented on utility bills, broken down by energy type (electric, gas, and others)
   - 3.4. If energy use is tied to the electrical grid, provide the following information:
     - 3.4.1. Peak electric demand
     - 3.4.2. Date/time of peak
     - 3.4.3. Load-duration curves for all 8,760 hours of the year (monthly, hourly, or seasonal)

Attached Files

- **FTI proposal to IECC 2024 for Energy Use Declaration.docx**
  http://localhost/proposal/453/818/files/download/146/

Reason Statement:

Historically, energy efficiency has been a means to address concerns over oil and fuel shortages, using demand reduction to limit our "vulnerability to energy supply disruptions"[1]. Over the past five decades, however, the role of energy efficiency has morphed into something even more critical – playing a key part in slowing down the rate of anthropogenic climate change highlighted by the IPCC's most recent Sixth Assessment Report and mitigating the impacts that climate change is already manifesting with dire consequences. As the International Code Council's Energy Efficiency website itself states, "The International Code Council family of solutions is helping our communities forge a path forward on energy and sustainability to confront the impacts of a changing climate."[2]With buildings making up nearly 40% of the total greenhouse gas emissions globally[3], it is imperative that we start enforcing accountability for actual building energy use rather than continue to rely on predicted energy consumption, which may not accurately reflect the building's true energy consumption. Of course, operational energy is not the only option we should pursue to mitigate the risks of climate change, but we should consider this a reasonable starting point, in line with the trajectory of the IECC.

We need to close the information loop on building energy performance, and we need to do it fast. If we don't start tracking actual energy use now, and correlating that to design intent, how will we know what aspects of building design, operations, and maintenance require our focus and dedication to rectify or improve upon? This proposal is for the 2024 code cycle, which means we only have two additional opportunities beyond this cycle to implement tangible step changes before we hit 2030, the target date for achieving zero energy buildings.

Furthermore, in the context of the current COVID-19 pandemic, we are seeing significant shifts in the way buildings are being used, with more flexibility in office schedules, hotdesking or hoteling, variable occupancy levels, and the need for more (natural) ventilation. These shifts make it even harder for energy models to predict energy use in a meaningful and informative way using current best standards and methods. Ongoing post-occupancy measurement and verification is the only way to reliably track and manage energy use. Without data, we cannot glean information and turn that into knowledge and even wisdom of how our buildings operate.

We are already seeing the following costs/risks associated with Business As Usual (BAU) here in the US and in Canada:- Shifting map of hurricane zones such that more areas are experiencing higher risks[4] (*e.g.,* Hurricane Sandy affecting New England)

- More extreme wildfires that create their own weather systems, making it even harder to contain them[5] (*e.g.,* Bootleg Fire in Oregon)

- Heat domes that exceed scientific predictions, even accounting for climate change[6] (*e.g.,* Pacific NW in early 2021)

Some are calling this the "social" cost of carbon, but it all boils down to a financial cost to humans – often inequitably – in the end.

Fabia Jeddere-Fisher, Senior Lecturer in Energy Engineering of University of the West of England (UWE) Bristol, Department of Architecture & Built Environment who is in charge of "metering, monitoring, and reporting energy use" and "identifying and setting targets for energy/carbon savings across the UWE estate" noted that Display Energy Certificate ratings do in fact impact the way building users interact with the buildings.

Proposal:

The FTI Advocacy Committee proposes the following new clause under **Chapter 4 – "Commercial Energy Efficiency", Section C407 – "Total Building Performance", Sub-Section, C407.2 – "Mandatory requirements"**:

Energy use intensity (EUI) shall be publicly declared for all buildings that are equal to or greater than 50,000 SF after 12 months of continuous occupied building use within the first 36 months of occupancy. These EUI declarations, based on actual measured energy consumption, will need to be displayed publicly on the building and accessible online.

The following information shall be reported and displayed publicly:

- Property information for each building, including:

o Property name

o Property address

o Property type

o Total gross floor area

o Year built / planned for construction completion

o Occupancy

- Predicted energy use as calculated for the *proposed design* using code-approved compliance software tools, per Section C407.5 – "Calculation software tools".

- Total building site energy use as documented on utility bills, broken down by energy type (*e.g.,* electricity, gas, etc.)*

- If energy use is tied to the electrical grid, provide the following information:

o Peak electric demand

o Date/time of peak

o Load-duration curves for all 8,760 hours of the year (TBD: Some might be monthly, hourly for the year, seasonal, etc.)

*Note: Consideration may also be needed to account for the following:

· Other energy sources on site (*e.g.,* oil, wood pellets, heat recovery incinerators, etc.)

· District heating/cooling (*e.g.,* steam or chilled water delivered to site)

· On-site electrical generation (*e.g.,* photovoltaics, fossil fuel, waste combustion, etc.)

· Waste heat generated on site but used offsite at another building

We have suggested 50,000 sq.ft. as the building size limit because of the relatively large impact that large buildings have on the overall energy usage, yet these comprise a relatively small number of actual buildings. The CBECS database indicates there are approximately 6 million commercial buildings with an average size of 16K sq.ft. Buildings of size greater than 50,000 sq.ft. represent a very small portion, ~5%, of the building stock in number, but around 50% of the floor area, and thus 50% of the energy impact. The 2018 Commercial Building Energy Consumption Survey[7] indicates that the top 3% of the largest buildings use 34% of the energy nationwide. Therefore addressing disclosure for the big buildings first is much easier both logistically and administratively, while not giving up much impact or savings.

The intent of this proposal is for benchmarking energy use, providing more transparency for building tenants, providing a needed feedback loop for energy simulation improvement, and getting the infrastructure in place for future measurement and verification opportunities, such as the possibility of including sub-metering for spotting trends and providing insight into potential areas of improvement.

The infrastructure to report actual building energy use is already in place, and some building energy labels "have gained significant market share".[8] In the US, one such established benchmarking platform is the ENERGY STAR® Portfolio Manager, an online reporting tool developed by the US Environmental Protection Agency (EPA). The following are two more platforms that can also be considered:

- ASHRAE Building Energy Quotient

- International Performance Measurement and Verification Protocol (IPMVP)

The additional effort required by building owners to comply with this proposed code development is not so onerous that it cannot be implemented at a national level. The ASHRAE 90.1 Standard has required sub-metering since the 2013 code cycle, which has been adopted by a number of states already. This EUI declaration proposal for IECC does not currently require sub-metering (to keep it simple and low cost), but it could be a consideration for future code cycles leading up to 2030.

In the future, the following incentives could be included in the further code cycles:

- Building owners will receive a rebate or credit for buildings that perform better than their predicted energy use.

- The IECC shall provide an opportunity for buildings that perform worse than their predicted energy use to make improvements over a subsequent 12-month period change their EUI.

Precedents in the US:

A number of states and cities already require commercial building energy disclosure[9] to some extent, including, but not limited to:

- California

- District of Columbia
- New Jersey
- New York
- Oregon
- Washington State
- Austin[10]
- Boston[11]
- Los Angeles[12]
- San Francisco[13]

A map of US cities and states with benchmarking programs and policies is given in this reference[14] and see attached version of this narrative with illustrations. Even more states require at least some or all of their public buildings and facilities to benchmark energy use[15], including, but not limited to the following states:

- Alabama
- Arkansas
- California
- Colorado
- Connecticut
- Florida
- Maryland
- Michigan
- Mississippi
- Nebraska
- New Mexico
- New York
- Ohio
- Pennsylvania
- Texas
- Washington State

Bibliography:

[1]https://www.ase.org/sites/ase.org/files/resources/Media%20browser/ee_commission_history_report_2-1-13.pdf

[2]https://www.iccsafe.org/products-and-services/codes-standards/energy/

[3]https://www.eia.gov/tools/faqs/faq.php?id=86&t=1

[4]https://www.c2es.org/content/hurricanes-and-climate-change/

[5]https://www.nytimes.com/2021/07/19/climate/bootleg-wildfire-weather.html

[6]https://www.theguardian.com/environment/2021/jul/02/canadian-inferno-northern-heat-exceeds-worst-case-climate-models

[8]2018 Commercial Building Energy Consumption Survey: https://www.eia.gov/consumption/commercial/pdf/CBECS%202018%20Preliminary%20Results%20Flipbook.pdf

[7]https://www.osti.gov/servlets/purl/1168594

[8]https://database.aceee.org/state/building-energy-disclosure

[9]https://austinenergy.com/ae/energy-efficiency/ecad-ordinance/for-commercial-buildings/for-commercial-buildings

[10]https://www.boston.gov/departments/environment/building-energy-reporting-and-disclosure-ordinance

[11]https://www.betterbuildingsla.com/

[12]https://sfenvironment.org/existing-buildings-energy-performance-ordinance

[13]https://www.energystar.gov/buildings/program-administrators/state-and-local-governments/see-federal-state-and-local-benchmarking-policies

[14]https://database.aceee.org/state/public-building-requirements

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Reporting data that is already available from utility bills, construction documents, and building simulations already submitted for code compliance and so will not change the cost of construction. If there is any administrative cost to disclosure, it should be minimal in the budget of a 50,000 sq.ft. building.

CEPI-203-21

CEPI-204-21

IECC®: C407.2

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition; Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:
C407.2 Mandatory requirements.

Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to 80 percent of the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.
3. The *building envelope* U-factors, C-factors, F-factors, and SHGCs shall be no greater than the values in Tables C402.1.4 and C402.4, with the following modifications to values in each table:
   3.1. For the opaque elements, each U-factor, C-factor, and F-factor in Table C402.1.4 shall be permitted to be increased by 15%.
   3.2. For vertical fenestration and skylights, each U-factor and SHGC in Table C402.4 shall be permitted to be increased by 15%.
   Exception: The U-factor, C-factor, F-factor, or SHGC shall not be modified where the requirement in the table is "NR" (no requirement).

Exception: Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

Reason Statement:

The purpose of this code change proposal is to improve the commercial total building performance path by incorporating a mandatory building thermal envelope trade-off backstop (limiting the user's ability to trade off the prescriptive envelope levels) similar to the residential version in Section R405.2 of the 2021 *IECC*. Although the residential provisions of the *IECC* have included mandatory trade-off limits (backstops) for various compliance paths for several editions now, and these trade-off limits were expanded and improved in the 2021 *IECC*, the commercial code compliance paths do not yet have similar trade-off backstops.

Even though the 2021 *IECC* requires a substantially improved level of efficiency in commercial building envelope components, an effective thermal envelope trade-off backstop would provide important additional benefits for the owners and occupants of these buildings by ensuring that all building envelopes exhibit a reasonable level of efficiency:

- The efficiency of the building envelope is the most important factor in a building's long-term performance (unlike equipment, the envelope can typically can last a very long time, even for the life for the building), but is the most costly to retrofit after the building is constructed;
- Occupants will be more comfortable and healthier in a building with a reasonably efficient envelope; and
- Well-insulated buildings are more resilient and will provide better protection for occupants and property in long-term power outages.

An effective thermal envelope backstop is crucial to ensure that the building retains reasonable envelope performance similar to the prescriptive path under an alternative compliance path, such as the performance path or an above-code program, etc., and that the envelope is not unduly traded-off for other measures. Trading off envelope and associated occupant comfort can have direct negative impacts on energy usage. For example, if the occupant responds to discomfort from a "cold" or "hot" room due to an inadequate building envelope by adjusting the thermostat, the additional energy use from the adjusted thermostat can be substantial. As a result,

backstops can save significant energy and energy costs in buildings.
Because the commercial performance path provides code users wider latitude than the residential chapters to trade efficiency among envelope, mechanical equipment, renewables and lighting, it is even more important that a backstop be included in the commercial performance path.

This proposal adds reasonable limits on efficiency trade-offs for opaque elements and fenestration, allowing code users to trade the efficiency of components up to 15% over the prescriptive U-factor, C-factor, F-factor or SHGC. These limits should be very straightforward to apply in any performance compliance software and should be easily understood by design professionals. As the *IECC* plays a bigger role in helping states and cities achieve their sustainability, resilience, energy efficiency and carbon reduction goals, it is more important than ever that each new building contain adequate insulation and efficient fenestration that will provide energy savings and comfort over the useful life of the building.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not increase the baseline stringency of the prescriptive requirements of the IECC, but merely limits trade-offs under a voluntarily chosen alternate compliance path. The mandatory minimum values proposed are 15% less stringent than prescriptive values of the IECC and only apply if an alternative compliance path is chosen. The user can be expected to choose an alternate compliance path, with the mandatory measures, when it produces lower costs than prescriptive compliance). As a result, whether costs of construction increase or decrease ultimately depends on choices made by the code user.

COST-EFFECTIVENESS

This proposal does not increase the stringency of the code or result in increased costs, so a cost-effectiveness analysis does not apply. The ICC Board of Directors set the 2021 IECC as the baseline for future IECC development – and by extension made the 2021 IECC the basis for cost-effectiveness analyses. This means for purposes of analyzing code proposals, the existing provisions of the 2021 *IECC* are considered cost-effective and reasonable (since they are the starting point for analyses of code changes and no rollbacks are permitted). Establishing trade-off backstops like this code change proposal (which utilizes U-factors and SHGCs 15% less stringent than the prescriptive measures of the 2021 *IECC*) does not increase the stringency of that baseline or impose any additional costs to meet specific measures. In addition, if the prescriptive values are cost-effective, then the backstop values would be cost-effective. These backstops serve only as a consumer protection against excessive trade-offs, but do not require anything more than what would be required for base code prescriptive compliance. Thus, a cost-effectiveness analysis would be difficult or impossible to apply and would not be informative.

CEPI-204-21

CEPI-205-21

IECC®: C407.2

Proponents:

Joseph Cain, representing Solar Energy Industries Association (SEIA) (JoeCainPE@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
C407.2 Mandatory requirements.

Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to 80 percent of the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* or a dedicated community solar facility shall be not more than ~~5~~ 15 percent of the total energy cost. ~~The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.~~

Exception: Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.

Reason Statement:

As renewable energy systems are increasing in deployment, the cost continues to drop. As renewable energy systems are an integral part of any path to net zero energy, or zero carbon, or decarbonization, it is important that they be integrated into the IECC. This proposal adds flexibility to the Total Building Performance compliance path, and can be compatible with a proposal for a commercial thermal envelope backstop, should one be approved by the IECC-C Committee.

As commercial buildings do not always have adequate roof space for renewable energy systems such as solar photovoltaic systems, off-site solar can be an important option if renewable energy is required by ASHRAE 90.1 or the IECC. U.S. DOE Secretary of Energy Granholm has made public statements about the growing importance of Community Solar facilities. The California Energy Commission has specifically included Community Solar as an off-site option when renewable energy systems are required. The contractual obligation between newly constructed buildings and their dedicated Community Solar facilities will be of growing importance.

The Total Building Performance compliance path should not penalize all off-site renewable energy equally, and needs to distinguish between dedicated Community Solar facilities and utility supplied grid power.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will not necessarily increase or decrease the cost of construction. Where renewable energy system are a cash purchase as first cost, the cost of construction can increase, with a cost benefit to the owner or tenant. Where third-party ownership or financing tools are used for the renewable energy system, the builder could experience reduced construction cost.

CEPI-205-21

CEPI-206-21

IECC®: C407.2

Proponents:

James Ranfone, representing American Gas Association

2021 International Energy Conservation Code

Revise as follows:
C407.2 Mandatory requirements.

Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to 80 percent of the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

Exception: ~~Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.~~ The energy use based on source energy expressed in Btu or Btu per square foot of conditioned floor area shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 2.80. The source energy multiplier for fuels other than electricity shall be 1.1.

Reason Statement:

The Exception is revised to recognize that source rather then site energy is a more accurate metric to measure energy use as a substitute for energy cost. The source energy multiplier is change to 2.80 from 3.10 to reflect the source energy multiplier used by the EPA in its Profile Manager program to convert to source energy. EPA states that it uses "national average ratios for the conversion to source energy to ensure that no specific building will be credited (or penalized) for the relative efficiency of its energy provider(s).

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is a clarification of the calculation for determining the source energy use for the Exception and will have no impact on cost.

CEPI-206-21

CEPI-207-21

IECC®: C407.2

Proponents:

James Ranfone, representing American Gas Association

2021 International Energy Conservation Code

Revise as follows:
C407.2 Mandatory requirements.

Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2.
2. An annual energy cost that is less than or equal to 80 percent of the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

Exception: ~~Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.~~ <u>Where energy use based on source energy expressed in Btu or Btu per square foot of conditioned floor area is substituted for the energy cost, the source energy multipliers shall be 2.80 for electricity and 1.1 for fuels other than electricity, or other multipliers for national or regional annual average energy consumption from nationally-recognized and validated data sources.</u>

Reason Statement:

The proposed change brings C407.2 into greater consistency with R405.3 and source energy metric usage in Federal energy programs including Energy Star for Commercial Buildings and Home Energy Score. This revised exception provides the only means of assessing energy performance on fuel cycle energy consumption and ultimately carbon footprints since site energy metrics alone cannot account for these upstream energy system losses. In addition, the allowance in the proposed exception language for use of "other multipliers" addresses a persistent criticism of national average multipliers, which may not reflect regional or local mixes of renewable energy in meeting building demands, and encourages authorities having jurisdiction to use locally-relevant multipliers that are available from utilities and other sources. Also, greater usefulness of the exception is critical since the basic requirements of C407.2 focusing on energy cost is not consistent with the intent of the IECC as stated in C101.3, which addresses energy use and conservation, not energy cost.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Cost Impact: The code change proposal will not increase or decrease the cost of construction The proposal would not increase the cost of construction since the proposal is for changes to an exception. If the use of source energy metrics allows more alternatives for achieving energy performance improvements, it may decrease construction costs ultimately.Cost Impact: The code change proposal will not increase or decrease the cost of construction The proposal would not increase the cost of construction since the proposal is for changes to an exception. If the use of source energy metrics allows more alternatives for achieving energy performance improvements, it may decrease construction costs ultimately.

CEPI-207-21

CEPI-208-21

IECC®: TABLE C407.2

Proponents: Marcin Pazera, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org); Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION [a]	TITLE
Envelope	
C402.2.1.2	Minimum thickness, lowest point
C402.2.1.3	Suspended ceilings
C402.2.1.4	Joints staggered
C402.2.1.5	Skylight curbs
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Reason: This section clarifies the code's intent that general roof insulation installation requirements apply to all of the IECC compliance methods by including the installation criteria when using total building performance in the IECC.
Currently, the proposed design that utilizes the total building performance path under Section C407 must meet only the mandatory air leakage provisions for the thermal envelope in Section C402.5. This proposal intends to add insulation installation requirements for roof assemblies as mandatory requirements. The specific sections proposed for addition include: minimum thickness, lowest point (Section C402.2.1.2), suspended ceilings (Section C402.2.1.3), joints staggered (C402.2.1.4). In addition, the proposal adds mandatory requirements for insulating skylight curbs, which is already part of (Section C402.2.1.5). This proposal does not bring new requirements into the IECC. It merely, references requirements in existing sections of the IECC for mandatory compliance. More importantly, the provisions that are being added have been developed and recognized as important measures that improve roof and overall performance of building envelopes from an energy, moisture, and air leakage standpoint. As an example, the practice of installing insulation above roof deck in minimum of two layers with joints staggered is not only required by the IECC but it is also recognized by roofing industry stakeholders as an approach that improves overall performance of roof systems.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal will not increase the cost of construction. The proposal does not introduce new requirements into the IECC, but clarifies that these important insulation installation requirements also apply to the total building performance compliance method.

CEPI-209-21

IECC®: TABLE C407.2

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION [a]	TITLE
Envelope	
C401.3	Thermal envelope certificate
C402.2.4.1	Insulation installation
C402.2.6	Insulation of radiant heating system
C402.2.7	Airspaces
C402.5	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4, except C403.4.3, C403.4.4 and C403.4.5	Heating and cooling system controls
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.11, except C403.11.3	Refrigeration equipment performance
C403.12	Construction of HVAC system elements
C403.13	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Reason: When this table was introduced last cycle to consolidate various mandatory requirements to be considered in the total building performance path, many details from the mechanical provisions were included. However, many similar mandatory details in the envelope provisions were missed. These include matters that apply regardless of the compliance path used. For example, an envelope certificate should apply regardless of the compliance path. This does not change requirements or limit the use of the performance path to adjust criteria. Instead, it ensures minimum practices are at least satisfied even when otherwise altering insulation and performance requirements for the building thermal envelope.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not change requirements but ensures that minimum practices are used consistently for all compliance paths, even though the criteria for those practices may be traded off in the the performance path.

CEPI-210-21

IECC®: TABLE C407.4.1(1)

Proponents:

Helen Sanders, Facade Tectonics Institute/Technoform North America, representing The Facade Tectonics Institute

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Vertical fenestration other than opaque doors	Area 1. The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 40 percent of above-grade wall area. 2. 40 percent of above-grade wall area; where the proposed vertical fenestration area is 40 percent or more of the above-grade wall area.	As proposed
	U-factor: as specified in Table C402.4	Fenestration shall meet the following requirements 1. Fixed fenestration: The weighted average U-factor of the combined fenestration assemblies shall not exceed 110% of the value in Table C402.4 for fixed fenestration 2. Operable fenestration: The weighted average U-factor of the combined fenestration assemblies shall not exceed 110% of the value in Table C402.4 for operable fenestration **Exceptions:** Fire-protection-rated fenestration assemblies, blast resistant fenestration assemblies, historic preservation or restoration projects.
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed
	External shading and PF: none	As proposed
	Area 1. The proposed skylight area; where the proposed skylight area is less than that permitted by Section C402.1. The area permitted by Section C402.1;	As proposed

Skylights	2. where the proposed skylight area exceeds that permitted by Section C402.1.	
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed

Reason Statement:

The Façade Tectonics Institute is supportive of the need to promote the implementation of higher performing façades and to make it less easy to trade off poor envelope performance with higher internal system performance. This proposal creates maximum allowable thermal transmittance values (U-factor) for fenestration for use in buildings following the total performance compliance path.

The goal of this proposal is to prevent poor performing fenestration (with performance significantly worse than the prescriptive requirements) being installed because of the ability to trade off with higher performing HVAC and lighting in the total performance compliance path.

This trade off happens quite often, and is a challenge being seen across the country, where fenestration with U-factors higher than the prescriptive path are used in performance path compliance. This is the reason why envelope backstops (a similar concept) have already been enacted in building energy codes in Washington State, New York City, Massachusetts, and more recently in ASHRAE 90.1.

It matters how total performance is achieved

While in principle, it shouldn't matter how the total energy performance of the building is achieved, as long as it is better than the base building, a building with poorer envelope leads to reduced resilience to acute weather events (human health and survivability consequences) and climate change, challenges with driving towards net-zero goals, poor thermal comfort next to the envelope, and potentially condensation issues leading to mold and indoor air quality problems (depending on the climate zone).

The use of a single metric around which the building is optimized – energy use intensity (or worse, energy cost) - can lead to buildings with sub-optimal occupant comfort and poor resilience and passive survivability. This does not help jurisdictions manage the impact of climate change, nor move quickly towards net zero energy performance.

The heat waves that have afflicted the western US this year, which has caused brown and black outs illustrate the importance of a high-performance envelope to maintain a functional indoor environment for a reasonable amount of time. Heat is the silent killer, which takes more lives than the acute impacts of storms [see reference 1]. A high-performance HVAC system is of no help to occupants if there is no power. Atelier 10 simulated the impact of high-performance envelope versus current building stock and code compliant envelope performance for Urban Green, and demonstrated the importance of the thermal performance of the building envelope for maintaining passive survivability in the buildings during power outages in both winter and summer conditions [see reference 2].

In addition, there is a big push to electrify buildings along with decarbonization of the grid. This means a switch from gas heating/boilers to heat pumps. In new construction an aggressive envelope should mean not only lower energy bills but lower peak loads and lower costs for HVAC systems and lower cost for PV/storage and grid upgrades; Utilities will have massive new heating loads that occur 6AM in winter when solar power is not available. So, loads will need to be reduced during those periods, which is why a focus on better facades is needed as one strategy to minimize those loads. Larger HVAC systems also come with increased greenhouse gas emissions from refrigerants, again pointing to the need for better envelope focus.

Also, since the performance of the building envelope is already overestimated because thermal bridging is ignored, making the envelope worse does not seem to be going in the right direction for actual energy savings nor moving closer to our nation's net zero carbon goals.

The Institute agrees that some architectural design flexibility is needed to manage innovation and challenging applications and believe that this can be achieved by identifying exceptions and through setting the area weighted limits somewhat higher than the prescriptive values.

We recognize that there may be specialty applications (e.g. fire, blast, historic renovation) that may need to be excepted.

Our proposal recommends:

1. The maximum area weighted U-factors be separated according to the type of fenestration e.g. fixed fenestration or operable

windows. It is also our desire to encourage the use of operable windows to achieve more natural ventilation in buildings. Since operable fenestration typically has higher U-factors than fixed fenestration, the committee could consider modifying the proposal such that the area weighted U-factor for operable fenestration may be traded off with better area weighted average of the fixed fenestration types in the building, so long as the total area weighted U-factor of the fixed and operable fenestration does not exceed the sum of the maximum allowable U-factor (operable)xArea of operable fenestration plus maximum allowable U-factor (fixed fenestration)xArea fixed fenestration divided by the total fenestration area.

We strongly prefer a fenestration maximum (a fenestration backstop), rather than creating a whole envelope maximum by combining into an area weighted value for opaque and transparent areas (an envelope backstop). This is because the fenestration maximum approach does not result in the potential negative consequence of trading off fenestration for opaque elements. We recognize the need for sufficient fenestration to be used in buildings to provide daylight and views for the health and well-being of occupants [see for example reference 3, but there is a large body of data on the human benefits of daylight and views] and for capturing daylight harvesting energy savings when combined with lighting controls.

2. The maximum area weighted U-factors be set at values 10% higher than the respective prescriptive requirement, to give design teams some flexibility. The cost effectiveness of the prescriptive values has already been shown, so allowing 10% above these values should also be cost-effective. We recommend using a percentage above the prescriptive baseline so that when the prescriptive U-factors are reduced, this requirement automatically changes with it.

3. Including exceptions are as follows:

a. Fire resistant glazing

b. Blast resistant glazing

c. Historic Preservation or historic restoration. We believe that an exception for just “renovation” is much too broad and that design teams should be made to increase the performance of the façade in all renovations unless they are true historic preservations or restorations. After all, renovations generally only happen once in a generation, and if we want to address existing building energy performance which is where most of the energy savings and resiliency impacts will be, we need to have higher expectations of post renovation performance.

d. Structural glass facades on the ground floor of single/two-story buildings or standalone structures where loads and/or movements (e.g. seismic) as demonstrated by engineering calculations preclude the use of insulating glass.

To illustrate the maximum values of fenestration U-factors proposed for the total performance path compared with the current prescriptive values, the maximum numbers are included in parenthesis next to the prescriptive values from Table C402.4 in the attached table. These U-factors are easy to meet in the given climate zone relative to the prescriptive values. The products are widely available and cost-effective based on the prescriptive values being 10% lower (more stringent).

CLIMATE ZONE	0 AND 1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7
Vertical fenestration							
U-factor (fenestration maximum values in parenthesis next to the prescriptive values for comparison)							
Fixed fenestration	0.50 (0.55)	0.45 (0.50)	0.42 (0.46)	0.36 (0.40)	0.36 (0.40)	0.34 (0.37)	0.29 (0.32)
Operable fenestration	0.62 (0.68)	0.60 (0.68)	0.54 (0.59)	0.45 (0.50)	0.45 (0.50)	0.42 (0.46)	0.36 (0.40)
Entrance doors	0.83	0.77	0.68	0.63	0.63	0.63	0.63

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal still allows for the use of lower performance fenestration in the total performance path than prescriptively allowed and the prescriptive values have already been shown to be cost-effective. While the proposal still provides some flexibility in moving dollars spent on the envelope to dollars spent on internal building systems like lighting and HVAC, it prevents larger transfers of cost/budget. It is possible that design teams trade off lower performance fenestration with higher efficiency HVAC and lighting because it is the less expensive route to deliver their design intent. This proposal will constrain this budget trade off and so may increase the cost of constructing a building if compared to one that could have used even poorer fenestration, but likely not relative to a building built to the prescriptive compliance path which would use higher performance fenestration.

CEPI-210-21

CEPI-211-21

IECC®: TABLE C407.4.1(1)

Proponents:

Anurag Goel, representing enVerid Systems (agoel@enverid.com); Kimberly Cheslak, NBI, representing NBI (kim@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Space use classification	Same as proposed	The space use classification shall be chosen in accordance with Table C405.3.2(1) or C405.3.2(2) for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.
Roofs	Type: insulation entirely above deck	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, above-grade	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, below-grade	Type: mass wall	As proposed
	Gross area: same as proposed	As proposed
	U-Factor: as specified in Table C402.1.4 with insulation layer on interior side of walls	As proposed
Floors, above-grade	Type: joist/framed floor	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
Floors, slab-on-grade	Type: unheated	As proposed
	F-factor: as specified in Table C402.1.4	As proposed
Opaque doors	Type: swinging	As proposed
	Area: Same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Area 1. The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 40	

Vertical fenestration other than opaque doors	percent of above-grade wall area. 2. 40 percent of above-grade wall area; where the proposed vertical fenestration area is 40 percent or more of the above-grade wall area.	As proposed
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed
	External shading and PF: none	As proposed
Skylights	Area 1. The proposed skylight area; where the proposed skylight area is less than that permitted by Section C402.1. 2. The area permitted by Section C402.1; where the proposed skylight area exceeds that permitted by Section C402.1.	As proposed
	U-factor: as specified in Table C402.4	As proposed
	SHGC: as specified in Table C402.4 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Section C405.3.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 watt per square foot based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Tables C405.5.2(1), C405.5.2(2) and C405.5.2(3). Areas and dimensions of surfaces shall be the same as proposed.	As proposed
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. End-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.
	Same as proposed **Exception:** Thermostat settings and	Operating schedules shall include hourly profiles for daily operation and shall account for variations between

Schedules	schedules for HVAC systems that utilize radiant heating, radiant cooling and elevated air speed, provided that equivalent levels of occupant thermal comfort are demonstrated by means of equal Standard Effective Temperature as calculated in Normative Appendix B of ASHRAE Standard 55.	weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.
Mechanical ventilation	~~Same as proposed~~ In accordance with Section 403.2.2.	~~As proposed, in accordance with Section C403.2.2.~~ Same as baseline. **Exception**: Where the proposed design includes an engineered ventilation system with air cleaning, reduced ventilation rates may be calculated for each HVAC zone.
Heating systems	Fuel type: same as proposed design	As proposed
	Equipment type[a]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in the tables in Section C403.3.2.	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design.	As proposed
Cooling systems	Fuel type: same as proposed design	As proposed
	Equipment type[c]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in Tables C403.3.2(1), C403.3.2(2) and C403.3.2(3)	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet cooling load hours and no larger cooling capacity safety factors are provided than in the proposed design.	As proposed
	Economizer[d]: same as proposed, in accordance with Section C403.5.	As proposed
Service water heating[e]	Fuel type: same as proposed	As proposed
	Efficiency: as specified in Table C404.2	For Group R, as proposed multiplied by SWHF. For other than Group R, as proposed multiplied by efficiency as provided by the manufacturer of the DWHR unit.
	Capacity: same as proposed	As proposed
	Where no service water hot water system exists or is specified in the proposed design, no service hot water heating shall be modeled.	

For SI: 1 watt per square foot = 10.7 w/m^2.

SWHF = Service Water Heat Recovery Factor, DWHR = Drain Water Heat Recovery.

a. Where no heating system exists or has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical in both the standard reference design and proposed design.

b. The ratio between the capacities used in the annual simulations and the capacities determined by sizing runs shall be the same for both the standard reference design and proposed design.

c. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal zone. The system characteristics shall be identical in both the standard reference design and proposed design.

d. If an economizer is required in accordance with Table C403.5(1) and where no economizer exists or is specified in the proposed design, then a supply-air economizer shall be provided in the standard reference design in accordance with Section C403.5.

e. The SWHF shall be applied as follows:

   1. Where potable water from the DWHR unit supplies not less than one shower and not greater than two showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.36)].
   2. Where potable water from the DWHR unit supplies not less than three showers and not greater than four showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.33)].
   3. Where potable water from the DWHR unit supplies not less than five showers and not greater than six showers, of which the drain water from the same showers flows through the DWHR unit, then SWHF = [1 – (DWHR unit efficiency × 0.26)].
   4. Where Items 1 through 3 are not met, SWHF = 1.0.

Reason Statement:

Section 403.2.2 Ventilation of the 2021 IECC allows for minimum outdoor airflow rates to be determined in accordance with (a) prescriptive ventilation rates under Table 403.3.1.1 of the 2021 IMC or (b) an engineered ventilation systems design as defined by Section 403.2 of the 2021 IMC. The latter approach may lead to a more efficient design by incorporating source control or removal measures, including air cleaning, to offset a portion of the outside air requirement under the prescriptive ventilation rate approach. Despite these two approaches for determining minimum outdoor airflow rates, baseline and proposed case ventilation rates must be the same. As such, the IECC does not enable design teams using an engineered ventilation system design to take energy credit for a more energy efficient engineered ventilation systems design. The proposed change fixes this.

According to Section 403.2 of the 2021 IMC, "Where a registered design professional demonstrates that an engineered ventilation system design will prevent the maximum concentration of containments from exceeding that obtainable by the rate of outdoor air ventilation determined in accordance with Section 403.3, the minimum required rate of outdoor air shall be reduced in accordance with such engineered system design." In other words, when source-control and/or removal measures are incorporated into an engineered ventilation system design, minimum outside airflow may be lowered to account for the efficiency of the source-control and/or removal measures. Using this approach, the implemented source-control and/or removal measures may offset a portion of the outside air required by conventional ventilation system designs sized using prescriptive ventilation rates found in Table 403.3.1.1 in order to achieve a more energy efficient design.

The proposed change will allow design teams using an engineered ventilation systems design to take energy credit for a more energy efficient engineered ventilation systems design in accordance with Section 403.2 of the 2021 IMC. This is currently not allowed because baseline and proposed case ventilation rates must be the same as per Table C407.4.1(1).

A 2017 report by the U.S. Department of Energy's Building Technology Office (BTO) called "Energy Savings Potential and RD&D Opportunities for Commercial Building HVAC Systems" identified Ventilation Reduction through Advanced Filtration as a top energy saving technology for commercial building HVAC systems. The report also said, "The largest barrier to market adoption is acceptance by building code jurisdictions (pg. 44)." More recently the U.S. Green Building Council has endorsed performance-based indoor air quality designs and assessments to reduce ventilation energy consumption by developing two pilot credits based on this approach: EQpc124 for LEED BD+C andEQpc119for LEED O+M. The next step to unlock the full potential of ventilation energy efficiency using source control and removal measures is to update the IECC to allow design teams using an engineered ventilation systems design to take energy credit for a more energy efficient engineered ventilation systems design.

Link to Energy Savings Potential and RD&D Opportunities for Commercial Building HVAC Systems" report:

https://www.energy.gov/sites/prod/files/2017/12/f46/bto-DOE-Comm-HVAC-Report-12-21-17.pdf

Cost Impact:

The code change proposal will decrease the cost of construction.

The code change proposal will decrease the cost of construction. Designs the use the IAQ Procedure typically result in reduced minimum outdoor airflows relative to prescriptive ventilation rates. Designing towards this reduced outside airflow can have a systemic effect on the HVAC design and can allow for the following first cost saving measures: 1. Reduce overall load on central heating and cooling equipment; 2. Reduce overall capacity of cooling and heating coils inside HVAC equipment; 3. Downsize or eliminate energy recovery systems; 4. Eliminate demand control ventilation / CO sensors, if applicable; 5. Downsize outside air intakes and respective ductwork; and 6. Downsize or eliminate general-exhaust / relief air fans.Example 6-AA IAQ Procedure, Single-Zone System in ASHRAE 62.1 User's Manual provides an example of how minimum outdoor airflow can be reduced by 1,000 CFM (47%) when applying the IAQ Procedure with air cleaning and comparing it with prescriptive ventilation rates. The reduction in minimum outdoor airflow results in a range of annual energy and energy cost savings depending on project location (climate) and utility rates. See Appendix A, attached, which includes a table with estimated load reduction and energy savings associated with a 1,000 CFM reduction in outside airflow across the different United States metro areas. Also included in Appendix A, is the calculation methodology used to populate the table.

1,000 CFM Reduction in Outdoor Airflow. Workday Operation (7am to 7 pm, 6 days)					
Top 20 US Metro Areas	Cooling Energy Savings (kBtu)	Heating Energy Savings (kBtu)	Total Energy Savings (kBtu)	Cooling Load Reduction (Tons)	Heating Load Reduction (MBH)
New York-Northern NJ-Long Island, NY-NJ-PA	8,099	41,984	50,083	3.6	66
Los Angeles-Long Beach-Santa Ana, CA	4,384	222	4,607	2.9	34
Chicago-Joliet-Naperville, IL-IN-WI	6,430	65,265	71,695	5.3	79
Dallas-Fort Worth-Arlington, TX	20,342	12,088	32,430	3.9	58
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	8,099	41,984	50,083	5.3	64
Houston-Sugar Land-Baytown, TX	28,129	3,018	31,147	4.7	48
Washington-Arlington-Alexandria, DC-VA-MD-WV	10,635	30,634	41,269	5.4	61
Miami-Fort Lauderdale-Pompano Beach, FL	38,263	0	38,263	5.1	28
Atlanta-Sandy Springs-Marietta, GA	15,614	16,843	32,457	5.2	57
Boston-Cambridge-Quincy, MA-NH	5,608	48,778	54,386	3.5	72
Detroit-Warren-Livonia, MI	6,255	64,649	70,904	4.7	74
Riverside-San Bernardino-Ontario, CA	4,384	222	4,607	3.5	41
Phoenix-Mesa-Glendale, AZ	14,981	817	15,799	4.7	38
Minneapolis-St. Paul-Bloomington, MN-WI	4,363	72,688	77,051	5.1	91
San Diego-Carlsbad-San Marcos, CA	3,431	13	3,444	1.7	32
St. Louis, MO-IL	10,480	30,823	41,303	4.7	75
Tampa-St. Petersburg-Clearwater, FL	32,637	938	33,575	5	38
Baltimore-Towson, MD	10,531	33,510	44,041	5.1	61

Appendix A – Energy Savings and Peak Load Reduction Calculations Methodology

A.1 General. Reducing outside air in a system results in a reduced cooling coil entering enthalpy (cooling equipment) & increased heating coil entering temperature (heating equipment). 2017 ASHRAE Handbook—Fundamentals[1] calculations are modified to quantity the difference in energy use & peak load when a system has utilized ASHRAE 62.1 IAQP to reduce outside air requirement.

A.2 Cooling Energy Savings. Sensible and latent cooling energy savings from load reduction is based on decreasing outside airflow (Q_{OAr}) requirements after applying IAQP and air cleaning. Outside air reduction is offset by increased return air to maintain constant primary airflow.

A.2.1 Methodology. For each occupied hour, calculate the enthalpy of outside air (h_{oa}) using 5-year (2009 to 2013) historical weather data[2] and return air enthalpy (h_{ra}) using assumed indoor conditions.

For each occupied hour:

$$Cooling\ Energy\ savings\ (BTUs) = \frac{Q_{OAr} \times (h_{oa} - h_{ra})}{Cooling\ COP}$$

where outside air reduction (Q_{OAr}) is assumed to be 1,000 CFM, h_{ra} is assumed based on summer return air condition [*75°F$_{dry\ bulb}$ / 50% relative humidity*], and *COP is the* coefficient of performance (*assumed 3.0*),

A.3 Heating Energy Savings. Sensible heating energy savings from load reduction based on decreasing outside airflow (Q_{OAr}) requirements after applying IAQP and air cleaning. Outside air reduction is offset by increased return air to maintain constant primary airflow.

A.3.1 Methodology. For each occupied hour, calculate the temperature of outside air (t_{oa}) using 5-year (2009 to 2013) historical weather data[2] return air temperature (t_{ra}) using assumed indoor conditions. Return air conditions are assumed to be:

For each occupied hour:

$$Heating\ Energy\ savings\ (BTUs) = \frac{Q_{OAr} \times (t_{oa} - t_{ra})}{Heating\ COP}$$

where outside air reduction (Q_{OAr}) is assumed to be 1,000 CFM, h_{ra} is assumed based on winter return air condition [*68°F$_{dry\ bulb}$*], and *COP is the* coefficient of performance (*assumed 1.0*).

A.4 Peak Cooling & Heating Load Reduction. Cooling and heating load reduction are calculated in a similar methodology to energy savings, but only for the hottest (summer) and coldest (winter) hours of the year. Summer design day temperatures were determined using the 0.4% dry bulb temperatures and 0.5% mean coincident wet bulb temperature (MCWB). Winter design day temperatures were determined using the 99.6% dry bulb temperature.

[1] *Calculations from "2017 ASHRAE Handbook—Fundamentals Chapter 1: psychrometrics"*

[2] *Weather data from "2017 ASHRAE Handbook—Fundamentals Appendix: Design Conditions for Selected Locations"*

CEPI-211-21

CEPI-212-21

IECC®: TABLE C407.4.1(1)

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Roofs	Type: insulation entirely above deck	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.4	As proposed
	Solar absorptance: 0.75<u>, except as specified in Table C402.3 for Climate Zones 0, 1, 2, and 3</u>	As proposed
	Emittance: 0.90<u>, except as specified in Table C402.3 for Climate Zones 0, 1, 2, and 3</u>	As proposed

Reason Statement:

This proposal aligns the standard reference design roof parameters with conditions required in the prescriptive path for roof solar reflectance and thermal emittance in Section C402.3. The prescriptive provisions are intended to serve as the basis for the standard reference design in the performance path of Section C407.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal addresses an apparent error or omission in aligning the standard reference design with the prescriptive path which is unchanged by this proposal and is the basis of cost-effectiveness.

CEPI-212-21

CEPI-213-21

IECC®: TABLE C407.4.1(1)

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Mechanical ventilation	Type, natural or mechanical: ~~Same~~ same as proposed. Airflow: as proposed. Energy recovery: where the proposed design specifies mechanical ventilation, energy recovery ventilation shall be provided in accordance with Section C403.7.4. Fan power: where the proposed design specifies mechanical ventilation, fan power shall be determined in accordance with C403.8.3.	As proposed, in accordance with Section C403.2.2.

Reason Statement:

This proposal incentivizes energy efficient mechanical ventilation, where provided, and ensures that the standard reference design is modeled to be minimally compliant with the relevant sections of Chapter 4.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal would increase the estimated savings associated with mechanical ventilation systems that outperform the code's minimum prescriptive energy efficiency requirements. This could help to reduce construction costs and encourage specification of energy efficient mechanical systems.

CEPI-213-21

CEPI-214-21

IECC®: C408.2 (New), ASTM Chapter 06 (New)

Proponents:

Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Add new text as follows:

C408.2 Building thermal envelope commissioning.

Commissioning of the *building thermal envelope* shall be in accordance with ASTM E2813. Requirements of the *building thermal envelope* are limited to inclusion in the owner's project requirements (OPR) and basis of design (BOD), as well as the review of the OPR, BOD and project design. The review of the *building thermal envelope* design shall be performed by a qualified independent member of the design or construction team who is not directly responsible for design of the building enclosure for the project.

Add new standard(s) as follows:

ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

E2813-18	Standard Practice for Building Enclosure Commissioning

Reason Statement:

This proposal adds a requirement for commissioning of the building thermal envelope. Currently MEP and lighting systems require commissioning, but the code does not include building envelope commissioning. The building envelope should also be commissioned if the building is to operate as a holistic system and for the building's designed energy efficient performance to be truly achieved. All the major green building standards (LEED, ASHRAE 189.1/lgCC, and Green Globes) contain building envelope commissioning provisions and the implementation of building envelope commissioning is increasing in the industry.

Bibliography:

1. C. C. Sullivan, "Calculating the ROI of Building Enclosure Commissioning", Building Design & Construction, June 28, 2013.

Cost Impact:

The code change proposal will increase the cost of construction.

Costs will be dependent of project size and consistency. According to a researcher at LBL [1] building enclosure commissioning (BECx) costs about $1.16/sf for new construction and has a payback period of as little as 14 months. Savings associated with using BECx from both maintenance and energy savings average about 13% for new construction. Savings include first-cost savings through right-sizing of HVAC equipment.

CEPI-214-21

CEPI-215-21

IECC®: C408.2

Proponents:

Kimberly Cheslak, New Buildings Institute, representing NBI (kim@newbuildings.org); Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:
C408.2 Mechanical systems and service water-heating systems commissioning and completion requirements.

Prior to the final mechanical and plumbing inspections, the *registered design professional or approved agency* shall provide evidence of mechanical systems *commissioning* and completion in accordance with the provisions of this section.

Construction document notes shall clearly indicate provisions for *commissioning* and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner or owner's authorized agent and made available to the *code official* upon request in accordance with Sections C408.2.4 and C408.2.5.

Exceptions: The following systems are exempt:

1. Buildings with less than 10,000 square feet (929 m^2)and ~~Mechanical systems and service water-heating systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW)~~ combined heating, cooling, and service water-heating ~~and space-heating~~ capacity of less than 960,000 Btu/h (280 kW).
2. Systems included in Section C403.5 that serve individual *dwelling units* and *sleeping units*.

Reason Statement:

Changes to exception will expand the applicability of commissioning requirements in commercial buildings. This approach is based off the combined heating, cooling and hot water heating capacity from 90.1-2019, and further informed by the prevalence of city and state benchmarking, retro-commissioning and BPS policies that continue to target 10,000 square feet as a cut off for determining compliance. By ensuring that buildings of this size have completed commissioning at construction, owners and facility managers are better equipped to operate the building as intended and meet continuing performance requirements.

Bibliography:

ANSI/ASHRAE/IES Addenda m, ai, aj, au, az, bg, dn to ANSI/ASHRAE/IES Standard 90.1-2016 https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90.1-2016/90_1_2016_m_ai_aj_au_az_bg_dn_20210324.pdf

https://www.buildingrating.org/

Cost Impact:

The code change proposal will increase the cost of construction.

Commissioning and functional testing are highly valuable activities that produce real savings in new construction. A research report covering 82 new construction projects has found that median payback is around 4.2 years and the benefit-to cost ratio is 1.1 years. (Mills, E. 2011. "Building commissioning: a golden opportunity for reducing energy costs and greenhouse gas emissions in the United States." Energy Efficiency.) This cost is based on full commissioning that includes commissioning of all Owner's Project Requirements, not just those requirements relevant to Standard 90.1. While some settings corrected during commissioning can decay, the cited study shows good persistence for a 5 year follow-up period, with longer-term impact expected; as assemblies, sequences and settings are correct at occupancy and documentation on proper system operation is available for operating staff later at the site. Based on an average persistence of 10 years, the average heating and cooling scalar limit for 90.1 is 8.5 years and the overall commissioning payback in the cited study is much lower at 4.2 years.

While many of the projects in the Mills study included design phase commissioning, this is required in Standard 90.1 only for buildings with at least 10,000 square feet of conditioned area. Buildings with simple HVAC systems up to 25,000 square feet and non-refrigerated warehouses are exempt. A 2011 study (California Statewide Utility Codes and Standards Program. September 2011. “Draft Measure Information Template – Design-Phase Commissioning.”) specifically looked at the cost of design phase commissioning. Looking just at the impact of design review included in commissioning, for buildings above 25,000 square feet, the cost ranges from $0.38 to $0.10 per square foot, with the cost reducing with size and an average of $0.22 per square foot. A weighted average of present value cost savings across climate zones is $1.08 to $1.47 for larger buildings resulting in a BCR of 2.8 for the highest cost and lowest savings situation. When the savings are adjusted to match the 90.1 scalar analysis, the payback is in the range of 2.5 to 7.7 years for five common building types. All these paybacks are under the scalar threshold of 8.7. Again, this analysis is just for the added cost of design review included in the commissioning process.

CEPI-215-21

CEPI-216-21

IECC®: C501.2, ASHRAE Chapter 06 (New)

Proponents:

Amy Boyce, representing Institute for Market Transformation (amy.boyce@imt.org)

2021 International Energy Conservation Code

Revise as follows:
C501.2 Compliance.

Additions, alterations, repairs, and changes of occupancy to, or relocation of, existing buildings and structures shall comply with Sections C502, C503, C504 and C505 of this code, as applicable, and with the provisions for alterations, repairs, additions and changes of occupancy or relocation, respectively, in the International Building Code , International Existing Building Code, International Fire Code, International Fuel Gas Code, International Mechanical Code, International Plumbing Code, International Property Maintenance Code, International Private Sewage Disposal Code and NFPA 70. Changes where unconditioned space is changed to conditioned space shall comply with Section C502.

Exceptions:

Additions, alterations, repairs or changes of occupancy complying with either

1. ANSI/ASHRAE/IESNA 90.1 or
2. ANSI/ASHRAE/IESNA 100, provided any addition complies with Section C502, applicable alterations comply with Section C503, changes in occupancy or use comply with Section C505, and use of renewable energy to assess compliance is limited to not more than 5 percent of the annual energy use of the building.

Add new standard(s) as follows:

ASHRAE ASHRAE 180 Technology Parkway NW Peachtree Corners GA 30092

100-2018 Energy Efficiency in Existing Buildings

Reason Statement:

Residential and commercial buildings combined account for about 40% of US energy consumption[1], but the building replacement rate is only 1 to 2%[2] meaning that the overwhelming majority of buildings that currently exist today will continue to do so long past 2030, and will account of the majority of energy use in that timeframe. Many opportunities exist to cost-effectively bring the building stock up closer to current building energy code requirements, and ASHRAE Standard 100 outlines the procedures and programs necessary to do so.

This proposal add options for addressing existing buildings; it does not change the requirements, nor does it strengthen or weaken the code, but rather adds flexibility. ASHRAE 100 provides guidance surrounding energy efficient operations and maintenance, increasing the energy efficiency of existing systems and components, and upgrading the envelope's thermal performance. It is a standardized approach to a holistic retrofit or renovation, leading to energy efficiency in existing commercial buildings.

[1] U.S. Energy Information Administration, Monthly Energy Review, available at https://www.eia.gov/totalenergy/data/monthly/

[2] U.S. Energy Information Administration, Annual Energy Outlook 2021, available at https://www.eia.gov/outlooks/aeo/

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This change provides an additional compliance option and therefore neither increases nor decreases the cost of construction.

Cost Effectiveness: Compliance with one of the exceptions listed in Section C501 will result in a broad range of construction cost impacts depending on the path chosen. Each of the options listed correlates to a series of choices made by the code user, the building owner, and the design team, and depends on the best case for the building and its systems given the climate and current economic parameters. It would be impossible for a cost-effectiveness analysis to anticipate the full range of options and choices available to the decision-makers to meet the code and an over-simplified analysis full of assumptions or a broad summary of cost-effectiveness provides, at best, only limited value.

To provide an example, however, the cost to renovate a 100-year old school, located in Cinncinati, OH, and featured in the ASHRAE Journal article, “Transforming School for 21st Century Needs”[1], was less than half the cost of a new school of the same size. The design team utilized ASHRAE 100 to set its target EUI of 68 kBtu/ft2-yr. Once all systems had been commissioned, the resulting EUI was in line with that predicted by the model, or 64 kBtu/ft2-yr. Additionally, when taking into account embodied carbon from reusing and renovating this building rather than demolishing and constructing a new one, the cumulative emissions through 2030 are on par with that of a newly constructed high-performance building operating at 25 kBtu/ft2-yr.

Addressing concerns related to Standard 90.1 versus 100, a recent research study[2] found that 11% (5 of 44) of large Class A office buildings (sized 100k ft2 to 1,500k ft2) met Standard 100. Most of these large buildings were likely designed to a version of 90.1. If 90.1 were producing buildings that consistently outperformed Standard 100, a percentage well above 25% should be expected.

[1] Rose, Brian. “Transforming School for 21st Century Needs”, ASHRAE Journal. October 2021.

[2] Kono, Jamie, et. al., 2020. “Raising the Bar: Comparing Building Energy Benchmarking Methods”, ASHRAE Transactions, Vol. 126, Part 1. 2020.

CEPI-216-21

CEPI-217-21

IECC®: C502.4 (New), C503.6 (New), SECTION C506 (New), C506.1 (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:
C502.4 Additional energy efficiency credits.

Additions shall achieve a total of 10 credits in accordance with Section C506. *Alterations* to the existing building that are not part of an *addition*, but permitted with an *addition*, may be used to achieve the required credits.

Exceptions:

1. *Buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H
2. *Additions* less than 1,000 ft^2 and less than 50% of existing floor area.
3. *Additions* that do not include the addition or replacement of equipment covered in Section C403.3 or C404.2 that achieve a total of 5 credits.
4. *Additions* that do not contain *conditioned space* that achieve a total of 5 credits.
5. *Buildings* in Residential Group R and Institutional Groups I in climate zones 3C, 4B, 4C, 5C that achieve a total of 5 credits
6. Where the *addition* alone or the existing building and *addition* together comply with Section C407

C503.6 Additional energy efficiency credits.

Alterations shall achieve a total of 5 credits in accordance with Section C506.

Exceptions:

1. A*lterations* that require compliance with only one of: C402.1, C403.3, C404.2, or C405.3.
2. *Alterations* that are part of an *addition* complying with section C502.
3. *Alterations* that comply with Section C407.

SECTION C506

ADDITIONAL EFFICIENCY CREDITS
C506.1 General.

Where required in Section C502 or C503, credits shall be achieved from Tables C406.1 (1) through C406.1 (5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. Where a building contains multiple use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits from the tables of calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9
9. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.

10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.

Reason Statement:

Since 2012, the IECC has leveraged Section C406 to achieve additional efficiency in the prescriptive path. This section has received steady improvements over the subsequent code cycles with an expansion in the number of options and the adoption of a more flexible credit approach to the additional efficiency option. However, there is one significant gap in C406, it does not apply to additions or alterations. C502 and C503 do not reference C406 in the sections with which additions and alterations must comply. The exclusion from C406 is a significant loophole. Additions and large alterations are prime opportunities for achieving greater energy efficiency utilizing C406.

This missed opportunity is particularly significant given the advent of Building Performance Standards (BPS). These policies set performance requirements that subject existing buildings need to meet. States and local jurisdiction around the country including the states of WA and CO and cities like New York, Boston, Washington DC, and St Louis have already adopted Building Performance Standards (BPS). Many more cities are considering this policy tool as they come to realize that meeting their climate goals will require achieving significant energy and/or carbon improvements in existing buildings. This creates a need for the IECC to be much more proactive in tailoring requirements specifically for existing buildings. Building energy retrofits that are implemented as part of alterations, additions and changes in occupancy are far more cost-effective than stand-alone retrofit projects implemented only to meet a BPS. By incorporating reasonable and cost-effective retrofits into typical existing building projects, the IECC will both provide additional energy, carbon and cost savings to building owners and tenants and help ensure that more building retrofits are undertaken at opportune and cost-effective times.

This proposal creates a framework to apply C406 to additions and large alterations. It creates a new Section C506 that provides guidance for how to utilize C406 for existing buildings. C506.1 essentially replaces and mirrors C406.1, providing charging language for how to calculate credit totals and utilize the sections (C406.2-12) that establish the requirements for each credit option. This section C506 is utilized by new sections in C502 and C503 to set credit requirements for additions and alterations, respectively.

The new Section C502.2.7.1 sets requirements for additions. As additions generally have to meet the requirements for new construction, the credit requirement has been set at 10 credits, the same as C406 for new construction. The section specifically allows additions and alterations to comply together under this section, eliminating the possibility that a building with both an addition and alteration would have to achieve credits for each individually. The section includes a number of important exceptions for situations where achieving the full 10 credits would be less feasible due to lower energy building types, more limited credit options and more limited project scope:

1. Occupancies such as storage, utility, factory and high hazard that generally have low energy usage.
2. Small additions
3. Additions that do not include new HVAC or hot water systems that achieve 5 credits
4. Additions that do not include conditioned space that achieve 5 credits
5. Group R and I occupancies in more temperate climate zones that achieve 5 credits
6. Additions that comply with C407.

The new section C503.7 requires that large alterations achieve 5 credits. The section includes important exceptions:

1. The first exception ensures that the requirements only apply to large additions with significant scope. The exemption is worded to address small alterations that only impact one of the main buildings systems: envelope (C402), HVAC (C403), water heating (C404) and lighting (C405). Alterations that impact two or more of these systems – and must therefore comply with two or more of these sections – will have a larger scope with more opportunities to choose from among the available credit options.
2. An exception that reflects the allowance for alterations and additions to comply together under C502.
3. An exception for buildings that model using C407.

By limiting requirement to large alterations and keeping the credit requirement low, the proposal ensures that projects will likely have sufficient credit options within the existing scope of the project. The project team will be able to pick credit options that apply to building elements that are already within the project scope.

The savings for this proposal would be at least 2.5% for additions and 1.25% for alterations based on the modeling for the C406 credit options done by PNNL for the 2021 edition of the IECC. However, the savings should be higher for alterations in particular since the baselines for alterations include many below-code existing building features. Depending on how inefficient the rest of the building is, the impact of this proposal could be substantially higher without any greater cost than new construction C406 measures.

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal is crafted so that it will only impact major renovations / large-scope alterations that are already impacting the major systems that serve as the basis for credits under C406. This means that these projects are already undertaking the cost of bringing two or more of these major systems up to current code requirements, and the incremental cost is therefore only the cost from code rather than the cost of a standalone retrofit. Therefore, the costs for this proposal are the same as the costs for C406 requirements for new construction. However, savings for each package will generally be much higher since the rest of the building will nearly always have specifications that fall short of the latest energy code and each package will deliver greater savings. As a result, any package that is cost effective for new construction will be even more cost effective for major alterations.

CEPI-217-21

CEPI-218-21 Part I

IECC®: SECTION 202 (New), C502.3.3.1 (New), C503.1.1 (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Add new definition as follows:
C202 FUEL GAS. A natural gas, manufactured gas, liquified petroleum gas or a mixture of these.
Add new text as follows:
C502.3.3.1 Fuel gas pipe testing.

Where new *fuel gas* equipment or a new *fuel gas* appliance is installed as part of an *addition*, all *fuel gas* piping that serves the equipment or appliance shall be tested and meet the requirements for leakage of Section 406 of the *International Fuel Gas Code.*

Exception: Where it has been demonstrated to the code official that the *fuel gas* piping has been tested and met the requirements of this section within the previous five years.

C503.1.1 Fuel gas pipe testing.

Where new *fuel gas* equipment or a *new fuel* gas appliance is installed as part of an *alteration*, all *fuel gas* piping that serves the equipment or appliance shall be tested and meet the requirements for leakage of Section 406 of the *International Fuel Gas Code.*

Exception: Where it has been demonstrated to the code official that the *fuel gas* piping has been tested and met the requirements of this section within the previous five years.

Staff Note: The code change proposals could be considered to be outside the scope of the energy code. The proposal will impose requirements for elements of the building that are regulated by the IFGC. It would cause a conflict with Section 102.2 through 102.4 and Sections 406.1 through 416.3 of the IFGC. Considering the life safety aspect of the code change proposal, it may be more appropriate and effective to put it in the IEBC**.**

Reason Statement:

Gas piping degrades over time, creating the possibility of natural gas leakage. Even though the natural gas is treated with mercaptan to give it that rotten egg smell, small leaks may go undetected[1], [2], [3], particularly in older buildings that are likely to have envelopes that are less tight than newer construction. According to US DOE, building leakage accounts for nearly 27% of the natural gas leakage in the US natural gas distribution system.[4] Therefore, natural gas leakage within existing buildings is a significant issue. Leaking natural gas represents a loss in energy, and even small leaks can add up over long periods of time. Therefore, the prevention of natural gas leaks falls well within the scope of the IECC. Additionally, natural gas is also a potent Green House Gas, with over 86 times the global warming potential of CO_2 on a short-term basis.[5] And of course, leaking gas poses a significant life safety issue.

The installation of new gas equipment provides an ideal time to test gas pipe leakage. Contractors are already on site and the gas will often be partially or fully turned off for the new equipment installation. Additionally, new equipment installation can disturb and inflict additional stresses on existing piping, creating opportunities for the formation of new leaks where existing natural gas piping has weakened but not previously failed.

This proposal creates a requirement that the gas piping that serves newly installed gas equipment or appliances in additions and alterations be tested in accordance with the IFGC. It includes the definition of “fuel gas” from the IMC. It includes an exception for any piping that has been recently tested to ensure that recently tested piping does not have to be tested again in a short span of time.

Savings will vary based on the level of degradation of the natural gas piping and whether any leaks were detected which will subsequently be eliminated.

[1] https://www.healthline.com/health/gas-leak-symptoms

[2] https://www.adt.com/resources/natural-gas-leaks-in-the-home

[3] https://www.medicalnewstoday.com/articles/321277#gas-leak-signs-in-the-home

[4] “Natural Gas Infrastructure Modernization Programs at Local Distribution Companies: Key Issues and Considerations.” US DOE, Office of Energy Policy and Systems Analysis. Washington DC, 2017.

[5] “Natural Gas Infrastructure Modernization Programs at Local Distribution Companies: Key Issues and Considerations.” US DOE, Office of Energy Policy and Systems Analysis. Washington DC, 2017.

Cost Impact:

The code change proposal will increase the cost of construction.

Cost will vary based on the amount of time the testing will require, which will scale up with the amount of piping tested.

CEPI-218-21 Part I

CEPI-218-21 Part II

IECC®: SECTION 202 (New), R502.1.1 (New), R503.1.1 (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:
R202 FUEL GAS.

A natural gas, manufactured gas, liquified petroleum gas or a mixture of these.

Add new text as follows:
R502.1.1 Fuel gas pipe testing.

Where new *fuel gas* equipment or a new *fuel gas* appliance is installed as part of an *addition*, all *fuel gas* piping that serves the equipment or appliance shall be tested and meet the requirements for leakage of Section 406 of the *International Fuel Gas Code* or Section G2417 of the *International Residential Code.*

Exception: Where it has been demonstrated to the code official that the *fuel gas* piping has been tested and met the requirements of this section within the previous five years.
R503.1.1 Fuel gas pipe testing.

Where new gas equipment or a new *fuel gas* appliance is installed as part of an *alteration*, all *fuel gas* piping that serves the equipment or appliance shall be tested and meet the requirements for leakage of Section 406 of the *International Fuel Gas Code.*

Exception: Where it has been demonstrated to the code official that the *fuel gas* piping has been tested and met the requirements of this section within the previous five years.
Staff Note: The code change proposals could be considered to be outside the scope of the energy code. The proposal will impose requirements for elements of the building that are regulated by the IFGCor Chapter 24 of the IRC. It would cause a conflict with Section 102.2 through 102.4 and Sections 406.1 through 406.1.3 of the IFGC or Sections 2417.1 through Section 2417.1.3 of the IRC. Considering the life safety aspect of the code change proposal, it may be more appropriate and effective to put it in the IEBC

Reason Statement:

Gas piping degrades over time, creating the possibility of natural gas leakage. Even though the natural gas is treated with mercaptan to give it that rotten egg smell, small leaks may go undetected[1], [2], [3], particularly in older buildings that are likely to have envelopes that are less tight than newer construction. According to US DOE, building leakage accounts for nearly 27% of the natural gas leakage in the US natural gas distribution system.[4] Therefore, natural gas leakage within existing buildings is a significant issue. Leaking natural gas represents a loss in energy, and even small leaks can add up over long periods of time. Therefore, the prevention of natural gas leaks falls well within the scope of the IECC. Additionally, natural gas is also a potent Green House Gas, with over 86 times the global warming potential of CO_2 on a short-term basis.[5] And of course, leaking gas poses a significant life safety issue.

The installation of new gas equipment provides an ideal time to test gas pipe leakage. Contractors are already on site and the gas will often be partially or fully turned off for the new equipment installation. Additionally, new equipment installation can disturb and inflict additional stresses on existing piping, creating opportunities for the formation of new leaks where existing natural gas piping has weakened but not previously failed.

This proposal creates a requirement that the gas piping that serves newly installed gas equipment or appliances in additions and alterations be tested in accordance with the IFGC or fuel gas section of the IRC. It includes the definition of “fuel gas” from the IMC. It also includes an exception for any piping that has been recently tested to ensure that recently tested piping does not have to be tested again in a short span of time.

Savings will vary based on the level of degradation of the natural gas piping and whether any leaks were detected which will subsequently be eliminated.

[1] https://www.healthline.com/health/gas-leak-symptoms

[2] https://www.adt.com/resources/natural-gas-leaks-in-the-home

[3] https://www.medicalnewstoday.com/articles/321277#gas-leak-signs-in-the-home

[4] “Natural Gas Infrastructure Modernization Programs at Local Distribution Companies: Key Issues and Considerations.” US DOE, Office of Energy Policy and Systems Analysis. Washington DC, 2017.

[5] “Natural Gas Infrastructure Modernization Programs at Local Distribution Companies: Key Issues and Considerations.” US DOE, Office of Energy Policy and Systems Analysis. Washington DC, 2017.

Cost Impact:

The code change proposal will increase the cost of construction.

Cost will vary based on the amount of time the testing will require, which will scale up with the amount of piping tested.

CEPI-218-21 Part II

CEPI-219-21

IECC®: C502.3.3.1 (New), C503.3.1 (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:
C502.3.3.1 Duct Testing.

Where the extension of existing ducts into an *addition* results in an increase of total duct volume in the *building* of more than 20 percent, the ducts that serve the *addition* shall be tested in accordance with the SMACNA HVAC Air Duct Leakage Test manual. Documentation of the test results shall be provided to the *code official* and the owner.

C503.3.1 Duct Testing.

Ducts and plenums that serve new heating, cooling or ventilation equipment in an *alteration*shall be tested in accordance with the SMACNA HVAC Air Duct Leakage Test manual. Documentation of the test results shall be provided to the *code official* and the owner.

Reason Statement:

This proposal requires that existing ductwork serving new equipment in additions and alterations is tested. In an alteration, all ductwork serving new equipment will need to be tested. In additions, the ductwork serving the addition, both existing and new ductwork, will need to be tested if it increases the total volume of the ductwork serving the addition by more than 20%. The proposal does not include a performance criterion for the testing; the testing is informational.

The requirements for duct construction and sealing in the IECC have developed substantially over recent code cycles. Fiberboard materials, cloth tape, un-sealed duct joints, cavity plenum returns and other materials and approaches that can lead to very leaky ducts were once commonplace but are not now allowed by the IECC. The result is that the ductwork in many existing buildings fall far below modern standards.

States and local jurisdiction around the country including the states of WA and CO and cities like New York, Boston, Washington DC, and St Louis have adopted Building Performance Standards (BPS). These policies set performance requirements that subject existing buildings need to meet. Many more cities are considering this policy tool as they come to realize that meeting their climate goals will require achieving significant energy and/or carbon improvements in existing buildings. This creates a need for the IECC to be much more pro-active in tailoring requirements specifically for existing buildings. Building energy retrofits that are implemented as part of alterations, additions and changes in occupancy are far more cost-effective than stand-alone retrofit projects implemented only to meet a BPS. By incorporating reasonable and cost-effective retrofits into typical existing building projects, the IECC will both provide additional energy, carbon and cost savings to building owners and tenants and help ensure that more building retrofits are undertaken at opportune and cost-effective times.

Duct tightening can be a very cost-effective energy retrofit. The replacement of equipment or substantial expansion of existing ductwork present prime opportunities to undertake this testing and will provide project teams and building owners important information about the relative need and savings opportunity that could come from duct tightening projects. It will also give project teams important information for configuring new equipment and ductwork to ensure the whole system performs effectively.

Cost Impact:

The code change proposal will increase the cost of construction.

The cost of the proposal will vary based on the size of the duct system.

CEPI-219-21

CEPI-220-21

IECC®: C502.3.5

Proponents:

David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:
C502.3.5 Pools and inground permanently installed spas.

New pools and inground permanently installed spas shall comply with Section ~~C404.9~~ C404.8.

Reason Statement:

C404.9 references portable spas. The correct reference should be C404.8 Energy consumption of pools and permanent spas.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Neutral. Correcting reference.

CEPI-220-21

CEPI-221-21

IECC®: SECTION C503, C503.1, C503.2, C503.2.1, C503.2.2, C503.2.3, C503.2.4 (New), C503.2.5 (New), C503.2.6 (New), C503.2.7 (New)

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

SECTION C503 ALTERATIONS
Revise as follows:
C503.1 General.

Alterations to any *building* or structure shall comply with the requirements of Section C503. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*. *Alterations* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall not create an unsafe or hazardous condition or overload existing *building* systems.

Exception: The following *alterations* need not comply with the requirements for new construction, provided that the energy use of the building is not increased:

1. Storm windows installed over existing *fenestration*.
2. Surface-applied window film installed on existing single-pane *fenestration* assemblies reducing solar heat gain, provided that the code does not require the glazing or *fenestration* to be replaced.

~~3. Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation.~~

~~4. Construction where the existing roof, wall or floor cavity is not exposed.~~

3.~~5.~~ *Roof recover*.

4. *Roof replacement* where roof assembly insulation is integral to or located below the structural roof deck.

5.~~6.~~ *Air barriers* shall not be required for *roof recover* and roof replacement where the *alterations* or renovations to the building do not include *alterations*, renovations or *repairs* to the remainder of the building envelope.

C503.2 Building thermal envelope.

Alterations of existing *building thermal envelope* assemblies shall comply with this section. New *building thermal envelope* assemblies that are part of the *alteration* shall comply with Sections C402.1 through C402.5. In no case shall the *R*-value of insulation be reduced or the *U*-factor of a *building thermal envelope* assembly be increased as part of a *building thermal envelope* alteration.

Exception: Where the existing building exceeds the fenestration area limitations of Section C402.4.1 prior to alteration, the building is exempt from Section C402.4.1 provided that there is not an increase in fenestration area.

C503.2.1 Roof alterations ~~replacement~~.

Roof insulation complying ~~*Roof replacements* shall comply~~ with Section C402.1.3, C402.1.4, C402.1.5 or C407 and Section C402.2.1 shall be provided for the following roof alteration conditions as applicable: ~~where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck. In no case shall the *R* value of the roof insulation be reduced or the *U* factor of the roof assembly be increased as part of the *roof replacement*.~~

1. *roof replacements* for roofs with insulation entirely above deck,

2. conversion of unconditioned attic space into *conditioned space*, and

3. replacement of ceiling finishes exposing cavities or surfaces of the roof assembly to which insulation can be applied.

C503.2.2 Vertical fenestration.

(Section unchanged)

C503.2.3 Skylight area.

(Section unchanged)

Add new text as follows:

C503.2.4 Above-grade wall alterations.

Above-grade wall alterations shall comply with the following requirements as applicable:

1. Where interior finishes are removed exposing wall cavities, the cavity shall be filled with existing or new *cavity insulation* complying with Section C303.1.4.
2. Where exterior wall coverings are removed and replaced for the full extent of any exterior wall assembly, *continuous insulation* shall be provided where required in accordance with Section C402.1.3, C402.1.4, C402.1.5, or an *approved* design.
3. Where Items 1 and 2 apply, the insulation shall be provided in accordance with Section C402.1.3, C402.1.4, C402.1.5, or C407.
4. Where new interior finishes or exterior wall coverings are applied to the full extent of any exterior wall assembly of mass construction, insulation shall be provided where required in accordance with Section C402.1.3, C402.1.4, C402.1.5, or an *approved* design.

Where any of the above requirements are applicable, the *above-grade wall* alteration shall comply with the insulation and water vapor retarder requirements of Section 1404.3 of the *International Building Code*. Where the exterior wall coverings are removed and replaced, the above-grade wall alteration shall comply with the weather protection requirements of Section 1402.2 of the *International Building Code*.

C503.2.5 Floor alterations.

Where an alteration to a floor or floor overhang exposes cavities or surfaces to which insulation can be applied and the floor or floor overhang is part of the *building thermal envelope*, the floor or floor overhang shall be brought into compliance with Section C402.1.3, C402.1.4, C402.1.5, or an *approved* design. This requirement shall apply to floor alterations where the floor cavities or surfaces are exposed and accessible prior to construction.

C503.2.6 Below-grade wall alterations.

Where a below-grade space is changed to *conditioned space*, the *below-grade walls* shall be insulated where required in accordance with Section C402.1.3, C402.1.4, or C402.1.5. Where the below-grade space is *conditioned space* and a *below grade wall* is altered by removing or adding interior finishes, it shall be insulated where required in accordance with Section C402.1.3, C402.1.4, or C402.1.5.

C503.2.7 Air barrier.

Building thermal envelope assemblies altered in accordance with Section C503.2 shall be provided with an *air barrier* in accordance with Section C402.5.1 and the *air barrier* shall not be required to be made continuous with unaltered portions of the *building thermal envelope*.

Reason Statement:

Existing building alterations are perhaps one of the primary opportunities to reduce national energy consumption, yet Chapter 5 misses many opportunities to effectively address this need. There are many opportunities to cost-effectively improve energy efficiency of the existing building stock by use of reasonable criteria to trigger (or avoid) requirements for alterations with flexibility in the manner or extent of compliance where needed. This proposal attempts to strike that balance in a practical and cost-effective manner for building envelope assemblies of existing building that are undergoing specific types of alterations. Consequently, this proposal will help to address the 40% of national energy use that is attributed to the existing building stock and will only apply where alterations are proposed that provide opportunity to improve the performance of the existing building stock. A similar coordinated proposal was also submitted for the IECC-R committee.

Key changes made in this proposal are summarized as follows:

1. Exceptions 3 and 4 of Section C503.1 are deleted as they are now addressed and preserved within requirements in new Section C503.2.4 for above-grade walls.

2. New exception 4 is added to Section C503.1 for roof replacements for roof assemblies that do not have insulation entirely above deck (which is addressed separately in Section C503.2.1).

3. A clause to prevent reduction of insulation levels in existing thermal envelope assemblies is moved from Section C503.2.1 to Section C503.2 to apply to all building thermal envelope alterations.

4. Section C503.2.1 is revised to address multiple types of roof alterations, including roof replacements for roofs with insulation entirely above deck.

5. A new Section C503.2.4 is provided for above-grade wall alterations which identifies conditions where it is appropriate and practical to provide insulation (if not already present). Language is also provided to ensure coordination with building code moisture control requirements which require integration with and can influence the method of complying with the insulation requirements.

6. A new Section C503.2.5 is provided for floor alterations and takes an approach similar to that done for above-grade walls (although with fewer conditional requirements).

7. A new Section C503.2.6 is provided for below-grade wall alterations. This captures the cases where a below-grade space is being converted to conditioned space and where below-grade wall alterations allow addition of insulation if the below grade space is already conditioned space.

8. Finally, new Section C503.2.7 is provided to address air barrier installation in building thermal envelope assemblies that are altered within the scope of Section C503.2. However, it is made clear that continuity of the air barrier with unaltered portions of the building thermal envelope is not required. This avoids causing an alteration to extend beyond its intended scope and extent. This is also consistent with the intent behind existing exception #6 to Section C503.1 dealing with air barriers in roof replacements.

Cost Impact:

The code change proposal will increase the cost of construction.

Where requirements are triggered and where upgrades in energy efficiency were not already planned for an alteration, this proposal will increase cost for a limited set of envelope alteration activities for existing buildings. Some existing requirements such as roof replacements and filling of exposed stud cavities remain unchanged. For those existing buildings with deficient insulation levels (or no insulation) and where planned alterations allow that deficiency to be addressed efficiently, the cost-benefits are expected to closely align with that for new buildings. However, it is not possible to conduct a simple cost-benefit analysis for existing buildings because of the multitude of variables involved and the flexibility provided in this proposal that make it nearly impossible to quantify with any reasonable level of certainty. Thus, we consider these proposed provisions to be cost-effective by judgment as these types of existing building thermal envelope upgrades are currently being used in the existing building/remodeling/renovation market, although not consistently or in an enforceable manner.

CEPI-221-21

CEPI-222-21

IECC®: CHAPTER 5 [CE], SECTION C503, C503.1

Proponents:

Bill McHugh, representing Chicago Roofing Contractors Association (bill@mc-hugh.us)

2021 International Energy Conservation Code

CHAPTER 5 [CE] EXISTING BUILDINGS

SECTION C503 ALTERATIONS
Revise as follows:
C503.1 General.

Alterations to any *building* or structure shall comply with the requirements of Section C503. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*. *Alterations* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall not create an unsafe or hazardous condition or overload existing *building* systems.

Exception: The following *alterations* need not comply with the requirements for new construction, provided that the energy use of the building is not increased:

1. Storm windows installed over existing *fenestration*.
2. Surface-applied window film installed on existing single-pane *fenestration* assemblies reducing solar heat gain, provided that the code does not require the glazing or *fenestration* to be replaced.
3. Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation.
4. Construction where the existing roof, wall or floor cavity is not exposed.
5. *Roof recover*.
6. *Roof replacements* for roof systems 2:12 slope or less where installation of insulation above the structural roof deck necessary to achieve the code-required R-value is deemed infeasible by the code official. Conditions of infeasibility presented by existing rooftop conditions include, but are not limited to flashing heights at HVAC or skylight curbs, low door or glazing, parapet, or weep holes in walls.

~~6.~~ 7. *Air barriers* shall not be required for *roof recover* and roof replacement where the *alterations* or renovations to the building do not include *alterations*, renovations or *repairs* to the remainder of the building envelope.

Reason Statement:

The purpose of this proposal is to provide the code official clear guidance when roof replacements on existing buildings have conditions that make it technically infeasible to meet new construction insulation thickness requirements.

This concept has been adopted by the State of Illinois in the 2018 version of the Illinois Energy Conservation Code. Prior to being added to the IL Energy Conservation Code, the 'relief' for flashing height infeasibility was on the State of Illinois' FAQ website, #14 C503, Roof Alterations.

The exception is also part of the City of Chicago's new 2019 Chicago Building Rehabilitation Code, based on the IEBC. Prior to codification, it was allowed based on a 2016 Roofing Memorandum, published by the City of Chicago, without code official approval required.

Both the City of Chicago and State of Illinois provide this solution as a reasonable way to manage the limits presented by existing building conditions, when new construction insulation thicknesses just are not technically feasible.   The City of Chicago’s Paradigm is that the scope of work for *roof replacement* is to replace the roof, not rebuild the top of the building to accommodate insulation. The City of Chicago only requires a letter stating that the flashing heights will not accommodate the additional thickness of insulation to gain permission to install less than the new construction requirement insulation thicknesses. The building official does not need to verify, grant permission nor review the question.

By adding approval for this type of operation by the code official before technical infeasibility takes place, it provides a 'check and balance' that those involved in this process will try first to add insulation, reducing energy costs, and that it is not just because a few 'easy to raise' pieces of equipment are on the roof.

Cost Impact:

The code change proposal will decrease the cost of construction.

This is a tough question to answer. Does this allowance than less than the code required insulation increase cost? No, it won't. If it is technically infeasible to install the insulation, is there really a decrease in construction costs? It seems it is a way to provide cost of construction that makes sense for the building.

CEPI-222-21

CEPI-223-21

IECC®: CHAPTER 2 [CE], SECTION C202, SECTION 202, C503.1, C503.2.1

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

CHAPTER 2 [CE] DEFINITIONS

SECTION C202 GENERAL DEFINITIONS
Revise as follows:
IECC2021P1E_CE_Ch02_SecC202_DefROOF_REPLACEMENT ROOF REPLACEMENT. The process of removing ~~the~~ all existing layers of the roof ~~covering~~ system down to the roof deck, repairing any damaged substrate and installing a new roof ~~covering~~ system.
C503.1 General.

Alterations to any *building* or structure shall comply with the requirements of Section C503. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*. *Alterations* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall not create an unsafe or hazardous condition or overload existing *building* systems.

Exception: The following *alterations* need not comply with the requirements for new construction, provided that the energy use of the building is not increased:

1. Storm windows installed over existing *fenestration*.
2. Surface-applied window film installed on existing single-pane *fenestration* assemblies reducing solar heat gain, provided that the code does not require the glazing or *fenestration* to be replaced.
3. Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation.
4. Construction where the existing roof, wall or floor cavity is not exposed.
5. *Roof recover*.
6. *Air barriers* shall not be required for *roof recover* and roof replacement where the *alterations* or renovations to the building do not include *alterations*, renovations or *repairs* to the remainder of the building envelope.

Revise as follows:
C503.2.1 Roof replacement.
Roof replacements shall comply with Section C402.1.3, C402.1.4, C402.1.5 or C407 where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck.

Exceptions: In accordance with the following, provided that the energy use of the *building* is not increased:

1. Where the existing roof insulation is integral to or is located below the roof deck.
2. Where the new *roof assembly* above deck *R-Value* or *roof assembly U-factor*, is installed in accordance with the following:
   2.1. In compliance with the provisions of either C402.1.3 or C402.1.4 or C402.1.5 or C407; and
   2.2. In maximum practicable compliance with Table C402.1.3 or Table C402.1.4 or C402.1.5 or C407, including any partial compliance in areas subject to limiting conditions identified in a survey of existing conditions conducted prior to the *alteration*

and provided to the *code official*; and

2.3. In no case shall the *R-value* of the roof insulation be reduced or the U-factor of the roof assembly be increased as part of the *roof replacement*.

Attached Files

- **7_2018 IECC_Illinois Specific Amendments (w SO-UL) - Effective 2019-07-01.pdf**
  http://localhost/proposal/355/632/files/download/79/
- **CodeMemorandum_Roofing Requirements_2016-06-20.pdf**
  http://localhost/proposal/355/632/files/download/78/
- **Analyzing R-value requirements--November 2014.pdf**
  http://localhost/proposal/355/632/files/download/77/

Reason Statement:

The proposal addresses envelope requirements applicable to *roof replacements* to existing buildings by:

- Defining *roof replacement* consistently with the *International Building Code* (IBC) with improvements consistent with NRCA's assessment of contemporary roofing industry practice and code enforcement terminology;
- Confirming *roof replacement* as an *alteration* having its unique set of provisions by exception, and
  - Consistent with the intent of the framers of existing building provisions of the IECC prior to the 2015 Edition.
  - Consistent with the intent of the framers of existing building provisions of the 2018 Illinois Energy Conservation Code (2018 IECC) for alterations to existing buildings;
  - Consistent with the Chicago Department of Buildings Memorandum (attached) negotiated by the CRCA and the former IL DCEO, Office of Energy & Recycling in support of the 2012, 2015, 2018 and 2021 Editions of the Chicago Energy Conservation Code (CECC);
  - Derived during "Envelope Subcommittee" work to develop similar provisions for ASHRAE 90.1-2023, which had remained silent on *roof replacement* since its inception.
- Adding a provision for an “survey” of existing conditions conducted prior to the alteration and requiring its submission to those who inspect to and enforce the Code; and
- Assuring advocates of efficiency measures that in no case shall the *R-value* of the roof insulation be reduced or the *U-factor* of the roof assembly be increased as part of *roof replacement* operations.

To further articulate the "clear intent" of the references identified in b. (ii.) and b. (iii.) of this proposal:

1. **C402.1.3.** This reference is "limited" solely to the selected path for R-values & fenestration U-factors using Table C402.1.3 only (it ends there); or
2. **C402.1.4.** This reference is "limited" solely to the selected path for U-factors, C-factors and F-factors using Table C402.1.4 only (it ends there); or
3. **C402.1.5.** This reference is "limited" solely to the Component Performance alternative path for UA compliance using Section C402.1.5, the COMcheck tool, or a "pencil and paper" UA calc only (it ends there); or
4. **C407.** This reference is "limited" solely to the "Total Building Performance" path for compliance using Section 407 or whole building energy simulation programs such as EnergyPlus™ or similar tools found at the Building Energy Software Tools Directory, only (it ends there).

These references are cited to establish clear linkage to any one (1) of the four (4) potential paths for COMMERCIAL R-value, U- C- F-factor, UA, or whole building energy simulation programs as the methodology by which "thermal performance" is declared. There is no intent or hint that the provisions of C402.2 "Specific building thermal envelope insulation requirements," are also subject to retroactive compliance.

https://energy.cdpaccess.com/proposal/355/632/files/download/79/

https://energy.cdpaccess.com/proposal/355/632/files/download/78/

https://energy.cdpaccess.com/proposal/355/632/files/download/77/

Bibliography:

[1] Graham M., “Analyzing R-value Requirements – Cost paybacks to increases in R-values may not be practical,” NRCA Industry Issue Update, National Roofing Contractors Association, 2014.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Increases in model energy codes' building energy performance requirements have resulted in increased R-values being specific for many of the thermal envelope components of the building, including and particularly, roof systems. Where is the equivalency among a four-story brownstone in Chicago required to provide a low-slope, above-deck R-value of R-60, while a four-story multi-family building in Oak Park is permitted to provide a low-slope, above-deck R-value of R-30? Comparatively, where is the equivalency among a three-story, three-flat in Rockford is required to provide a low-slope, above-deck R-value of R-60, while a two-story Bass Pro Shop in Belleville is allowed to provide a low-slope, above-deck R-value of R-30?

Such R-value increases have been implemented into the code with little to no consideration of the added initial (construction) costs and long-term payback to building owners and local property managers who (primarily) initiate their maintenance, repair and replacement by initiating such inquiries, not with an Architect or code enforcement but a roofing contractor.

Accordingly, NRCA conducted a 2014 energy-savings and payback analysis for roof assembly R-value increases[1] in sixteen (16) of Americas largest cities and representative of the Standard's (then) eight (8) U.S. climate zones. We believe that using contemporary pricing for materials and the relatively flat-costs of energy across the commercial building sector, will only increase the paybacks forecast.

[1] Graham M., "Analyzing R-value Requirements – Cost paybacks to increases in R-values may not be practical," NRCA Industry Issue Update, National Roofing Contractors Association, 2014.

CEPI-223-21

CEPI-224-21

IECC®: SECTION 202 (New), C503.1

Proponents:

Bill McHugh, representing Chicago Roofing Contractors Association (bill@mc-hugh.us)

2021 International Energy Conservation Code

Add new definition as follows:
C202

ROOF MEMBRANE PEEL AND REPLACEMENT

. Condition where an existing weather resisting roof membrane is removed, exposing insulation, an existing roof membrane or sheathing, and a new weather resisting roof membrane is installed.

Revise as follows:
C503.1 General.

Alterations to any *building* or structure shall comply with the requirements of Section C503. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*. *Alterations* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall not create an unsafe or hazardous condition or overload existing *building* systems.

Exception: The following *alterations* need not comply with the requirements for new construction, provided that the energy use of the building is not increased:

1. Storm windows installed over existing *fenestration*.
2. Surface-applied window film installed on existing single-pane *fenestration* assemblies reducing solar heat gain, provided that the code does not require the glazing or *fenestration* to be replaced.
3. Existing ceiling, wall or floor cavities exposed during construction, provided that these cavities are filled with insulation.
4. Construction where the existing roof, wall or floor cavity is not exposed.
5. *Roof recover*.
6. *Roof Membrane Peel and Replacement.*

~~6.~~7. *Air barriers* shall not be required for *roof recover* and roof replacement where the *alterations* or renovations to the building do not include *alterations*, renovations or *repairs* to the remainder of the building envelope.

Reason Statement:

As listed in Section 503, ROOF ALTERATIONS, neither the definitions of *Roof Replacement* nor *Roof Recover* handle the situation that is described in the newly proposed definition. Both definitions invoke the addition of material not scoped in a *roof covering peel and replacement*. The proposed definition provides a clear direction to the code user for this circumstance. This allows the building owner and manager to remove (or "peel") only the existing roof covering, reuse the roof membrane or existing insulation that has much life left in it, and replace the roof covering / membrane alone. There are several applications where this is not only practical, but preferred. The proposal, if approved, will be consistent with the positions of the IL Energy Office (Now IL EPA) FAQ No. 14, effective 2016-1-1 and of the Chicago Department of Buildings in their 2016 Roofing Code Memorandum effective 2016-7-20 and also the 2019 Chicago

Energy Code, based on the 2018 International Energy Conservation Code. The proposal also covers where two roofs exist, and where the underlying roof assembly is dry, or 'recover' board was used to prepare the surface for a roof membrane, removing the top layer, leaving the underlying layer, also considered a *roof covering peel and replacement*.

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposal will provide the building owner and manager with a very viable option not covered in the current code.

CEPI-224-21

CEPI-225-21

IECC®: SECTION 202 (New), C503.2.1

Proponents:

Marcin Pazera, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org); Justin Koscher, Polyisocyanurate Insulation Manufacturers Association, representing Polyisocyanurate Insulation Manufacturers Association (jkoscher@pima.org)

2021 International Energy Conservation Code

Add new definition as follows:
Section C202 APPROVED SOURCE.

An independent person, firm or corporation, approved by the *building official*, who is competent and experienced in the application of engineering principles to materials, methods or systems analyses.

SECTION C202 CONSTRUCTION DOCUMENTS. Written, graphic and pictorial documents prepared or assembled for describing the design, location and physical characteristics of the elements of a project necessary for obtaining a building *permit*.

Revise as follows:

C503.2.1 Roof replacement, insulation entirely above deck.

Roof replacements shall comply with Section C402.1.3, C402.1.4, C402.1.5 or C407 where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck. ~~In no case shall the *R*-value of the roof insulation be reduced or the *U*-factor of the roof assembly be increased as part of the *roof replacement*.~~

Exception: Where compliance with Table C402.1.3, Table C402.1.4 or Table C402.1.5 cannot be met due to limiting conditions on an existing roof, the following shall be permitted to demonstrate compliance with the insulation requirements:

1. *Construction documents* that include a report by an *approved source* documenting details of the limiting conditions affecting compliance with the insulation requirements.
2. *Construction documents* that include a roof design by an *approved source* that minimizes deviation from the insulation requirements.

Insulation shall be installed in accordance with the requirements of Sections C402.2.1.2 through C402.2.1.5. In no case shall the *R*-value of the roof insulation be reduced or the *U*-factor of the roof assembly be increased as part of the *roof replacement*.

Reason Statement:

Low-sloped roofs comprise the largest thermal envelope surface in many non-residential buildings, which offers a significant opportunity to improve the energy efficiency of the roof and the overall building energy performance. Where an existing roof contains insulation entirely above the deck and is in need of replacement, the roof replacement must comply with the IECC's opaque thermal envelope requirements. For buildings constructed prior to the wide-spread adoption of energy codes, energy-code compliant roof replacements can significantly decrease whole building energy use and reduce associated costs and carbon emissions. This requirement for roof replacements has been part of the IECC since the energy code first regulated existing buildings. However, instances can arise on specific projects where the complexities of other rooftop features create limiting conditions that pose significant practical and cost challenges for installing a replacement roof system containing increased levels of above deck roof insulation in order to comply with the IECC's opaque thermal envelope requirements.

This code change proposal allows for these unique roof replacement projects to, on case-by-case basis, use alternative designs that minimize deviations from the code required insulation levels while also presenting a practical roof replacement solution under the limiting conditions that prevent full compliance. In order to qualify for the exception, the limiting conditions must be documented in construction documents, and report prepared by the approved source and provided to the building code official. The roof design must also be prepared by the approved source showing that deviations from the insulation requirements have been minimized in order to maintain the intent of the IECC to increase building energy efficiency during alterations. The proposal also reinforces that insulation must be installed in accordance with current requirements of applicable sections in Chapter 4 of the IECC. The proposal retains very important existing language regarding insulation R-value and roof assembly U-factor requirements in this provision, and the intent of relocating this language is to ensure that provision is applicable whether or not the exception is utilized. Finally, the proposal also adopts two definitions for "approved source" and "construction documents," Both definitions are in Chapter 2 of the IBC but are not in

Chapter 2 of the IECC.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal does not increase the cost of construction. In many instances, there may be cost savings to the building owner, since less than the code required levels of insulation may be installed in roof replacement work.

CEPI-225-21

CEPI-226-21

IECC®: C503.2.1

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:

C503.2.1 Roof replacement.

Roof *replacement* ~~*replacements*~~ shall comply with Section C402.1.3, C402.1.4, C402.1.5 or C407 where the existing roof assembly is part of the *building thermal envelope* and contains insulation entirely above the roof deck. In no case shall the *R*-value of the roof insulation be reduced or the *U*-factor of the roof assembly be increased as part of the *roof replacement*.

Reason Statement:

The italicized defined term is singular not plural.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will neither increase nor decrease the cost of construction.

CEPI-226-21

CEPI-227-21

IECC®: C503.3.2 (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:
C503.3.2 Controls.

New heating and cooling equipment that are part of the *alteration* shall be provided with controls that comply with Section C403.4.

Exception: Systems with direct digital control of individual zones reporting to a central control panel

Reason Statement:

The IECC only requires that new portions of HVAC systems comply with the requirements for new construction. This leaves unaltered portions of the HVAC system unaffected, including controls. Controls are a vital component of effective and efficient operation of heating and cooling systems and older controls that do not meet current code requirements significantly hamper efficiency in buildings. Obsolete controls also increase the operational costs for building owners and tenants. The IECC has relied on HVAC controls as a cost-effective means of delivering energy efficiency in buildings, so this is a significant missed opportunity. Equipment replacement is an ideal time to also upgrade controls. Contractors are onsite, operation of the HVAC system is already disrupted, and the cost of controls would generally be a small line-item cost in the project.

This missed opportunity is particularly significant given the advent of Building Performance Standards (BPS). These policies set performance requirements that subject existing buildings need to meet. States and local jurisdiction around the country including the states of WA and CO and cities like New York, Boston, Washington DC, and St Louis have already adopted Building Performance Standards (BPS). Many more cities are considering this policy tool as they come to realize that meeting their climate goals will require achieving significant energy and/or carbon improvements in existing buildings. This creates a need for the IECC to be much more pro-active in tailoring requirements specifically for existing buildings. Building energy retrofits that are implemented as part of alterations, additions and changes in occupancy are far more cost-effective than stand-alone retrofit projects implemented only to meet a BPS. By incorporating reasonable and cost-effective retrofits into typical existing building projects, the IECC will both provide additional energy, carbon and cost savings to building owners and tenants and help ensure that more building retrofits are undertaken at opportune and cost-effective times.

This proposal requires that thermostatic controls be brought into compliance with current control requirements when equipment is replaced. It includes an exception for systems with complex central control systems where control upgrades would be far more involved. The proposal does not require the installation of new controls, so if the existing controls already meet current code requirements, they would already be in compliance with this new section.

Cost Impact:

The code change proposal will increase the cost of construction.

Cost will vary depending on the type of control and how obsolete existing controls are. In most systems subject to this requirement, compliance would require replacing one thermostat with another. Modern, wireless thermostats can be used to control costs when existing control wiring is insufficient to support modern controls.

The modern, single-zone thermostatic controls subject to this requirement can be purchased for less than $30.[1] Thermostat swaps should easily represent only a fraction of an hour of additional labor.

[1] https://www.supplyhouse.com/Lux-P711-010-7-Day-5-2-day-Programming-or-Non-Programmable-Thermostat-Horizontal-Mount-1-Heat-1-Cool

CEPI-227-21

CEPI-228-21

IECC®: C503.3.2 (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:
C503.3.2 System sizing.

New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with Section C403.1.1 based on the existing *building* features as modified by the *alteration.*

Exception: Where is has been demonstrated to the *code official* that compliance with this section would result in heating or cooling equipment that is incompatible with the rest of the heating or cooling system.

Reason Statement:

Historically, HVAC equipment has been routinely oversized. Studies have found very high rates of equipment oversizing; for example, 60% of RTU units in CA were found to be oversized.[1] Oversized equipment results in increased energy use, decreased occupant comfort and increased wear-and-tear on equipment.[2] Oversized equipment is also less effective at dehumidification. Like-for-like equipment replacement are particularly vulnerable to oversizing. The original equipment may have been installed when code requirements for “right-sizing” equipment did not exist or was not enforced. The materials markups that are common practice among contractors disincentivize them to install smaller, right-sized equipment. Changes to building use could have occurred since the original equipment was installed, creating a mismatch between current design loads and the original equipment. The building may have modified, particularly by energy efficiency programs, altering the design loads of the building. Lighting especially stands out here. Fluorescent and LED lighting is ubiquitous, but many HVAC systems were designed to account for incandescent lamps that convert over 75% of the energy they consume into heat.

With all of these considerations, it is reasonable to assume that the existing equipment sizing is more likely to be wrong than right, yet many equipment replacements use existing system sizing to size new equipment. This proposal explicitly requires that new equipment installed as part of an alteration be sized based on current building characteristics and loads, using current sizing standards. The resulting installations will be more efficient and more effective and many will be less costly to install as owners stop paying for more equipment than they need.

Savings will vary based on the amount that existing equipment is oversized. “Right-sizing” has been found to result in about 0.2% energy savings for every 1% reduction in oversizing.[3]

[1] D.R. Felts, P. Bailey, The State of Affairs – Packaged Cooling Equipment in California, 2000.

[2] Ery Djunaedy, Kevin van den Wymelenberg, Brad Acker, Harshana Thimmana, *Oversizing of HVAC system: Signatures and penalties.* “Energy and Buildings,” Volume 43, Issues 2–3, 2011,

[3] H.McLain,D.Goldberg. “Benefits of Replacing Residential Central Air Conditioning Systems.” American Council for an Energy-Efficient Economy, WashingtonDC, USA, 1984.

Bibliography:

D.R. Felts, P. Bailey, The State of Affairs – Packaged Cooling Equipment in California, 2000.

Ery Djunaedy, Kevin van den Wymelenberg, Brad Acker, Harshana Thimmana. *Oversizing of HVAC system: Signatures and penalties.* “Energy and Buildings,” Volume 43, Issues 2–3, 2011,

H.McLain,D.Goldberg, Benefits of Replacing Residential Central Air Conditioning Systems, American Council for an Energy-Efficient Economy, Washington DC, USA, 1984, pp. E226–E227.

Cost Impact:

The code change proposal will decrease the cost of construction.

As “wrong-sized” equipment is generally oversized, this proposal will generally decrease the cost of installation. Smaller, right-sized equipment will generally be less costly to install.

CEPI-228-21

CEPI-229-21

IECC®: C503.3.2 (New), C503.4.1 (New), C503.5.1 (New)

Proponents:

Sean Denniston, New Buildings Institute, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:

C503.3.2 Mechanical system acceptance testing.

Where an *alteration* requires compliance with Section C403 or any of its subsections, mechanical systems that serve the *alteration* shall comply with Sections C408.2.2, C408.2.3 and C408.2.5.

Exceptions:

1. Mechanical systems and service water heater systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.
2. Systems included in Section C403.5 that serve individual *dwelling units* and *sleeping units*.

C503.4.1 Service hot water system acceptance testing.

Where an *alteration* requires compliance with Section C404 or any of its subsections, service hot water systems that serve the *alteration* shall comply with Sections C408.2.3 and C408.2.5.

Exceptions:

1. Service water heater systems in buildings where the total mechanical equipment capacity is less than 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.
2. Systems included in Section C403.5 that serve individual dwelling units and sleeping units.

C503.5.1 Lighting acceptance testing.

Where an *alteration* requires compliance with Section C405 or any of its subsections, lighting systems that serve the *alteration* shall comply with Section C408.3.

Reason Statement:

The IECC requires that new mechanical, hot water and lighting systems comply with the acceptance testing requirements of C408. However, the IECC commentary for C503 states that unaltered portions of systems do not have to be brought into compliance with the code. This means that the requirements of C408 only apply to the new portions of existing systems. However, the whole purpose of C408 is to ensure that building systems meet and document a minimum level of system configuration. Even when only part of a system is replaced, there is still the need to ensure this minimum level of system configuration for the whole building. Even in like-for-like replacements, new equipment can have different operating characteristics. It is therefore important to ensure that the whole system is operating appropriately after new components are installed, not just the new components.

Additionally, all systems see their performance degrade over time as components wear, operational parameters change and modifications accumulate. The installation of new portions of equipment also presents the most reasonable and cost-effective opportunity to recalibration the system based on current operations. Therefore, this proposal requires that the whole system meet relevant C408 requirements, rather than just the new components. The proposal is tailored to focus on the parts of C408 that are relevant to existing buildings rather than just a blanket reference to C408 and includes specific references to the appropriate commissioning /acceptance testing requirements:

- The balancing (C408.2.2), functional testing (C408.2.3) and documentation (C408.2.5) requirements for HVAC systems.
- The functional testing (C408.2.3) and documentation (C408.2.5) requirements for water heating systems
- The functional testing, documentation and reporting requirements for lighting (C408.3).·

It repeats the system-size thresholds in the charging language in C408. In this way, it has the same scope as the requirements for new construction.The proposal does not include references to the commissioning plan requirement (C408.2.1) for HVAC and SHW equipment (C408.2.4) since these requirements are most appropriate for new construction.

Retro-commissioning and building re-tuning is generally accepted as one of the most cost-effecting energy efficiency measures for existing buildings. Average savings for building re-tuning is 12%, and studies have found savings as high as 52%.[1], [2]

[1] “Improving Commercial Building Operations through Building Re-tuning: Meta-Analysis.” Pacific Northwest National Laboratory, S. Katipamula and N. Fernandez. 2020.

[2] “The Cost-Effectiveness of Commercial Buildings Commissioning.” Lawrence Berkeley National Laboratory, Mills, E., H. Friedman, T. Powell, N. Bourassa, D. Claridge, T. Haasl, and M.A. Piette. 2004

Cost Impact:

The code change proposal will increase the cost of construction.

According to “Improving Commercial Building Operations through Building Re-tuning: Meta-Analysis,” the median costs for building re-tuning was $0.16/sf.

CEPI-229-21

CEPI-230-21

IECC®: C503.5, C503.5.1 (New), C503.5.2 (New), C503.5.3 (New), C503.5.4 (New), C503.5.5 (New)

Proponents:

Glenn Heinmiller, representing International Association of Lighting Designers (glenn@lampartners.com)

2021 International Energy Conservation Code

Revise as follows:
C503.5 Lighting systems.

~~New lighting~~ Lighting systems ~~that are part of the *alteration*~~ shall comply with Sections ~~C405 and C408.~~ C503.5.1 through C503.5.5

~~**Exception:** *Alterations* that replace less than 10 percent of the luminaires in a space, provided that such *alterations* do not increase the installed interior lighting power.~~

Add new text as follows:
C503.5.1 Reconfiguration of spaces.

Where the size or configuration of interior spaces is altered, lighting systems in such spaces shall comply with Section C405.

C503.5.2 Alteration of interior lighting power.

Where the connected interior lighting power within a space is altered, the lighting system in such space shall comply with Section C405.3.Exception: Any space where the connected lighting power is reduced by 20 percent or more is not required to comply with Section C405.3.

C503.5.3 Alteration of exterior lighting power.

Where the connected exterior lighting power is increased by more than 10 percent, all exterior lighting, including lighting that is not proposed to be altered, shall comply with Section C405.5, and all lighting that is added or altered shall be controlled in accordance with Section C405.2.7

C503.5.4 Interior lighting controls.

Where lighting controls are added or altered within a space, the lighting controls within such space shall comply with Section C405.2.

C503.5.5 Exterior lighting controls.

Where exterior lighting controls are added or altered, those portions of the lighting control system that are altered shall comply with Section C405.2.7.

Reason Statement:

This proposal provides a set of comprehensive provisions for the alteration of lighting systems which addresses several long standing problems with the existing code language:

1. It is not clear whether existing light fixtures can be altered without a requirement that existing lighting controls also be altered to comply with the current code, and vice-versa. This proposal clearly de-links these, so that existing lighting controls can be upgraded without triggering a mandatory upgrade of existing light fixtures, and vice-versa.

2. It is not clear how compliance should be determined for exterior lighting alterations. For interior spaces compliance can always be determined for one individual room , but for exterior lighting compliance can only be determined for the entire site.

3. The existing exceptions do not acknowledge the type of alterations that people actually make to existing lighting systems, as they only address one-for-one replacement of light fixtures within a room . This proposal would create more meaningful exceptions for smaller projects.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal would have the effect of exempting some smaller alteration projects which are currently required to comply with the code (but which in truth are often not filed).

CEPI-230-21

CEPI-231-21

IECC®: C503.5.1 (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:
C503.5.1 Controls.

New luminaires that are part of the *alteration* shall be provided with controls that comply with Section C405.2.

Exceptions:

1. *Alterations* that replace less than 10 percent of the luminaires operated by a common lighting control device.
2. Luminaires controlled by *luminaire level lighting controls* in compliance with C405.2(2).

Reason Statement:

The IECC requires that new portions of lighting alterations comply with the requirements for new construction. This leaves unaltered portions of the lighting system unaffected, including lighting controls. The IECC has relied on lighting controls as a cost-effective means of delivering energy efficiency in buildings, so this is a significant missed opportunity. Obsolete controls also increase the operational costs for building owners and tenants. Luminaire replacement is an ideal time to also upgrade lighting controls. Contractors are onsite and operation of the lighting system is already disrupted.

This missed opportunity is particularly significant given the advent of Building Performance Standards (BPS). These policies set performance requirements that subject existing buildings need to meet. States and local jurisdiction around the country including the states of WA and CO and cities like New York, Boston, Washington DC, and St Louis have already adopted Building Performance Standards (BPS). Many more cities are considering this policy tool as they come to realize that meeting their climate goals will require achieving significant energy and/or carbon improvements in existing buildings. This creates a need for the IECC to be much more pro-active in tailoring requirements specifically for existing buildings. Building energy retrofits that are implemented as part of alterations, additions and changes in occupancy are far more cost-effective than stand-alone retrofit projects implemented only to meet a BPS. By incorporating reasonable and cost-effective retrofits into typical existing building projects, the IECC will both provide additional energy, carbon and cost savings to building owners and tenants and help ensure that more building retrofits are undertaken at opportune and cost-effective times.

This proposal requires that lighting controls be brought into compliance with current lighting control requirements when luminaires are replaced. It includes exceptions for when only a small number of luminaires on a lighting control are being replaced and for LLLCs. This will ensure that the control upgrade is not triggered for minor lighting modifications or when lighting is controlled by a larger, centralized system. The proposal does not require the installation of new controls, so if the existing controls already meet current code requirements, they would already be in compliance with this new section.

Cost Impact:

The code change proposal will increase the cost of construction.

Costs will vary based on how obsolete the existing lighting controls are. Where existing controls are outdated, they will generally only need to be swapped out with new controls. Cost will generally be highest in lighting systems with no controls at all; however, these systems will also have the greatest saving potential. Utilities have consistently found lighting control retrofits to be cost effective efficiency incentive measures.

CEPI-231-21

CEPI-232-21

IECC®: SECTION 202 (New), C505.1, C505.1.1 (New), C505.1.2 (New), C505.2 (New), C505.2.1 (New), C505.2.2 (New), TABLE C505.2.2 (New), C505.2.3 (New), TABLE C505.2.3 (New), C505.2.4 (New), TABLE C505.2.4 (New)

Proponents:

David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

2021 International Energy Conservation Code

Add new definition as follows:
C202 ENERGY USE INTENSITY (EUI). The metric indicating the total amount of energy consumed by a building in one year divided by the total gross floor area of the building.
Revise as follows:
C505.1 General.

Spaces undergoing a change in occupancy ~~that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this code. Where the use in a space changes from one use in Table C405.3.2(1) or C405.3.2(2) to another use in Table C405.3.2(1) or C405.3.2(2), the installed lighting wattage shall comply with Section C405.3. Where the space undergoing a change in occupancy or use is in a building with a fenestration area that exceeds the limitations of Section C402.4.1, the space is exempt from Section C402.4.1 provided that there is not an increase in fenestration area.~~ from F, H, or U occupancy classification shall comply with Section C503. Buildings or portions of buildings undergoing a change of occupancy without alterations shall comply with Section C502.2.

~~Exceptions~~ Exception:

~~1.~~ ~~Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall not be greater than 110 percent of the target UA.~~

~~2.~~ Where the total building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall not be greater than 110 percent of the annual energy cost otherwise permitted by Section C407.3.

Add new text as follows:
C505.1.1 Alterations and change of occupancy. .
Alterations made concurrently with any change of occupancy shall be in accordance with Section C503.
C505.1.2 Portions of buildings. .
Where changes in occupancy and use are made to portions of an existing building, only those portions of the building shall comply with Section C505.2.
C505.2 Energy Use Intensitie.

Building envelope, space heating, cooling, ventilation, lighting and service water heating shall comply with Sections C505.2.1 through C505.2.4.

Exceptions:
1. Where it is demonstrated by analysis approved by the code official that the change will not increase energy use intensity.
2. Where the occupancy or use change is less than 5,000 square feet in area.

C505.2.1 Building Envelope. .

Where a change of occupancy or use is made to a whole building that exceeds the maximum fenestration area allowed by Section C402.4.1, the building shall comply with Section C402.1.5, with a proposed UA that shall not be greater than 110 percent of the targe UA.

Exception: Where the change of occupancy or use is made to a portion of the building, the new occupancy is exempt from Section C402.4.1 provided that there is not an increase in fenestration area.
C505.2.2 Building Mechanical Systems.
Where a change of occupancy or use results in the same or increased energy use intensity rank as specified in Table C505.2.2, the

systems serving the building or space undergoing the change shall comply with Section C403.C505.2.3 Service Water Heating. Where a change of occupancy or use results in the same or increased energy use intensity rank as specified in Table C505.2.3, the service water heating systems serving the building or space undergoing the change shall comply with Section C404.

TABLE C505.2.2 BUILDING MECHANICAL

Energy Use Intensity Rank	**International Building Code Occupancy Classification and Use**
1. High	A-2, B-Laboratories, I-2
2. Medium	A-1, A-3[a], A-4, A-5, B[b], E, I-1, I-3, I-4, M, R-4
3. Low	A-3 Places of Religious Worship, R-1, R-2, R-3[c], S-1, S-2

a. Excluding places of religious worship.

b. Excluding laboratories.

c. Buildings three stories or less in height above grade plane shall comply with Section R505.

C505.2.3 Service Water Heating.

Where a change of occupancy or use results in the same or increased energy use intensity rank as specified in Table C505.2.3, the service water heating systems serving the building or space undergoing the change shall comply with Section C404.

TABLE C505.2.3 Service Water Heating

Energy Use Intensity Rank	**International Building Code Occupancy Classification and Use**
1. High	A-2, I-1, I-2, R-1
2. Low	All other occupancies and uses

C505.2.4 Lighting.

Where a change of occupancy or use results in the same or increased energy use intensity rank as specified in Table C505.2.4, the lighting systems serving the building or space undergoing the change shall comply with Section C405 except for Sections C405.2.6 and C405.4.

TABLE C505.2.4 LIGHTING

Energy Use Intensity Rank	International Building Code Occupancy Classification and Use
1. High	B-Laboratories, B-Outpatient Healthcare, I-2, M
2. Medium	A-2, A-3, Courtrooms, B[a], I-1, I-3, I-4, R-1, R-2, R-3[b], R-4, S-1, S-2
3. Low	A-1, A-3[c], A-4, E

a. Excluding laboratories and outpatient healthcare.

b. Buildings three stories or less in height above grade plane shall comply with Section R505.

c. Excluding courtrooms.

Reason Statement:

The IECC 2018 change of occupancy requirement (C505.1) begins with this statement:

“Spaces undergoing a change in occupancy that would result in an increase in demand for either fossil fuel or electrical energy shall comply with this

code.”

Field research and surveys of building officials demonstrate that this requirement is difficult to enforce (Clinton et al, 2016). One reason for this is

that while it is a clear performance requirement, there is no simple compliance evaluation method other than energy modeling, which is beyond the

capabilities of most change-of-occupancy permit applicants. As depicted in the referenced survey findings and community-based pilot research, building officials often require energy efficiency equipment upgrades, such as lighting or HVAC, in buildings undergoing a change of occupancy. This

proposal seeks to provide clarity to that approach by providing a simple breakdown of energy use intensity (EUI) by building occupancy type and

system type.

The proposed code change draws on a tradition of rehabilitation “smart codes” use-based lookup tables, is more consistent with the intent of the

IECC, presents no cost increase, and incorporates extensive research and stakeholder input.

This proposal advances the Energy Use Intensity (EUI) as the metric for energy demand and the trigger for code compliance. Historic energy

intensity per square foot is recorded for commercial buildings in the Commercial Buildings Energy Consumption Survey (CBECS). The CBECS data

make it possible to rank building occupancies in the order of the energy intensities. Note that the ranking of occupancies to trigger specific code

requirements has been a feature of the International Existing Building Code (IEBC) since its earliest editions (see IEBC 2009 Section 912, Change of

Occupancy Classification, Tables 912.4, 912.5 and 912.6), and thus is familiar to building code officials.

Energy intensity data in CBECS is further broken down by various end uses (space conditioning, service water heating and lighting) which makes it

possible to identify when it is appropriate to trigger code compliance of specific sections of the IECC. For each of these end uses, an increase in

intensity triggers compliance with the correlating code provisions related to new construction in Chapter 4. Only an increase in energy intensities in

all three of the end uses triggers full compliance with the code.

There are two exceptions that apply to all four end uses, indicated in Section C505.2:

1. Where it is demonstrated by analysis approved by the code official that the change will not increase energy use intensity.

2. Where the occupancy or use change is less than 5,000 square feet in area.

A matrix has been developed for each system end use that groups building occupancy classifications into HIGH, MEDIUM and LOW energy use

intensities, measured in annual kBTU/sf. Data for this analysis came from the U.S. Department of Energy’s 2012 CBECS. When occupancy

classification or use is being changed from one energy intensity rank to a higher energy use intensity rank (or remains within the same energy use

intensity rank), this proposal requires that specific system end-use to comply with the code.

Occupancy classifications F, H and U are typically not designed primarily for occupant comfort, and are generally classified as low energy use
intensity buildings. Thus any change from one of these groups to any other should be required to comply with the provisions under

Section C503
Alterations, even if no physical alteration is planned.
Section C505.2.1 Building Envelope is included as a building system, although with different criteria than EUI Intensity. The requirement and
exception exist in the 2018 language; they are simply relocated in this proposal.
This code change proposal has been developed with support from the Consortium for Building Energy Innovation (CBEI), a project of the U. S.
Department of Energy, and research conducted by Rutgers University Center for Green Building.

Change of Occupancy Scale - Space Heating, Cooling and Ventilation

EUI Rank	CBECS Building Type	EUI Range kBTU/sq.ft.	IBC Occupan Classificatio
1. High	Food Service, Laboratories, Health Care (Inpatient)	> 55	A-2, B-Laboratories, I-
2. Medium	Public Assembly, Public Order and Safety, Office, Service, Health Care (Outpatient), Education, Retail, Residential Care/Assisted Living	27 - 55	A-1, A-3, A-4, A-5, B, 3, I-4, M, R-4
3. Low	Religious Worship, Apartments, Warehouse and Storage	<27	A-3 Places of Worshi R-2, R-3, S-1, S-2

Change of Occupancy Scale - Service Water Heating

EUI Rank	CBECS Building Type	EUI Range kBTU/sq.ft.	IBC Occupanc Classification
1. High	Food Service, Health Care (Inpatient), Residential Care/Assisted Living, Lodging	> 15	A-2, I-1, I-2, R-1
2. Low	All the rest	< 15	All the rest

Change of Occupancy Scale- Lighting

EUI Rank	CBECS Building Type	EUI Range kBTU/sq.ft.	IBC Occupancy Classif
1. High	Laboratories, Health Care (Outpatient), Health Care (Inpatient), Retail	> 11	B-Laboratories, B-Healthc (Outpatient), I-2, M
2. Medium	Food Service, Office, Health Care (Outpatient), Service, Public Order and Safety, Residential Care/Assisted Living, Lodging, Apartments, Warehouse and Storage	6.5 - 11	A-2, A-3-Courtrooms, B, I- 4, R-1, R-2, R-3, R-4, S-1,
3. Low	Public Assembly, Religious Worship, Education	< 6.5	A-1, A-3, A-4, E

Bibliography:

Clinton J. Andrews, David Hattis, David Listokin, Jennifer A. Senick, Gabriel B. Sherman & Jennifer Souder (2016): Energy –Efficient Reuse of Existing Commercial Buildings, Journal of the American Planning Association. doi.10.1080/01944363.2015.1134275

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The code change proposal will not increase or decrease the cost of construction
The current code requirements trigger full compliance with the code when there is an increase in energy demand. The proposed code change offers
the metric of energy use intensity per square foot per year for measuring energy demand by occupancy. It applies this metric separately to three
energy end uses: space conditioning, lighting, and water heating. Therefore, compliance with the code is triggered only for the end uses for which
energy intensity is increased.
In most cases, the proposed change triggers partial code compliance, and only rarely will it trigger full code compliance.

CEPI-232-21

CEPI-233-21

IECC®: CB103.6, CB103.7, CB103.8, CB103.9

Proponents:

Joseph Cain, representing Solar Energy Industries Association (SEIA) (JoeCainPE@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
CB103.6 Interconnection pathway.

Construction documents shall indicate pathways for routing of conduit or piping from the solar-ready zone to the electrical service panel ~~and electrical energy storage system area~~ or service hot water system.

~~CB103.7 Electrical energy storage system-ready area~~.
~~The floor area of the electrical energy storage system-ready area shall be not less than 2 feet (610 mm) in one dimension and 4 feet (1219 mm) in another dimension, and located in accordance with Section 1207 of the *International Fire Code*. The location and layout diagram of the electrical energy storage system-ready area shall be indicated on the construction documents.~~
~~CB103.8~~ CB103.7 Electrical service reserved space.

The main electrical service panel shall have a reserved space to allow installation of a dual-pole circuit breaker for future solar electric and ~~a dual-pole circuit breaker for future electrical energy storage system installation. These spaces~~ shall be labeled "For Future Solar Electric and Storage." The reserved ~~spaces~~ space shall be positioned at the end of the panel that is opposite from the panel supply conductor connection.

~~CB103.9~~ CB103.8 Construction documentation certificate.

A permanent certificate, indicating the solar-ready zone and other requirements of this section, shall be posted near the electrical distribution panel, water heater or other conspicuous location by the builder or registered design professional.

Reason Statement:

This proposal is intended to strike out language that was created by Proposal CE262-19, which was Disapproved at the Committee Action Hearing and again disapproved at the Public Comment Hearing. The ICC Long-Term Code Development Process Committee has recommended to the ICC Board of Directors that double-disapproved proposals not move forward to the Online Governmental Consensus Vote. Under CP28 Section 8.1, the OGCV vote for double-disapproved proposals can be voted on only As Submitted or Disapprove. That means these proposals do not benefit from public testimony or Committee discussion at the Committee Action Hearing, and do not have the benefit of being revised or improved during the public comment process, in response to identification of flaws or opportunities for improvement.

Although it is desirable to have buildings constructed as both solar ready and energy storage ready, the requirements for commercial energy storage are far too complex to lend themselves to simple readiness. For example, the construction document requirements of 2021 IFC Section 1207.1.3 illustrate the types of components and systems that are required to accompany commercial ESS, and further illustrate that some of these requirements are product-specific and can only be known once the commercial ESS product manufacturer is identified and selected for the project.

1207.1.3 Construction documents.

The following information shall be provided with the permit application:

1. Location and layout diagram of the roof or area in which the ESS is to be installed.

2. Details on the hourly fire-resistance ratings of assemblies enclosing the ESS.

3. The quantities and types of ESS to be installed.

4. Manufacturer's specifications, ratings and listings of each ESS.

5. Description of energy (battery) management systems and their operation.

6. Location and content of required signage.

7. Details on fire suppression, smoke or fire detection, thermal management, ventilation, exhaust and deflagration venting systems, if provided.

8. Support arrangement associated with the installation, including any required seismic restraint.

9. A commissioning plan complying with Section 1207.2.1.

10. A decommissioning plan complying with Section 1207.2.3.

Further, the space requirement of 2021 IECC Section CB103.7 is noted as "The floor area of the electrical energy storage system-ready area shall be not less than 2 feet (610 mm) in one dimension and 4 feet (1219 mm)in another dimension ..." The 2 feet x 4 feet ready area does not provide adequate space for ESS, and does not comply with basic work area requirements of NFPA 70 National Electrical Code for electrical safety.

Appendix CB should be restored to solar readiness only, as in the 2018 IECC.

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposal will restore Appendix CB to solar readiness only, and will strike out the additional requirements for storage readiness. As the storage readiness requirements in 2021 IECC are not practical, they represent added expense without value, so this proposal will decrease the cost of construction.

CEPI-233-21

CEPI-234-21

IECC®: APPENDIX CC, CC101.1, CC101.2

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

APPENDIX CC ZERO NET ENERGY COMMERCIAL BUILDING PROVISIONS

CC101.1 Purpose.
The purpose of this appendix is to supplement the *International Energy Conservation Code* and require renewable energy systems of adequate capacity to achieve net zero energy ~~carbon~~.
CC101.2 Scope.
This appendix applies to new buildings that are addressed by the *International Energy Conservation Code* or ASHRAE 90.1.

Exceptions:

1. Detached one- and two-family dwellings and townhouses as well as Group R-2 buildings three stories or less in height above grade plane, manufactured homes (mobile dwellings), and manufactured houses (modular dwellings).

2. Buildings that do not use ~~neither~~ electricity ~~nor~~ or fossil fuel or hydrogen.

Reason Statement:

Several changes are proposed for your consideration.

The appendix should use the more technically correct terms of "zero net energy" or "net zero energy." The term "zero energy" is more suited for a misleading marketing brochure, rather than an IECC Appendix or an ICC code. All buildings use energy, and the use of a term like "zero energy", while appealing, is not accurate and can mislead consumers and businesses.

There is no definition of "zero net carbon", and a building can be zero net energy without being zero net carbon (and can be zero net carbon without being zero net energy). To be consistent with the title and definitions, it is suggested that "carbon" be replaced with "energy" in CC101.1.

There are jurisdictions that use ASHRAE 90.1 for commercial and multi-family buildings, so this addition would ensure that those buildings are covered.

It is suggested that hydrogen be added to Exception 2, as more commercial buildings are using applications that use hydrogen (such as fuel cells or other combustion devices).

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed edits are primarily editorial and have no impact on the cost of construction.

CEPI-234-21

CEPI-235-21

IECC®: SECTION 202

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Delete without substitution:
~~IECC2021P1E_CE_AppxCC_SecCC102_DefENERGY_UTILIZATION_INTENSITY_EUI_ ENERGY UTILIZATION INTENSITY (EUI)~~. ~~The site energy for either the baseline building or the proposed building divided by the gross *conditioned floor area* plus any semiheated floor area of the building. For the baseline building, the EUI can be divided between regulated energy use and unregulated energy use.~~

Reason Statement:

This appendix establishes a minimum renewable energy requirement to achieve zero-net carbon. The term *energy utilization intensity (EUI)* created confusion with the original Appendix CC, so it is being replaced with the term *minimum renewable energy requirement*. This proposal is one of four related proposals implementing this replacement, and these changes carry over to Section CC103.1 and Table CC103.1.

The term *energy utilization intensity (EUI)* is no longer used in Appendix CC and is instead intended to be replaced by the term *minimum renewable energy requirement*, which is being added in a separate code change proposal.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-235-21

CEPI-236-21

IECC®: SECTION 202 (New)

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Add new definition as follows:
CC102 MINIMUM RENEWABLE ENERGY REQUIREMENT. The minimum amount of on-site or adjusted off-site renewable energy needed to comply with this appendix.

Reason Statement:

This appendix establishes a minimum renewable energy requirement to achieve zero-net carbon. The term *energy utilization intensity (EUI)* created confusion with the original Appendix CC, so it is being replaced with the term *minimum renewable energy requirement*. This proposal is one of four related proposals implementing this replacement, and these changes carry over to Section CC103.1 and Table CC103.1.

The equation to determine the *minimum renewable energy requirement* has been modified, and this term is intended as a substitute for the definition *energy utilization intensity (EUI)*, which we are proposing to delete in a separate code change proposal.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-236-21

CEPI-237-21

IECC®: SECTION 202

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Revise as follows:

IECC2021P1E_CE_AppxCC_SecCC102_DefOFF_SITE_RENEWABLE_ENERGY_SYSTEM OFF-SITE RENEWABLE ENERGY SYSTEM. Renewable energy system which serves the building project and is not an *on-site renewable energy system*~~not located on the building project~~.

Reason Statement:

This code change proposal modifies the definition of *off-site renewable energy system* to be consistent with a separate, related proposal to update the definition of *on-site renewable energy system,* which aims to make that definition consistent with *ASHRAE Standard 189.1-2020* and the *2021 International Green Construction Code (IgCC)*. The definition for *off-site renewable energy system* directly references the definition for *on-site renewable energy system*, so this change is necessary.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-237-21

CEPI-238-21

IECC®: SECTION 202

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Revise as follows:

IECC2021P1E_CE_AppxCC_SecCC102_DefON_SITE_RENEWABLE_ENERGY_SYSTEM ON-SITE RENEWABLE ENERGY SYSTEM. Renewable energy systems ~~on the building project~~ located on any of the following:

1. The building;
2. The property upon which the building is located;
3. A property that shares a boundary with and is under the same ownership or control as the property on which the building is located; or
4. A property that is under the same ownership or control as the property on which the building is located and is separated only by a public right-of-way on which the building is located.

Reason Statement:

This code change proposal modifies the definition of *on-site renewable energy system* to be consistent with *ASHRAE Standard 189.1-2020* and the *2021 International Green Construction Code (IgCC)*. There is a separate related proposal to update the definition for *off-site renewable energy system* since it references the first definition.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-238-21

CEPI-239-21

IECC®: SECTION 202 (New)

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Add new definition as follows:
CC102 RENEWABLE ENERGY CERTIFICATE. A tradeable, market-based instrument that represents the legal property rights to the "renewable-ness"—or non-power (i.e., environmental) attributes—of renewable electricity generation.

Reason Statement:

This definition is added for clarity and is consistent with language used by the United States EPA.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-239-21

CEPI-240-21

IECC®: SECTION CC102, SECTION 202

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

SECTION CC102 DEFINITIONS
Revise as follows:
IECC2021P1E_CE_AppxCC_SecCC102_DefENERGY_UTILIZATION_INTENSITY_EUI_ ENERGY UTILIZATION INTENSITY (EUI). The annual site energy for either the baseline building or the proposed building divided by the gross *conditioned floor area* plus any semiheated floor area of the building. ~~For the baseline building, the EUI can be divided between regulated energy use and unregulated energy use.~~
IECC2021P1E_CE_AppxCC_SecCC102_DefOFF_SITE_RENEWABLE_ENERGY_SYSTEM OFF-SITE RENEWABLE ENERGY SYSTEM. A ~~Renewable~~ renewable energy production system not located on or at the building project.
IECC2021P1E_CE_AppxCC_SecCC102_DefON_SITE_RENEWABLE_ENERGY_SYSTEM ON-SITE RENEWABLE ENERGY SYSTEM. A ~~Renewable~~ renewable energy production system~~s~~ located on or at the building project.
IECC2021P1E_CE_AppxCC_SecCC102_DefRENEWABLE_ENERGY_SYSTEM RENEWABLE ENERGY SYSTEM. Photovoltaic, solar thermal, geothermal energy, ~~and~~ wind, or other *approved* renewable energy production systems used to generate energy.

Reason Statement:

This proposal updates and clarifies the definitions in Appendix CC.

For EUI, it clarifies that the metric uses annual energy, not monthly or other time period. It also takes out the last sentence, since it is not needed for the definition, and Table CC103.1 has no information related to the breakout of regulated versus non-regulated energy in any building type.

It clarifies the definitions of off-site and on-site renewable energy systems (a system does not have to be "on" a building, but it can be "at" the building project apart from the building).

For renewable energy systems, it adds necessary language. In many states and localities, hydroelectric (especially smaller projects) and biomass systems are defined as renewable energy systems. Since the current list does not include them, the current definition will be in conflict with many state or local laws. It also conflicts with the current IECC definition of "Renewable Energy Resources" shown on page C2-6. The new addition eliminates the conflict by ensuring that *approved* (and legal) renewable energy systems are allowed to qualify.

Another option would be to change the definition to "A system that uses *renewable energy resources* to produce energy."

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal only revises definitions and will have no impact on the cost of construction.

CEPI-240-21

CEPI-241-21

IECC®: CC103.1

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:

CC103.1 Renewable energy.

On-site renewable energy systems shall be installed, or off-site renewable energy shall be procured to offset the building energy as calculated in Equation CC-1.

$$RE_{onsite} + RE_{offsite} \geq E_{building}$$

(Equation CC-1)

where:

RE_{onsite} = Annual site energy production from on-site renewable energy systems (see Section CC103.2).

$RE_{offsite}$ = Adjusted annual site energy production from off-site renewable energy systems that may be credited against building energy use (see Section CC103.3).

$E_{building}$ = Building energy use without consideration of renewable energy systems.

<u>The *building envelope* U-factors, C-factors, F-factors, and SHGCs shall be no greater than the values in Tables C402.1.4 and C402.4.</u>

When Section C401.2.1(1) is used for compliance with the *International Energy Conservation Code*, building energy shall be determined by multiplying the gross *conditioned floor area* plus the gross semiheated floor area of the proposed building by an EUI selected from Table CC103.1. Use a weighted average for mixed-use buildings.

When Section C401.2.1, Item 2 or Section C401.2.2 is used for compliance with the *International Energy Conservation Code*, building energy shall be determined from energy simulations.

Reason Statement:

The purpose of this code change proposal is to improve the Zero Energy Commercial Buildings Appendix by incorporating a mandatory building thermal envelope efficiency backstop (limiting the user's ability to trade-off the prescriptive envelope performance levels) similar to the backstop included in the Zero Energy Residential Building Appendix. The 2021 *IECC* includes, for the first time, residential and commercial zero energy options for jurisdictions seeking to go beyond the base *IECC* requirements. As more cities and states rely upon building energy codes as a means of achieving energy efficiency and greenhouse gas reduction goals, we expect that adoption of these appendices and similar net-zero supplements to the code will become more common. As with any above-code framework, it is important to ensure that buildings constructed to these programs or appendices will achieve no less efficiency (and ideally more efficiency) than a building constructed to the base code requirements.

The proposal above adds an important safeguard for building owners by requiring that the zero-energy building have a building envelope that meets the prescriptive efficiency requirements required by the *IECC*. Although we believe greater envelope efficiency is justified in a program that purports to be "zero energy," a good starting point is the prescriptive envelope requirements. A well-insulated building envelope with high-performance fenestration is critical to the long-term efficiency of a commercial building and is particularly appropriate for a "zero energy" commercial building:

- The efficiency of the building envelope is the most important factor in a building's long-term performance (unlike equipment, renewable generation and other measures, the envelope can last for a very long time, even for the life of the building), but is the most costly to retrofit after the building is constructed;
- Occupants will be more comfortable and healthier in a building with a reasonably efficient envelope; and
- Well-insulated buildings are more resilient and will provide better protection for occupants and property in long-term power outages.

An effective thermal envelope backstop is crucial to ensure that the building retains reasonable envelope performance similar to the prescriptive path under an alternative compliance path, such as the net zero path, performance path or an above-code program, etc., and that the envelope is not unduly traded-off for other measures. Trading off envelope and associated occupant comfort can have direct negative impacts on energy usage. For example, if the occupant responds to discomfort from a "cold" or "hot" room due to an inadequate building envelope by adjusting the thermostat, the additional energy use from the adjusted thermostat can be substantial.

As a result, backstops can save significant energy and energy costs in buildings.

This backstop is similar to the one adopted as part of the 2021 *IECC* Zero Energy Residential Building Appendix (Table RC102.2, footnote a), but rather than referencing a previous edition of the *IECC*, this proposal refers directly to the envelope tables of the current code. This will allow the backstop to automatically include any improvements in the envelope tables in future editions of the code and will reduce the need for additional code changes in the future. As the *IECC* Zero Energy Appendices serve an increasingly large role in helping jurisdictions achieve net-zero goals, we believe it is more important than ever to lock in basic energy conservation requirements.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will neither increase nor decrease the cost of construction. This proposal does not increase the baseline stringency of the IECC, but merely limits trade-offs under the net zero alternate compliance path. The mandatory minimum values proposed are no more stringent than prescriptive values of the IECC and only apply if this compliance path is chosen.

COST-EFFECTIVENESS

This code change proposal does not increase the stringency of the code or result in increased costs, so a cost-effectiveness analysis does not apply. The ICC Board of Directors set the 2021 IECC as the baseline for future IECC development – and by extension made the 2021 IECC the basis for cost-effectiveness analyses. This means for purposes of analyzing code proposals, the existing provisions of the 2021 *IECC* are considered cost-effective and reasonable, since they are the starting point for analyses of code changes and no rollbacks are permitted. Establishing trade-off backstops like this code change proposal, which utilizes U-factors and SHGCs equal to the prescriptive measures of the 2021 *IECC*, does not increase the stringency of that baseline or impose any additional costs to meet specific measures. In addition, if the prescriptive values are cost-effective, then the backstop values would be cost-effective. Changes to trade-off backstops like the proposal above do not increase the stringency of that baseline or impose any additional costs to meet specific measures. These backstops serve only as a consumer protection against excessive trade-offs, but do not require anything more than what would be required for base code prescriptive compliance. Thus, a cost-effectiveness analysis would be difficult or impossible to apply and would not be informative.

CEPI-241-21

CEPI-242-21

IECC®: TABLE CC103.1, TABLE CC103.1 (New)

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Delete without substitution:

~~TABLE CC103.1 ENERGY UTILIZATION INTENSITY FOR BUILDING TYPES AND CLIMATES (kBtu/ft² – yr)~~

BUILDING AREA TYPE	CLIMATE ZONE																
	0A/1A	0B/1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
	kBtu/ft² – yr																
~~Healthcare/hospital (I-2)~~	~~119~~	~~120~~	~~119~~	~~113~~	~~116~~	~~109~~	~~106~~	~~116~~	~~109~~	~~106~~	~~118~~	~~110~~	~~105~~	~~126~~	~~116~~	~~131~~	~~142~~
~~Hotel/motel (R-1)~~	~~73~~	~~76~~	~~73~~	~~68~~	~~70~~	~~67~~	~~65~~	~~69~~	~~66~~	~~65~~	~~71~~	~~68~~	~~65~~	~~77~~	~~72~~	~~81~~	~~89~~
~~Multiple-family (R-2)~~	~~43~~	~~45~~	~~41~~	~~41~~	~~43~~	~~42~~	~~36~~	~~45~~	~~43~~	~~41~~	~~47~~	~~46~~	~~41~~	~~53~~	~~48~~	~~53~~	~~59~~
~~Office (B)~~	~~31~~	~~32~~	~~30~~	~~29~~	~~29~~	~~28~~	~~25~~	~~28~~	~~27~~	~~25~~	~~29~~	~~28~~	~~25~~	~~33~~	~~30~~	~~32~~	~~36~~
~~Restaurant (A-2)~~	~~389~~	~~426~~	~~411~~	~~408~~	~~444~~	~~420~~	~~395~~	~~483~~	~~437~~	~~457~~	~~531~~	~~484~~	~~484~~	~~589~~	~~538~~	~~644~~	~~750~~
~~Retail (M)~~	~~46~~	~~50~~	~~45~~	~~46~~	~~44~~	~~44~~	~~37~~	~~48~~	~~44~~	~~44~~	~~52~~	~~50~~	~~46~~	~~60~~	~~52~~	~~64~~	~~77~~
~~School (E)~~	~~42~~	~~46~~	~~42~~	~~40~~	~~40~~	~~39~~	~~36~~	~~39~~	~~40~~	~~40~~	~~39~~	~~43~~	~~37~~	~~44~~	~~40~~	~~45~~	~~54~~
~~Warehouse (S)~~	~~9~~	~~12~~	~~9~~	~~11~~	~~12~~	~~11~~	~~10~~	~~17~~	~~13~~	~~14~~	~~23~~	~~17~~	~~15~~	~~32~~	~~23~~	~~32~~	~~32~~
~~All others~~	~~55~~	~~58~~	~~54~~	~~53~~	~~53~~	~~51~~	~~48~~	~~54~~	~~52~~	~~51~~	~~57~~	~~54~~	~~50~~	~~63~~	~~57~~	~~65~~	~~73~~

Add new text as follows:

TABLE CC103.1 PRESCRIPTIVE RENEWABLE ENERGY REQUIREMENT FOR BUILDING TYPES AND CLIMATES (kBtu/ft² – yr)

Climate Zone	**Building Area Type**								
	Healthcare /hospital (I-2)	**Hotel/motel (R-1)**	**Multifamily (R-2)**	**Office (B)**	**Restaurant (A-2)**	**Retail (M)**	**School (E)**	**Warehouse (S)**	**All others**
0A	119	77	43	35	438	59	53	11	60
0B	114	74	41	34	421	56	50	12	58
1A	110	69	38	30	385	48	44	10	53
1B	110	70	39	31	403	51	46	11	54
2A	109	67	37	29	390	44	41	9	51
2B	102	63	36	28	369	41	38	10	48
3A	103	63	36	27	398	44	38	12	49
3B	100	62	35	26	376	40	36	9	47
3C	95	61	31	23	342	34	32	8	43
4A	105	63	39	27	419	52	36	19	51
4B	100	61	36	26	386	42	35	12	47
4C	95	59	35	24	380	44	35	13	46
5A	106	64	43	29	455	59	38	26	54
5B	101	63	39	27	425	49	38	17	50
5C	100	59	34	23	395	45	33	12	46
6A	113	68	48	33	514	70	44	36	61
6B	112	65	43	29	468	58	38	26	55
7	126	71	48	32	560	68	46	34	63
8	136	76	53	36	649	79	56	35	70

Reason:

This appendix establishes a minimum renewable energy requirement to achieve zero-net carbon. The term *energy utilization intensity (EUI)* created confusion with the original Appendix CC, so it is being replaced with the term *minimum renewable energy requirement*. This proposal is one of four related proposals implementing this replacement, and these changes carry over to Section CC103.1 and Table CC103.1.

The new term *minimum renewable energy requirement* has been proposed to replace the term *energy utilization intensity (EUI)* by separate code change proposals, since the EUI term has been consistently misinterpreted. Values in the table have been modified to be consistent with the estimated energy consumption that will result from compliance with the latest standards. The rows and columns of the table have been switched from the previous table version to improve formatting.

Cost Impact:

The code change proposal will decrease the cost of construction.

This code change proposal is expected to decrease the cost of construction. These proposed numbers in this table are all lower than the version of the table in the 2021 IECC Appendix CC, which will lower the cost of compliance, since less renewable energy will be required.

CEPI-243-21

IECC®: TABLE CC103.1

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE CC103.1 ENERGY UTILIZATION INTENSITY FOR BUILDING TYPES AND CLIMATES (kBtu/ft^2 – yr)

BUILDING AREA TYPE	CLIMATE ZONE																
	0A/1A	0B/1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
	kBtu/ft^2 – yr																
Healthcare/hospital (I-2)	119	120	119	113	116	109	106	116	109	106	118	110	105	126	116	131	142
Hotel/motel (R-1)	73	76	73	68	70	67	65	69	66	65	71	68	65	77	72	81	89
Multiple-family (R-2)	43	45	41	41	43	42	36	45	43	41	47	46	41	53	48	53	59
Office (B)	31	32	30	29	29	28	25	28	27	25	29	28	25	33	30	32	36
Restaurant (A-2)	389	426	411	408	444	420	395	483	437	457	531	484	484	589	538	644	750
Retail (M)	46	50	45	46	44	44	37	48	44	44	52	50	46	60	52	64	77
School (E)	42	46	42	40	40	39	36	39	40	40	39	43	37	44	40	45	54
Warehouse (S)	9	12	9	11	12	11	10	17	13	14	23	17	15	32	23	32	32
~~All others~~	~~55~~	~~58~~	~~54~~	~~53~~	~~53~~	~~51~~	~~48~~	~~54~~	~~52~~	~~51~~	~~57~~	~~54~~	~~50~~	~~63~~	~~57~~	~~65~~	~~73~~

Reason: In the current table, the "catch all" category of "all others" will cover buildings ranging from assembly buildings and houses of worship to grocery stores and data centers. In other words, the energy intensity of buildings represented in this line vary by orders of magnitude that are well below or well above the values shown for "all other" buildings in all climate zones. The values shown will not be useful or usable for many building area types.

The quickest solution is to eliminate the line, as is proposed. A long-term solution would be to use EIA CBECS and/or EPA Energy Star Portfolio Manager and/or city/state building energy benchmarking data to create more rows of different building area types. Another resource that may be of use are the site energy data tables found in ASHRAE Standard 100 for existing buildings.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal will have no impact on the cost of construction.

CEPI-244-21

IECC®: CC103.1

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Revise as follows:

CC103.1 Renewable energy.

On-site renewable energy systems shall be installed, or off-site renewable energy shall be procured to meet the *minimum renewable energy requirement*~~, offset the building energy~~ as calculated in Equation CC-1.

$$RE_{onsite} + RE_{offsite} \geq E_{building}$$

(Equation CC-1)

where:

RE_{onsite} = Annual site energy production from on-site renewable energy systems (see Section CC103.2).

$RE_{offsite}$ = Adjusted annual site energy production from off-site renewable energy systems that may be credited against building energy use (see Section CC103.3).

$E_{building}$ = Minimum ~~Building energy use without consideration of~~ renewable energy requirement ~~systems~~.

When Section C401.2.1(1) is used for compliance with the *International Energy Conservation Code*, ~~building energy~~the *minimum renewable energy requirement* shall be determined by multiplying the gross *conditioned floor area* plus the gross semiheated floor area of the proposed building by ~~an EUI selected~~the prescriptive renewable energy requirement from Table CC103.1. Use a weighted average for mixed-use buildings.

When Section C401.2.1, Item 2 or Section C401.2.2 is used for compliance with the *International Energy Conservation Code*, the *minimum renewable energy requirement* shall be equal to the building energy as ~~shall be~~ determined from energy simulations.

Reason Statement:

This appendix establishes a minimum renewable energy requirement to achieve zero-net carbon. The term *energy utilization intensity (EUI)* created confusion with the original Appendix CC, so it is being replaced with the term *minimum renewable energy requirement*. This proposal is one of four related proposals implementing this replacement, and these changes carry over to Section CC103.1 and Table CC103.1.

This is an editorial code change.

The new term *minimum renewable energy requirement* has been proposed to replace the term *energy utilization intensity (EUI)* by separate code change proposals. The substitution of the new term for the deleted term has been applied to this section for consistency and clarity.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-244-21

CEPI-245-21

IECC®: CC103.1, CC103.2, CC103.3.1, CC103.3.2, CC103.3.3

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
CC103.1 Renewable energy.
On-site renewable energy systems shall be installed, or off-site renewable energy shall be procured to offset the building energy as calculated in Equation CC-1.

$$RE_{onsite} + RE_{offsite} \geq E_{building}$$

(Equation CC-1)
where:
RE_{onsite} = Annual site energy production from on-site renewable energy systems (see Section CC103.2).
$RE_{offsite}$ = Adjusted annual site energy production from off-site renewable energy systems that may be credited against building energy use (see Section CC103.3).
$E_{building}$ = Building energy use without consideration of renewable energy systems.
When Section C401.2.1(1) is used for compliance with the *International Energy Conservation Code*, building energy shall be determined by multiplying the gross *conditioned floor area* plus the gross semiheated floor area of the proposed building by an EUI selected from Table CC103.1.
Exception: ~~Use a weighted average for~~ For mixed-use buildings, a weighted average based on the percentages of total area by building area types shall be used.

When Section C401.2.1, Item 2 or Section C401.2.2 is used for compliance with the *International Energy Conservation Code*, building energy shall be determined from energy simulations.

CC103.2 Calculation of on-site renewable energy.

The annual energy production from on-site renewable energy systems shall be determined using ~~the PVWatts software or other~~ software approved by the code official.

CC103.3.1 Qualifying off-site procurement methods.
The following are considered qualifying off-site renewable energy procurement methods:

1. Community renewables: an off-site renewable energy system for which the building project owner has purchased or leased renewable energy ~~capacity~~ along with other subscribers.

2. ~~Renewable energy investment fund~~ Third party provider: an entity that installs, operates, and maintains renewable energy capacity on behalf of the building project owner.

3. Virtual power purchase agreement: a power purchase agreement for off-site renewable energy where the building project owner agrees to purchase renewable energy output at a ~~fixed~~ specific price schedule.

4. Direct ownership: an off-site renewable energy system owned, operated, and maintained by the building project owner.

5. Direct access to wholesale market: an agreement between the building project owner and ~~a renewable energy developer~~ an Electric Wholesale Generator or Independent Power Producer to purchase renewable energy.

6. Green retail tariffs: a program by the retail electricity provider to provide up to 100-percent renewable energy to the building project owner.

7. Unbundled Renewable Energy Certificates (RECs): certificates purchased by the building project owner representing the environmental benefits of renewable energy generation that are sold separately from the electric power.

CC103.3.2 Requirements for all procurement methods.
The following requirements shall apply to all off-site renewable energy procurement methods:

1. The building owner shall sign a legally binding contract to procure qualifying *off-site renewable energy*.
2. The procurement contract shall have duration of not less than ~~15~~ 10 years ~~and shall be structured to survive a partial or full transfer of ownership of the property.~~
3. RECs and other environmental attributes associated with the procured *off-site renewable energy* shall be assigned to the building project for the duration of the contract.
4. The *renewable energy* generating system ~~source~~ shall consist of one or more *renewable energy resources.* ~~include one or more of the following: photovoltaic systems, solar thermal power plants, geothermal power plants and wind turbines.~~
5. The generation source shall be located where the energy can be delivered to the *building site* by the same utility or distribution entity, the same independent system operator (ISO) or regional transmission organization (RTO), or within integrated ISOs (electric coordination council).
6. ~~The *off-site renewable energy* producer shall maintain transparent accounting that clearly assigns production to the building.~~ Records on power sent to or purchased by the building project shall be retained by the building project owner and made available for inspection by the code official upon request.

CC103.3.3 Adjusted off-site renewable energy.
The ~~process for calculating~~ amount of the annual adjusted *off-site renewable energy* ~~is shown in~~ shall be determined by using Equation 2.

$$RE_{offsite} = \sum_{i=1}^{n} PF_i \times RE_i = PF_1 \times RE_1 + PF_2 \times RE_2 + ... + PF_n \times RE_n$$

(Equation CC-2)
where:
$RE_{offsite}$ = Adjusted annual off-site renewable energy.
PF_i = Procurement factor for the i^{th} renewable energy procurement option ~~method or class~~ taken from Table CC103.3.3.
RE_i = Annual energy production for the i^{th} renewable energy procurement option ~~method or class~~.
n = The number of renewable energy procurement options ~~or classes~~ considered.

Reason Statement:

Significant changes are needed to section CC103. Some of the proposed changes are editorial clarifications, while other changes are needed due to poor definitions, vague terms, or language that can't be enforced.

In C103.2, there are multiple simulation softwares that can be used to simulate energy production, so the reference to PVWatts has been removed (such information can be put into a User's Manual or in an informative note that is not part of the standard).

In C103.3, for example, the current language says "Renewable Energy Investment Fund: an entity that installs renewable energy capacity on behalf of the owner". Does that mean that a private company like Solar City or Sun Run or Tesla is a "renewable energy investment fund"? What if the system is installed by a government agency on behalf of the building? Or installed by a local utility? The term "third party provider" would be much more clear.

Also, if a building project has "direct access to wholesale market", they sign a contract with an Electric Wholesale Generator or Independent Power Producer that sell into the wholesale market. They do not sign a contract with a "renewable energy generator".

In CC103.3.2, there is language that is vague and not enforceable. For example, currently in Line 2, how is a code official supposed to determine whether a procurement contract is "structured to survive a partial or full transfer of ownership of the property"? This proposal removes that language.

The current Line 4 with the proposed definitions of renewable energy will conflict with state laws that allow other resources and conflicts with the current definition of renewable energy resources found on page C2-6 of the IECC. This proposal aligns this line with the current definition of renewable energy resources that avoids conflicts with state laws.

On Line 6, it currently says that the off-site renewable energy producer "shall maintain transparent accounting that clearly assigns production to the building". How is a code official supposed to determine if they have "transparent accounting"? Also, what if the off-site producer is located in a different jurisdiction from the building? How will this current language be enforced? This proposal removes that language.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

None of the proposed language changes will alter the cost of construction.

CEPI-245-21

CEPI-246-21

IECC®: CC103.2

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Revise as follows:

CC103.2 Calculation of on-site renewable energy.

The annual energy production from on-site renewable energy systems shall be determined using ~~the PVWatts software or other~~ software approved by the code official. Renewable energy certificates and other environmental attributes associated with the on-site renewable energy system shall be assigned to the initial and subsequent building owner(s) for a period of not less than 15 years. The building owner(s) may transfer renewable energy certificates to building tenants while they are occupying the building.

Reason Statement:

This code change proposal is intended to address concerns from supporters during the initial addition of this appendix to the IECC last cycle. Since the software program PVWatts has not been recognized by an accredited standard development organization, the reference to that individual program has been removed so that only the use of a software program approved by the code official may be employed.

Language is added to make it clear that RECs must be assigned to the building owner for at least 15 years. This is clear for off-site renewable energy, but is also a requirement for on-site systems. With some on-site systems installed through solar leases or power purchase agreements, the seller keeps the RECs. In this case, the system would not qualify.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-246-21

CEPI-247-21

IECC®: CC103.3.1

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Revise as follows:
CC103.3.1 Qualifying off-site procurement methods.

The following are considered qualifying off-site renewable energy procurement methods:

1. Community renewables: an off-site renewable energy system for which the owner has purchased or leased renewable energy capacity along with other subscribers.

2. Renewable energy investment fund: an entity that installs renewable energy capacity on behalf of the owner.

3. Virtual power purchase agreement: a power purchase agreement for off-site renewable energy where the owner agrees to purchase renewable energy output at a fixed price schedule.

4. Direct ownership: an off-site renewable energy system owned by the building project owner.

5. Direct access to wholesale market: an agreement between the owner and a renewable energy developer to purchase renewable energy.

6. Green retail pricing ~~tariffs~~: a program by the retail electricity provider to provide 100-percent renewable energy to the owner.

7. Unbundled Renewable Energy Certificates (RECs): certificates purchased by the owner representing the environmental benefits of renewable energy generation that are sold separately from the electric power.

8. Renewable Energy Investment Fund (REIF). A fund established by the local government or on behalf of the local government to accept payment from building owners to construct or acquire qualifying renewable energy (along with RECs) on their behalf.

Reason Statement:

The *renewable energy investment fund (REIF)* has been added to the list of qualifying off-site procurement methods, to be consistent with the list in Table CC103.3.3.

Green pricing is substituted for *green tariffs*, to be consistent with industry practice.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-247-21

CEPI-248-21

IECC®: SECTION 202 (New), SECTION 202, CC103.3.1, TABLE CC103.3.3

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:

COMMUNITY RENEWABLE ENERGY FACILITY. A facility that produces energy from *renewable energy systems* and is qualified as a community energy facility under applicable jurisdictional statutes and rules.

FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (FPPA). A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

Revise as follows:

OFF-SITE RENEWABLE ENERGY SYSTEM. Renewable energy system ~~not~~ located ~~on the building project~~ outside of the site boundary.

ON-SITE RENEWABLE ENERGY SYSTEM. Renewable energy systems on the ~~building project~~*building site*.

Add new definition as follows:

PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (PPPA). A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

RENEWABLE ENERGY CERTIFICATE (REC). A market-based instrument that represents and conveys the environmental, social, and other non-power attributes of one megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with *renewable energy systems*; also known as an energy attribute and energy attribute certificate (EAC).

Revise as follows:

CC103.3.1 Qualifying off-site procurement methods. The following are considered qualifying off-site renewable energy procurement methods:

1. *Community renewable energy facility.*~~Community renewables: an off-site renewable energy system for which the owner has purchased or leased renewable energy capacity along with other subscribers.~~
2. Renewable energy investment fund: an entity that installs renewable energy capacity on behalf of the owner.
3. *Financial renewable energy power purchase agreement.*~~Virtual power purchase agreement: a power purchase agreement for off-site renewable energy where the owner agrees to purchase renewable energy output at a fixed price schedule.~~
4. Direct ownership: an off-site renewable energy system owned by the building project owner.
5. Direct access to wholesale market: an agreement by~~between~~ the owner ~~and a renewable energy developer~~ to purchase renewable energy from the wholesale market.
6. Green retail tariffs: a program by the retail electricity provider to provide 100-percent renewable energy to the owner.
7. Unbundled *Renewable Energy Certificates (RECS).*~~Renewable Energy Certificates (RECs): certificates purchased by the owner representing the environmental benefits of renewable energy generation that are sold separately from the electric power.~~
8. *Physical renewable energy power purchase agreement.*

TABLE CC103.3.3 DEFAULT OFF-SITE RENEWABLE ENERGY PROCUREMENT METHODS, CLASSES AND COEFFICIENTS

CLASS	PROCUREMENT FACTOR (PF)	PROCUREMENT OPTIONS	ADDITIONAL REQUIREMENTS (see also Section CC103.3.2)
1	0.75	~~Community solar~~ *Community renewable energy facility*	—
		REIFs	Entity must be managed to prevent fraud or misuse of funds.
		~~Virtual PPA~~ *Financial PPA* or *Physical PPA*	—
		Self-owned off-site	Provisions shall prevent the generation from being sold separately from the building.
2	0.55	Green retail tariffs	The offering shall not include the purchase of unbundled RECs.
		Direct access	The offering shall not include the purchase of unbundled RECs.
3	0.20	Unbundled RECs	The vintage of the RECs shall align with building energy use.

Reason: This proposal clarifies renewable energy terminology and requirements by removing the definition of terms out of the body of the appendix in CC103.3.1 and moving those terms and their definitions to Section CC102. The proposed definitions clarifies and aligns off-site renewable energy requirements with other codes by aligning community renewable energy facility, financial renewable power purchase agreement, off-site and on-site renewable energy systems, physical power purchase agreement and renewable energy credits with language under consideration both in ASHRAE Standard 228P, The Standard Method of Evaluating Zero Energy Building Performance, and in ASHRAE Standard 189.1, which will be the basis of the 2024 IgCC. The proposed definition for renewable energy investment fund is unchanged from the original definition in the Appendix.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal simply clarifies requirements and thus will result in no additional cost for compliance with the standard.

CEPI-249-21

IECC®: CC103.3.2

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Revise as follows:

CC103.3.2 Requirements for all procurement methods.

The following requirements shall apply to all off-site renewable energy procurement methods:

1. Documentation of off-site renewable energy procurement shall be submitted to the code official. ~~The building owner shall sign a legally binding contract to procure qualifying *off-site renewable energy*.~~
2. The ~~procurement~~ purchase contract shall have duration of not less than 15 years and shall be structured to survive a partial or full transfer of ownership of the property.
3. RECs and other environmental attributes associated with the procured *off-site renewable energy* shall be assigned to the initial and subsequent building owners for a period of not less than 15 years. The building owner(s) may transfer RECs to building tenants while they are occupying the building. ~~project for the duration of the contract.~~
4. The *renewable energy* generating source shall include one or more of the following: photovoltaic systems, solar thermal power plants, geothermal power plants and wind turbines.

   Exceptions:

   1. Captured methane from feed-lots and landfills is permitted to be used to generate electricity for the purposes of this section when it meets the requirements of the Green-e Renewable Fuels standard, Version 1.0, September 16, 2021.
   2. Hydropower from new generation capacity on a non-impoundment or new generation capacity on an existing impoundment that meets one or more of the following conditions:
      - 2.1. The the hydropower facility complies with the Low Impact Hydropower Certification Handbook and is certified by a nationally recognized accreditation organization.
      - 2.2. The hydropower facility complies with UL 2854 and is certified by an organization that has the standard in its ISO 17065 scope of accreditation.
      - 2.3. The hydropower facility consists of a turbine in a pipeline or a turbine in an irrigation canal.
5. The generation source shall be located where the energy can be delivered to the *building site* by any of the following: ~~the same utility or distribution entity, the same independent system operator (ISO) or regional transmission organization (RTO), or within integrated ISOs (electric coordination council).~~
   - 5.1. By direct connection to the off-site renewable energy facility
   - 5.2. By the local utility or distribution entity
   - 5.3. By an interconnected electrical network where energy delivery capacity between the generator and the building site is available
6. The *off-site renewable energy* producer shall maintain transparent accounting that clearly assigns production to the building. Records on power sent to or purchased by the building shall be retained by the building owner and made available for inspection by the code official upon request.

Reason Statement:

Section 103.3.2.1: Editorial adjustment.

Section 103.3.2.2: Editorial adjustment.

Section 103.3.2.3: Language is consistent with ASHRAE Standard 189.1-2020 and the IgCC.

Section 103.3.2.4: Language modified to be consistent with ASHRAE Standard 189.1-2020 and the International Green Construction Code.

Section 103.3.2.5: Language modified to be consistent with ASHRAE Standard 189.1-2020 and the International Green Construction Code.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-249-21

CEPI-250-21

IECC®: CC103.3.3

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Revise as follows:

CC103.3.3 Adjusted off-site renewable energy.

The process for calculating the adjusted *off-site renewable energy* is shown in Equation 2.

$$RE_{offsite} = \sum_{i=1}^{n} PF_i \times RE_i = PF_1 \times RE_1 + PF_2 \times RE_2 + \ldots + PF_n \times RE_n$$

(Equation CC-2)

where:

$RE_{offsite}$ = Adjusted off-site renewable energy.

PF_i = Procurement factor for the i^{th} renewable energy procurement method or class taken from Table CC103.3.3.

RE_i = Annual energy purchase ~~production~~ for the i^{th} renewable energy procurement method or class.

n = The number of renewable energy procurement options or classes considered.

Reason Statement:

Editorial adjustment.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-250-21

CEPI-251-21

IECC®: TABLE CC103.3.3

Proponents: Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE CC103.3.3 DEFAULT OFF-SITE RENEWABLE ENERGY PROCUREMENT METHODS, CLASSES AND COEFFICIENTS

~~CLASS~~	PROCUREMENT FACTOR (PF)	PROCUREMENT OPTIONS	ADDITIONAL REQUIREMENTS (see also Section CC103.3.
~~1~~	0.75	Community Solar (no on-site renewable energy)	
	1.00	Community Solar (with on-site renewable energy installed to be at least 25% of the renewable energy requirement)	
	0.75	REIFs	Entity must be managed to prevent fraud or misuse of funds.
	0.75	Virtual PPA	
~~2~~	0.55	Green Pricing ~~Retail Tariffs~~ (with no on-site renewable energy)	The offering shall not include the purchase of unbundled RECs.
	1.00	Green Pricing (with on-site renewable energy installed to be at least 45% of the renewable energy requirement)	The offering shall not include the purchase of unbundled RECs.
	0.55	Direct Access	The offering shall not include the purchase of unbundled RECs.
~~3~~	0.20	Unbundled RECs	The vintage of the RECs shall align with the building energy use.

Reason: Two exceptions are added to the table to enable compliance through a combination of on-site renewable energy and participation in green pricing or community renewable programs. With these programs it is not possible to purchase more renewable energy than is consumed.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-252-21

IECC®: TABLE CC103.3.3

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE CC103.3.3 ~~DEFAULT~~ OFF-SITE RENEWABLE ENERGY PROCUREMENT OPTIONS, ~~METHODS,~~ CLASSES AND FACTORS ~~COEFFICIENTS~~

CLASS	PROCUREMENT FACTOR (PF)	PROCUREMENT OPTIONS	ADDITIONAL REQUIREMENTS (see also Section CC103.3.2)
1	0.75	Community solar	—
	0.75	~~REIFs~~ Third party providers	~~Entity must be managed to prevent fraud or misuse of funds.~~ ---
	0.75	Virtual PPA	—
	0.95	Self-owned off-site	~~Provisions shall prevent the generation from being sold separately from the building.~~
2	~~0.55~~ 0.70	Green retail tariffs	The offering shall not include the purchase of unbundled RECs.
		Direct access	The offering shall not include the purchase of unbundled RECs.
3	0.20	Unbundled RECs	The vintage of the RECs shall align with building energy use.

Reason: This proposal provides clarification along with editorial and substantive updates to this table. It replaces the term REIF with "Third party provider" to be consistent with another proposal.
The current table also has vague and unenforceable language. For REIFs, the table says "Entity must be managed to prevent fraud or misuse of funds". How is a code official supposed to enforce that, especially if the REIF is a national or global entity? Also, when is a code official supposed to enforce this provision? Before the building is occupied? Every year of the procurement contract? In addition, what action should a code official take if they determine that there is mismanagement? Shut the renewable energy system down? In this proposal, this unenforceable language is deleted.

It also says for a self-owned off-site system, "Provisions shall prevent the generation from being sold separately from the building". There are times when the system is producing maximum energy and the building is using a minimal amount of energy (e.g., a sunny mild weekend day). Why shouldn't the system be allowed to sell the excess power to the grid, or to another end-user? If the building project does not have on-site energy storage, the current language could mean that renewable energy will be curtailed or not used. Again, there could be an enforcement issue (should a code official shut down a system if it is found to sell excess renewable energy to the grid or another customer)? In this proposal, this language is also deleted.

In addition, the procurement factors are updated for the following reasons: technically, there is very little difference between a PPA and a green retail tariff or direct access. In all of these options, power is being sold via the grid to the building project owner.

The self-owned off-site option should receive the highest or one of the highest procurement factors. In this case, the building project owner is purchasing the renewable energy production system, installing the renewable energy production systems, operating the system, and maintaining the system. In this case, they are spending the most capital, time, and labor to produce and use renewable energy (compared to the other procurement options).

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed updates to the table will not have any impact on the cost of construction.

CEPI-252-21

IECC®: TABLE CC103.3.3

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE CC103.3.3 ~~DEFAULT~~ OFF-SITE RENEWABLE ENERGY PROCUREMENT OPTIONS, ~~METHODS,~~ CLASSES AND FACTORS ~~COEFFICIENTS~~

CLASS	PROCUREMENT FACTOR (PF)	PROCUREMENT OPTIONS	ADDITIONAL REQUIREMENTS (see also Section CC103.3.2)
1	0.75	Community solar	—
	0.75	~~REIFs~~ Third party providers	~~Entity must be managed to prevent fraud or misuse of funds.~~ ---
	0.75	Virtual PPA	—
	0.95	Self-owned off-site	~~Provisions shall prevent the generation from being sold separately from the building.~~
2	~~0.55~~ 0.70	Green retail tariffs	The offering shall not include the purchase of unbundled RECs.
		Direct access	The offering shall not include the purchase of unbundled RECs.
3	0.20	Unbundled RECs	The vintage of the RECs shall align with building energy use.

Reason: This proposal provides clarification along with editorial and substantive updates to this table. It replaces the term REIF with "Third party provider" to be consistent with another proposal.
The current table also has vague and unenforceable language. For REIFs, the table says "Entity must be managed to prevent fraud or misuse of funds". How is a code official supposed to enforce that, especially if the REIF is a national or global entity? Also, when is a code official supposed to enforce this provision? Before the building is occupied? Every year of the procurement contract? In addition, what action should a code official take if they determine that there is mismanagement? Shut the renewable energy system down? In this proposal, this unenforceable language is deleted.

It also says for a self-owned off-site system, "Provisions shall prevent the generation from being sold separately from the building". There are times when the system is producing maximum energy and the building is using a minimal amount of energy (e.g., a sunny mild weekend day). Why shouldn't the system be allowed to sell the excess power to the grid, or to another end-user? If the building project does not have on-site energy storage, the current language could mean that renewable energy will be curtailed or not used. Again, there could be an enforcement issue (should a code official shut down a system if it is found to sell excess renewable energy to the grid or another customer)? In this proposal, this language is also deleted.

In addition, the procurement factors are updated for the following reasons: technically, there is very little difference between a PPA and a green retail tariff or direct access. In all of these options, power is being sold via the grid to the building project owner.

The self-owned off-site option should receive the highest or one of the highest procurement factors. In this case, the building project owner is purchasing the renewable energy production system, installing the renewable energy production systems, operating the system, and maintaining the system. In this case, they are spending the most capital, time, and labor to produce and use renewable energy (compared to the other procurement options).

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed updates to the table will not have any impact on the cost of construction.

CEPI-253-21

IECC®: CC103.3.4 (New)

Proponents:

Vincent Martinez, representing 2030, Inc. / Architecture 2030 (martinez@architecture2030.org); David Collins, representing The American Institute of Architects (dcollins@preview-group.com); Charles Eley, representing Architecture 2030 (charles@eley.com)

2021 International Energy Conservation Code

Add new text as follows:

CC103.3.4 Future Adjustments to Off-Site Procurement.
Where the off-site renewable energy producer ceases operation, the building owner shall procure alternative qualifying renewable energy. The duration of renegotiated contract(s) shall continue until a date at least 15 years after the initial certificate of occupancy was issued.

Reason Statement:

This provision is added since some of the off-site renewable energy procurement methods may be discontinued by the provider before the 15-year commitment is over.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change proposal is not expected to either increase or decrease the cost of construction.

CEPI-253-21

CEPI-254-21

IECC®: TABLE C405.3.2(1), TABLE C405.3.2(2), TABLE C405.5.2(2), TABLE C405.5.2(3)

Proponents:

Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD

BUILDING AREA TYPE	LPD (w/ft2)
Automotive facility	0.75
Convention center	0.64
Courthouse	0.79
Dining: bar lounge/leisure	0.80
Dining: cafeteria/fast food	0.76
Dining: family	0.71
Dormitory[a, b]	0.53
Exercise center	0.72
Fire station[a]	0.56
Gymnasium	0.76
Health care clinic	0.81
Hospital[a]	0.96
Hotel/Motel[a, b]	0.56
Library	0.83
Manufacturing facility	0.82
Motion picture theater	0.44
Multiple-family[c]	0.45
Museum	0.55
Office	0.64
Parking garage	0.18
Penitentiary	0.69
Performing arts theater	0.84
Police station	0.66
Post office	0.65

Religious building	0.67
Retail	0.84
School/university	0.72
Sports arena	0.76
Town hall	0.69
Transportation	0.50
Warehouse	0.45
Workshop	0.91

For SI: 1 watt per square foot = 10.76 ~~w/m²~~ watts per square meter.

- a.

  Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

- b.

  Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

- c.

  Dwelling units are excluded. Neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPESa	LPD (watts/ft²)
Atrium	
Less than 40 feet in height	0.48
Greater than 40 feet in height	0.60
Audience seating area	
In an auditorium	0.61
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	0.67
In a performing arts theater	1.16
In a religious building	0.72
In a sports arena	0.33
Otherwise	0.33
Banking activity area	0.61

Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	0.89
Otherwise	0.71
Computer room, data center	0.94
Conference/meeting/multipurpose room	0.97
Copy/print room	0.31
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	0.71
Otherwise	0.41
Courtroom	1.20
Dining area	
In bar/lounge or leisure dining	0.86
In cafeteria or fast food dining	0.40
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.27
In family dining	0.60
In a penitentiary	0.42
Otherwise	0.43
Electrical/mechanical room	0.43
Emergency vehicle garage	0.52
Food preparation area	1.09
Guestroom[c, d]	0.41
Laboratory	
In or as a classroom	1.11
Otherwise	1.33
Laundry/washing area	0.53
Loading dock, interior	0.88
Lobby	
For an elevator	0.65
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.69
In a hotel	0.51
In a motion picture theater	0.23
In a performing arts theater	1.25
Otherwise	0.84

Locker room	0.52
Lounge/breakroom	
In a healthcare facility	0.42
Otherwise	0.59
Office	
Enclosed	0.74
Open plan	0.61
Parking area, interior	0.15
Pharmacy area	1.66
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	1.26
Otherwise	0.63
Sales area	1.05
Seating area, general	0.23
Stairwell	0.49
Storage room	0.38
Vehicular maintenance area	0.60
Workshop	1.26
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft^2)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	0.61
Dormitory—living quarters[c, d]	0.50
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	0.70
In a recreation room (and not used primarily by the staff)	1.77
Fire Station—sleeping quarters[c]	0.23
Gymnasium/fitness center	
In an exercise area	0.90
In a playing area	0.85
Healthcare facility	
In an exam/treatment room	1.40
In an imaging room	0.94
In a medical supply room	0.62
In a nursery	0.92
In a nurse's station	1.17
In an operating room	2.26

In a patient room[c]	0.68
In a physical therapy room	0.91
In a recovery room	1.25
Library	
In a reading area	0.96
In the stacks	1.18
Manufacturing facility	
In a detailed manufacturing area	0.80
In an equipment room	0.76
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	1.42
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
Museum	
In a general exhibition area	0.31
In a restoration room	1.10
Performing arts theater—dressing room	0.41
Post office—sorting area	0.76
Religious buildings	
In a fellowship hall	0.54
In a worship/pulpit/choir area	0.85
Retail facilities	
In a dressing/fitting room	0.51
In a mall concourse	0.82
Sports arena—playing area	
For a Class I facility[e]	2.94
For a Class II facility[f]	2.01
For a Class III facility[g]	1.30
For a Class IV facility[h]	0.86
Transportation facility	
At a terminal ticket counter	0.51
In a baggage/carousel area	0.39
In an airport concourse	0.25
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 ~~w/m²~~watts per square meter.

- a.

  In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

- b.

  A ‘Facility for the Visually Impaired’ is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

- c.

  Where sleeping units are excluded from lighting power calculations by application of Section R404.1, neither the area of the sleeping units nor the wattage of lighting in the sleeping units is counted.

- d.

  Where dwelling units are excluded from lighting power calculations by application of Section R404.1, neither the area of the dwelling units nor the wattage of lighting in the dwelling units is counted.

- e.

  Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

- f.

  Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

- g.

  Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

- h.

  Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

TABLE C405.5.2(2) LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

	LIGHTING ZONES			
	Zone 1	Zone 2	Zone 3	Zone 4
Base Site Allowance	350 W	400 W	500 W	900 W
Uncovered Parking Areas				
Parking areas and drives	0.03 W/ft^2	0.04 W/ft^2	0.06 W/ft^2	0.08 W/ft^2
Building Grounds				
Walkways and ramps less than 10	0.50 W/linear	0.50 W/linear	0.60 W/linear	0.70 W/linear

feet wide	foot	foot	foot	foot
Walkways and ramps 10 feet wide or greater, plaza areas, special feature areas	0.10 W/ft²	0.10 W/ft²	0.11 W/ft²	0.14 W/ft²
Dining areas	0.65 W/ft²	0.65 W/ft²	0.75 W/ft²	0.95 W/ft²
Stairways	0.60 W/ft²	0.70 W/ft²	0.70 W/ft²	0.70 W/ft²
Pedestrian tunnels	0.12 W/ft²	0.12 W/ft²	0.14 W/ft²	0.21 W/ft²
Landscaping	0.03 W/ft²	0.04 W/ft²	0.04 W/ft²	0.04 W/ft²
Building Entrances and Exits				
Pedestrian and vehicular entrances and exits	14 W/linear foot of opening	14 W/linear foot of opening	21 W/linear foot of opening	21 W/linear foot of opening
Entry canopies	0.20 W/ft²	0.25 W/ft²	0.40 W/ft²	0.40 W/ft²
Loading docks	0.35 W/ft²	0.35 W/ft²	0.35 W/ft²	0.35 W/ft²
Sales Canopies				
Free-standing and attached	0.40 W/ft²	0.40 W/ft²	0.60 W/ft²	0.70 W/ft²
Outdoor Sales				
Open areas (including vehicle sales lots)	0.20 W/ft²	0.20 W/ft²	0.35 W/ft²	0.50 W/ft²
Street frontage for vehicle sales lots in addition to "open area" allowance	No allowance	7 W/linear foot	7 W/linear foot	21 W/linear foot

For SI: 1 foot = 304.8 mm, 1 watt per square foot = ~~W/0.0929 m²~~ 10.76 watts per square meter.

W = watts.

TABLE C405.5.2(3) INDIVIDUAL LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

LIGHTING ZONES				
	Zone 1	Zone 2	Zone 3	Zone 4
Building facades	No allowance	0.075 W/ft² of gross above-grade wall area	0.113 W/ft² of gross above-grade wall area	0.15 W/ft² of gross above-grade wall area
Automated teller machines (ATM) and night depositories	135 W per location plus 45 W per additional ATM per location			
Uncovered entrances and gatehouse inspection stations at guarded facilities	0.50 W/ft² of area			
Uncovered loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.35 W/ft² of area			
Drive-up windows and doors	200 W per drive through			
Parking near 24-hour retail entrances.	400 W per main entry			

For SI: For SI: 1 watt per square foot = ~~W/0.0929 m²~~ 10.76 watts per square meter.

W = watts.

Reason:

Correct SI conversion errors and present footnote information consistently for all LPA tables.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Editorial corrections only.

CEPI-255-21 Part I

IECC®: APPENDIX X (New), X101.1 (New), X101.2 (New), X101.3 (New), X101.3.1 (New), X101.3.2 (New), X101.3.3 (New), X101.4 (New), X101.5 (New), ICC Chapter 06 (New)

Proponents:

Hope Medina, representing Myself (hmedina@coloradocode.net)

THIS IS A 2 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Add new text as follows:

APPENDIX X

ABOVE BASE ENERGY CODE PROVISIONS

X101.1 Scope.

The provisions of this appendix shall apply to new construction.

Exception: Projects that comply with the International Green Construction Code or the National Green Building Standard shall be deemed to comply with the provisions of this appendix.

X101.2 Air barriers.

Where not required by section C402.5.1, a continuous air barrier shall be provided throughout the building thermal envelope. The continuous air barriers shall be located on the inside or outside of the building thermal envelope, located within the assemblies composing the building thermal envelope, or any combination thereof. The air barrier shall comply with Sections C402.5.1.1, and C402.5.1.2.

1. Buildings or portions of buildings, including Group R and I occupancies, shall meet the provisions of Section C402.5.2.
2. Buildings or portions of buildings other than Group R and I occupancies shall meet the provisions of Section C402.5.3.

X101.3 Heating outside uses.

Mechanical systems providing a heat source outside of the thermal envelope of a building shall comply with Sections X101.3.1 through X101.3.3

X101.3.1 Snow and ice melt systems..

Snow and ice melt systems shall install a minimum R-10 insulation located below the tubing and or piping utilized in the heating system for snow and ice melt systems.

Exception: snow and ice melt systems located on roof when the location of the thermal envelope is not located at the roof, but at the ceiling.

X101.3.2 Swimming pools and spas.

Permanent swimming pools and spas shall have insulation on the sides and bottom surfaces located on the exterior. The type of insulation shall be impermeable and impervious to water logging or saturation and unaffected by water, mold, mildew, and have capability to resist compression. The insulation value shall be a minimum of R-15.

X101.3.3 Automatic Covers.

Permanent swimming pools and spas shall have insulation on the sides and bottom surfaces located on the exterior. The type of insulation shall be impermeable and impervious to water logging or saturation and unaffected by water, mold, mildew, and have capability to resist compression. The insulation value shall be a minimum of R-15.

X101.4 Appliances.

The following appliances shall meet ENERGY STAR performance or equivalent.

1. Water coolers
2. Commercial Fryer
3. Commercial hot food holding cabinets
4. Commercial dishwashers
5. Commercial steam cookers
6. Commercial Griddles
7. Commercial ovens
8. Commercial refrigerator and/or freezers
9. Dwelling/sleeping unit(s) Refrigerator
10. Dwelling/sleeping unit(s) Dishwasher
11. Dwelling/sleeping unit(s) Washing machine

X101.5 Additional efficiency package options..

Projects complying with this appendix shall be required to achieve an addition 5 credits for a total of 15 points from Tables C406.1(1) through C406.1(5).

Add new standard(s) as follows:

ICC International Code Council, Inc. 500 New Jersey Avenue NW 6th Floor Washington DC 20001

IgCC - 2024 International Green Construction Code

ICC International Code Council, Inc. 500 New Jersey Avenue NW 6th Floor Washington DC 20001

700-2020 National Green Building Standard

Reason Statement:

Currently we are really all over the board as far as to the degree of compliance or even direction the jurisdictions are looking for when it comes to the IECC. We really are at a great precipice for a one size fits all energy code. I think if we continue on the current path of the IECC concept we are going to lose jurisdictions for various reasons including the current body of the code is not efficient enough or it moves to too much efficiency for what a jurisdiction is capable of doing. By utilizing the approach of a “dedicated appendix” to introduce more advanced concepts you allow the “minimum” code provisions to address many entities starting off with energy compliance or do not have support from elected officials and their community for more advance energy to still be able to use the IECC. You leave the body of the IECC alone to progress naturally without introducing advanced concepts, and work through the appendices to move the IECC along some of those more advanced or intense energy efficiency provisions.

The Above Base Energy Code appendix allows for a jurisdiction to go beyond the base of the energy code without requiring that the thermal envelope values are increased. This appendix expands on the heating outside requirements found in the base of the code. Requiring insulation under the snow and ice melts directs the heat to move in the direction that is intended. We do not need to heat the ground below these systems it’s the surface above the tubing or piping that is intended to be heated. Swimming pools and spas are a massive energy loss through the giant heat sink of the earth. I believe it is time we address this concern. If a pool or spa is to be installed there are measures to assist with mitigating these issues. One is to insulate the pool/spa structure with appropriate insulation type, and to also require an automatic cover to be installed. The reality is if the cover is easy to do it will more likely be utilized helping to not only keep the heat where it is intended to be utilizing less energy, but also has a bonus of keeping water from evaporating as quickly.

Appliances are an area that the IECC currently does not have provisions for but are an area to create a conscience for energy efficiency.

Requiring for an additional energy efficiency package to be included increases the energy efficiency by using provisions already within the code that have been vetted previously.

Some of these requirements are good practices, or reside in the IECC as options or exceptions, or are provisions found in the IgCC, or found in the NGBS. They are provisions that are already being utilized, and this placed them in one location for jurisdictions wanting to go a beyond what is in the base of the code.

Cost Impact:

The code change proposal will increase the cost of construction.

These practices will increase the cost of construction, but will provide a return on investment as these best practices rethink how to build.

CEPI-255-21 Part I

CEPI-255-21 Part II

IECC®: APPENDIX X (New), X101.1 (New), X101.2 (New), X101.2.1 (New), X101.2.2 (New), X101.2.3 (New), X101.3 (New), X101.4 (New), ICC Chapter 06 (New)

Proponents:

Hope Medina, representing Myself (hmedina@coloradocode.net)

2021 International Energy Conservation Code

Add new text as follows:

APPENDIX X

ABOVE BASE ENERGY CODE PROVISIONS

X101.1 Scope.

The provisions of this appendix shall apply to new construction.

Exception: Projects that comply with the National Green Building Standard or International Green Construction Code shall be deem to comply with the provisions of this appendix.
X101.2 Heating outside uses..

Mechanical systems providing a heat source outside of the thermal envelope of a building shall comply with Sections X101.2.1 through X101.2.3

X101.2.1 Snow and ice melt systems.

Snow and ice melt systems shall install a minimum R-10 insulation located below the tubing and or piping utilized in the heating system for snow and ice melt systems.

Exception: Snow and ice melt systems located on roof when the location of the thermal envelope is not located at the roof, but at the ceiling.
X101.2.2 Swimming pools and spas..

All permanent swimming pools and spas shall have insulation on the sides and bottom surfaces located on the exterior. The type of insulation shall be impermeable and impervious to water logging or saturation and unaffected by water, mold, mildew, and have capability to resist compression. The insulation value shall be a minimum of R-15.

X101.2.3 Automatic Covers.

Swimming pools and spas located inground shall have an automatic motorized non-permeable pool cover that covers the entire pool or spa surface.

Exception: Above grade spas
X101.3 Appliances.

The following appliances shall meet ENERGY STAR performance or equivalent.

1. Refrigerator
2. Dishwasher
3. Washing machine
4. Ventilation fans

X101.4 Additional Efficiency Package options..

Projects complying with this appendix shall utilize two additional energy efficiency options located in Sections R408.2.1 through

R408.2.5

Add new standard(s) as follows:

ICC International Code Council, Inc. 500 New Jersey Avenue NW6th Floor Washington DC 20001

700-2020 National Green Building Standard

ICC International Code Council, Inc. 500 New Jersey Avenue NW 6th Floor Washington DC 20001

IgCC - 2024 International Green Construction Code

Reason Statement:

Currently we are really all over the board as far as to the degree of compliance or even direction the jurisdictions are looking for when it comes to the IECC. We really are at a great precipice for a one size fits all energy code. I think if we continue on the current path of the IECC concept we are going to lose jurisdictions for various reasons including the current body of the code is not efficient enough or it moves to too much efficiency for what a jurisdiction is capable of doing. By utilizing the approach of a “dedicated appendix” to introduce more advanced concepts you allow the “minimum” code provisions to address many entities starting off with energy compliance or do not have support from elected officials and their community for more advance energy to still be able to use the IECC. You leave the body of the IECC alone to progress naturally without introducing advanced concepts, and work through the appendices to move the IECC along some of those more advanced or intense energy efficiency provisions.

The Above Base Energy Code appendix allows for a jurisdiction to go beyond the base of the energy code without requiring that the thermal envelope values are increased. This appendix expands on the heating outside requirements found in the base of the code. Requiring insulation under the snow and ice melts directs the heat to move in the direction that is intended. We do not need to heat the ground below these systems it’s the surface above the tubing or piping that is intended to be heated. Swimming pools and spas are a massive energy loss through the giant heat sink of the earth. I believe it is time we address this concern. If a pool or spa is to be installed there are measures to assist with mitigating these issues. One is to insulate the pool/spa structure with appropriate insulation type, and to also require an automatic cover to be installed. The reality is if the cover is easy to do it will more likely be utilized helping to not only keep the heat where it is intended to be, but also has a bonus of keeping water from evaporating as quickly.

Appliances are an area that the IECC currently does not have provisions for but are an area to create a conscience for energy efficiency.

Requiring for an additional energy efficiency package to be included increases the energy efficiency by using provisions already within the code that have been vetted previously.

Some of these requirements are good practices, or reside in the IECC as options or exceptions, or are provisions found in the IgCC, or found in the NGBS. They are provisions that are already being utilized, and this placed them in one location for jurisdictions wanting to go a beyond what is in the base of the code.

Cost Impact:

The code change proposal will increase the cost of construction.

Many of these practices while outside of what is currently done will increase the cost of construction, but will also increase the energy efficiency of these new concepts.

CEPI-255-21 Part II

CEPI-256-21

IECC®: APPENDIX X (New), X101.1 (New), X101.2 (New), X101.3 (New), X101.3.1 (New), X101.4 (New)

Proponents:

Hope Medina, representing Myself (hmedina@coloradocode.net)

2021 International Energy Conservation Code

Add new text as follows:

APPENDIX X

CONSTRUCTION AND SITE WASTE DECARBONIZATION

X101.1 General.

The provisions of this appendix are to improve efforts for decarbonization.

X101.2 Scope.

The provisions of this appendix shall apply to new construction and construction performed on existing buildings.

X101.3 Building site waste management Plan.

A building site waste management plan shall be developed and implemented for excavated soil, rock, and land-clearing debris. Land-clearing debris is limited to stumps and vegetation. Diverted land-clearing debris and removed rock and soil shall not be sent to sites where development activity is prohibited or to greenfield sites other than those being used for agricultural purposes or being developed as part of a building project.

Not less than 90% of the land-clearing debris, excluding invasive plant materials, shall be diverted from disposal in landfills and incinerators other than waste-to-energy systems with an energy-recovery efficiency rate higher than 60%. Land-clearing debris calculations shall be based on either weight or volume but not both. Receipts or other documentation related to diversion shall be maintained through the course of construction, and provide to the code official for certificate of occupancy.

The plan shall address all of the following:

1. Land-clearing debris, rock, and soil to be diverted from disposal by composting, recycling, or reuse.
2. Waste materials that will be diverted on-site.
3. The locations to which waste materials will be diverted off-site.
4. Soils to be stockpiled for future use at any location.
5. Woody waste to be used as fuel.
6. The destruction and disposal of invasive plant materials.
7. The methods of removal of any contaminated soils.
8. The treatment of vegetation to comply with the rules of government-designated quarantine zones for invasive insect species.

X101.3.1 Construction and demolition waste management plan.

Prior to the start of any construction, demolition, or deconstruction, a construction and demolition waste management plan shall be prepared and made available to the owner and AHJ. The plan shall do the following:

1. Identify the construction and demolition waste materials expected to be diverted.
2. Identify materials or building elements to be deconstructed.
3. Indicate whether construction and demolition waste materials are to be source-separated or comingled.
4. Identify service providers and designate destination facilities for construction and demolition waste materials generated at the job site.

Identify the average diversion rate for facilities that accept or process comingled construction and demolition materials. Separate

5. average percentages shall be included for those materials collected by construction and demolition materials processing facilities that end up as alternative daily cover and incineration.
6. Specify a method for tracking.
7. Specify a reporting mechanism for disposition of waste using items (1) through (6).

X101.4 Diversion.

A minimum of 50% of nonhazardous construction, demolition, or deconstruction waste material shall be diverted from disposal in landfills and incinerators through reuse, recycling, repurposing, and/or composting. Excavated soil and land-clearing debris shall not be included in the calculation. Alternative daily cover and waste-to-energy incineration shall not be included as diverted material. All diversion calculations shall be based on weight throughout the construction process.

Reason Statement:

Currently we are really all over the board as far as to the degree of compliance or even direction the jurisdictions are looking for when it comes to the IECC. We really are at a great precipice for a one size fits all energy code. I think if we continue on the current path of the IECC concept we are going to lose jurisdictions for various reasons including the current body of the code is not efficient enough or it moves to too much efficiency for what a jurisdiction is capable of doing. By utilizing the approach of a “dedicated appendix” to introduce more advanced concepts you allow the “minimum” code provisions to address many entities starting off with energy compliance or do not have support from elected officials and their community for more advance energy to still be able to use the IECC. You leave the body of the IECC alone to progress naturally without introducing advanced concepts, and work through the appendices to move the IECC along some of those more advanced or intense energy efficiency provisions.

Many cities are looking at ways to achieve their goals including reducing green house gases and decarbonization. People are looking at the design of the building, mechanical equipment sizing and efficiency, electrification, and one of the areas that is overlooked is site and construction waste. Construction practices in the United States is often wasteful. The amount of waste found in the construction dumpsters as one visits a development is astounding. Diverting materials through various means is a practice often found in other locations of the world, and it is something we need to consider as our landfills fill up and our options start to dwindle.

Some of these requirements are good practices, and are provisions found in the IgCC, or found in the NGBS. They are provisions that are already being utilized, and this places them in one location for jurisdictions wanting to work towards their carbon reduction goals.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The cost of disposing the waste into the landfill will be shifted to being recycled.

CEPI-256-21

CEPI-257-21

IECC®: APPENDIX X (New), X.1 (New), X.2 (New), X.3 (New), X3.1 (New), X.4 (New), X.4.1 (New)

Proponents:

Duane Jonlin, representing City of Seattle (duane.jonlin@seattle.gov)

2021 International Energy Conservation Code

Add new text as follows:

APPENDIX X THE GLIDE PATH

X.1 Prescriptive compliance.

Where compliance is demonstrated using the Prescriptive Compliance option, the number of additional efficiency credits required by Section C406.1 shall be XX, rather than 10. [NOTE: This number of credits to be finalized when the energy use reduction of the 2024 IECC base code can be estimated, so that it results in a net 10% energy cost reduction compared with the 2021 IECC.]

X.2 Total Building Performance compliance.
Where compliance is demonstrated using the Total Building Performance option, Item 2 in Section C407.2 shall require the *proposed design* energy cost to be XX percent rather than 80 percent of the *standard reference design* energy cost. [NOTE: This percentage to be finalized when the energy use reduction of the 2024 IECC base code can be estimated, so that it results in roughly a net 10% energy cost reduction compared with the 2021 IECC.]
X.3 Renewable energy.

In addition to any renewable energy required or provided to comply with other sections of this code, 2.4 watts of on-site renewable energy per square foot of conditioned space, and 0.8 watts of on-site renewable energy per square foot of semi-heated or unconditioned space, shall be provided.

X3.1 Site-recovered energy.

Waste energy recovered on site is permitted to substitute for all or part of the renewable energy required by Section X.3. Waste energy consists of thermal energy that would otherwise be lost to the ground, atmosphere, or sewer.

X.4 Off-site renewable energy.

Off-site renewable energy is permitted to be substituted where the off-site renewable energy production is 1.25 times the required amount of on-site renewable energy production and the renewable energy is located in the same US EPA eGRID subregion as the project.

X.4.1 Documentation requirements for off-site renewable energy systems..
Off-site renewable energy delivered or credited to the building project shall be subject to a legally binding contract to procure qualifying off-site renewable energy. Qualifying off-site renewable energy shall meet the following requirements:

1. Documentation of off-site renewable energy procurement shall be submitted to the code official.
2. The purchase contract shall have a duration of not less than 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.
3. Records on renewable power purchased by the building owner from the off-site renewable energy generator that specifically assign the RECs to the building owner shall be retained or retired by the building owner on behalf of the entity demonstrating financial or operational control over the building seeking compliance to this standard and made available for inspection by the code official upon request.
4. Where multiple buildings in a building project are allocated energy procured by a contract subject to this section, the owner shall allocate for not less than 15 years the energy procured by the contract to the buildings in the building project. A plan on operation shall be developed which shall indicate how renewable energy produced from on-site or off-site systems that is not allocated before issuance of the certificate of occupancy will be allocated to new or existing buildings included in the building project.
5. The plan shall include provisions to use a REC tracking system that meets the requirements of Section V.B of the Green-e Framework for Renewable Energy Certification. The plan shall describe how the building owner will procure alternative qualifying renewable energy in the case that the renewable energy producer ceases operation.

Attached Files

- **Glide Path diagram.pdf**
  http://localhost/proposal/541/850/files/download/234/

Reason Statement:

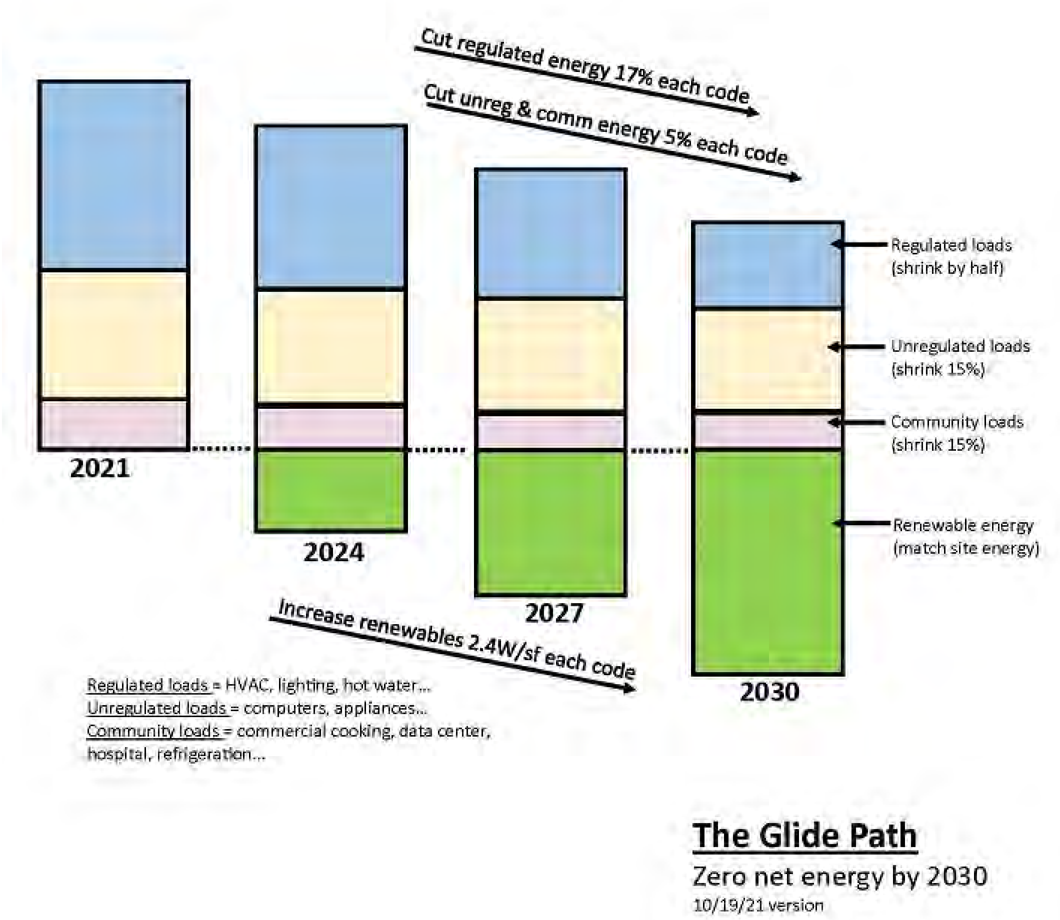
This appendix is intended to be adopted by jurisdictions that will require new construction to operate at net zero energy by the year 2030. It reduces the net annual energy use of buildings by approximately one-third in comparison with buildings constructed in compliance with the 2021 IECC, assuming that the 2027 and 2030 editions will also reduce energy use by one-third each.

It is estimated that *regulated* energy uses in buildings can be cut by 50% from current levels by 2030, but that unregulated loads and large community process loads will only diminish about 15% in the same time period. If regulated loads comprise 60% of building energy use, and unregulated loads (not counting large process loads) comprise the remaining 40%, halving the regulated loads would result in a 30% reduction in energy use, or 10% for each of the three Glide Path steps. Reducing unregulated and process loads by 15% over this decade would result in an additional 9% overall building energy use reduction by 2030, or 3% reduction per code cycle. Some of this 13% reduction (10% regulated and 3% unregulated/process) will occur in the base code development, and the remainder is required by this appendix.

For the 2030 ZNE target, renewable or site-recovered energy will be required to compensate for the remaining half of regulated energy use, plus the typical unregulated building energy use, and an additional amount to cover a proportionate share of community process energy.

Rather than burdening those buildings that contain large process loads (restaurant, grocery, hospital, data center, laboratory, etc.) with a requirement to provide renewable energy to cover their entire operating energy use, this Appendix requires an additional amount of renewable energy for *all* new building square footage in recognition of the fact that those large process loads serve the entire community with essential services. It is estimated that such community process loads equal approximately 20% of all other building energy loads.

If 39% of a building's net energy use reduction can be covered with efficiency and technology improvements, the remaining 61% of the *net* energy use reduction will be accomplished with acquisition of renewable energy resources, also in three roughly equal steps. Assuming typical PV production to be 1.5 kWh/year/watt, this would result in a requirement for 7 W/sf of conditioned floor area for 2030, or roughly 2.4 W/sf for 2024. For semi-heated or unconditioned space, the requirement will be 1/3 of this amount, or 0.8 W/sf for 2024.



Cost Impact:

The code change proposal will increase the cost of construction.

The installed cost of rooftop PV arrays will be something like $2.00 per watt during the active period of this code edition, although additional price decreases may continue to occur. The savings will vary greatly, depending on climate zone and utility rates.

The number of additional efficiency credits required for those pursuing the prescriptive compliance paths will vary depending on how much efficiency progress is made in the base code - the more the base code advances, the lower the cost of compliance.

CEPI-257-21

CEPI-258-21 Part I

IECC®: SECTION 202 (New), C401.4.1 (New), Table C401.4.1 (New), C401.4.1.1 (New), C401.4.2 (New), Table C401.4.2 (New)

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

THIS IS A 3 PART PROPOSAL. PART I WILL BE HEARD BY THE IECC-COMMERCIAL COMMITTEE. PART II AND PART III WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Add new definition as follows:

C202 **ELECTRIC VEHICLE (EV).** An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

C202 **ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE).** The conductors, including the ungrounded, grounded and equipment grounding conductors, and the EV connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of transferring energy between the premises wiring and the EV.

C202 **EV-CAPABLE SPACE.** A dedicated parking space which is provided with electrical panel capacity and space to support a minimum 40-ampere, 208/240-volt branch circuit for each EV parking space, and the installation of raceways, both underground and surface mounted, to support the EVSE.

C202 **EV-READY SPACE.** A designated parking space which is provided with one 40-ampere, 208/240-volt dedicated branch circuit for future dedicated Level 2 *EVSE* servicing EVs. The circuit shall terminate in a suitable termination point such as a receptacle, junction box, or an *EVSE*, and be located in close proximity to the proposed location of the EV parking spaces. The circuit shall have no other outlets. The service panel shall include an over-current protective device and provide sufficient capacity and space to accommodate the circuit and over-current protective device and be located in close proximity to the proposed location of the EV parking spaces.

Add new text as follows:

C401.4.1 Electric Vehicle ready parking.

Where parking is provided, new construction shall provide EVSE installed spaces and facilitate future installation and use of *EVSE* through the provision of *EV-Ready Spaces* and *EV-Capable Spaces* provided in compliance with Sections C401.4.1 through C401.4.3, Where more than one parking facility is provided on a site, *EV-Ready Spaces* and *EV-Capable Spaces* shall be calculated separately for each parking facility.

Table C401.4.1 EVSE Installed, EV-Ready Space and EV-Capable Space Requirements for New Commercial Buildings

Total Number of Parking Spaces	**Minimum number of Spaces with EVSE Installed**[a.]	**Minimum Number of EV-Ready Spaces**	**Minimum Number of EV-Capable Spaces**
1	1	1	-
2 – 10	1	2	-
11 – 15	1	2	1
16 – 19	1	2	2
21 – 25	2	3	2
26+	5% of total parking spaces	10% of total parking spaces	10% of total parking spaces

- a.

  Spaces that terminate with a Level 2 EVSE are considered EV-Ready Spaces and count towards the minimum number of EV-Ready Spaces.

C401.4.1.1 New commercial and multifamily buildings.

EVSE Installed spaces, *EV-Ready Spaces* and *EV-Capable Spaces* shall be provided in accordance with Table C401.4.1 for commercial buildings and Table C401.4.2 for multifamily buildings. Where the calculation of percent served results in a fractional parking space, it shall be shall rounded up to the next whole number. The service panel or subpanel circuit directory shall identify the spaces reserved to support EV charging as "EV-Capable" or "EV-Ready." The raceway location shall be permanently and visibly marked as "EV-Capable."

Exception: Where the number of *EV-Ready Spaces* exceeds the required minimum, the additional *EV Ready Spaces* shall be used for compliance with the minimum *EV-Capable Spaces* requirement.

C401.4.2 Identification.

Construction documents shall indicate the raceway termination point and proposed location of future EV spaces and EV chargers. Construction documents shall also provide information about the amperage of future EVSE, raceway methods, wiring schematics, and electrical load calculations to verify that the electrical panel service capacity and electrical system, including any on-site distribution transformers, have sufficient capacity to simultaneously charge all EVs at all required EV spaces at the full rated amperage of the EVSE.

Table C401.4.2

EVSE Installed, EV-Ready Space and EV-Capable Space Requirements for New Multifamily Buildings

Total Number of Parking Spaces	**Minimum number of Spaces with EVSE Installed[a.]**	**Minimum Number of EV-Ready Spaces**	**Minimum Number of EV-Capable Spaces**
1	1	1	-
2 – 10	1	2	-
11 – 15	1	2	1
16 – 19	1	2	2
21 – 25	2	3	2
26+	5% of total parking spaces	10% of total parking spaces	10% of total parking spaces

- a.

  EV-Ready Spaces and count towards the minimum number of *EV-Ready Spaces*.

  Spaces that terminate with a Level 2 EVSE are considered

Reason:

Numerous studies show that sales of electric vehicles (EVs) have grown consistently over recent years in the U.S. Edison Electric Institute (EEI) estimates one million EVs on the road in 2018 and forecasts a total of 18.7 million EVs on the road by 2030. Based on this forecast, EEI projects the need for an additional 9.6 million EV charging stations by 2030. It is imperative that the EV charging infrastructure keeps pace with sales of EVs to to enhance overall EV growth, and to ensure that lack of access to EV charging stations is minimized as a critical barrier to EV adoption.

EVs provide substantial benefits to the consumer and society. EVs are less expensive to operate than conventional gas vehicles, have lower maintenance costs, and have the convenience of fueling (charging) at home or work. EVs likewise reduce GHG emissions. EV market growth combined with a cleaner grid will support goals of reduced GHG emissions established across the U.S. and others by federal agencies, as well as many states and local governments. According to the U.S. Environmental Protection Agency (EPA), the transportation sector (cars, trucks, trains, ships, airplanes, and other vehicles) accounts for 29% of total U.S. GHG emissions. Globally, road travel accounts for 75% of transportation emissions. Studies conducted in California show that costs associated with installing EV charging infrastructure can be substantially more expensive for retrofit scenarios compared to new construction.

Many states and local governments have added EV provisions to their building codes, local ordinances and zoning requirements. This proposed code language for EV charging infrastructure builds upon language considered for the 2021 IECC, and includes additional requirements developed by both PNNL staff and ICC staff.

Bibliography:

Salcido R, M Tillou, and E Franconi. 2021. Electric Vehicle Charging for Residential and Commercial Energy Codes. PNNL-31576, Rev. 1, Pacific Northwest National Laboratory for U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. www.energycodes.gov/sites/default/files/2021-07/TechBrief_EV_Charging_July2021

Cost Impact:

The code change proposal will increase the cost of construction.

The costs associated with installing EV charging infrastructure during new construction are substantially lower than during a retrofit. A cost-effectiveness study for the City and County of San Francisco conducted by Pacific Gas & Electric (PG&E) showed costs for installing Level 2 EV charging stations as a retrofit are several times more expensive than installing them during new construction.[1] Installing infrastructure during new construction avoids the retrofit costs of breaking and repairing walls, installing longer raceways, and using more expensive methods of upgrading service panels. A study conducted by DOE determined the installed costs of a single port ESVE unit ranges from $0-$3,000 for Level 1, $600-$12,700 for Level 2 and $4,000-$51,000 for DC fast charging. Various elements lead to the high variability of costs due to the type of unit, applications and cost factors to determine if a ESVE unit will be on the low or high end of the range.[2]

Table 1 compares the cost of installing Level 2 EV charging infrastructure during new construction and during a retrofit. Figure 7 shows the cost breakdown of the Level 2 EV charging infrastructure installation.

Table 1 Cost of EV Charging Infrastructure

	Per EV Parking Space with Electric Circuit		Total Incremental Cost of Building	
	New	Retrofit	New	Retrofit
Scenario A – 10 Parking Space Building, two EV Parking Spaces	$920	$3,710	$1,840	$7,420
Scenario B – 60 Parking Space Building, 12 EV Parking Spaces	$860	$2,370	$10,320	$28,440

Source: PG&E 20[illegible]

For one- and two-family dwellings, costs for Level 2 charging stations include the price and labor associated with the installation of one 40-ampere, 208/240-volt dedicated branch circuit and a circuit terminating in a receptacle, junction box, or EVSE. The average cost to install (exclusive of charger cost) a Level 2 EVSE in an existing home was $1,354 across 13 cities in the U.S. based on more than 25,000 installations. The average maximum installation cost across these 13 locations was approximately $4,000. The key factors affecting the cost of installing EVSE in an existing home included insufficient electrical panel capacity for a dedicated 40-ampere charging circuit, location of the electric panel relative to the garage, and permit costs, which averaged 8.6% of the installed cost. The capacity limitation was found to be more prevalent in less-affluent areas.[3] The proposed code would reduce the cost impact for a home-owner to make the switch to EV by requiring EVSE infrastructure to be included in new homes.

Table 2. Cost of EV Charging Infrastructure – Single Family

	New[a]	Avg. Retrofit[b]	Avg. Max. Retrofit[b]
Single Family Home	$860-920	$1,354	$4,000

Notes: (a).Source PG&E 2016, (b) Source Francfort et al. 2015

1. http://evchargingpros.com/wp-content/uploads/2017/04/City-of-SF-EV-Infrastructure-Cost-Effectiveness-Report-2016.pdf

2. https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

3. Francfort, Jim, Brion Bennett, Richard Carlson, Thomas Garreston, LauraLee Gourley, Donald Karner, Mindy Kirkpatrick, Patti McGuire, Don Scoffield, Matthew Shirk, Shawn Salisbury, Stephen Schey, John Smart, Sera White, Jeffery Wishart.2015. 2015*Plug-in Electric Vehicle and Infrastructure Analysis.* Publication Number: INL/EXT-15-35708, Idaho National Laboratory, Idaho Falls, Idaho.

CEPI-258-21 Part II

IECC®: SECTION 202 (New), R401.4 (New), R401.4.1 (New), R401.4.2 (New), R401.4.3 (New), Table R401.4.3 (New), R401.4.4 (New)

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Add new definition as follows:

R202 **ELECTRIC VEHICLE (EV).** An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

R202 **ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE).** The conductors, including the ungrounded, grounded and equipment grounding conductors, and the EV connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of transferring energy between the premises wiring and the EV.

R202 **EV-CAPABLE SPACE.** A dedicated parking space which is provided with electrical panel capacity and space to support a minimum 40-ampere, 208/240-volt branch circuit for each EV parking space, and the installation of raceways, both underground and surface mounted, to support the EVSE.

R202 **EV-READY SPACE.** A designated parking space which is provided with one 40-ampere, 208/240-volt dedicated branch circuit for future dedicated Level 2 *EVSE* servicing EVs. The circuit shall terminate in a suitable termination point such as a receptacle, junction box, or an *EVSE*, and be located in close proximity to the proposed location of the EV parking spaces. The circuit shall have no other outlets. The service panel shall include an over-current protective device and provide sufficient capacity and space to accommodate the circuit and over-current protective device and be located in close proximity to the proposed location of the EV parking spaces.

Add new text as follows:

R401.4 Plug-in electric vehicle charging.

Where parking is provided, new construction shall provide EVSE-installed spaces and facilitate future installation and use of EVSE through the provision of *EV-Ready Spaces* and *EV-Capable Spaces* provided in compliance with Sections R401.4.1 through R401.4.4 (IRC N1101.15.1 through IRC N1101.15.3). Where more than one parking facility is provided on a site, electric vehicle ready parking spaces shall be calculated separately for each parking facility. The service panel or subpanel circuit directory shall identify the spaces reserved to support EV charging as “EV-Capable” or “EV-Ready”. The raceway location for *EV-Capable Spaces* shall be permanently and visibly marked as “EV-Capable”.

Exception: This section does not apply to parking spaces used exclusively for trucks or delivery vehicles.

R401.4.1 Electric vehicle service equipment (EVSE) ready circuit.

Each *EV-Ready Space* shall be provided with a minimum 40-ampere branch circuit to accommodate a future dedicated Level-2 EVSE. The service panel shall provide sufficient capacity and space to accommodate the circuit and over-current protective device. A permanent and visible label stating “EV-READY” shall be posted in a conspicuous place at both the service panel and the circuit termination point.

R401.4.2 One- to two-family dwellings and townhouses.

For each dwelling unit, provide at least one *EV-Ready Space*. The branch circuit shall be identified as "EV-Ready" in the service panel or subpanel directory, and the termination location shall be marked as "EV-Ready."

Exception: *EV-Ready Spaces* are not required where no parking spaces are provided.

R401.4.3 Multifamily dwellings (three or more units).

EVSE-Installed, EV-Ready Spaces and EV-Capable Spaces shall be provided in accordance with Table R401.4.3. EV-Ready Spaces that terminate with an installed Level 2 EVSE shall count as spaces under the EV-Ready Space requirements Where the calculation of percent served results in a fractional parking space, it shall round up to the next whole number.

Exception: Where the number of *EV-Ready Spaces* exceeds the required minimum in Table R401.4.3, the additional *EV Ready Spaces* shall be used for compliance with the minimum *EV-Capable Spaces* requirement.

Table R401.4.3 EVSE Installed, EV-Ready and EV-Capable Space Requirements for New Multifamily Buildings

Total Number of Parking Spaces	**Minimum Number of Spaces with EVSE Installed**[a.]	**Minimum Number of EV-Ready Spaces**.	**Minimum Number of *EV-Capable Spaces***
1	1	1	-
2 – 10	1	2	-
11 – 15	1	2	1
16 – 19	1	2	2
21 – 25	2	3	2
26+	5% of total parking spaces	10% of total parking spaces	10% of total parking spaces

- a.

  Spaces that terminate with a Level 2 EVSE are considered EV-Ready Spaces and count towards the minimum number of EV-Ready Spaces

R401.4.4 Identification.

Construction documents shall indicate the raceway termination point and proposed location of future EV spaces and EV chargers. Construction documents shall also provide information about the amperage of future EVSE, raceway methods, wiring schematics, and electrical load calculations to verify that the electrical panel service capacity and electrical system, including any on-site distribution transformers, have sufficient capacity to simultaneously charge all EVs at all required EV spaces at the full rated amperage of the EVSE.

Reason:

Numerous studies show that sales of electric vehicles (EVs) have grown consistently over recent years in the U.S. Edison Electric Institute (EEI) estimates one million EVs on the road in 2018 and forecasts a total of 18.7 million EVs on the road by 2030. Based on this forecast, EEI projects the need for an additional 9.6 million EV charging stations by 2030. It is imperative that the EV charging infrastructure keeps pace with sales of EVs to to enhance overall EV growth, and to ensure that lack of access to EV charging stations is minimized as a critical barrier to EV adoption.

EVs provide substantial benefits to the consumer and society. EVs are less expensive to operate than conventional gas vehicles, have lower maintenance costs, and have the convenience of fueling (charging) at home or work. EVs likewise reduce GHG emissions. EV market growth combined with a cleaner grid will support goals of reduced GHG emissions established across the U.S. and others by federal agencies, as well as many states and local governments. According to the U.S. Environmental Protection Agency (EPA), the transportation sector (cars, trucks, trains, ships, airplanes, and other vehicles) accounts for 29% of total U.S. GHG emissions. Globally, road travel accounts for 75% of transportation emissions. Studies conducted in California show that costs associated with installing EV charging infrastructure can be substantially more expensive for retrofit scenarios compared to new construction.

Many states and local governments have added EV provisions to their building codes, local ordinances and zoning requirements. This proposed code language for EV charging infrastructure builds upon language considered for the 2021 IECC, and includes additional requirements developed by both PNNL staff and ICC staff.

Bibliography:

Salcido R, M Tillou, and E Franconi. 2021. Electric Vehicle Charging for Residential and Commercial Energy Codes. PNNL-31576, Rev. 1, Pacific Northwest National Laboratory for U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. www.energycodes.gov/sites/default/files/2021-07/TechBrief_EV_Charging_July2021

Cost Impact:

The code change proposal will increase the cost of construction.

The costs associated with installing EV charging infrastructure during new construction are substantially lower than during a retrofit. A cost-effectiveness study for the City and County of San Francisco conducted by Pacific Gas & Electric (PG&E) showed costs for installing Level 2 EV charging stations as a retrofit are several times more expensive than installing them during new construction.[1] Installing infrastructure during new construction avoids the retrofit costs of breaking and repairing walls, installing longer raceways, and using more expensive methods of upgrading service panels. A study conducted by DOE determined the installed costs of a single port ESVE unit ranges from $0-$3,000 for Level 1, $600-$12,700 for Level 2 and $4,000-$51,000 for DC fast charging. Various elements lead to the high variability of costs due to the type of unit, applications and cost factors to determine if a ESVE unit will be on the low or high end of the range.[2]

Table 1 compares the cost of installing Level 2 EV charging infrastructure during new construction and during a retrofit. Figure 7 shows the cost breakdown of the Level 2 EV charging infrastructure installation.

Table 1 Cost of EV Charging Infrastructure

	Per EV Parking Space with Electric Circuit		Total Incremental Cost of Building	
	New	Retrofit	New	Retrofit
Scenario A – 10 Parking Space Building, two EV Parking Spaces	$920	$3,710	$1,840	$7,420
Scenario B – 60 Parking Space Building, 12 EV Parking Spaces	$860	$2,370	$10,320	$28,440

Source: PG&E 2016

For one- and two-family dwellings, costs for Level 2 charging stations include the price and labor associated with the installation of one 40-ampere, 208/240-volt dedicated branch circuit and a circuit terminating in a receptacle, junction box, or EVSE. The average cost to install (exclusive of charger cost) a Level 2 EVSE in an existing home was $1,354 across 13 cities in the U.S. based on more than 25,000 installations. The average maximum installation cost across these 13 locations was approximately $4,000. The key factors affecting the cost of installing EVSE in an existing home included insufficient electrical panel capacity for a dedicated 40-ampere charging circuit, location of the electric panel relative to the garage, and permit costs, which averaged 8.6% of the installed cost. The capacity limitation was found to be more prevalent in less-affluent areas.[3] The proposed code would reduce the cost impact for a home-owner to make the switch to EV by requiring EVSE infrastructure to be included in new homes.

Table 2. Cost of EV Charging Infrastructure – Single Family

	New[a]	Avg. Retrofit[b]	Avg. Max. Retrofit[b]
Single Family Home	$860-920	$1,354	$4,000

Notes: (a).Source PG&E 2016, (b) Source Francfort et al. 2015

1. http://evchargingpros.com/wp-content/uploads/2017/04/City-of-SF-EV-Infrastructure-Cost-Effectiveness-Report-2016.pdf

2. https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

3. Francfort, Jim, Brion Bennett, Richard Carlson, Thomas Garreston, LauraLee Gourley, Donald Karner, Mindy Kirkpatrick, Patti McGuire, Don Scoffield, Matthew Shirk, Shawn Salisbury, Stephen Schey, John Smart, Sera White, Jeffery Wishart.2015. 2015*Plug-in Electric Vehicle and Infrastructure Analysis.* Publication Number: INL/EXT-15-35708, Idaho National Laboratory, Idaho Falls, Idaho.

CEPI-258-21 Part III

IRC: SECTION 202 (New), N1101.15 (New), N1101.15.1 (New), N1101.15.2 (New), N1101.15.3 (New)

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Residential Code

Add new definition as follows:

N1101.6 ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

N1101.6 ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). The conductors, including the ungrounded, grounded and equipment grounding conductors, and the EV connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatuses installed specifically for the purpose of transferring energy between the premises wiring and the EV.

N1101.6 EV-CAPABLE SPACE. A dedicated parking space which is provided with electrical panel capacity and space to support a minimum 40-ampere, 208/240-volt branch circuit for each EV parking space, and the installation of raceways, both underground and surface mounted, to support the EVSE.

N1101.6 EV-READY SPACE. A designated parking space which is provided with one 40-ampere, 208/240-volt dedicated branch circuit for future dedicated Level 2 EVSE servicing EVs. The circuit shall terminate in a suitable termination point such as a receptacle, junction box, or an EVSE, and be located in close proximity to the proposed location of the EV parking spaces. The circuit shall have no other outlets. The service panel shall include an over-current protective device and provide sufficient capacity and space to accommodate the circuit and over-current protective device and be located in close proximity to the proposed location of the EV parking spaces.

Add new text as follows:

N1101.15 Plug-in electric vehicle charging.

Where parking is provided, new construction shall provide EVSE-installed spaces and facilitate future installation and use of EVSE through the provision of EV-Ready Spaces and EV-Capable Spaces provided in compliance with Sections N1101.15.1 through N1101.15.3. Where more than one parking facility is provided on a site, electric vehicle ready parking spaces shall be calculated separately for each parking facility. The service panel or subpanel circuit directory shall identify the spaces reserved to support EV charging as “EV-Capable” or “EV-Ready”. The raceway location for EV-Capable Spaces shall be permanently and visibly marked as “EV-Capable”.

Exception: This section does not apply to parking spaces used exclusively for trucks or delivery vehicles.

N1101.15.1 Electric vehicle service equipment (EVSE) ready circuit. .

Each EV-Ready Space shall be provided with a minimum 40-ampere branch circuit to accommodate a future dedicated Level-2 EVSE. The service panel shall provide sufficient capacity and space to accommodate the circuit and over-current protective device. A permanent and visible label stating “EV-READY” shall be posted in a conspicuous place at both the service panel and the circuit termination point.

N1101.15.2 One- to two-family dwellings and townhouses.

For each dwelling unit, provide at least one EV-Ready Space. The branch circuit shall be identified as “EV-Ready” in the service panel or subpanel directory, and the termination location shall be marked as “EV-Ready.”

Exception: EV-Ready Spaces are not required where no parking spaces are provided.

N1101.15.3 Identification.

Construction documents shall indicate the raceway termination point and proposed location of future EV spaces and EV chargers. Construction documents shall also provide information about the amperage of future EVSE, raceway methods, wiring schematics, and electrical load calculations to verify that the electrical panel service capacity and electrical system, including any on-site distribution transformers, have sufficient capacity to simultaneously charge all EVs at all required EV spaces at the full rated amperage of the EVSE.

Reason Statement:

Numerous studies show that sales of electric vehicles (EVs) have grown consistently over recent years in the U.S. Edison Electric Institute (EEI) estimates one million EVs on the road in 2018 and forecasts a total of 18.7 million EVs on the road by 2030. Based on this forecast, EEI projects the need for an additional 9.6 million EV charging stations by 2030. It is imperative that the EV charging infrastructure keeps pace with sales of EVs to to enhance overall EV growth, and to ensure that lack of access to EV charging stations is minimized as a critical barrier to EV adoption.

EVs provide substantial benefits to the consumer and society. EVs are less expensive to operate than conventional gas vehicles, have lower maintenance costs, and have the convenience of fueling (charging) at home or work. EVs likewise reduce GHG emissions. EV market growth combined with a cleaner grid will support goals of reduced GHG emissions established across the U.S. and others by federal agencies, as well as many states and local governments. According to the U.S. Environmental Protection Agency (EPA), the transportation sector (cars, trucks, trains, ships, airplanes, and other vehicles) accounts for 29% of total U.S. GHG emissions. Globally, road travel accounts for 75% of transportation emissions. Studies conducted in California show that costs associated with installing EV charging infrastructure can be substantially more expensive for retrofit scenarios compared to new construction.

Many states and local governments have added EV provisions to their building codes, local ordinances and zoning requirements. This proposed code language for EV charging infrastructure builds upon language considered for the 2021 IECC, and includes additional requirements developed by both PNNL staff and ICC staff.

Bibliography:

Salcido R, M Tillou, and E Franconi. 2021. Electric Vehicle Charging for Residential and Commercial Energy Codes. PNNL-31576, Rev. 1, Pacific Northwest National Laboratory for U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. www.energycodes.gov/sites/default/files/2021-07/TechBrief_EV_Charging_July2021

Cost Impact:

The code change proposal will increase the cost of construction.

The costs associated with installing EV charging infrastructure during new construction are substantially lower than during a retrofit. A cost-effectiveness study for the City and County of San Francisco conducted by Pacific Gas & Electric (PG&E) showed costs for installing Level 2 EV charging stations as a retrofit are several times more expensive than installing them during new construction.[1] Installing infrastructure during new construction avoids the retrofit costs of breaking and repairing walls, installing longer raceways, and using more expensive methods of upgrading service panels. A study conducted by DOE determined the installed costs of a single port ESVE unit ranges from $0-$3,000 for Level 1, $600-$12,700 for Level 2 and $4,000-$51,000 for DC fast charging. Various elements lead to the high variability of costs due to the type of unit, applications and cost factors to determine if a ESVE unit will be on the low or high end of the range.[2]

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Source: PG&E 2016

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Table 2. Cost of EV Charging Infrastructure – Single Family

	New[a]	Avg. Retrofit[b]	Avg. Max. Retrofit[b]
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Notes: (a).Source PG&E 2016, (b) Source Francfort et al. 2015

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2. https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

3. Francfort, Jim, Brion Bennett, Richard Carlson, Thomas Garreston, LauraLee Gourley, Donald Karner, Mindy Kirkpatrick, Patti McGuire, Don Scoffield, Matthew Shirk, Shawn Salisbury, Stephen Schey, John Smart, Sera White, Jeffery Wishart.2015. 2015*Plug-in Electric Vehicle and Infrastructure Analysis.* Publication Number: INL/EXT-15-35708, Idaho National Laboratory, Idaho Falls, Idaho.
CEPI-258-21 Part III

2021 PUBLIC INPUT - PROPOSED CHANGES TO THE INTERNATIONAL ENERGY CONSERVATION CODE

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Interest Category
[A] Manufacturer
[B] Builder
[C] Stds Promulgator/Testing Lab
[D] User
[E] Utility
[F] Consumer
[G] Public Segment
[H] Government Regulator
[I] Insurance

REPI-3-21 Part I

IECC®: R102.1.1, R102.1.1.1 (New)

Proponents:

Craig Conner, representing self (craig.conner@mac.com)

THIS IS A 2 PART PROPOSAL. PART I & II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

R102.1.1 Above code programs.

The *code official* or other authority having jurisdiction shall be permitted to deem a national, state or local energy-efficiency program to exceed the energy efficiency required by this code. *Buildings approved* in writing by such an energy-efficiency program shall be considered to be in compliance with this code where such buildings also meet the requirements identified in Table R405.2 and the *building thermal envelope* is greater than or equal to levels of efficiency and solar heat gain coefficients in Tables 402.1.1 and 402.1.3 of the 2009 *International Energy Conservation Code*.

Add new text as follows:

R102.1.1.1 Specific Programs.

Buildings verified by an approved 3rd party as complying with the National Green Building Standard or LEED for Homes shall be deemed to comply with this code.

REPI-3-21 Part I

REPI-3-21 Part II

IRC: N1101.4, N1101.4.1 (New)

Proponents:

Craig Conner, representing self (craig.conner@mac.com)

2021 International Residential Code

Revise as follows:
N1101.4 Above code programs.

The *code official* or other authority having *jurisdiction* shall be permitted to deem a national, state or local energy-efficiency program to exceed the energy efficiency required by this code. *Buildings approved* in writing by such an energy-efficiency program shall be considered to be in compliance with this code. The requirements identified in Table N1105.2, as applicable, shall be met and the building thermal envelope is greater than or equal to levels of efficiency and solar heat gain coefficients (SHGC) in Tables 402.1.1 and 402.1.3 of the 2009 *International Energy Conservation Code*.

Add new text as follows:
N1101.4.1 Specific Programs.

Buildings verified by an approved 3rd party as complying with the National Green Building Standard or LEED for Homes shall be deemed to comply with the energy portion of this code.

Reason Statement:

Both the National Green Building Standard and LEED for Homes have energy requirements well above the IECC. Further the required 3rd party verification will result in better buildings.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Those who are already qualifying for NGBS or LEED will not see increases in costs. Those who are not in those two programs are not going to use this provision.

REPI-3-21 Part II

REPI-4-21

IECC®: R102.1.1

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:
R102.1.1 (N1101.4) Above code programs.

The *code official* or other authority having jurisdiction shall be permitted to deem a national, state or local energy-efficiency program to exceed the energy efficiency required by this code. *Buildings approved* in writing by such an energy-efficiency program shall be considered to be in compliance with this code where such buildings also meet the requirements identified in Table R405.2 and the proposed total *building thermal envelope* UA, which is the sum of *U*-factor times assembly area, shall be less ~~is greater~~ than or equal to the building thermal envelope UA using the prescriptive *U*-factors from Table R402.1.2 multiplied by 1.15 in accordance with Equation 4-1. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.~~levels of efficiency and solar heat gain coefficients in Tables 402.1.1 and 402.1.3 of the 2009 *International Energy Conservation Code*.~~

$$UA_{\text{Proposed design}} = 1.15 \times UA_{\text{Prescriptive reference design}}$$

(Equation 4-1)

Attached Files

- **R7 table pix.PNG**
  http://localhost/proposal/318/935/files/download/184/

Reason Statement:

The purpose of this code change proposal is to improve the mandatory thermal envelope trade-off backstop applicable to the above code programs compliance alternative in Section R102.1.1. This proposal improves the efficiency and usability of the *IECC* by combining two successful concepts incorporated into the 2021 *IECC*. First, it adds flexibility for code users who are complying with the *IECC* through approved above-code programs by changing the thermal envelope backstop from being based on the 2009 *IECC* prescriptive tables to a calculation based on a percentage of the Total UA of the current code's envelope requirements. This would make the thermal envelope backstop that applies to above-code programs consistent with the backstop that applies to the ERI (which is often used in above-code programs). The ERI backstop, which was originally based on the 2009 *IECC* in the 2015 and 2018 editions of the *IECC*, was changed to a Total UA-based backstop in the 2021 *IECC* as a result of Proposal No. RE150-19 (as modified by the Committee). We believe that code users would benefit from both trade-off backstops working in the same way.

Second, this proposal will improve efficiency and streamline future code development by replacing a reference to an older code edition with a reference to the current code requirements. Basing the calculation on the current code helps ensure that improvements to the code baseline in 2024 and in future code editions will be reflected in the backstop without a need for additional code change proposals in the future. This will also simplify compliance and enforcement efforts by reducing the need to refer to other code books.

An effective thermal envelope backstop is crucial to ensure that the home retains reasonable envelope performance similar to the prescriptive path under alternative compliance paths such as above-code programs, the performance path, ERI, etc., and that the envelope is not unduly traded-off for other measures. Trading off envelope and associated occupant comfort can have direct impacts on energy usage. For example, if the occupant responds to discomfort from a "cold" or "hot" room due to an inadequate building envelope by adjusting the thermostat, the additional energy use from the adjusted thermostat can be substantial. Below is a summary of estimated energy use increases associated with adjusting a thermostat 1 degree higher or lower, broken out by climate zone.

[R7 table pix.png]

Increased Energy Use Resulting from Thermostat Adjustment									
Measure	**Nat'l Avg**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	
+1 Degree Heating	4.1%	0.5%	3.0%	4.2%	4.4%	4.7%	4.5%	4.0%	2
-1 Degree Cooling	3.2%	7.8%	5.3%	3.9%	2.6%	1.8%	1.4%	0.7%	0

An effective envelope trade-off backstop can help improve occupant comfort and can save significant energy and energy cost.

As the *IECC* and above-code programs play an increasingly important role in helping states and cities achieve energy efficiency and carbon reduction goals, it is more important than ever to put in place improved and streamlined trade-off backstops. These backstops are critical consumer protections that will maintain a minimum level of efficiency across all new homes, providing long-term comfort and energy savings for homeowners, and more broadly, reducing peak demand and greenhouse gas production at the state and national level.

Bibliography:

Pacific Northwest National Laboratory, *National Cost Effectiveness of the Residential Provisions of the 2021 IECC* (June 2021)

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will neither increase nor decrease the cost of construction. This proposal does not increase the baseline stringency of the *IECC*, and whether the proposal results in increased or decreased costs ultimately depends on compliance choices made by the code user in each case. The added flexibility of moving to a UA-based backstop will allow builders to use what they conclude is the optimal combination of envelope measures to meet the building thermal envelope UA under the code, which may reduce construction costs as compared with the current backstop in some cases.

COST-EFFECTIVNESS

This proposal does not increase or otherwise affect the stringency of the prescriptive code values or necessarily result in increased costs. Instead, the above-code-programs thermal envelope backstop only places limits on choices under an alternative compliance path (which is optional), so a cost-effectiveness analysis does not apply.

The ICC Board of Directors set the 2021 *IECC* as the baseline for future IECC development – and by extension made the 2021 *IECC* the basis for cost-effectiveness analyses. This means for purposes of analyzing code proposals, the existing provisions of the 2021 *IECC* are considered cost-effective and reasonable, since they are the starting point for analyses of code changes and no rollbacks are permitted. It should also be noted that US DOE found the entire 2021 *IECC* cost effective, including section R406. *See* Pacific Northwest National Laboratory, *National Cost Effectiveness of the Residential Provisions of the 2021 IECC* (June 2021). Changes to trade-off backstops like this code change proposal, which utilizes U-factors and SHGCs less stringent than the prescriptive measures of the 2021 *IECC*, do not increase the stringency of that baseline or impose any additional costs to meet specific measures. In addition, if the prescriptive values are cost-effective, then the backstop values would be cost-effective. These backstops serve only as a consumer protection against excessive trade-offs, but do not require anything more than what would be required for base code compliance. Thus, a cost-effectiveness analysis would be difficult or impossible to apply and would not be informative.

REPI-4-21

REPI-5-21

IECC®: SECTION 202 (New), R103.2, R401.3, R401.3.1 (New)

Proponents: seth wiley, representing architect, self

2021 International Energy Conservation Code

Add new definition as follows:

CARBON DIOXIDE EQUIVALENT (CO2e). A measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO2e approximates the timeintegrated warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO2). GWP is an index for estimating the relative global warming contribution of atmospheric emissions of 1 kg of a particular greenhouse gas compared to emissions of 1 kg of CO2. The following GWP values are used based on a 100-year time horizon: 1 for CO2, 25 for methane (CH4), and 298 for nitrous oxide (N2O). [Carbon Dioxide Equivalent Definition courtesy of New Buildings Institute]

Revise as follows:

R103.2 Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the *building*, systems and equipment as herein governed. Details shall include the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and *solar heat gain coefficients* (SHGC).
4. Area-weighted *U*-factor and *solar heat gain coefficients* (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.
10. CO2e annual electric energy usage emissions from building or dwelling unit operations, reported in kilograms (kgCO2e).
11. CO2e annual fossil fuel energy usage emissions from building or dwelling unit operations, reported in kilograms (kgCO2e).

R401.3 Certificate. A permanent certificate shall be completed by the builder or other *approved* party and posted on a wall in the space where the furnace is located, a utility room or an *approved* location inside the *building*. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory *label*, service disconnect *label* or other required labels. The certificate shall indicate the following:

1. The predominant *R*-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, *basement walls*, *crawl space walls* and floors and ducts outside *conditioned spaces.*
2. *U*-factors of fenestration and the *solar heat gain coefficient* (SHGC) of fenestration. Where there is more than one value for any component of the building envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.
3. The results from any required duct system and building envelope air leakage testing performed on the building.
4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment. Where a gas-fired unvented room heater, electric furnace or baseboard electric heater is installed in the residence, the certificate shall indicate “gas-fired unvented room heater,” “electric furnace” or “baseboard electric heater,” as appropriate. An efficiency shall not be indicated for gas-fired unvented room heaters, electric furnaces and electric baseboard heaters.
5. Where on-site *photovoltaic panel* systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.
6. For buildings where an Energy Rating Index score is determined in accordance with Section R406, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate.
7. The code edition under which the structure was permitted and the compliance path used.
8. CO2e annual electric energy usage emissions from building or dwelling unit operations, reported in kilograms (kgCO2e).
9. CO2e annual fossil fuel energy usage emissions from building or dwelling unit operations, reported in kilograms (kgCO2e).

Add new text as follows:

R401.3.1 Calculation of CO2e annual emissions. Building or dwelling unit CO2e annual emissions shall be calculated in kgCO2e in the following manner:

1. Based on annual energy use in Mbtus as calculated in and documented on building or dwelling unit ANSI/RESNET/ICC 301 Standard Energy Rating Certificate and process.
   1.1. That portion of building or dwelling energy use derived from electric grid sources as calculated per ANSI/RESNET/ICC 301 Standard Energy Rating Certificate process in Mbtus converted to kgCO2e based on current U.S. Environmental Protection Agency eGrid Summary Table 3 State Output Emissions Rates, lbCO2/MWh. https://www.epa.gov/egrid/summary-data

   1.2. Megawatt-hours shall be converted to Mbtus.

   1.3. That portion of building or dwelling energy use as derived from natural gas, liquefied petroleum gas, and fuel oil fossil fuel sources as calculated per ANSI/RESNET/ICC 301 Standard Energy Rating Certificate process in Mbtus converted to kgCO2e based on current U.S. Energy Information Administration Carbon Dioxide Emissions Coefficients by Fuel, lbCO2/Mbtu. https://www.eia.gov/environment/emissions/co2_vol_mass.php

   1.4. Pounds shall be converted to kilograms.

   1.5. In coordination with the Energy Rating Certificate process, on-site electric energy generated by on-site renewable sources such as rooftop photovoltaic sources shall not be included in on-site electric energy usage provided the building or dwelling unit primary occupant has secured an annual or longer operational system installation agreement in cooperation with the local utility company, and can provide such agreement as required.

   1.6. In coordination with the Energy Rating Certificate process, on-site electric energy generated by off-site renewable sources such as hydropower sources shall not be included in on-site electric energy usage provided the building or dwelling unit primary occupant has secured an annual or longer power purchase agreement in cooperation with the local utility company, and can provide such agreement as required.

   1.7. Results shall separately indicate building or dwelling annual operational kgCO2e emissions from electric energy usage and fossil fuel energy usage for documentation per R103.2 and R401.3.

2. When a building or dwelling unit will not receive an ANSI/RESNET/ICC 301 Standard Energy Rating Certificate and accompanying calculation process, current U.S. Environmental Protection Agency (EPA) Estimated Home Energy Use shall be used to assess building and home annual energy use emissions in kgCO2e.
   2.1. Current EPA Estimated Home Energy Use values equate to the following Emissions:
      2.1.1. 2.839 kgCO2e/sf from electricity usage;

      2.1.2. 1.181 kgCO2e/sf from natural gas usage;

      2.1.3. 0.119 kgCO2e/sf from liquefied petroleum gas usage; and

      2.1.4. 0.150 kgCO2e/sf from fuel oil usage.

      https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-andreferences

   2.2. Multiply building or dwelling unit square footage by the EPA Estimated Home Energy Use values to calculate the building or dwelling annual operational kgCO2e emissions for documentation per R103.2 and R401.3.

   2.3. Results shall separately indicate building or dwelling annual operational kgCO2e emissions from electric energy usage and fossil fuel energy usage for documentation per R103.2 and R401.3.

Reason: To improve occupant health and safety, improve energy efficiency, and decrease greenhouse gas emissions.An example as to how to calculate CO2e annual emissions is as follows
Example:

A 2,000 square foot new construction or renovation project will be appropriately documented, filed with authorities having jurisdiction, and constructed.

There will not be an ANSI/RESNET/ICC 301 Energy Rating Certification and its standard supporting analysis performed as part of the project.

The project’s annual emissions from electric usage equate to 5,678.184 kgCO2e (2,000 x 2.839).

The project’s annual emissions from natural gas usage equate to 2,362.042 kgCO2e (2,000 x 1.181).

The project’s annual emissions from liquefied petroleum gas usage equate to 237.236 kgCO2e (2,000 x 0.119).

Therefore, the project’s annual emissions from fuel oil usage equate to 299.123 kgCO2e (2,000 x 0.150).

Therefore, the project's CO2e annual emissions from electric energy usage is 5,678.184 kgCO2e and from fossil fuel energy usage is 2,898.401 kgCO2e (2,362.042 + 237.236 + 299.123) for documentation per R103.2 and R401.3.

Bibliography: Based on professional knowledge and experience, feedback from other professionals, established research, and established local and national construction quality frameworks

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code chance proposal is understood to neither increase nor decrease the cost of construction

Attached Files

- **IECC-2024_Proposal_Embodied-Operational-Energy-GHG_2021-09-22.pdf**
  https://energy.cdpaccess.com/proposal/332/592/files/download/73/

Proposed Code Change Language for
the 2024 International Energy Conservation Code
regarding Embodied and Operational
Energy and Greenhouse Gas Emissions

Date: 2021/09/22

Revision: 0

Proposed 2024 International Energy Conservation Code Language to replace Current 2021 International Energy Conservation Code Language *(See Current 2021 International Energy Conservation Code Language as reference below)*

Abbreviations and Notations

CO2e	Carbon dioxide equivalent

R103.2 Information on construction documents.

10. CO2e annual electric energy usage emissions from building or dwelling unit operations, reported in kilograms (kgCO2e).

11. CO2e annual fossil fuel energy usage emissions from building or dwelling unit operations, reported in kilograms (kgCO2e).

R202 GENERAL DEFINITIONS.

CARBON DIOXIDE EQUIVALENT (CO2e). A measure used to compare the impact of various greenhouse gases based on their global warming potential (GWP). CO2e approximates the time-integrated warming effect of a unit mass of a given greenhouse gas relative to that of carbon dioxide (CO2). GWP is an index for estimating the relative global warming contribution of atmospheric emissions of 1 kg of a particular greenhouse gas compared to emissions of 1 kg of CO2. The following GWP values are used based on a 100-year time horizon: 1 for CO2, 25 for methane (CH4), and 298 for nitrous oxide (N2O). *[Carbon Dioxide Equivalent Definition courtesy of New Buildings Institute]*

R401.3 Certificate.

8. CO2e annual electric energy usage emissions from building or dwelling unit operations, reported in kilograms (kgCO2e).

9. CO2e annual fossil fuel energy usage emissions from building or dwelling unit operations, reported in kilograms (kgCO2e).

R401.3.1 Calculation of CO2e annual emissions.

Building or dwelling unit CO2e annual emissions shall be calculated in kgCO2e in the following manner:

1. Based on annual energy use in Mbtus as calculated in and documented on building or dwelling unit ANSI/RESNET/ICC 301 Standard Energy Rating Certificate and process.
    a) That portion of building or dwelling energy use derived from electric grid sources as calculated per ANSI/RESNET/ICC 301 Standard Energy Rating Certificate process in Mbtus converted to kgCO2e based on current U.S. Environmental Protection Agency eGrid Summary Table 3 State Output Emissions Rates, lbCO2/MWh. https://www.epa.gov/egrid/summary-data
    b) Megawatt-hours shall be converted to Mbtus.
    c) That portion of building or dwelling energy use as derived from natural gas, liquefied petroleum gas, and fuel oil fossil fuel sources as calculated per ANSI/RESNET/ICC 301 Standard Energy Rating Certificate process in Mbtus converted to kgCO2e based on current U.S. Energy Information Administration Carbon Dioxide Emissions Coefficients by Fuel, lbCO2/Mbtu. https://www.eia.gov/environment/emissions/co2_vol_mass.php
    d) Pounds shall be converted to kilograms.
    e) In coordination with the Energy Rating Certificate process, on-site electric energy generated by on-site renewable sources such as rooftop photovoltaic sources shall not be included in on-site electric energy usage provided the building or dwelling unit primary occupant has secured an annual or longer operational system installation agreement in cooperation with the local utility company, and can provide such agreement as required.
    f) In coordination with the Energy Rating Certificate process, on-site electric energy generated by off-site renewable sources such as hydropower sources shall not be included in on-site electric energy usage provided the building or dwelling unit primary occupant has secured an annual or longer power purchase agreement in cooperation with the local utility company, and can provide such agreement as required.
    g) Results shall separately indicate building or dwelling annual operational kgCO2e emissions from electric energy usage and fossil fuel energy usage for documentation per R103.2 and R401.3.
2. When a building or dwelling unit will not receive an ANSI/RESNET/ICC 301 Standard Energy Rating Certificate and accompanying calculation process, current U.S. Environmental Protection Agency (EPA) Estimated Home Energy Use shall be used to assess building and home annual energy use emissions in kgCO2e.
    a) Current EPA Estimated Home Energy Use values equate to the following Emissions:
        1. 2.839 kgCO2e/sf from electricity usage;
        2. 1.181 kgCO2e/sf from natural gas usage;
        3. 0.119 kgCO2e/sf from liquefied petroleum gas usage; and
        4. 0.150 kgCO2e/sf from fuel oil usage.

        https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

b) Multiply building or dwelling unit square footage by the EPA Estimated Home Energy Use values to calculate the building or dwelling annual operational kgCO2e emissions for documentation per R103.2 and R401.3.
c) Example:
    3. A 2,000 square foot new construction or renovation project will be appropriately documented, filed with authorities having jurisdiction, and constructed.
    4. There will not be an ANSI/RESNET/ICC 301 Energy Rating Certification and its standard supporting analysis performed as part of the project.
    5. The project's annual emissions from electric usage equate to 5,678.184 kgCO2e (2,000 x 2.839).
    6. The project's annual emissions from natural gas usage equate to 2,362.042 kgCO2e (2,000 x 1.181).
    7. The project's annual emissions from liquefied petroleum gas usage equate to 237.236 kgCO2e (2,000 x 0.119).
    8. Therefore, the project's annual emissions from fuel oil usage equate to 299.123 kgCO2e (2,000 x 0.150).
    9. Therefore, the project's CO2e annual emissions from electric energy usage is 5,678.184 kgCO2e and from fossil fuel energy usage is 2,898.401 kgCO2e (2,362.042 + 237.236 + 299.123) for documentation per R103.2 and R401.3.
a) Results shall separately indicate building or dwelling annual operational kgCO2e emissions from electric energy usage and fossil fuel energy usage for documentation per R103.2 and R401.3.

Current 2021 International Energy Conservation Code Language *(as reference)*

There is no current language on this topic.

REPI-6-21

IECC®: R103.2, TABLE R402.1.2, TABLE R402.1.3

Proponents: Robby Schwarz, BUILDTank, Inc., representing Colorado Chapter of the ICC (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

R103.2 (N1101.5) Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the *building*, systems and equipment as herein governed. Details shall include the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and *solar heat gain coefficients* (SHGC).
4. Area-weighted *U*-factor and *solar heat gain coefficients* (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Equipment and system controls.
8. Duct sealing, duct and pipe insulation and location.
9. Air sealing details.
10. Glazing area square footage as a percentage of floor area (windows to floor ratio)

TABLE R402.1.2 (Table N1102.1.2) MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]	CEILING *U*-FACTOR	WOOD FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
0	0.50 / 0.30[g]	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
1	0.50 / 0.30[g]	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40 / 0.30[g]	0.65	0.25	0.026	0.084	0.165	0.064	0.360	0.477
3	0.30 / 0.27[g]	0.55	0.25	0.026	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.30 / 0.27[g]	0.55	0.40	0.024	0.045	0.098	0.047	0.059	0.065
5 and Marine 4	0.30 / 027[g]	0.55	0.40	0.024	0.045	0.082	0.033	0.050	0.055
6	0.30 / 027[g]	0.55	NR	0.024	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30 / 027[g]	0.55	NR	0.024	0.045	0.057	0.028	0.050	0.055

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

f A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation above sea level, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

g Where the proposed glazing area is more than 15.0% of the conditioned floor area, as provided by per Section R103.2 information on construction documents, the second U-value shall be required.

TABLE R402.1.3 (TABLE N1102.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[g]	MASS WALL *R*-VALUE[h]	FLOOR *R*-VALUE	BASEMENT[c,g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c,g] WALL *R*-VALUE
0	NR / 030[i]	0.75	0.25	30	13 or 0 & 10ci	3/4	13	0	0	0
1	NR / 030[i]	0.75	0.25	30	13 or 0 & 10ci	3/4	13	0	0	0
2	0.40 / 030[i]	0.65	0.25	49	13 or 0 & 10ci	4/6	13	0	0	0
3	.30 / 027[i]	0.55	0.25	49	20 or 13 & 5ci[h] or 0 & 15ci[h]	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]
4 except Marine	.30 / 027[i]	0.55	0.40	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5 and Marine 4	0.30 / 027[ij]	0.55	0.40	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	13/17	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
6	0.30 / 027[ij]	0.55	NR	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	15/20	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
7 and 8	0.30 / 027[ij]	0.55	NR	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	19/21	38	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

    Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 & 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab-edge insulation *R*-value for slabs. as indicated in the table. Slab edge insulation shall be installed to separate conditioned from unconditioned spaces including adjacent garages, entries, and porches.The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, “13 & 5” means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

i. A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

    1. Above 4,000 feet in elevation, or
    2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

j. Where the proposed glazing area is more than 15.0% of the conditioned floor area, as provided by per Section R103.2 information on construction documents, the second U-value shall be required.

Reason: Based on energy modeling and to create parity and calibration between the prescriptive and performance compliance paths , changes were made in the R and U-value tables.
The U value changes for windows are based off of the Total Building Performance reference home table R405.4.2(1) Section “Vertical Fenestration other than opaque doors” where it states that:

Total areah =

(a) The proposed glazing area, where the proposed glazing

area is less than 15 percent of the conditioned floor

area.

(b) 15 percent of the conditioned floor area, where the

proposed glazing area is 15 percent or more of the

conditioned floor area.

This section makes compliance with the IECC more difficult when the window to floor ratio is above 15%. Changes in the R and U-value table equalize compliance within the compliance paths to begin the journey to better energy performance in new homes.

In addition to achieving better parity between compliance options this proposal directly being to address glass in our buildings. Glass will never be able to retard heat gain and loss as well as a wall assembly. In theory we can still build an all-glass house that is code compliant, but we know that to build an efficient house we need to reduce window area and install better performing windows. This proposal is a small step to being having this discussion.

Lastly, although window to wall ratios would be a better metric for this proposal, window to floor ratio was chosen because it is what is used in the Total Building Performance reference home in Section R405.4.2(1). I did not change the ratio in the R405 reference home because I believe that every change to made to the reference home table need to be vetted by software developers not the ICC Committee. The ICC has no oversite role over software developers, which is a problem in and of itself, so this code development process needs to seek consult with developers while addressing changes to the R405 reference home.

Under Slab and slab edge insulation is also addressed in footnotes to the R-value table. These installation criteria have been strengthened here to ensure the total boundary of the slab is insulated in places where it traditionally has not been such as between the conditioned space of the house and the non-conditioned garage.

Cost Impact: The code change proposal will increase the cost of construction.
0.27 U-value windows are the current EnergyStar compliant window and are readily available. 0.30 U-value windows are the last version of EnergyStar compliant windows. This proposal may increase cost because creating parity also means leveling the required efficiency between compliance paths. However, if designers are forced through all compliance options to assess the window to floor ratio, they should reduce the cost of construction by lowering the ratio through better window placement. In addition, there is a movement to install fewer operable windows which in tandem with this proposal could reduce cost.

The slab edge footnote clarification may increase first cost of construction however, this detail not only will safe operational cost, increase comfort in the home, but has been an implied requirement that has just been made evident.

REPI-7-21

IECC®: SECTION 202 (New), R103.2.2 (N1101.5.2) (New), R105.2.3, R105.2.5 (New), R105.2.5, R401.3, R404.4 (N1104.4) (New), R404.4.1 (N1104.4.1) (New), R404.4.1.1 (N1104.4.1.1) (New), R404.4.1.2 (N1104.4.1.2) (New), R404.4.1.3 (N1104.4.1.3) (New), R404.4.1.4 (N1104.4.1.4) (New), R404.4.2 (N1104.4.2) (New)

Proponents:

Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Amber Wood, representing ACEEE (awood@aceee.org)

2021 International Energy Conservation Code

Add new definition as follows:
R202 SOLAR-READY ZONE.

A section or sections of the roof or building overhang designated and reserved for the future installation of a solar photovoltaic or solar thermal system.

Add new text as follows:
R103.2.2 (N1101.5.2) Solar-ready system.

The construction documents shall provide details for dedicated roof area, structural design for roof dead and live load, and routing of conduit or pre-wiring from *solar-ready zone* to electrical service panel or plumbing from *solar-ready zone* to *service water heating* system for the *solar-ready zone* shall be represented on the construction documents.

Revise as follows:
R105.2.3 Plumbing rough-in inspection.
Inspections at plumbing rough-in shall verify compliance as required by the code and *approved* plans and specifications as to types of insulation and corresponding *R*-values and protection, and required controls. Where the solar-ready zone is installed for solar water heating, inspections shall verify pathways for routing of plumbing from solar-ready zone to service water heating system.
Add new text as follows:
R105.2.5 Electrical rough-in inspection.

Inspections at electrical rough-in shall verify compliance as required by the code and the approved plans and specifications as to the locations, distribution, and capacity of the electrical system. Where the solar-ready zone is installed for electricity generation, inspections shall verify conduit or pre-wiring from solar-ready zone to electrical panel.

Revise as follows:
~~R105.2.5~~ R105.2.6 Final inspection.
The *building* shall have a final inspection and shall not be occupied until *approved*. The final inspection shall include verification of the installation of all required *building* systems, equipment and controls and their proper operation and the required number of high-efficacy lamps and fixtures.
R401.3 (N1101.14) Certificate.

A permanent certificate shall be completed by the builder or other *approved* party and posted on a wall in the space where the furnace is located, a utility room or an *approved* location inside the *building*. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory *label*, service disconnect *label* or other required labels. The certificate shall indicate the following:

1. The predominant *R*-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, *basement walls*, *crawl space walls* and floors and ducts outside *conditioned spaces.*

U-factors of fenestration and the *solar heat gain coefficient* (SHGC) of fenestration. Where there is more than one value for any

2. component of the building envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.

3. The results from any required duct system and building envelope air leakage testing performed on the building.

4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment. Where a gas-fired unvented room heater, electric furnace or baseboard electric heater is installed in the residence, the certificate shall indicate “gas-fired unvented room heater,” “electric furnace” or “baseboard electric heater,” as appropriate. An efficiency shall not be indicated for gas-fired unvented room heaters, electric furnaces and electric baseboard heaters.

5. Where on-site *photovoltaic panel* systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.

6. For buildings where an Energy Rating Index score is determined in accordance with Section R406, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate.

7. The code edition under which the structure was permitted and the compliance path used.

8. Where a *solar-ready zone* is provided, the certificate shall indicate the location, dimensions, and capacity reserved on the electrical service panel.

Add new text as follows:

R404.4 (N1104.4) Renewable energy infrastructure.

The building shall comply with the requirements of R404.4.1 or R404.4.2

R404.4.1 (N1104.4.1) One- and two- family dwellings and townhouses.

One- and two-family dwellings and townhouses shall comply with Sections R404.4.1.1 through R404.4.1.4.

Exceptions:

1. A *building* with a permanently installed on-site renewable energy system.
2. A *building* with a solar-ready zone area that is less than 600 square feet (55 m^2) of roof area oriented between 110 degrees and 270 degrees of true north.
3. A *building* with a solar-ready zone area that is shaded for more than 70 percent of daylight hours annually.

R404.4.1.1 (N1104.4.1.1) Solar-ready zone area.

The total area of the *solar-ready zone* shall not be less than 300 square feet (28 m^2) and shall be composed of areas not less than 5.5 feet (1676 mm) in width and not less than 80 square feet (7.4 m^2) exclusive of access or set back areas as required by the International Fire Code.

Exception: Townhouses three stories or less in height above grade plane and with a total floor area less than or equal to 2,000 square feet (186 m^2) per dwelling shall be permitted to have a solar-ready zone area of not less than 150 square feet (14 m^2).

R404.4.1.2 (N1104.4.1.2) Obstructions.

Solar-ready zones shall be free from obstructions, including but not limited to vents, chimneys, and roof-mounted equipment.

R404.4.1.3 (N1104.4.1.3) Electrical service reserved space.

The main electrical service panel shall have a reserved space to allow installation of a dual pole circuit breaker for future solar electric installation and shall be labeled “For Future Solar Electric.” The reserved space shall be positioned at the opposite (load) end from the input feeder location or main circuit location.

R404.4.1.4 (N1104.4.1.4) Electrical interconnection.

An electrical junction box shall be installed within 24 inches (610 mm) of the main electrical service panel and shall be connected to a

An electrical junction box shall be installed within 24 inches (610 mm) of the main electrical service panel and shall be connected to a capped roof penetration sleeve or a location in the attic that is within 3 feet (914 mm) of the *solar ready zone* by one of the following:

1. Minimum ¾-inch (19 mm) nonflexible conduit
2. Minimum #10 Metal copper 3-wire

Where the interconnection terminates in the attic, location shall be no less than 12” (35 mm) above ceiling insulation. Both ends of the interconnection shall be labeled “For Future Solar Electric”.

R404.4.2 (N1104.4.2) Group R occupancies.

Buildings in Group R-2, R-3 and R-4 shall comply with Section C405.13.

Reason Statement:

In 2020, renewable energy sources were responsible for 21% of U.S. electricity generation. In order to cost-effectively achieve a Biden’s goal to create a carbon-free power sector by 2035, we must make sure our buildings are capable of cost effectively installing renewable energy now. According to a recent study entitled “A New Roadmap for the Lowest Cost Grid”, the least expensive grid involves a large amount of centralized renewables and a large amount of distributed renewables located on the building site. More renewables placed on site enables more clean utility-scale renewables to be deployed efficiently. It is therefore crucial for new residential buildings to be solar-ready so that the U.S. can reach its 100% carbon-free electricity goal by 2035 in the most cost-effective manner. Installing renewables on-site will also allow homeowners to economically benefit from the transition towards a low-carbon economy and benefit from additional resiliency during disruptions in centrally supplied power.

In addition, this solar-ready requirement would help grow good paying jobs. According to the Bureau of Labor Statistics, the two fastest growing occupations in the US are solar PV and wind turbine service technician. The Interstate Renewable Energy Council estimates that to reach Biden’s target of 100% renewable energy by 2035, the industry will need to employ three times the number of workers employed in 2020.

The proposed revisions and additions to the code have been moved from the 2021 IECC Appendix RB Solar-Ready Provisions to the most appropriate place in the base code. The amendments would require all new homes to be solar ready by requiring a designated 300 square foot minimum “solar ready zone” on the roof. Conduit and wire from this zone must be installed and space in the electrical panel must be reserved for a future solar array. Homes where solar is not feasible due to shading or not enough solar exposure due to orientation are exempt. Information on compliance with this requirement must be placed on the construction documents to improve compliance and so that future homeowners know their home is solar-ready. Revisions to Table R405.2 and R406.2 make this a mandatory requirement in the energy code. This amendment points multifamily buildings (Group R-2 and R-3 occupancies) to a similar amendment in the commercial energy code. If the residential committee chooses to accept this amendment but the commercial solar amendment is not accepted by the commercial committee, this amendment should be revised accordingly.

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Why Local Solar For All Costs Less: A New Roadmap for the Lowest Cost Grid, Vibrant Clean Energy, Dec. 2020, www.vibrantcleanenergy.com/wp-content/uploads/2020/12/WhyDERs_ES_Final.pdf.

The National Solar Job Census 2020, Interstate Renewable Energy Council, May 2021, https://irecusa.org/wp-content/uploads/2021/07/National-Solar-Jobs-Census-2020-FINAL.pdf.Richardson, Jake. *Solar and Wind Tech Are the Fastest Growing Jobs in US*, Red, Green, and Blue, 28 Jan. 2019, http://redgreenandblue.org/2019/01/27/solar-wind-tech-fastest-growing-jobs-us/.

Solar Ready: An Overview of Implementation Practices, National Renewable Energy Laboratory, Jan. 2012, www.nrel.gov/docs/fy12osti/51296.pdf.

Cost Impact:

The code change proposal will increase the cost of construction.

Recent analysis by NBI and partners using cost data from RSMeans indicates that adding the infrastructure to make a home solar ready would cost $216 or $0.09 per square foot for a typical home at the time of construction. According to an NREL report, if a home is not made solar ready but chooses to add solar at a later date, the cost of the retrofit (if the retrofit is feasible) is $4,373 or $1.84 per square foot, assuming a 2,376 s.f. home. Therefore, adding the infrastructure to make a home solar ready now saves $4,157 or $1.75 per square foot for homeowners who choose to add solar at a later date.

REPI-7-21

REPI-8-21

IECC®: R103.2.2 (N1101.5.2) (New), R105.2.5 (New), R105.2.5, R404.4 (N1104.4) (New), R404.4.1 (N1104.4.1) (New), R404.4.2 (N1104.4.2) (New), TABLE R405.2, TABLE R406.2

Proponents: Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Amber Wood, representing ACEEE (awood@aceee.org)

2021 International Energy Conservation Code

Add new text as follows:

R103.2.2 (N1101.5.2) Energy storage-ready system. The construction documents shall provide the location of pathways for routing of raceways or cable from the energy storage system area to the electrical service panel and the location and layout of a designated area for electrical energy storage system.

R105.2.5 Electrical rough-in inspection. Inspections at electrical rough-in shall verify compliance as required by the code and the approved plans and specifications as to the locations, distribution, and capacity of the electrical system. Where the energy storage system area is not in the same space as the electrical panel, inspections shall verify conduit or pre-wiring from the energy storage ready zone to the electrical panel.

Revise as follows:

~~**R105.2.5**~~ **R105.2.6 Final inspection.** The *building* shall have a final inspection and shall not be occupied until *approved*. The final inspection shall include verification of the installation of all required *building* systems, equipment and controls and their proper operation and the required number of high-efficacy lamps and fixtures.

Add new text as follows:

R404.4 (N1104.4) Energy storage infrastructure. Each *building site* shall have a dedicated location for the installation of future on-site energy storage in accordance with this section.

Exception: Where an onsite electrical energy system storage system is installed.

R404.4.1 (N1104.4.1) One- and two- family dwellings and townhouses. One- and two-family dwellings and townhouses shall be provided with an energy storage ready area in accordance with the following:

1. Floor area not less than 2 feet (610 mm) in one dimension and 4 feet (1219 mm) in another dimension and located in accordance with Section 1207 of the International Fire Code and Section 110.26 of the NFPA 70.
2. The main electrical service panel shall have a reserved space to allow installation of a two-pole circuit breaker for future electrical energy storage system installation. This space shall be labeled “For Future Electric Storage.” The reserved spaces shall be positioned at the end of the panel that is opposite from the panel supply conductor connection.

R404.4.2 (N1104.4.2) Group R occupancies. Buildings with Group R-2, R-3 and R-4 occupancies shall comply with Section C405.15.

Revise as follows:

TABLE R405.2 (TABLE N1105.2) REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration U-factor and SHGC
Mechanical	
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R404.4	Energy storage infrastructure

a. Reference to a code section includes all the relative subsections except as indicated in the table.

TABLE R406.2 (TABLE N1106.2) REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
General	
R401.2.5	Additional efficiency packages
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
Mechanical	
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R404.4	Energy storage infrastructure
R406.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

Reason: Energy storage will soon become critical to achieving President Biden's goal of a carbon-free power sector by 2035. These systems could also bolster economy, present a cost savings opportunity for homeowners and increase resilience to power outages. In 2020, 21% of the United State's electricity is sourced from renewable energy, primarily wind, an intermittent source of energy. As the U.S. increases the amount of electricity generated from renewables, buildings must be prepared to aid in this transition by storing energy to match grid demands.
Policies to encourage energy storage will improve the U.S. economy. Energy storage is expected to grow by over 40% each year until 2025 and the U.S., because of its manufacturing background and experience in battery-storage technology for cars is becoming a clear leader in this market.

Energy storage will also present a cost-saving opportunity for homeowners. Battery prices have and will likely continue to fall in the United States, meaning that behind-the-meter storage will likely become more accessible and affordable in the short-term. More and more utilities are moving beyond voluntary programs and are expanding use of time-of-use rates for electricity as a tool for shaping demand. Ensuring homes are energy-storage ready now will allow them to cost effectively install storage systems in the future and take advantage of these voluntary programs.Finally, energy storage will improve resilience to power outages. In 2020, DOE found that an average household in the United States goes without power for 8 hours in a year. Because of extreme weather events caused by climate change, those outages are increasing. These outages are estimated to cost the U.S. economy between $25 billion to $70 billion annually. Requiring homes to be storage-ready will ensure communities are more resilient by allowing buildings to cost effectively install storage which can operate for a short-period of time without relying on the electricity grid.

Infrastructure for energy storage language has been adapted from Appendix CB Solar-Ready Zone into the main body of the residential energy code. This language includes revisions from the 2019 Group B Public Comment that were not incorporated into the final text of the 2021 IECC but modified the language to ensure needed correlation with the IFC and NFPA. Single and two family dwellings are subject to a prescriptive based sizing requirement, while low-rise multifamily buildings will be asked to refer to commercial guidelines. Additional language is provided for construction documents, inspections, and to make this requirement mandatory across all compliance paths.

Bibliography: “Battery Storage Paves Way for a Renewable-Powered Future.” *International Renewable Energy Agency*, www.irena.org/newsroom/articles/2020/Mar/Battery-storage-paves-way-for-a-renewable-powered-future.
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Campbell, Richard. *Weather-Related Power Outages and Electric System Resiliency*, 28 Aug. 2012, https://sgp.fas.org/crs/misc/R42696.pdf.

Economic Benefits of Increasing Electric Grid Resilience to Weather Outages, U.S. Department of Energy and President's Council of Economic Advisors, Aug. 2013, https://www.energy.gov/sites/prod/files/2013/08/f2/Grid%20Resiliency%20Report_FINAL.pdf.

Cost Impact: The code change proposal will increase the cost of construction.
Commercial analysis for a similar measure showed no incremental costs. Some costs are expected on residential. Overall savings potential impacts are outlined in reason statement - costs of outages and other grid infrastructure are passed on to consumers, it just isn't as recognizable on an energy bill. Measure will also allow consumers the ability to install energy storage in the future, removing retrofit costs, and allowing homeowners to have resiliency onsite, which have quantifiable health, wellness, and comfort co-benefits.

REPI-9-21

IECC®: R105.2, R105.2.1, R105.2.2, R105.2.3 (New), R105.2.3, R105.2.4, R105.2.5

Proponents:

Aaron Gary, representing Seft (aaron.gary@texenergy.org)

2021 International Energy Conservation Code

Revise as follows:
R105.2 Required inspections.
The *code official* or his or her designated agent, upon notification, shall make the inspections set forth in Sections R105.2.1 through R105.2.6 ~~R105.2.5~~.
R105.2.1 Footing and foundation inspection.
Inspections associated with footings and foundations shall verify compliance with the code as to *R*-value, location, thickness, depth of burial and protection of insulation as required by the code and *approved* plans and specifications.
Revise as follows:
R105.2.2 Framing and air-barrier rough-in inspection.
Inspections at framing and air-barrier rough-in shall be made before application of insulation~~interior finish~~ and shall verify compliance with the code as to: ~~types of insulation and corresponding *R*-values and their correct location and proper installation; fenestration properties such as *U*-factor and SHGC and proper installation;~~ air leakage controls as required by the code; and *approved* plans and specifications.
Add new text as follows:
R105.2.3 Insulation and fenestration rough-in inspection.

Inspections at insulation and fenestration rough-in shall be made before application of interior finish and shall verify compliance with the code as to: types of insulation and corresponding R-values and their correct location and proper installation; fenestration properties such as U-factor and SHGC and proper installation.

Revise as follows:
R105.2.4 ~~R105.2.3~~ Plumbing rough-in inspection.
Inspections at plumbing rough-in shall verify compliance as required by the code and *approved* plans and specifications as to types of insulation and corresponding *R*-values and protection, and required controls.
R105.2.5 ~~R105.2.4~~ Mechanical rough-in inspection.

Inspections at mechanical rough-in shall verify compliance as required by the code and *approved* plans and specifications as to installed HVAC equipment type and size, required controls, system insulation and corresponding *R*-value, system air leakage control, programmable thermostats, dampers, whole-house ventilation, and minimum fan efficiency.

Exception: Systems serving multiple dwelling units shall be inspected in accordance with Section C105.2.4.

R105.2.6 ~~R105.2.5~~ Final inspection.
The *building* shall have a final inspection and shall not be occupied until *approved*. The final inspection shall include verification of the installation of all required *building* systems, equipment and controls and their proper operation and the required number of high-efficacy lamps and fixtures.

Reason Statement:

In many cases the inspection of the air-sealing of the air-barrier is greatly obstructed by the presence of insulation in the thermal envelope at the time of inspection. As such, it has become common practice to separate the inspection of the framing and air-barrier from the insulation and fenestration during rough-in. Codifying this current best practice creates a more enforceable and verifiable code.

Cost Impact:

The code change proposal will increase the cost of construction.

As the separation of the air barrier and insulation inspection is already common practice in many locations for practical reasons, codifying this inspection practice should not significantly increase the cost of construction, if at all.

REPI-9-21

REPI-10-21

IECC®: R105.4, R105.4.1 (New), R105.4.2 (New), R105.4.3 (New)

Proponents:

Robby Schwarz, BUILDTank, Inc., representing Colorado Chapter of the ICC (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:
R105.4 Approved third-party inspection agencies.
The *code official* is authorized to accept reports of third-party inspection agencies not affiliated with the *building* design or construction, provided that such agencies are *approved* as to qualifications and reliability relevant to the *building* components and systems that they are inspecting or testing, and authorization is given prior to issuance of the building permit.
Add new text as follows:
R105.4.1 Authorization of approved third- party inspection agency.

When authorized, the third-party inspection agency shall have powers as delegated, as deputies of the authority having jurisdiction, per section R103.3 of the *International Residential Code* to pass or fail inspection.

R105.4.2 Approved third-party inspections scope.

The authority having jurisdiction shall determine and delegate compliance verification measures the third-party inspection agency shall perform.

R105.4.3 Approved third-party inspections reporting.

The approved agency shall submit inspection reports to the authority having jurisdiction and to the owner's representative in accordance with *International Residential Code* Section R104.4 before the Certificate of Occupancy can be issued.

Reason Statement:

In relation to the International Energy Conservation Code, third-party inspection agencies and building officials currently have a variety of ideas regarding what should constitute the work of the agency. For the ERI path, for example, many Raters understand that they must develop an ERI score, but do not fully understand their relationship to inspection of other requirements in the IECC. Jurisdictions having authority, are often either abdicating inspections or believe that Rater's are looking at mandatory inspection items. In addition, the creation of a HERS Index score is different from the creation of an ERI score. A HERS Index score is an asset rating which allows for the derating of the R-value of poorly installed insulation in the energy model, as the objective is to benchmark the energy performance of the home on the HERS Index scale. An IECC ERI evaluation of the installation of Insulation does not allow for the deration of poorly installed insulation. If insulation is not installed in accordance with the manufactures instruction and the guidance given in Table R402.4.1.1, then the installation should fail inspection and be reinstalled until it meets the mandatory requirement of the code. This disconnect in understanding is the genesis of this code change proposal.

There are three aspects of the relationship that are specifically troublesome within the context of IECC enforcement and which this proposal addresses.

1. Assurance that a transfer of authority is established so that a third-party inspection agency is authorized to fail or pass the inspections they perform and that the party being inspected clearly understands that authority.

2. The code official must clearly establish what is needed from the third-party inspection agency. R105.4.2 above has been significantly changed to address concerns revealed during the 2021 code development cycle. Now the section establishes a scope of work thus requiring the code official to dictate the nature of the scope of work needed.

3. Lastly, anything inspected by a third-party agency must be reported to the code official and the owner's representative

The clarity gained in the relationship between the authority having jurisdiction and the approved third-party inspection agency is crucial as we progress into more complicated and meaningful energy codes. Nationally, jurisdictions are losing experienced professionals to retirement. Consequently, more third-party inspection agencies are stepping in to fill the gap. These third-party inspection agencies tend to be solely focused on energy and are capable, and eager to work in the energy code compliance niche. They are filling a need for jurisdictions that are either under staffed or lack a desire to fully enforce the energy components of the code. This proposal clearly defines a path forward to meet the need by defining scope and responsibilities to better ensure compliance and thus achieve expected energy savings.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not increase cost but better allocates dollars currently being spent to ensure that the job being undertaken by approved third party inspection agencies truly meets the needs of the authority having jurisdiction.

REPI-10-21

REPI-11-21

IECC®: SECTION 202 (New), R303.1.1

Proponents:

Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Add new definition as follows:
R202

ENCLOSED REFLECTIVE AIR SPACE

.

An unventilated cavity with a low-emittance surface bounded on all sides by building components.

R202

REFLECTIVE INSULATION

.

A material installed in an assembly consisting of one or more enclosed reflective air spaces with a surface emittance of 0.1 or less.

Revise as follows:
R303.1.1 (N1101.10.1) Building thermal envelope insulation.

An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation that is 12 inches (305 mm) or greater in width. Alternatively, the insulation installers shall provide a certification that indicates the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown-in or sprayed fiberglass and cellulose insulation, the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be indicated on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered and the *R*-value of the installed thickness shall be indicated on the certification. For reflective insulation, the number of reflective sheet(s), the number and thickness of the enclosed reflective air space(s) and the R-value for the installed assembly, shall be listed on the certification. For insulated siding, the *R*-value shall be on a label on the product's package and shall be indicated on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

Exception: For roof insulation installed above the deck, the *R*-value shall be labeled as required by the material standards specified in Table 1508.2 of the International Building Code or Table R906.2 of the International Residential Code, as applicable.

Reason Statement:

The section at present incorporates requirements that are specific to blown or sprayed fiberglass, cellulose insulation and sprayed polyurethane foam insulation together with general requirements for thermal envelope insulation materials. However, the code is silent on reflective insulations.

The proposal adds specific requirements similar to those for the other insulation materials (as well as appropriate definitions) for a type of material, (reflective insulation) that has been in the market place for over 35 years and has had nationwide distribution and installation. These products are well established and have two associated ASTM Standards, ASTM C727, Standard Practice for Installation and Use of Reflective Insulation in Building Constructions, and ASTM C1224,Standard Specification for Reflective Insulation for Building Applications.

The U.S. Department of Energy's website on weatherizing homes: https://www.energy.gov/energysaver/weatherize/insulation/types-insulation includes the advantages of reflective insulation systems. It states that reflective systems are most effective in preventing downward heat flow but that the effectiveness depends on spacing. This is the critical reason this code change is needed.

Many states and jurisdictional codes already include references on reflective insulation; the list follows:

IBC 2021

- Section 720 Thermal- and Sound-Insulating Materials
- Section 2614 Reflective Plastic Core Insulation

2020 Florida Building Code, Energy Conservation, 7th Edition

- R303.1.1 Building thermal envelope insulation
- Table R303.2.1 Insulation Installation Standards
- R303.2.1.2 Substantial contact

2020 Florida Building Code, Building, 7th Edition

- Section 720 Thermal- and Sound-Insulating Materials
- Section 2614 Reflective Plastic Core Insulation

2020 Minnesota Building Code

- Section 720 Thermal- and Sound-Insulating Materials
- Section 2614 Reflective Plastic Core Insulation
- Thermal Insulation Standards 2020, Section 7640.0130, Subpart 7

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will not increase the cost of construction because only information regarding reflective insulation is being added.

REPI-11-21

REPI-12-21

IECC®: R303.1.1

Proponents:

Robert DeVries, representing Self (rdevries@nuwool.com)

2021 International Energy Conservation Code

Revise as follows:
R303.1.1 (N1101.10.1) Building thermal envelope insulation.

An *R*-value identification mark shall be applied by the manufacturer to each piece of *building thermal envelope* insulation that is 12 inches (305 mm) or greater in width. Alternatively, the insulation installers shall provide a certification that indicates the type, manufacturer and *R*-value of insulation installed in each element of the *building thermal envelope*. For blown-in or sprayed fiberglass and cellulose insulation, the initial installed thickness, settled thickness, settled *R*-value, installed density, coverage area and number of bags installed shall be indicated on the certification. For sprayed polyurethane foam (SPF) insulation, the installed thickness of the areas covered, the density and the *R*-value of the installed thickness shall be indicated on the certification. For insulated siding, the *R*-value shall be on a label on the product's package and shall be indicated on the certification. The insulation installer shall sign, date and post the certification in a conspicuous location on the job site.

Exception: For roof insulation installed above the deck, the *R*-value shall be labeled as required by the material standards specified in Table 1508.2 of the International Building Code or Table R906.2 of the International Residential Code, as applicable.

Reason Statement:

As with the other insulation types listed in this section the installed density of the spray foam can indicate if the material is within specification for the R-Value listed for the material.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Since the determination of density is already required for other materials there should be no cost associated with determining the density of another.

REPI-12-21

REPI-13-21

IECC®: SECTION 202 (New), R303.1.1.2 (N1101.10.1.2) (New), ASTM Chapter 06 (New)

Proponents:

Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Add new definition as follows:
R202

RADIANT BARRIER

.

A material having a low emittance surface of 0.1 or less installed in building assemblies.

Add new text as follows:
R303.1.1.2 (N1101.10.1.2) Radiant barrier.

Where installed, radiant barriers shall comply with the requirements of ASTM C1313/C1313M.

Add new standard(s) as follows:

ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

C1313/C1313M-13(2019) Standard Specification for Sheet Radiant Barriers for Building Construction Applications

Reason Statement:

This proposal DOES NOT require the use of radiant barriers. But rather requires that WHEN radiant barriers are used, they comply with the appropriate ASTM standard. Furthermore this proposal provides important information to the code user and code enforcement community regarding radiant barriers.

The definition for Radiant Barrier is included in the 2021 IBC.

Radiant barriers are typically installed in attics to reduce summer heat gains through the roof. According to the DOE's website: https://www.energy.gov/energysaver/weatherize/insulation/radiant-barriers, Radiant barriers help to reduce cooling costs by reducing radiant heat gain. To be effective, radiant barriers are very dependent of their installationbecause their reflective surface must face an air space.

Radiant barriers follow two ASTM Standards – ASTM C1313/C1313M, "Standard Specification for Sheet Radiant Barriers for Building Construction Applications," and ASTM C1743, "Standard Practice for Installation and Use of Radiant BarrierSystems (RBS) in Residential Building Construction".

The proposed language is being included in this section specifically because the American Society for Testing andMaterials (ASTM) classifies radiant barriers as thermal insulation. The ASTM committee C16 on Thermal Insulation includespublished standards for this product. Subcommittee C16.21 deals specifically with reflective products, which include reflective insulation, radiant barrier and interior radiation control coatings. C16.21 develops standards and practices for these reflective building material thermal insulating products.

Radiant barrier products include a surface with an emittance of 0.1 or less that is installed in roof assemblies or attics with the low-emittance surface facing an open or ventilated air space. The low emittance material can be bonded to plastic film, woven fabric, reinforced paper, OSB or plywood. The thermal performance of radiant barriers depends on emittance and location in the attic, wall or roof assembly. Radiant barriers are predominantly installed in attic spaces below the roof deck. The low-emittance surface of radiant barrier products dramatically reduces the heat gain by radiation into the structure and attic HVAC ducts. For this reason, radiant barriers are especially effective in warm sunny climates where they provide reduced use of air conditioning. Radiant barrier products that are available include single-sheet material, multi-layer assemblies and wood sheathing with attached aluminum film or foil. The single sheet material is installed in roof assemblies by attaching directly to the roof deck, in between the rafters or trusses or to the underside of the rafters or trusses. The foil-faced sheathing is installed with the low-emittance side of the sheathing or panel facing toward the attic space to create a radiant barrier. Attic radiant barriers are in extensive use. These products have been on the market for several decades and are used by 87 of the top 100 US Builders. They have an established history and have been accepted into several regional code requirements. Over one billion square feet of the product is being installed annually.

IBC 2021

- Section 1510, Radiant Barriers Installed Above Deck

Hawaii Title 3, Chapter 181.1 2015

- Section 407.2 Requirements
- Table 407.1 Points Option

Texas

- City of Austin Ordinance No. 20210603-055, City Code Chapter 12-25, Article 12, R402.6

2020 Florida Building Code, Energy Conservation, 7th Edition

- R405.7.1 Installation criteria for homes claiming the radiant barrier option
- Figure R405.7.1 Acceptable attic radiant barrier configurations
- Table 303.2.1 Insulation Installation Standards

2019 California Title 24, Part 6

- Section 100.1 Definitions
- Section 110.8 Mandatory requirements for insulation, roofing products and radiant barriers

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will not increase the cost of construction because it only adds informational language regarding radiant barriers.

REPI-13-21

REPI-14-21

IECC®: R303.1.4.1

Proponents:

Robert DeVries, representing Self (rdevries@nuwool.com)

2021 International Energy Conservation Code

Add new standard(s) as follows:
R303.1.4.2 (N1101.10.4.2) Insulating foam plastic.
The thermal resistance, *R*-value, of insulated siding shall be determined in accordance with ASTM C1303. Installation for testing shall be in accordance with the manufacturer's instructions.

Reason Statement:

It is critical to have the correct and relevant data when calculating energy savings of thermal insulation.

Bibliography:

See section 5 of the attached ASTM test method for information on LTTR

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

These tests are industry standards

REPI-14-21

REPI-15-21

IECC®: SECTION 202 (New), CHAPTER 4 [RE], SECTION R401, R401.4 (IRC N1101.15) (New), R401.4.1 (IRC N1101.15.1) (New), R401.4.2 (New), R401.4.3 (IRC N1101.15.2) (New), TABLE R401.4.3 (IRC N1101.15.2) (New), R401.4.4 (IRC N1101.15.3) (New)

Proponents:

Emily Kelly, representing ChargePoint (emily.kelly@chargepoint.com)

2021 International Energy Conservation Code

Add new definition as follows:
R202 ELECTRIC VEHICLE. An automotive-type vehicle for on-road use primarily powered by an electric motor that draws current from an onboard battery charged through a building electrical service, *Electric Vehicle Supply Equipment* (EVSE), or another source of electric current.
R202 ELECTRIC VEHICLE ENERGY MANAGEMENT SYSTEMS. A system to control electric vehicle supply equipment electrical loads comprised of monitor(s), communications equipment, controller(s), timer(s) and other applicable devices.
R202 ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE).

The apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *Electric Vehicle*.

R202 EV-READY SPACE. A designated parking space that features an electrical branch circuit terminating in a junction box or receptacle for *Level 2 Electric Vehicle Supply Equipment* located in close proximity to the proposed location of the EV parking space.
R202 LEVEL 2 ELECTRIC VEHICLE SUPPLY EQUIPMENT. *Electric Vehicle Supply Equipment* capable of providing AC Level 2 EV charging, as defined by the standard SAE J1772.

CHAPTER 4 [RE] RESIDENTIAL ENERGY EFFICIENCY

SECTION R401 GENERAL
Add new text as follows:
R401.4 (IRC N1101.15) Electric Vehicle Charging.

Where parking is provided, new construction shall provide electric vehicle spaces in compliance with Sections R401.4.1 through R401.4.4 (IRC N1101.15.1 through IRC N1101.15.3).

Exception: This section does not apply to parking spaces used exclusively for trucks or delivery vehicles.
R401.4.1 (IRC N1101.15.1) New single family, two-family, and townhome dwelling units with parking accessible exclusive to that dwelling unit.

Single family, two-family and townhome dwelling units with parking accessible exclusively to that dwelling unit shall provide not less than one *EVSE-Installed* or *EV-Ready* space per dwelling unit.

R401.4.2 New multifamily dwellings with shared parking areas.

All residential parking in multifamily dwellings with shared parking areas shall be *EVSE-Installed* or *EV-Ready* Spaces.

R401.4.3 (IRC N1101.15.2) EV Charging Performance Requirements.

Electric Vehicle Energy Management Systems may be used to control electric vehicle loads for *EV-Ready* or *EVSE-Installed* spaces, subject to the performance requirements in Table R401.4.3 (IRC N1101.15.2)

TABLE R401.4.3 (IRC N1101.15.2)

EVSE-INSTALLED AND EV-READY PERFORMANCE REQUIREMENT

Circuit Breaker Amerage	Maximum Number of EV-Ready Performance Requirements
20A	1
30A	1
40A	3
50A	4

60A	5
70A	6
80A	8
90A	9
100A	10
125A	12

R401.4.4 (IRC N1101.15.3) Identification.

Construction documents shall indicate the branch circuit termination point and proposed location of future EV spaces and EVSE. Construction documents shall also provide information on amperage of future EVSE, raceway methods, wiring schematics, *Electric Vehicle Energy Management Systems*, and electrical load calculations to verify that the electrical panel service capacity and electrical system, including any on-site distribution transformers, have sufficient capacity to simultaneously charge all EVs at all required EV spaces.

Staff Note: Proponent unable to provide required copies prior to printing of monograph.

Reason Statement:

The U.S. transportation sector accounted for 29 percent of the nation's greenhouse gas (GHG) emissions in 2019. As a signatory to the Paris Climate Agreement, the USA has adopted the goal of limiting global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. Achieving this goal will require that the overwhelming majority of passenger vehicles be zero emissions electric vehicles by the 2040s, well within the lifetime of buildings that will be constructed to the 2024 IECC – see e.g. (Princeton University, 2020). In August of this year, the U.S administration released an Executive Order that one-half of all new vehicles sold in 2030 to be zero-emissions vehicles, including battery electric and plug-in hybrid electric vehicles (EVs); many states are pursuing yet more aggressive targets. EV battery prices are declining rapidly, and passenger EVs are expected to reach first cost parity (without subsidies) with traditional internal combustion engine vehicles (ICEVs) by the mid-2020s, and decline below ICEVs thereafter (International Council on Clean Transportation, 2019).

To facilitate adoption of EVs, it is critical that drivers have access to convenient, cost-effective EV charging. More than 80% of EV charging in the USA currently occurs at home, and it is projected that into the future, the most convenient, cost-effective means of providing charging will be household's home assigned parking space (if households have access to onsite parking at their residence), or at work. Additionally, some drivers will make use of publicly accessible EV charging infrastructure located at amenities they regularly visit (e.g. retail, assembly uses, etc.) – see e.g. (International Council on Clean Transportation, 2021).

It is very costly and complicated to renovate EV charging infrastructure into existing multifamily buildings. Therefore, new construction should be future-proofed for the near-universal EV adoption necessary in the coming decades. If parking is provided as part of new residential developments, the greatest societal value can be realized by ensuring each households' onsite parking space is "EV Ready" (I.e. parking that features an adjacent electrical outlet at which "AC Level 2" electric vehicle supply equipment [EVSE] can be easily installed in the future). Likewise, significant portions of workplace parking and publicly accessible parking in commercial developments should be made EV Ready.

100% EV Ready residential parking new construction requirements are the best practice in North America. The City of Vancouver and 16 other communities in British Columbia, Canada, have adopted 100% EV Ready requirements for multifamily buildings, as has the City of Toronto, Canada, in "Tier 2" of its Toronto Green Standard Version 4. Similar requirements are being considered by multiple other cities across North America. In 2019, Natural Resources Canada submitted 100% residential EV Ready requirements for inclusion in the model Canadian National Energy Code for Buildings (NECB); changes to appropriate objectives statement in the NECB are currently being pursued to enable these requirements.

High levels of EV Ready parking can be realized cost-effectively in new developments by allowing designs to use of EV energy management systems (EVEMS, i.e. automatic load management systems, systems to monitor and control of EV charging). EVEMS can facilitate load sharing across branch circuits, sharing at the electrical panel level, electrical service monitoring and associated control of EVSE, and other forms of controlling EVSE loads. The Canadian jurisdictions that have adopted 100% EV Ready requirements allow for reasonable levels of load sharing across branch circuits, as well as other EVEMS strategies (e.g. panel sharing, service monitoring, etc.). Allowing for appropriate use of load sharing between EV Ready parking spaces significantly reduces the electrical capacity required to provide for 100% EV Ready parking, and associated costs for new developments. Providing a maximum limit on load sharing across branch circuits ensures that all drivers will receive a reasonable quality of EV charging. Jurisdictions will typically establish performance requirements intended to ensure that drivers receive full overnight charge (residential uses) or full day-time charge (workplace parking) the vast majority of the time. Appropriate performance requirements vary with geography, depending on how far households typically drive, climate, and other factors – for explanation of these factors see: (Chandler, 2020). The charging performance requirements in the proposed Tables R401.4.3 and C401.4.2 are anticipated to be adequate for many suburban geographies. More sharing may be possible in central cities, where on average vehicles travel shortly total distances daily. Conversely, less sharing may be appropriate for areas where vehicles drive relatively far and/or are relatively inefficient/large.

Several costing studies performed for Canadian jurisdictions suggest that the proposed requirements can be achieved for approximately $1000 USD per parking space (ChargePoint and AES Engineering is currently coordinating with these jurisdictions, requesting they provide permission to share the results of these studies). These studies suggest retrofit costs of 3 to 4 times greater per parking space, emphasizing the importance of EV Ready new construction.

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Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Several costing studies performed for Canadian jurisdictions suggest that the proposed requirements can be achieved for approximately $1000 USD per parking space (ChargePoint and AES Engineering is currently coordinating with these jurisdictions, requesting they provide permission to share the results of these studies). These studies suggest retrofit costs of 3 to 4 times greater per parking space, emphasizing the importance of EV Ready new construction.

REPI-15-21

REPI-16-21

IECC®: R401.2, R401.2.5 (N1101.13.5) (New), SECTION R408 (IRC N1108) (New), R408.1 (IRC N1108.1) (New), R408.2 (IRC N1108.2) (New), R408.3 (IRC N1108.3) (New), TABLE R408.3 (IRC N1108.3) (New), R408.4 (IRC N1108.4) (New), R408.4.1 (IRC 1108.4.1) (New), SECTION R408

Proponents: Greg Johnson, representing Johnson & Associates Consulting Services (gjohnsonconsulting@gmail.com)

2021 International Energy Conservation Code

Revise as follows:

R401.2 (N1101.13) Application . Residential buildings shall comply with Section R401.2.5 or R401.2.6 and either Sections R401.2.1, R401.2.2, R401.2.3 or R401.2.4.

Exception: Additions, *alterations*, repairs and changes of occupancy to existing buildings complying with Chapter 5.

Add new text as follows:

R401.2.5 (N1101.13.5) Simplified Equivalent Compliance Alternative Option. The Simplified Equivalent Compliance Alternative Option requires compliance with Section R408.

SECTION R408 (IRC N1108)
SIMPLIFIED EQUIVALENT COMPLIANCE ALTERNATIVE

R408.1 (IRC N1108.1) Scope. This section establishes criteria for compliance using heating and cooling load analysis.

R408.2 (IRC N1108.2) Requirements. Compliance with this section requires that the provisions identified in Sections R103.2, R401.3, R403.5, R403.8, R403.9, R403.10, R403.11, and R404.1 be met.

R408.3 (IRC N1108.3) Equivalent envelope load. The ratio of the envelope loads to *conditioned floor area* shall be less than or equal to the values in Table R408.3. Heating and cooling loads shall be calculated in accordance with ACCA Manual J Block Load method.

TABLE R408.3 (IRC N1108.3) COOLING AND HEATING LOAD PER SQUARE FOOT

CLIMATE ZONE	COOLING LOAD PER SQUARE FOOT	HEATING LOAD PER SQUARE FOOT
0	10.1 Btuh	3.1 Buh
1	8.9 Btuh	4.6 Btuh
2	11.6 Btuh	7.3 Btuh
3A and 3B	6.5 Btuh	8.5 Btuh
4A and 4B	7.6 Btuh	8.8 Btuh
3C	3.3 Btuh	5.8 Btuh
4C	6.0 Btuh	7.1 Btuh
5	7.0 Btuh	11.4 Btuh
5C	TBD	TBD
6	5.5 Btuh	11.6 Btuh
7	4.9 Btuh	13.1 Btuh
8	4.0 Btuh	18.1 Btuh

R408.4 (IRC N1108.4) Air leakage. The *building* or dwelling unit shall be tested and verified as having an air leakage rate not exceeding the design infiltration rate in the load calculations. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official.* Testing shall be peformed at any time after creation of all penetrations of the *building thermal envelope.*
During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

R408.4.1 (IRC 1108.4.1) Duct leakage. Ducts shall be tested in accordance with R403.3.5 and R403.3.6.

Revise as follows:

SECTION ~~R408~~ R409
ADDITIONAL EFFICIENCY PACKAGE OPTIONS

Reason:
This is a similar proposal to what was submitted in the previous cycle which was approved by the committee. This language includes the slight modification made by the committee during the hearing as well as other revisions that address feedback through the 2019 process. The committee stated that "this is a clean simple compliance path, it increases flexibility by adding another option, focuses not on materials but efficiency. The modifications clarified that the language applies to envelope load, and it does not impact equipment efficiencies or lighting, corrected the citation, and added as mandatory the certificate."

The concept of the proposal is to simplify the residential energy code by providing another compliance path that regulates the use andconservation of energy by creating an energy budget of a certain btu/sqft. for each climate zone. It is an alternative way of measuring energy use than the prescriptive path which prescribes specific envelope components.

The modeling used to formulate this proposal is consistent with PNNL protocol. However, because the cost-effective criteria has not yet been developed, nor has the energy savings threshold been established for this cycle, the values contained in this proposal have been left at the levels proposed during the 2019 cycle. This will allow the newly formed IECC committee to be able to determine what the 2024 code levels should be.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

This proposal just adds another compliance path as an option. This option provides the most flexibility than any of the other paths and may in fact lower the cost of construction.

REPI-17-21

IECC®: SECTION 202 (New), R401.2, R401.3, R402.4.4, R404.1.2, R408.2.2, R408.2.3

Proponents:

Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Chris Castro, representing City of Orlando; Brad Smith, representing City of Fort Collins (brsmith@fcgov.com)

2021 International Energy Conservation Code

Add new definition as follows:

R202 ALL-ELECTRIC BUILDING. A building that contains no combustion equipment, or plumbing for combustion equipment, installed within the building, or building site.

R202 APPLIANCE. A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

R202 COMBUSTION EQUIPMENT. Any equipment or appliance used for space heating, service water heating, cooking, clothes drying, or lighting that uses fuel gas or fuel oil.

R202 EQUIPMENT. Piping, ducts, vents, control devices and other components of systems other than appliances that are permanently installed and integrated to provide control of environmental conditions for buildings. This definition shall also include other systems specifically regulated in this code.

Revise as follows:

R401.2 (N1101.13) Application .

Residential buildings shall be all-electric buildings and shall comply with Section R401.2.5 and either Sections R401.2.1, R401.2.2, R401.2.3 or R401.2.4.

Exception: Additions, *alterations*, repairs and changes of occupancy to existing buildings complying with Chapter 5.

R401.3 (N1101.14) Certificate.

A permanent certificate shall be completed by the builder or other *approved* party and posted on a wall in the space where the furnace is located, a utility room or an *approved* location inside the *building*. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory *label*, service disconnect *label* or other required labels. The certificate shall indicate the following:

1. The predominant *R*-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, *basement walls*, *crawl space walls* and floors and ducts outside *conditioned spaces.*
2. *U*-factors of fenestration and the *solar heat gain coefficient* (SHGC) of fenestration. Where there is more than one value for any component of the building envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.
3. The results from any required duct system and building envelope air leakage testing performed on the building.
4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment. Where a ~~gas-fired unvented room heater,~~ electric furnace or baseboard electric heater is installed in the residence, the certificate shall indicate ~~“gas-fired unvented room heater,”~~ “electric furnace” or “baseboard electric heater,” as appropriate. An efficiency shall not be indicated for ~~gas-fired unvented room heaters,~~ electric furnaces and electric baseboard heaters.
5. Where on-site *photovoltaic panel* systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.

6. For buildings where an Energy Rating Index score is determined in accordance with Section R406, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate.

7. The code edition under which the structure was permitted and the compliance path used.

Delete without substitution:

~~R402.4.4 Rooms containing fuel-burning appliances~~.

~~In Climate Zones 3 through 8, where open combustion air ducts provide combustion air to open combustion fuel-burning appliances, the appliances and combustion air opening shall be located outside the *building thermal envelope* or enclosed in a room that is isolated from inside the thermal envelope. Such rooms shall be sealed and insulated in accordance with the envelope requirements of Table R402.1.3, where the walls, floors and ceilings shall meet a minimum of the *basement wall R*-value requirement. The door into the room shall be fully gasketed and any water lines and ducts in the room insulated in accordance with Section R403. The combustion air duct shall be insulated where it passes through *conditioned space* to an *R*-value of not less than R-8.~~

~~**Exceptions:**~~

1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside.

2. Fireplaces and stoves complying with Section R402.4.2 and Section R1006 of the International Residential Code.

Revise as follows:

R404.1.2 (N1104.1.2) Fuel gas lighting equipment.

Fuel gas lighting systems shall not be permitted ~~have continuously burning pilot lights~~.

R408.2.2 (N1108.2.2) More efficient HVAC equipment performance option.
Heating and cooling *equipment* shall meet one of the following efficiencies:

~~1. Greater than or equal to 95 AFUE natural gas furnace and 16 SEER air conditioner.~~

~~2.~~ 1. Greater than or equal to 10 HSPF/16 SEER air source heat pump.

~~3.~~ 2. Greater than or equal to 3.5 COP ground source heat pump.

For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.
R408.2.3 (N1108.2.3) Reduced energy use in service water-heating option.
The hot water system shall meet one of the following efficiencies:

~~1. Greater than or equal to 82 EF fossil fuel service water-heating system.~~

~~2.~~ 1. Greater than or equal to 2.0 EF electric service water-heating system.

~~3.~~ 2. Greater than or equal to 0.4 solar fraction solar water-heating system.

Reason Statement:

In order to meet President Biden’s 2050 goal of reducing greenhouse gas emissions in half by 2030 and achieving net zero carbon emissions by 2050, the United States must not only reduce energy use through energy efficiency and move to utility scale and on-site renewable energy, but also transition away from using combustion equipment in buildings that runs on fossil fuels to electric equipment. In 2020, combustion equipment in commercial and residential buildings accounted for 36% of the United States energy-related greenhouse gas emissions. To meet President Biden’s goal, it is crucial that new homes built today are all-electric so that emissions from these buildings are not “locked-in” by gas-dependent building infrastructure. Reduced carbon emissions was also recently cited as a priority of energy code development by the ICC in their Leading the Way to Energy Efficiency: A Path Forward on Energy and Sustainability to Confront a Changing Climate in 2021. This proposed code amendment seeks to address the carbon impact of homes by requiring all new residential buildings to be all-electric.

Fortunately, heat pump technology has dramatically improved over the last few decades, giving contractors and building owners access to highly efficient electric heating and cooling, and water heating technologies. An Ecotope study of the 2017 Oregon Residential code found that homes heated by electric heat pumps use 40 percent less energy than homes heated with gas (including water heating). Even accounting for reduced efficiency in extreme cold weather, according to a study by RMI, modern air source heat pumps are more than twice as efficient as gas furnaces and can save families up to 9 percent on their utility bills in Climate Zone 6. This is one reason why the U.S. EPA just announced that standards for the most efficient appliances in 2022 certified under the ENERGY STAR program will be all-electric.

All-electric homes are also healthier homes. Gas appliances release harmful pollutants like nitrogen dioxide (NO2) and carbon monoxide (CO) either indoors because of gas stoves or outdoors because of space-heating and water heating equipment. A recent study from the Harvard Chang School of Public Health and RMI shows that in 2017, air pollution from burning fuels in buildings led to an estimated 48,000 to 64,000 early deaths and $615 billion in health impact costs. These emissions can particularly affect children. In a meta-analysis analyzing the connections between gas stoves and childhood asthma, children in homes with gas stoves were 42% more likely to experience asthma symptoms, and 32% more likely to being diagnosed with asthma.

All-electric new construction is also less expensive to build than a home with gas appliances and in the long term will result in fewer retrofit costs for homeowners to meet future policy goals to eliminate all carbon emissions in the U.S. by 2050.

Therefore, building all-electric buildings is critical to reducing air pollution, protecting public health, reducing utility and construction costs, and meeting climate goals. NBI is submitting this amendment along with amendments that address on-site renewables, electric vehicles, and grid integration techniques. These proposed changes to the 2021 IECC, working together, will put the U.S. on the path to a decarbonized, resilient, and healthier future.

To achieve this, the proposal adds key definitions, alters charging language and edits the remaining vestigial language with references to fossil fuels by removing small pieces or whole sections. This clean up will lead to more consistent enforcement and comprehension of the code.

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Dinulescu, Cristina, Cost to Replace Electrical Panel: Factors & Prices. Penna Electric, 27, July 2020, https://pennaelectric.com/electrician-blog/cost-to-replace-electrical-panel-factors-prices/

Cost Impact:

The code change proposal will decrease the cost of construction.

Electric appliances and equipment cost less than gas appliances. Installing all-electric appliances also reduces natural gas infrastructure costs such as gas mains, services and meters. Using data from RSMeans, Grainger, Home Depot, NBI estimates that an all-electric home costs $8,735 less than a home built with natural gas appliances and equipment. A recent analysis by RMI which examined the cost effectiveness of all-electric homes in seven cities across the country from Climate Zone 2A to 6A, found that installing efficient heat pumps in water heating and space-heating compared to standard equipment installed in a mixed-fuel home resulted in life cycle cost savings in every city. Including the cost of more efficient electric equipment, the all-electric home cost on average $2,700 less than a code compliant mixed-fuel home. All-electric homes with efficient heat pumps exhibited on average $107 in lower annual utility costs. The analysis concluded that a homeowner with an all-electric home would save $3,700 over a 15-year analysis period. In addition, all electric homes with efficient heat pumps resulted in carbon emissions savings of between fifty to ninety-three percent in all climate zones. Accounting for the societal benefit carbon emissions would result in increased life cycle cost savings across all climate zones.

NBI also analyzed the cost effectiveness of an all-electric home in New York City (Climate Zone 4A) that met the requirements in NBI's Decarbonization code compared to a code compliant mixed-fuel home that met the requirements of the 2021 IECC. NBI's decarbonization code all-electric home analyzed was solar-ready, EV-ready, utilized a heat pump water heater, demand responsive controls and minimum code compliant HVAC system. These features resulted in reduced cost of $8,357 for a single-family home. Utilizing local time-of-use rates, the all-electric home resulted in equivalent utility costs as the baseline mixed fuel home and positive life cycle cost savings of $14,828 for the consumer over a 30-year analysis period. Life cycle cost savings doubled to $23,934 if the social cost of carbon is included in the analysis.

Finally, neither analysis cited includes the cost of electrical retrofits that will be required of homes that are not all-electric to meet future policy goals of achieving net zero carbon emissions by 2050. Simply upgrading the electrical panel itself to add electrical capacity for new electric appliances can cost a homeowner between $2,650 to $4,500. Adding electrical outlets that can service major appliances so that homeowners can replace a natural gas appliance with an all-electric appliance will also add significant additional costs especially if those appliances are in areas where dry wall must be removed and repaired.

REPI-17-21

REPI-18-21

IECC®: R401.2.1, R401.2.2, R401.2.3, R401.2.5, R408.1, R408.2, TABLE R408.2 (TABLE N1108.2) (New), R408.2.1, R408.2.2 (N1108.2.2) (New), R408.2.2, R408.2.3, R408.2.4, R408.2.5

Proponents:

Mark Lyles, representing New Buildings Institute (markl@newbuildings.org); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

R401.2.1 (N1101.13.1) Prescriptive Compliance Option.

The Prescriptive Compliance Option requires compliance with Sections R401 through R404 and R408.

R401.2.2 (N1101.13.2) Total Building Performance Option.

The Total Building Performance Option requires compliance with Section R405 and one of the following:

1. Section R408 without including such measures in the proposed design under Section R405.
2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 90 percent of the annual energy cost of the standard reference design.

R401.2.3 (N1101.13.3) Energy Rating Index Option.

The Energy Rating Index (ERI) Option requires compliance with Section R406 and one of the following:

1. Section R408 without including such measures in the proposed design under Section R405.
2. The Energy Rating Index value shall be at least 10 percent less than the Energy Rating Index target specified in Table R406.5.

R401.2.5 (N1101.13.5) Additional energy efficiency.

~~This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.~~

~~1. For buildings complying with Section R401.2.1, one of the additional efficiency package options shall be installed according to Section R408.2.~~

~~2. For buildings complying under with Section R401.2.2 , the building shall meet one of the following:~~

~~2.1. One of the additional efficiency package Options in Section R408.2 shall be installed without including such measures in the proposed design under Section R405; or~~

~~2.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.~~

~~3. For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.~~

The ~~option~~ additional efficiency measures selected for compliance with R408 shall be identified in the certificate required by Section R401.3 and the construction documents as required by Section R103.2.

R408.1 (N1108.1) Scope.

This section establishes additional efficiency ~~package options~~ credits to achieve additional energy efficiency in accordance with Section ~~R401.2.1~~ R401.2.

R408.2 (N1108.2) Additional efficiency credits ~~package options~~.

Additional efficiency ~~package options for compliance with Section R401.2.1 are set forth in Sections R408.2.1 through R408.2.5~~ measures shall be selected from Table R408.2 that meet or exceed ten credits. Each measure selected measure shall meet the relevant subsections of Section R408 and receive credit as indicated in the Table for the specific Climate Zone. Interpolation of credits between measures shall not be permitted.

Add new text as follows:

TABLE R408.2 (TABLE N1108.2) ADDITIONAL EFFICIENCY CREDITS

Measure Number	**Measure Description**	**Credit Value**								
		CZ 0&1	**CZ 2**	**CZ 3**	**CZ 4**	**CZ 4A**	**CZ 5**	**CZ 6**	**CZ 7**	**CZ 8**
R408.2.1 (1)	≥2.5% reduction in total UA	1	1	2	2	2	2	3	4	4
R408.2.1 (2)	≥5% reduction in total UA	3	3	3	3	3	4	5	5	5
R408.2.1 (3)	>7.5% reduction in total UA	5	5	5	5	5	6	7	8	8
R408.2.2 (1)	20% reduction SHGC	4	1	NA	NA	NA	NA	NA	NA	NA
R408.2.2 (2)	0.22 U-factor windows	NA	NA	2	2	2	2	2	3	3
R408.2.3 (1)	High performance cooling system	9	7	3	2	NA	NA	NA	NA	NA
R408.2.3 (2)	High performance gas furnace	NA	2	6	9	10	10	11	12	14
R408.2.3 (3)	High performance heat pump system	NA	NA	3	4	4	5	4	3	3
R408.2.3 (4)	Ground source heat pump	NA	2	4	6	6	8	7	6	5
R408.2.4 (1)	Fossil fuel service water heating system	7	5	4	3	2	2	2	1	1
R408.2.4 (2)	Heat pump water heating system	5	5	5	5	5	5	5	5	5
R408.2.4 (3)	Solar hot water heating system	8	9	9	7	9	6	5	4	3
R408.2.5 (1)	More efficient distribution system	8	8	9	11	8	12	15	17	17
R408.2.5 (2)	100% of ducts in conditioned space	8	8	9	11	8	12	15	17	17
R408.2.6 (1)	2 ACH50 air leakage rate with ERV or HRV installed	2	5	NA	NA	NA	NA	NA	NA	NA
R408.2.6 (2)	1 ACH50 air leakage rate with ERV or HRV installed	2	5	7	9	9	9	10	11	11

Revise as follows:

R408.2.1 (N1108.2.1) Enhanced envelope performance UA ~~option~~.

The total ~~*building thermal envelope*~~ UA of the *building thermal envelope* as designed shall be one of the following: ~~, the sum of *U*-factor times assembly area, shall be less than or equal to 95 percent of the total UA resulting from multiplying the *U*-factors in Table R402.1.2 by the same assembly area as in the proposed building. The UA calculation shall beperformed in accordance with Section R402.1.5, . The area-weighted average SHGC of all glazed fenestration shall be less than or equal to 95 percent of the maximum glazed fenestration SHGC in Table R402.1.2.~~

1. Not less than 2.5% below the total UA of the *building thermal envelope* in accordance with Section R402.1.5.
2. Not less than 5% below the total UA of the *building thermal envelope* in accordance with Section R402.1.5.
3. Not less than 7.5% below the total UA of the *building thermal envelope* in accordance with Section R402.1.5.

Add new text as follows:

R408.2.2 (N1108.2.2) Improved fenestration.

Vertical fenestration shall meet one of the following:

1. 20% reduction in glazed area-weighted average SHGC.
2. Have a U-factor equal to or less than 0.22.

Revise as follows:

R408.2.3 ~~R408.2.2(N1108.2.2)~~ More efficient HVAC equipment performance ~~option~~.

Heating and cooling *equipment* shall meet one of the following efficiencies:

1. Greater than or equal to ~~95 AFUE natural gas furnace and 16~~ 18 SEER and 14 EER air conditioner.
2. Greater than or equal to 95 AFUE natural gas furnace.

3~~2.~~ Greater than or equal to 10 HSPF/16 SEER air source heat pump.

4~~3.~~ Greater than or equal to 3.5 COP ground source heat pump.

For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.
R408.2.4 ~~R408.2.3(N1108.2.3)~~ Reduced energy use in service water-heating ~~option~~.
The hot water system shall meet one of the following efficiencies:

1. Greater than or equal to ~~82 EF~~ 0.91 UEF fossil fuel service water-heating system.

2. Greater than or equal to ~~2.0 EF~~ 2.9 UEF electric service water-heating system.

3. Greater than or equal to 0.4 solar fraction solar water-heating system.

R408.2.5 ~~R408.2.4 (N1108.2.4)~~ More efficient duct thermal distribution system ~~option~~.
The thermal distribution system shall meet one of the following efficiencies:

~~1. 100 percent of ducts and air handlers located entirely within the *building thermal envelope*.~~

1~~2~~. 100 percent of ductless thermal distribution system or hydronic thermal distribution system located completely inside the *building thermal envelope*.

2~~3~~. 100 percent of duct thermal distribution system located in *conditioned space* as defined by Section R403.3.2.

R408.2.6 ~~R408.2.5(N1108.2.5)~~ Improved air sealing and efficient ventilation system ~~option~~.

The measured air leakage rate shall be less than or equal to one of the following:

1. ~~3.0~~ 2.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed.
2. 1.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed.

Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent Sensible Recovery Efficiency (SRE), less than or equal to 1.1 cubic feet per minute per watt (0.03 m^3/min/watt) and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent Latent Recovery/Moisture Transfer (LRMT).

Reason Statement:

This proposal builds on the additional efficiency options in the 2021 IECC by converting those package options into a points-based system similar to the “Additional Efficiency Credits” system in C406 of the commercial section of the energy code. The proposal requires projects to select additional efficiency "credits" equal to achieve a target of 10. There are several options provided, covering all aspects of building performance. The Northwest pioneered the use of the prescriptive residential options that are currently in place in Washington, and formally were used in Oregon, and found them to be an effective method of increasing efficiency for residential construction using the prescriptive approach. This option does not require performance energy modeling or HERS verification which will increase its usefulness. This type of flex points option can also be easily implemented in the U.S. DOE REScheck software. The purpose of this code change proposal is to improve overall residential building efficiency (heating, cooling and water heating energy) by roughly 10% and to create a scalable, flexible means of improving residential building efficiency for future IECC updates. Instead of requiring efficiency improvements to specific building components that are not equal, the new “credit” approach in Section R408 provides a multitude of options for builders that are calibrated to achieve the efficiency requirements of the IECC. This approach is also scalable according to a jurisdiction’s needs – states or localities who need additional energy savings to meet energy or climate policy goals can adjust the number of required credits accordingly. Points-based approaches have been used for several years in Washington and Oregon. This proposal is similar to the Flex Points proposal for the 2021 IECC in overall structure, but the points table has been updated based on the updates included in the 2021 IECC and feedback received. Like the previous version, this proposal also includes alternative compliance pathways for builders who select the simulated performance alternative or the Energy Rating Index (ERI) and will bring roughly equivalent improvements to all three compliance paths.

This additional efficiency credit proposal is cost-effective, since it includes a number of options in every climate zone to achieve 10 points that are cost- effective and will provide three distinct benefits for jurisdictions adopting the 2024 IECC:

1. **This proposal meets a clear need for efficiency improvements in the model energy code now and in the future.** Although the 2021 IECC was determined to be roughly 9% more efficient than the 2018 IECC (PNNL 2021), major gains have plateaued. Buildings still consume an estimated 42% of the nation's energy, 54% of its natural gas, and 71% of its electricity. Governors, legislators, and mayors are increasingly turning to building energy codes to meet energy and climate goals, and those codes should continue to provide reasonable improvements going forward. The U.S. Conference of Mayors, in its fourth consecutive resolution on the subject, reiterated their "concerted support for putting future triennial IECC updates on a "glide path" of steady efficiency gains that will improve the efficiency performance of millions of U.S. residential, multi- family, and commercial buildings." *See* 2018 U.S.C.M. Resolution 86 (June 11, 2018). Several jurisdictions have already created or are in the process of creating package-based compliance paths or improved code provisions to meet their policy needs. The result is improved efficiency, but a lack of consistency in both format and requirements. Incorporating Flex Points into the 2024 IECC will not only provide a 10% boost in energy conservation but will also provide a realistic map for additional improvements going forward. And, by providing more uniform targets for the efficiency of building components, this proposal will contribute to economies of scale, potentially lowering prices for builders and ultimately consumers.
2. **This proposal will provide maximum flexibility for builders to achieve improved efficiency.** Additional efficiency credits trusts that builders and design professionals will select the most cost-effective and sensible efficiency improvements for a given project. There are several alternatives for compliance in each climate zone, along with options to comply in a performance- or rating-based path. There are alternatives related to more insulation, more efficient windows, reduced air and duct leakage and improved equipment. We believe that this approach provides the right incentives for builders to make long-lasting improvements in residential buildings that are in the best interests of homeowners. The credit values were calculated based on the present value of energy cost savings over the 2018 IECC (including relevant federal equipment efficiency standards) and would need to be updated, these values are provided here for reference and reflect the estimated useful life of each measure over an assumed 30-year life of the building. While a 30-year period is consistent with the typical life of a mortgage, it is a very conservative period given the likelihood that some measures will provide efficiency benefits for decades beyond the initial 30-year period. The analysis behind the 2021 IECC proposal , which used the methodology and assumptions included in the U.S. Department of Energy's Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes, including the economic equations to obtain the present value of energy costs within the calculation methodology. The energy consumption calculations take into consideration heating, cooling, and water heating energy, using DOE-2 energy simulation across 105 TMY3 weather locations and 12 building types to account for varying stories, foundations, and fuel types for each of the baseline and upgrade measures. The analysis compares the annual energy savings between a home with and without an efficiency measure over the useful life of the efficiency measure using useful life data from NAHB and other sources. Energy costs were calculated using the most recent national EIA projections for natural gas and electricity.
3. **This proposal will encourage efficiency improvements in building components that are currently difficult to regulate.** Additional efficiency credits addresses two issues that have complicated model energy codes for many years. First, innovative building practices or emerging technologies can benefit from being listed in codes, but states (and national code developing organizations) are reluctant to require new technologies or practices before they are market-tested. As a result, there are high barriers to entry for new technologies, even when they could transform the marketplace and provide energy- or cost-saving benefits for homeowners. As an example, Heat Recovery Ventilators (HRVs) are cost-effective and reasonable for much of the country, but individual circumstances or climate conditions may favor another approach. Rather than require HRVs in every case, or most cases with exceptions, HRVs and Energy Recovery Ventilators are included as one of several options available to builders in every climate zone. Not only will credits create an opportunity for good technology to be used in more buildings, but it will open the door for market forces to make these technologies more widely available (and presumably less expensive). As new technologies or practices become available, these advances can be quickly and easily added into the credit table, fast-tracking technology that is good for consumers. Second, much of the heating, cooling, and water heating equipment installed in residential buildings is subject to federal preemption under the National Appliance Energy Conservation Act. As has been debated at length in ICC Code Development hearings over the last 15 years, including equipment efficiencies in performance trade-offs tends to weaken the efficiency of the energy code, since federal minimum efficiencies for nearly every covered product is well below the efficiency levels of commonly installed products. When these efficiency levels are used in trade-off baselines, builders use the improved efficiency of common heating, cooling, and water heating products as a means of trading away efficiency of more permanent building components and features, even though the equipment would have

been installed anyway. This "free ridership" may provide short-term cost savings for homebuilders, but it saddles homeowners with unexpected high energy costs over the entire useful life of the building. Moreover, this equipment often carries a much shorter useful life, which is not typically captured in code compliance simulations. This credit structure creates a new incentive to improve the efficiency of covered products without resulting in efficiency rollbacks elsewhere in the code. Heating, cooling, and water heating improvements (among others) are included among the Flex Points options with points calculated according to climate-specific energy cost savings and the longevity of the equipment. Each of these upgrades will build upon the current IECC efficiency, rather than trading it away.

In sum, we believe that this proposal will improve efficiency by roughly 10% while unlocking the competitive market for new technologies or building components that are difficult to regulate and will provide a useful new tool for policymakers across the country – all without rolling back the effectiveness or efficiency of the IECC.

Bibliography:

Salcido et al; *Energy Savings Analysis: 2021 IECC for Residential Buildings;* PNNL 2021; available at:https://www.energycodes.gov/sites/default/files/202107/2021_IECC_Final_Determination_AnalysisTSD.pdf

Uniting Cities to Accelerate Focus on the Economic and Climate Benefits of Boosting America's Building Energy Efficiency, 2019 U.S.C.M. Resolution 86 (June 11, 2018), *available at* https://www.usmayors.org/the-conference/resolutions/?category=c9211&meeting=86th%20Annual%20Meeting.

Cost Impact:

The code change proposal will increase the cost of construction.

Requiring additional efficiency measures, such as more insulation, more efficient windows, reduced air leakage and duct leakage, and/or more efficient equipment, to save 10% energy will increase the cost of construction, but the resulting energy and cost savings will recoup the initial costs and will continue to benefit consumers over the useful life of the home. Additionally, the flexibility of this approach allows for the most cost-effective means of meeting the stated ICC energy reduction goals.

REPI-18-21

REPI-19-21

IECC®: R401.2.5

Proponents:

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2021 International Energy Conservation Code

Revise as follows:
R401.2.5 (N1101.13.5) Additional energy efficiency.
This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.

1. For buildings complying with Section R401.2.1, ~~one~~ two of the additional efficiency package options shall be installed according to Section R408.2.
2. For buildings complying under with Section R401.2.2 , the building shall meet one of the following:
   - 2.1. ~~One~~ Two of the additional efficiency package Options in Section R408.2 shall be installed without including such measures in the proposed design under Section R405; or
   - 2.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to ~~95~~ 90 percent of the annual energy cost of the standard reference design.
3. For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least ~~5~~ 10 percent less than the Energy Rating Index target specified in Table R406.5.

The options selected for compliance shall be identified in the certificate required by Section R401.3.

Reason Statement:

The purpose of this code change proposal is to require code users to install two Additional Energy Efficiency Options under Section R408 (instead of one) or achieve a 10% improvement (instead of 5%) under the performance path or ERI. This proposal is intended to improve the efficiency of all residential compliance paths in the *IECC* by roughly 5% or more.

The 2021 *IECC* took an important step forward in residential efficiency by adding an options-based compliance path (section R408) similar to the Additional Efficiency Options that has applied to commercial buildings since the 2012 *IECC* and residential options paths used successfully in states like OR, WA, VT, and DC. Section R408 provides code users with several options for achieving the improved efficiency of the 2021 *IECC*, including simplified packages of improvements or a 5% improvement in either the performance path or ERI path. These changes (which resulted from proposal RE209-19 in the last code cycle) represent the largest efficiency improvement in the 2021 *IECC* and received widespread support among ICC Governmental Member Voting Representatives.

The new framework in Section R408 not only provides significant flexibility in achieving increased energy efficiency, but also facilitates the opportunity for additional improvement in code efficiency in future editions (and in state and local adoptions) by establishing a platform for changes in the number of additional efficiency options required and in the percentage of improvement in performance and ERI paths. This code change proposal builds on this framework by increasing the number of required selections from the Additional Efficiency Options from one to two and would require an additional 5% improvement in the performance path and ERI path. This proposal is a relatively simple and easy approach to gain a substantial improvement in efficiency in this code cycle. To achieve even more efficiency, more of the options and greater improvement to the performance path and ERI could be required.

The technologies included in the Additional Efficiency Package Options are widely available and have been proven feasible in residential buildings. Several options are already included in state-developed options packages, and we expect that these options will be improved and/or additional options will be added to the list in future editions of the *IECC* as additional technologies and building methods become available. However, because several of these measures would be difficult to include in the prescriptive path because of federal preemption of covered products, inapplicability to certain home designs, or other limitations, Section R408 provides these options in a format that allows the *IECC* to take full advantage of the efficiency improvements of these measures, while still allowing broad flexibility to code users. In addition, for projects that would benefit from a performance- or rating-based approach, Section R408 updates these compliance alternatives.

The nation is at a crossroads in its efforts to reduce energy use and the production of greenhouse gases, and it is clearer than ever before that the path to long-term energy security runs through efficient buildings. Buildings consume 42% of the nation's energy, including 54% of the nation's natural gas and 71% of its electricity. Each new building constructed today will either become part of the climate solution or part of the problem for decades. The ICC Board of Directors has revised the Scope and Intent provisions of the *IECC* to include more specific goals, including the requirement that each edition of the *IECC* will provide "increased energy savings over the prior edition." The proposal above makes a straightforward and substantial improvement in the efficiency of (and increased energy savings from) the 2024 *IECC* using the framework adopted in 2021. We urge the Consensus Committee to use the tools available today to lay the groundwork for a more sustainable built environment in the future.

Bibliography:

Pacific Northwest National Laboratory, *National Cost Effectiveness of the Residential Provisions of the 2021 IECC* (June 2021).

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal will increase the cost of construction in many cases by requiring an additional efficiency measure or an additional 5% improvement under the performance path or ERI. The actual cost impact of requiring the additional measure in any given case will vary significantly depending on where the home is located, the compliance path selected, the design and features of the home, and which combination of options is selected by the code user. In some cases, such as locating ducts inside conditioned space, these measures may already be included in the design, and thus would result in no increase in construction cost. In other cases, the cost increase will only be the incremental cost difference, if any, between the efficiency of commonly-installed equipment or components and the efficiency requirement in Section R408. It can also be expected that the costs of certain measures may drop over time due to economies of scale and/or increased experience in installing such measures in homes. Moreover, incremental cost estimates for each measure from various sources are likely to vary substantially. As a result, such cost estimates and analyses based on them are only of limited usefulness at best. Under the approach in Section R408, the code user is considered to be in the best position to select the options or approach that provide the most benefits at the lowest cost to the consumer, but each of the options will result in a substantial reduction in energy costs.

COST-EFFECTIVENESS

Compliance paths with multiple options like Section R408 will result in a broad range of construction cost impacts depending on a series of choices made by the code user, such as the building design and combination of options selected, as well as the climate zone, local market conditions, and other variables. Other assumptions and estimates are also likely to vary significantly. In the end, it would be impossible for a cost-effectiveness analysis to anticipate the full range of options and choices made by a builder to meet the code (particularly when the ERI and performance options are considered), and an over-simplified analysis full of assumptions or a broad summary of cost-effectiveness provides, at best, only limited value.

That said, an analysis for EECC prepared in support of proposal RE209-19 produced a range of cost-effectiveness results for the five measures (based on modeling with NREL's BEopt software). And while the costs and energy savings for specific projects cannot be derived from such a study, a few broad conclusions became apparent:

- On a national weighted-average basis, all five options were life-cycle cost-effective.
- Any two options combined provided a significant increase in energy efficiency and a significant reduction in energy costs for homeowners.

Moreover, if the user does not sufficiently benefit from two of these five options, then the code user may choose to comply through the enhanced ERI or performance path.
The ICC Board of Directors has determined that the 2021 *IECC* is the new baseline for the 2024 *IECC* Standard. This means for purposes of analyzing code proposals, the existing provisions of the 2021 *IECC* are considered cost-effective and reasonable (since they are the starting point for analyses of code changes and no rollbacks are permitted). It should also be noted that US DOE found the entire 2021 *IECC* cost effective, including section R406. *See* Pacific Northwest National Laboratory, *National Cost Effectiveness of the Residential Provisions of the 2021 IECC* (June 2021).

This code change proposal does not introduce any new measures into the code, but simply requires code users to select more than one of the options already written into the baseline code. In any event, since the proposed code change would require the user to choose only two options, it should be sufficient that at least two of the options are cost-effective. Just as the *IECC* does not guarantee that every potential choice made by code users in the performance or ERI paths will be cost-effective, every choice under Section R408 need not be cost-effective.

REPI-19-21

REPI-20-21

IECC®: R401.2.5

Proponents:

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2021 International Energy Conservation Code

Revise as follows:
R401.2.5 (1101.13.5) Additional energy efficiency.
This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.

1. For buildings with not more than 5,000 square feet (465 m^2) of conditioned floor area complying with Section R401.2.1, one of the additional efficiency package options shall be installed according to Section R408.2.

2. For buildings with more than 5,000 square feet (465 m^2) of conditioned floor area complying with Section R401.2.1, two of the additional efficiency package options shall be installed according to section R408.2.

~~2~~ 3. For buildings with not more than 5,000 square feet (465 m^2) of conditioned floor area complying with Section R401.2.2, the building shall meet one of the following:
   - ~~2.1~~ 3.1. One of the additional efficiency package options in Section R408.2 shall be installed without including such measures in the proposed design under Section R405; or
   - ~~2.2~~ 3.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.

4. For buildings with more than 5,000 square feet (465 m^2) of conditioned floor area complying with Section R401.2.2, the building shall meet one of the following:
   - 4.1. Two of the additional efficiency package options in Section R408.2 shall be installed without including such measures in the proposed design under Section R405; or
   - 4.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 90 percent of the annual energy cost of the standard reference design.
   - 4.3. For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.

~~3~~ 5. For buildings with not more than 5,000 square feet (465 m^2) of conditioned floor area complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.

6. For buildings with more than 5,000 square feet (465 m^2) of conditioned floor area complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 10 percent less than the Energy Rating Index target specified in Table R406.5.

The option selected for compliance shall be identified in the certificate required by Section R401.3.

Reason Statement:

The average home size for new construction in North America is approximately 2,301 square feet for homes built in 2019, according to the Statistica Research Department[i]. The average number of people per household in the United States has stayed consistently between 2.53 and 5.54 from 2016 to 2020 according to the same research group[ii]. Energy codes have been basing savings on energy use index (kBtu/ft^2) for both site and source energy according to the U.S. Department of Energy. This metric, while useful for overall analysis of savings associated with code change, does not reflect operational cost for[i] homebuyers, or carbon footprint per individual.

Above code programs such as the ENERGY STAR Certified Homes Program and the Department of Energy's Zero Energy Ready Home[iii] have developed benchmarking schemes comparing house size to bedrooms with the formula or corresponding table:

(#BRs x 600 sq ft) + 400 sq ft = CFA Benchmark

Benchmark Home Size

Bedrooms in Home to be Built	0	1	2	3	4	5	6	7
Conditioned Floor Area $_{Benchmark Home}$	1,000	1,000	1,600	2,200	2,800	3,400	4,000	4,600

RESNET, the body responsible for ANSI Standards 301, 310, and 380 developed a “house size adjustment” for modeled homes in 2019 to ensure that larger and smaller homes were not unfairly given too high or two low a HERS or ERI strictly based on size[iv].

Other adopted codes, such as the Washington State Residential Energy Code (WSEC-R)[v] has adopted for the previous two code cycles a tiered system for additional energy efficiency credits/options, requiring fewer credits for homes below 1,500 square feet and more credits for homes at or above 5,000 square feet.

i Median size of single family housing unit in the United States from 2000 to 2019; Statistica.

Median size of U.S. single family house 2000-2019 | Statista

ii Average number of people per household in the United States from 1960 to 2020; Statistica.

Average size of households in the U.S. 2020 | Statista

iii Benchmark Home Size: Determine Path by Bedrooms and Conditioned Floor Area; Building America Solution Center. https://basc.pnnl.gov/information/benchmark-home-size-determine-path-bedrooms-and-conditioned-floor-area

iv RESNET Adopts Home Size Adjustment Factor for HERS Index Scores – Transition Period to January 1, 2019

https://www.resnet.us/articles/resnet-adopts-home-size-adjustment-factor-for-hers-index-scores-transition-period-to-january-1-2019/

v Washington State Energy Code - Residential 2018 Edition. Washington State Building Codes Council. 2018 WSEC_R Final package.pdf (wa.gov)

vi 2021 IECC Residential Cost Effectiveness Analysis prepared for the National Association of Home Builders by the Home Innovation Research Labs https://www.nahb.org/-/media/NAHB/advocacy/docs/top-priorities/codes/code-adoption/2021-iecc-cost-effectiveness-analysis-hirl.pdf

Bibliography:

i Median size of single family housing unit in the United States from 2000 to 2019; Statistica.

Median size of U.S. single family house 2000-2019 | Statista

ii Average number of people per household in the United States from 1960 to 2020; Statistica.

Average size of households in the U.S. 2020 | Statista

iii Benchmark Home Size: Determine Path by Bedrooms and Conditioned Floor Area; Building America Solution Center. https://basc.pnnl.gov/information/benchmark-home-size-determine-path-bedrooms-and-conditioned-floor-area

iv RESNET Adopts Home Size Adjustment Factor for HERS Index Scores – Transition Period to January 1, 2019

https://www.resnet.us/articles/resnet-adopts-home-size-adjustment-factor-for-hers-index-scores-transition-period-to-january-1-2019/

v Washington State Energy Code - Residential 2018 Edition. Washington State Building Codes Council. 2018 WSEC_R Final

package.pdf (wa.gov)

vi 2021 IECC Residential Cost Effectiveness Analysis prepared for the National Association of Home Builders by the Home Innovation Research Labs https://www.nahb.org/-/media/NAHB/advocacy/docs/top-priorities/codes/code-adoption/2021-iecc-cost-effectiveness-analysis-hirl.pdf

Cost Impact:

The code change proposal will increase the cost of construction.

The 2021 IECC Residential Cost Effectiveness Analysis[vi], as prepared for the National Association of Home Builders by the Home Innovation Research Labs has found that addition R408.2 that the incremental construction cost (weighted averages) between “Total without additional efficiency package options” and “Total with Option” ranges from $1,071 to $3,824, with the average cost being $2,875, with a lowest cost option of $1,071. The Simple Payback for homebuyers for additional costs, based on the 2018 Baseline Reference House ranged from 32 to 67 years, with an average of 44 years. By comparison, the average payback without an additional efficiency option is 48 years.

Adding a second measure for homes larger than 5,000 square feet could have a lowest cost option of $4,144, without taking into considerations new options added to the table for 2024. Considering that all but the Ventilation Option from the current R408.2 options that were assessed have resulted in a net reduction in simple payback for homebuyers, it is expected that having two measures added may result in Simple Payback average dropping from 44 years to 39 years, using an additive approach to payback years, but with a conservative estimate for the savings associated with adding a second measure (claiming on 66% of the likely savings due to the incremental reduction in proposed energy use as code advances).

REPI-20-21

REPI-21-21

IECC®: R401.2.5

Proponents:

Vladimir Kochkin, representing NAHB (vkochkin@nahb.org)

2021 International Energy Conservation Code

Revise as follows:
R401.2.5 (N1101.13.5) Additional energy efficiency.
This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.

1. For buildings complying with Section R401.2.1, one of the additional efficiency package options shall be installed according to Section R408.2.
2. For buildings complying under with Section R401.2.2 , the building shall meet one of the following:
   2.1. One of the additional efficiency package Options in Section R408.2 shall be installed without including such measures in the proposed design under Section R405; or
   2.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.
3. ~~For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.~~

The option selected for compliance shall be identified in the certificate required by Section R401.3.

Reason Statement:

This proposal removes the unjustified penalty on the ERI compliance path. The 2018 ERI threshold values in Table R406.5 were developed based on energy modeling that included above-federal minimum equipment efficiencies. Therefore, the ERI path complies with the additional requirements of Sections R401.2.5 and R408 by default via meeting the minimum thresholds. The 2021 IECC further reduced the ERI targets through a separate proposal. Approval of both proposals was due to lack of coordination during the 2021 IECC development process. This change will not impact the DOE determination because DOE analysis does not include the ERI compliance path.

The 5% penalty in combination with the 2021 IECC revised ERI thresholds results in ERI values close to the zero-energy ready levels listed in Appendix RC ZERO ENERGY RESIDENTIAL BUILDING PROVISIONS in the IECC. This level of performance has not been justified for minimum code provisions. According to RESNET, less than 7% of all rated dwelling units reached an ERI/HERS below 50 and only 1% of rated dwelling received an ERI/HERS below 45 in year 2020. Less than 25 percent of dwelling units constructed in the US obtain an ERI/HERS rating.

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposal removes an unjustified penalty on the ERI path.

REPI-21-21

REPI-22-21

IECC®: R401.2.5, R406.3.1, R406.3.2

Proponents:

Amanda Hickman, representing Leading Builders of America (LBA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Revise as follows:

R401.2.5 (N1101.13.5) Additional energy efficiency.

This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.

1. For buildings complying with Section R401.2.1, one of the additional efficiency package options shall be installed according to Section R408.2.
2. For buildings complying under with Section R401.2.2 , the building shall meet one of the following:
   2.1. One of the additional efficiency package Options in Section R408.2 shall be installed without including such measures in the proposed design under Section R405; or
   2.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.
3. ~~For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.~~

The option selected for compliance shall be identified in the certificate required by Section R401.3.

~~R406.3.1 (N1106.3.1) On-site renewables are not included~~.

~~Where on-site renewable energy is not included for compliance using the ERI analysis of Section R406.4, the proposed total building thermal envelope UA, which is sum of *U* factor times assembly area, shall be less than or equal to the building thermal envelope UA using the prescriptive *U* factors from Table R402.1.2 multiplied by 1.15 in accordance with Equation 4-1. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.~~

$$UA_{\text{Proposed design}} = 1.15 \times UA_{\text{Prescriptive reference design}}$$

~~(Equation 4-1)~~

~~R406.3.2 (N1106.3.2) On-site renewables are included~~.

~~Where on-site renewable energy is included for compliance using the ERI analysis of Section R406.4, the *building thermal envelope* shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2018 *International Energy Conservation Code.*~~

Reason Statement:

This proposal addresses the inequity with the ERI path and the other compliance paths. The Energy Rating Index is far more stringent than any of the other compliance paths. This proposal allows for more flexibility in an energy neutral manner.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal provides more flexibility in achieving energy targets and if anything, would reduce the cost of construction.

REPI-22-21

REPI-23-21

IECC®: R401.2.5, TABLE R406.2, R406.3, R406.3.1, R406.3.2, R406.4

Proponents: Ryan Meres, representing RESNET (ryan.meres@gmail.com)

2021 International Energy Conservation Code

Revise as follows:

R401.2.5 Additional energy efficiency. This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.

1. For buildings complying with Section R401.2.1, one of the additional efficiency package options shall be installed according to Section R408.2.
2. For buildings complying under with Section R401.2.2 , the building shall meet one of the following:

    2.1. One of the additional efficiency package Options in Section R408.2 shall be installed without including such measures in the proposed design under Section R405; or

    2.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.

3. ~~For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.~~

The option selected for compliance shall be identified in the certificate required by Section R401.3.

TABLE R406.2 REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
General	
~~R401.2.5~~	~~Additional efficiency packages~~
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
Mechanical	
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R406.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

R406.3 Building thermal envelope. ~~Building and portions thereof shall comply with Section R406.3.1 or R406.3.2.~~ <u>The building thermal envelope shall meet the levels of efficiency of Table R402.1.2 or R402.1.4 of the 2018 International Energy Conservation Code.</u>

Delete without substitution:

~~**R406.3.1 On-site renewables are not included.** Where on-site renewable energy is not included for compliance using the ERI analysis of Section R406.4, the proposed total building thermal envelope UA, which is sum of *U*-factor times assembly area, shall be less than or equal to the building thermal envelope UA using the prescriptive *U*-factors from Table R402.1.2 multiplied by 1.15 in accordance with Equation 4-1. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.~~

$$UA_{\text{Proposed design}} = 1.15 \times UA_{\text{Prescriptive reference design}}$$ ~~**(Equation 4-1)**~~

~~**R406.3.2 On-site renewables are included.** Where on-site renewable energy is included for compliance using the ERI analysis of Section R406.4, the *building thermal envelope* shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2018 *International Energy Conservation Code.*~~

Revise as follows:

R406.4 Energy Rating Index. The Energy Rating Index (ERI) shall be determined in accordance with RESNET/ICC 301~~except for buildings covered by the *International Residential Code* , the ERI reference design ventilation rate shall be in accordance with Equation 4-2~~.

$$\text{Ventilation rate, CFM} = (0.01 \times \text{total square foot area of house}) + [7.5 \times (\text{number of bedrooms} + 1)]$$ ~~**(Equation 4-2)**~~

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the building site shall not be included in the *ERI reference design* or the *rated design*. ~~For compliance purposes, any reduction in energy use of the rated design associated with on-site renewable energy shall not exceed 5 percent of the total energy use.~~

Reason: This proposal seeks to improve Section R406, Energy Rating Index Compliance Alternative in the following four ways:

1. Delete the 5 percent additional energy efficiency package requirement in section R401.2.5. The ERI is already the most stringent compliance option, so this added 5 percent efficiency is unnecessary. If it's the consensus of the committee that this 5% improvement is necessary, then revise the ERI targets in Table R406.5 accordingly.
2. Delete Sections R406.3.1 and R406.3.2 and revise Section R406.3 to create a single minimum building thermal envelope requirement based on the 2018 IECC prescriptive tables. The current requirements for a changing building thermal envelope baseline, based on the presence of renewable energy is confusing and unnecessary.
3. Revise Section R406.4 to eliminate Equation 4-2 and the language for changing the reference home ventilation rate. The original proposal that added this change into the 2018 IECC was misguided and did not have the intended effect. See below for a more detailed discussion on this change.
4. Revise Section R406.4 to delete the last sentence which limits the impact of on-site renewable energy to 5 percent of total energy use. By implementing a minimum building thermal envelope requirement, based on the 2018 IECC levels, as described in #2 above, this arbitrary 5 percent limitation on renewable energy is unnecessary.

General comments pertaining to the performance options in the IECC: There have been significant efforts over many code cycles to chip away at the usability of the performance paths in the IECC. Unfortunately, many of these efforts have been successful. The performance compliance options in the IECC (R405 and R406) are meant to be performance options. Their purpose is to allow builders' some flexibility in how they achieve a given performance target. Ultimately, that performance target should serve as the indicator of achieving compliance. It is also worth noting that these two compliance paths necessitate hiring a professional (HERS Rater, energy modeling professional, etc.) to use an energy modeling software to verify compliance. The ERI path is the one compliance option in the IECC capable of demonstrating net-zero energy compliance. However, it is not possible to achieve net-zero energy construction without the use of renewable energy. This should be kept in mind when setting net-zero policy because not all building types or building sites are suited for on-site renewable energy. When considering maximizing efficiency prior to the implementation of on-site renewable energy, an ERI score from the low 30's (northern climates) to the low 40's (southern climates) is typically as low as a builder can get with efficiency measures alone.

Background and Reason Statement for Deleting the Reference Home Ventilation Requirements in R406.4.

The language being proposed for deletion was approved during the 2018 IECC development cycle. Both of the original proponents of this change in 2018, testified in favor or deleting it during the 2021 update cycle. That motion was approved during the in-person public comment hearings, but later over turned in on-line voting.

Here is the proponent's reason statement from the original 2018 proposal:

"As written the ERI ventilation rate specification is in conflict with the ventilation rate specified by the IRC. The current language references ANSI/RESNET/ICC Standard 301 which references the ASHRAE 62.2-2013. The ventilation rate in the ASHRAE Standard 62.2 is significantly higher than the ventilation rate in the IRC. The IRC rate was reaffirmed in Group A changes this code cycle. Without this ventilation rate correction, the higher ventilation rate would use more energy unnecessarily and thereby increase ERI scores for no good reason. Interestingly the ASHRAE 62.2-2010 used the same rate as is in the current IRC. Third party organizations should not set ventilation rates for the IRC and the IECC. Ventilation rates in the IRC and IECC should be set by the ICC code development process. This proposal brings the IECC/IRC ERI calculation into compliance with the IRC ventilation rate by using the same ventilation equation as will be in Section 1507.3.3 of the 2018 IRC. The published committee reason expected this update, stating: "The difference in ventilation rate might need to be resolved but the experts can solve that through public comments." This is the public comment they were referring to."

The proponent makes this statement: "Without this ventilation rate correction, the higher ventilation rate would use more energy unnecessarily and thereby increase ERI scores for no good reason." In a study conducted by the Florida Solar Energy Center (FSEC), attached, it was found that this change, as included in the 2018 IECC, actually increases ERI scores from 2-10 points, depending on climate zone. The reason for this is that the rated home under Standard 301 is not allowed to use a

ventilation rate less than ASHRAE 62.2-2013. Since the 2018 IECC changed the reference home to require less ventilation than the rated home, the home will be shown to use more energy and increase the ERI score.

In a second statement the proponent says: "Third party organizations should not set ventilation rates for the IRC and IECC." This statement is also false. ANSI/RESNET/ICC Standard 301 does not require any specific ventilation rate, nor does RESNET take a position as to proper ventilation rates. RESNET's Standard Development Committee 300 chose to reference the most recent ANSI-approved standard for ventilation rates which is

ASHRAE 62.2-2013. The standard does not require homes to meet those ventilation rates, instead, the standard simply doesn't give any "credit" (in the form of lower index scores) for ventilation rates that are less than required by ASHRAE 62.2.

When the proponent of this change in the 2018 cycle, submitted a proposal to RESNET to change Standard 301, RESNET's Standard Development Committee 300 rejected the change with the following reason statement:

"ASHRAE Standard 62.2 is the sole American National Standard on ventilation for indoor air quality in low-rise residential buildings. RESNET has chosen to not conflict with this indoor air quality standard. ANSI/RESNET/ICC Standard 301 does not require any specific level of outdoor air ventilation. However, in order to not encourage outdoor air ventilation levels that do not meet the indoor air quality requirements of ASHRAE Standard 62.2, RESNET has chosen to provide no Energy Rating Index credit for ventilation air flow rates that are less than those required by ASHRAE Standard 62.2. There is no other American National Standard on ventilation for indoor air quality and RESNET has chosen to not provide credits for outdoor air ventilation rates that do not achieve this level of indoor air quality. ANSI/RESNET/ICC Standard 301 does not "require" any level of outdoor air ventilation. Rather it simply stops giving outdoor air exchange energy reduction credit at the 62.2 ventilation specification. The commenter would better seek resolution of the issue raised by this comment by working with the ASHRAE to amend ASHRAE Standard 62.2."

RESNET acknowledges that the scientific and political discussions regarding the "correct" ventilation rate for residential homes is contentious. Neither RESNET nor Standard 301 seek to determine the correct ventilation rate for homes. To align with published American National Standards for indoor air quality, RESNET chose to adopt the ventilation rates prescribed by ASHRAE 62.2-2013. RESNET considers this decision to be procedural. RESNET as an organization acknowledges ventilation is important for homes that are built to modern building energy codes, which require fairly tight envelopes. However, RESNET is neutral regarding the "correct" ventilation rate.

Regardless of which rate may be best, the ERI calculation procedure does not establish requirements for home ventilation rates. Rather such requirements are established by building code authorities and model codes such as set forth in Section R403.6 of the 2021 IECC. The ventilation rates used in the ANSI/RESNET/ICC 301 procedure do not change or modify any requirements of building codes or standards.

Reason Statement for Revisions to R406.3

Section R406 has two different requirements for the building thermal envelope, depending on whether the home is using renewable energy. Then Section R406.4 further limits the impact of renewable energy to 5 percent of total energy use. These requirements unnecessarily over-complicate code implementation. This proposal seeks to delete R406.3.1 and R406.3.2 and create one envelope requirement for R406, regardless of renewable energy use.

https://energy.cdpaccess.com/proposal/175/893/files/download/95/

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The ERI is a compliance option that considers whole-home performance. In doing so, builders have the flexibility to design a home in the most cost-effective manner to meet the ERI target scores.

REPI-24-21

IECC®: R401.3

Proponents:

Joseph Cain, representing Solar Energy Industries Association (SEIA) (JoeCainPE@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
R401.3 (N1101.14) Certificate.

A permanent certificate shall be completed by the builder or other *approved* party and posted on a wall in the space where the furnace is located, a utility room or an *approved* location inside the *building*. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory *label*, service disconnect *label* or other required labels. The certificate shall indicate the following:

1. The predominant *R*-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, *basement walls*, *crawl space walls* and floors and ducts outside *conditioned spaces.*

2. *U*-factors of fenestration and the *solar heat gain coefficient* (SHGC) of fenestration. Where there is more than one value for any component of the building envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.

3. The results from any required duct system and building envelope air leakage testing performed on the building.

4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment. Where a gas-fired unvented room heater, electric furnace or baseboard electric heater is installed in the residence, the certificate shall indicate "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be indicated for gas-fired unvented room heaters, electric furnaces and electric baseboard heaters.

5. Where on-site *photovoltaic panel* systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.

~~6.~~ ~~For buildings where an Energy Rating Index score is determined in accordance with Section R406, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate.~~

~~7~~ 6. The code edition under which the structure was permitted and the compliance path used.

Reason Statement:

This proposal is intended to strike the language created by RE21-19, which was Disapproved at the Committee Action Hearing and then Disapproved again at the Public Comment Hearing. The ICC Long-Term Code Development Process Committee has recommended to the ICC Board of Directors that double-disapproved proposals not move forward to the Online Governmental Consensus Vote. Under CP28 Section 8.1, the OGCV vote for double-disapproved proposals can be voted on only As Submitted or Disapprove. That means these proposals do not benefit from public testimony or Committee discussion at the Committee Action Hearing, and do not have the benefit of being revised or improved during the public comment process, in response to identification of flaws or opportunities for improvement.

This proposal is intended to strike out language for a documentation requirement that is discriminatory to a particular compliance path, and discriminatory toward projects that use renewable energy systems for compliance.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will not have any impact on cost of construction, but will save some time for the consultant preparing an energy compliance report by not having to model every building twice and report two different results with the compliance documentation.

REPI-24-21

REPI-26-21

IECC®: SECTION 202 (New), TABLE R402.1.2, R402.2.9, R402.1.2, R402.1.3, R402.1.5

Proponents:

Jeremy Williams, U.S. Department of Energy, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Add new definition as follows:
R202 *F*-Factor (Thermal Transmittance). The perimeter heat loss factor for slab-on-grade floors (Btu/h·ft·°F) [W/(m·K)].
Revise as follows:

TABLE R402.1.2 (TABLE N1102.1.2) MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

Portions of table not shown remain unchanged.

CLIMATE ZONE	BASEMENT WALL *U*-FACTOR	UNHEATED SLAB F-FACTOR	HEATED SLAB F-FACTOR	CRAWL SPACE WALL *U*-FACTOR
0	0.360	0.73	1.03	0.477
1	0.360	0.73	1.03	0.477
2	0.360	0.73	1.03	0.477
3	0.091[c]	0.54	0.77	0.136
4 except Marine	0.059	0.54	0.68	0.065
5 and Marine 4	0.050	0.54	0.68	0.055
6	0.050	0.48	0.68	0.055
7 and 8	0.050	0.48	0.68	0.055

For SI: 1 foot = 304.8 mm.

g. F-factors for heated slabs correspond to the configuration described by footnote (d) of Table R402.1.3

R402.2.9 (N1102.2.9) Slab-on-grade floors.

Slab-on-grade floors, in contact with the ground, with a floor surface within 24~~less than 12~~ inches (600~~305~~ mm) above or below grade shall be insulated in accordance with Table R402.1.3.

Exception: Slab-edge insulation is not required in jurisdictions designated by the code official as having a very heavy termite infestation.

R402.1.2 (N1102.1.2) Insulation and fenestration criteria.
The *building thermal envelope* shall meet the requirements of Table R402.1.2, based on the *climate zone* specified in Chapter 3. Assemblies shall have a *U*-factor or *F*-factor equal to or less than that specified in Table R402.1.2. Fenestration shall have a *U*-factor and glazed fenestration SHGC equal to or less than that specified in Table R402.1.2.
R402.1.3 (N1102.1.3) R-value alternative.
Assemblies with *R*-value of insulation materials equal to or greater than that specified in Table R402.1.3 shall be an alternative to the *U*-factor or *F*-factor in Table R402.1.2
R402.1.5 (N1102.1.5) ~~Total UA~~ Component performance alternative.

Where the proposed total *building thermal envelope* thermal conductance ~~UA, the sum of *U*-factor times assembly area,~~ is less than or equal to the required total building thermal envelope conductance using ~~UA resulting from multiplying the *U*-~~factors in Table R402.1.2 ~~by the same assembly area as in the proposed *building*,~~ the *building* shall be considered to be in compliance with Table R402.1.2. The ~~UA calculation~~ total thermal conductance shall be ~~performed~~ determined in accordance with Equation 4-1. Proposed *U*-factors and slab-on-grade *F*-factors shall be taken from ANSI/ASHRAE/IES Standard 90.1 Appendix A or determined using a method consistent with the ASHRAE *Handbook of Fundamentals* and shall include the thermal bridging effects of framing materials. In addition to ~~UA~~ total thermal conductance compliance, the SHGC requirements of Table R402.1.2 and the maximum fenestration *U*-factors of Section R402.5 shall be met.

$(U_pA + F_pP) <= (U_rA + F_rP)$
(Equation 4-1)

where:

U_pA = the sum of proposed *U*-factors times the assembly areas in the proposed building.
F_pP = the sum of proposed *F*-factors times the slab-on-grade perimeter lengths in the proposed building.
U_rA = the sum of *U*-factors in Table R402.1.2 times the same assembly areas as in the proposed building.
F_rP = the sum of *F*-factors in Table R402.1.2 times the same slab-on-grade perimeter lengths as in the proposed building.

Reason Statement:

Residential building energy codes that are based on any version of the International Energy Conservation Code (IECC) typically allow compliance to be demonstrated in several ways, one of which is a component tradeoff approach whereby prescriptive requirements for some building components may be relaxed in trade for corresponding improvements in other components. Calculations for this component tradeoff are based on maintaining a maximum overall building UA value, which is the sum across all building envelope components of the product of each component's U-factor (conductance) and area. For slabs on grade, the component UA is based on an F-factor rather than a U-factor and is multiplied by the slab-edge perimeter length rather than slab area.

The IECC does not give explicit instruction on calculating slab F-factors, relying instead on external materials such as ASHRAE's Handbook of Fundamentals. Slab insulation is usually required only around the perimeter of the slab, but the 2018 IECC added a new requirement for full under-slab insulation of heated slabs. It is not clear, even using the ASHRAE reference, how to calculate F-factors for such slabs.

The recommended code-change text refers to Appendix A of ASHRAE Standard 90.1, where precomputed F-factors are tabulated for various combinations of slab insulation placement and R-value, but any F-factor source consistent with the ASHRAE Handbook of Fundamentals may be used.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The text presented here does not change the code's requirements in any way; it merely adds clarifying text showing one good source of slab F-factors as a function of insulation R-value and depth. There is no additional cost and no energy impact.

REPI-26-21

REPI-27-21

IECC®: TABLE R402.1.2, TABLE R402.1.3, R402.1.2.1 (New), TABLE R402.1.2.1 (New)

Proponents:

seth wiley, representing architect, self

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.1.2 MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e, g]	CEILING *U*-FACTOR	WOOD FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
0	~~0.50~~0.40	0.75	~~0.25~~0.19	0.035	0.084	0.197	0.064	0.360	0.477
1	~~0.50~~0.40	0.75	~~0.25~~0.19	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	~~0.25~~0.22	0.026	0.084	0.165	0.064	0.360	0.477
3	0.30	0.55	~~0.25~~0.22	0.026	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	~~0.30~~0.27	0.55	~~0.40~~0.25	0.024	0.045	0.098	~~0.047~~0.033	0.059	~~0.065~~0.055
5 and Marine 4	~~0.30~~0.27	0.55	~~0.40~~NR	0.024	0.045	0.082	0.033	0.050	0.055
6	~~0.30~~0.27	0.55	NR	0.024	0.045	0.060	0.033	0.050	0.055
7 and 8	~~0.30~~0.20	0.55	NR	0.024	0.045	0.057	0.028	0.050	0.055

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation above sea level, or

2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

g. Fenestrations may use Solar Heat Gain Coefficients per Section R402.1.2.1 and Table R402.1.2.1 in place of Solar Heat Gain Coefficients listed in Table R402.1.2.

TABLE R402.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e, i]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[g]	MASS WALL *R*-VALUE[h]	FLOOR *R*-VALUE	BASEMENT[c,g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c,g] WALL *R*-VALUE
0	~~NR~~0.40	0.75	~~0.25~~0.19	30	13 or 0 & 10ci	3/4	13	0	0	0
1	~~NR~~0.40	0.75	~~0.25~~0.19	30	13 or 0 & 10ci	3/4	13	0	0	0
2	0.40	0.65	~~0.25~~0.22	49	13 or 0 & 10ci	4/6	13	0	0	0
3	.30	0.55	~~0.25~~0.22	49	20 or 13 & 5ci[h] or 0 & 15ci[h]	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]
4 except Marine	~~.30~~0.27	0.55	~~0.40~~0.25	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	8/13	~~19~~30	10ci or 13	10ci, 4 ft	~~10~~15ci or ~~13~~19
5 and Marine 4	~~0.30[i]~~0.27	0.55	~~0.40~~NR	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	13/17	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
6	~~0.30[i]~~0.27	0.55	NR	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	15/20	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
7 and 8	~~0.30[i]~~0.27	0.55	NR	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	19/21	38	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

b. **Exception:** In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 & 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab-edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13 & 5" means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

i. A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

j. Fenestrations my use Solar Heat Gain Coefficients per Section R402.1.2.1 and Table R402.1.2.1 in place of Solar Heat Gain Coefficients listed in Table R402.1.3.

Add new text as follows:

R402.1.2.1 Projection factor.

South-, east-, and west-facing glazed fenestrations and openings may use Solar Heat Gain Coefficients per Table R402.1.2.1 provided that such glazed fenestrations and openings include fixed passive exterior shading as calculated in projection factor Equation 4-5. (Equation 4-5)

PF=A/B

where:

PF = Projection factor (decimal).

A = Distance measured horizontally from the farthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the glazing.

B = Distance measures vertically from the bottom of the glazing to the underside of the overhang, eave, or permanently attached shading device.

Where different windows or glass doors have different PF values, they shall each be evaluated separately.

TABLE R402.1.2.1 BUILDING ENVELOPE FENESTRATION SOLAR HEAT GAIN COEFFICIENTS PER PROJECTION FACTOR VALUES

CLIMATE ZONE	0 AND 1	0 AND 1	2	2	3	3	4 EXCEPT MARINE	4 EXCEPT MARINE	5 AND MARINE 4	5 AND MARINE 4	6
	FIXED	OPERABLE	FIXED	OPERABLE	FIXED	OPERABLE	FIXED	OPERABLE	FIXED	OPERABLE	FIXED
PF<0.2	0.23	0.21	0.25	0.23	0.25	0.23	0.36	0.33	0.38	0.33	0.38
0.2<PF<0.5	0.28	0.25	0.30	0.28	0.30	0.28	0.43	0.40	0.46	0.40	0.46
PF>0.5	0.37	0.34	0.40	0.37	0.40	0.37	0.58	0.53	0.61	0.53	0.61

Attached Files

- **IECC-2024_Proposal_Fenestration-and-Projects-Factor_2021-09-25.pdf**
  http://localhost/proposal/334/594/files/download/75/

Reason Statement:

To improve occupant health and safety, improve energy efficiency, and decrease greenhouse gas emissions

Bibliography:

Based on professional knowledge and experience, feedback from other professionals, established research, and established local and national construction quality frameworks

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code chance proposal is understood to neither increase nor decrease the cost of construction

REPI-27-21

REPI-28-21

IECC®: TABLE R402.1.2, TABLE R402.1.3

Proponents:

Thomas Culp, Birch Point Consulting LLC, representing the Glazing Industry Code Committee (culp@birchpointconsulting.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.1.2 (TABLE N1102.1.2) MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

Portions of table not shown remain unchanged.

CLIMATE ZONE	FENESTRATION *U*-FACTOR[d]	SKYLIGHT[d] *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]
0	~~0.50~~ 0.40	~~0.75~~ 0.60	0.25
1	~~0.50~~ 0.40	~~0.75~~ 0.60	0.25
2	0.40	~~0.65~~ 0.60	0.25
3	0.30	~~0.55~~ 0.53	0.25
4 except Marine	0.30	~~0.55~~ 0.53	0.40
5 and Marine 4	~~0.30~~ 0.27[f,g]	~~0.55~~ 0.50	~~0.40~~NR
6	~~0.30~~ 0.27[f,g]	~~0.55~~ 0.50	NR
7 and 8	~~0.30~~ 0.27[f,g]	~~0.55~~ 0.50	NR

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed ~~0.30~~ 0.28.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation above sea level, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

g. <u>In Marine Climate Zone 4 and Climate Zones 5 through 8, the maximum *U*-factor for vertical fenestration shall be 0.28 when the SHGC is from 0.32 to 0.36, 0.29 when the SHGC is from 0.37 to 0.42, and 0.30 when the SHGC is greater than or equal to 0.42.</u>

TABLE R402.1.3 (TABLE N1102.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

Portions of table not shown remain unchanged.

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]
0	~~NR~~ <u>0.40</u>	~~0.75~~ <u>0.60</u>	0.25
1	~~NR~~ <u>0.40</u>	~~0.75~~ <u>0.60</u>	0.25
2	0.40	~~0.65~~ <u>0.60</u>	0.25
3	0.30	~~0.55~~ <u>0.53</u>	0.25
4 except Marine	0.30	~~0.55~~ <u>0.53</u>	0.40
5 and Marine 4	~~0.30~~ <u>0.27[i,j]</u>	~~0.55~~ <u>0.50</u>	~~0.40~~ <u>NR</u>
6	~~0.30~~<u>0.27[i,j]</u>	~~0.55~~ <u>0.50</u>	NR
7 and 8	~~0.30~~<u>0.27[i,j]</u>	~~0.55~~ <u>0.50</u>	NR

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed ~~0.30~~ <u>0.28</u>.

c. "5ci or 13” means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 & 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab-edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, “13 & 5” means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

i. 1. Above 4,000 feet in elevation, or

2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

j. <u>In Marine Climate Zone 4 and Climate Zones 5 through 8, the maximum *U*-factor for vertical fenestration shall be 0.28 when the SHGC is from 0.32 to 0.36, 0.29 when the SHGC is from 0.37 to 0.42, and 0.30 when the SHGC is greater than or equal to 0.42.</u>

Reason Statement:

This proposal advances the residential fenestration criteria in a cost effective manner by aligning with the Energy Star version 6 requirements. EPA is advancing the Energy Star version 7 requirements for Windows, Doors, and Skylights with an implementation date in 2023, so aligning the 2024 IECC with the version 6 requirements allows the energy code to progress while also maintaining the philosophy that the Energy Star criteria be a notch beyond the base code.

In aligning and maintaining consistency with Energy Star, this proposal also corrects a rollback in energy efficiency which occurred last cycle when a maximum SHGC of 0.40 was added in zone 5 in the R-value table, in conflict with Energy Star. The EPA and DOE analyses conducted by Lawrence Berkeley National Laboratory both for version 6 in 2012 and for version 7 in 2021 clearly show that imposing a maximum SHGC in climate zone 5 actually harms energy efficiency and increases use of fossil fuels. Therefore, the Energy Star program has maintained a baseline SHGC of "Any" (or NR) for zones 5-8 in both version 6 and 7, as well as optional U-factor alternatives that include higher SHGC to allow increased flexibility and energy efficiency (footnote g). (Note that the Energy Star Most Efficient program for windows also imposes a minimum SHGC of > 0.20 in zones 5-8. That is not being proposed here, but also supports that a maximum SHGC in zone 4 was an energy rollback that needs to be corrected.)

The current market share of Energy Star version 6 products is very high: 86% for windows, 80% for hinged entry doors, 84% for patio doors, and 72% for skylights. The high market share shows that fenestration meeting these proposed requirements are ubiquitous and cost effective.

Bibliography:

- Energy Star Version 6 final specification: https://www.energystar.gov/sites/default/files/ES_Final_V6_Residential_WDS_Spec.pdf
- Energy Star Version 6 draft 1 criteria analysis: https://www.energystar.gov/sites/default/files/specs//Draft6_V1_Criteria_Analysis_Report.pdf
- Energy Star Version 7 draft 1 criteria analysis: https://www.energystar.gov/sites/default/files/asset/document/ES_Residential_WDS_Draft%201_Criteria%20Analysis%2
- Energy Star Version 7 presentation: https://www.energystar.gov/sites/default/files/asset/document/V7_Stakeholder%20Meeting_7-27-2021_final.pdf

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

EPA estimates that the current market share of Energy Star version 6 products is very high: 86% for windows, 80% for hinged entry doors, 84% for patio doors, and 72% for skylights. This demonstrates that fenestration meeting the proposed requirements are ubiquitous and will not increase the cost of construction for the vast majority of homeowners. Nonetheless, for the minority of products that do not meet the Energy Star version 6 criteria, there will be a marginal increase in cost. EPA's analysis in 2012-14 of the change to the version 6 criteria "shows that average-cost products offer payback periods of less than 10 years in all but five cities and payback periods of less than seven years in half of the cities for which EPA performed energy savings analysis", and less for lower cost products. As the industry transitions to the Energy Star version 7 requirements, the cost and payback for these version 6 criteria will be even less. Additionally, there would be no increase in construction cost for locations meeting the altitude or windborne debris provisions in footnote f.

- Energy Star version 7 info including market share: https://www.energystar.gov/sites/default/files/asset/document/V7_Stakeholder%20Meeting_7-27-2021_final.pdf
- Energy Star version 6 cost effectiveness review: https://www.energystar.gov/sites/default/files/ESWDS-ReviewOfCost_EffectivenessAnalysis.pdf

REPI-28-21

REPI-29-21

IECC®: TABLE R402.1.2, TABLE R402.1.3

Proponents:

Mark Lyles, representing New Buildings Institute (markl@newbuildings.org); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.1.2 (TABLE N1102.1.2) MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]	CEILING *U*-FACTOR	WOOD FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
0	0.40~~50~~	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
1	0.40~~50~~	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
2	0.30~~40~~	0.65	0.25	0.026	0.084	0.165	0.064	0.360	0.477
3	0.27~~30~~	0.55	0.25	0.026	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.25~~30~~	0.55	0.40	0.024	0.045	0.098	0.047	0.059	0.065
5 and Marine 4	0.25~~30~~	0.55	0.40	0.024	0.045	0.082	0.033	0.050	0.055
6	0.25~~30~~	0.55	NR	0.024	0.045	0.060	0.033	0.050	0.055
7 and 8	0.25~~30~~	0.55	NR	0.024	0.045	0.057	0.028	0.050	0.055

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

~~f.~~ ~~A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:~~

~~1. Above 4,000 feet in elevation above sea level, or~~

2. ~~In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.~~

TABLE R402.1.3 (N1102.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b~~, i~~]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[g]	MASS WALL *R*-VALUE[h]	FLOOR *R*-VALUE	BASEMENT[c,g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c,g] WALL *R*-VALUE
0	~~0.40NR~~	0.75	0.25	30	13 or 0 & 10ci	3/4	13	0	0	0
1	0.40~~NR~~	0.75	0.25	30	13 or 0 & 10ci	3/4	13	0	0	0
2	0.30~~40~~	0.65	0.25	49	13 or 0 & 10ci	4/6	13	0	0	0
3	0.27~~30~~	0.55	0.25	49	20 or 13 & 5ci[h] or 0 & 15ci[h]	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]
4 except Marine	0.25~~30~~	0.55	0.40	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5 and Marine 4	0.25~~30[i]~~	0.55	0.40	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	13/17	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
6	0.25~~30[i]~~	0.55	NR	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	15/20	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
7 and 8	0.25~~30[i]~~	0.55	NR	60	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	19/21	38	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

b. **Exception:** In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 & 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab-edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13 & 5" means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

~~i.~~ ~~A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:~~

~~1. Above 4,000 feet in elevation, or~~

~~2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.~~

Reason Statement:

The proposal improves the U-Factor of residential insulated glazing units (IGU) in both single family and low-rise multifamily buildings. The change aligns all the climate zones to the performance values that are currently included in Version 6 of the EnergyStar ratings for windows, doors, and skylights (WDS) for all climate zones and to set slightly better U-Factor maximums in the colder climate zones.

This change will result in several benefits for most buildings in most affected climate zones. This change will reduce energy transfer through the windows, saving energy needed to both heat and cool the building throughout the year. In low-rise multifamily housing in climate zone 6A, changing the U-factor from 0.30 to 0.25 reduces total HVAC energy consumption by approximately 5 percent. The savings will be higher for single family housing and for climate zones that have colder winters.

In addition, this change will improve the thermal comfort of the living space by reducing the temperature differential of the window to the interior walls of the room which will reduce the radiant thermal imbalance. An additional secondary effect is that the lower U-Factor windows will reduce the amount of cold air that collects below the window in the space. Both effects will improve (reduce) the predicted personal dissatisfaction (PPD) with the overall thermal environment. (NEEA, 2020)

A study done by the EPA on the EnergyStar performance levels indicates that in 2019, 86 percent of all windows sold in the United States met the then-current Energy Star performance levels and this trend of high market penetration has persisted for nearly a decade. (EPA, EnergyStar Windows, Doors, and Skylights Version 7.0 Specification Discussion Guide, 2019) This has led the Department of Energy to develop a draft Version 7 of the WDS performance that tightens all the values in the current (Version 6) WDS document somewhat. (EPA, EnergyStar Product Specification Residential Windows, Doors, and Skylights Eligibility Criteria Draft 1 Version 7.0, 2019) The anticipated adoption for Version 7 of the WDS document is January, 2022.

The high EnergyStar rating percentages indicate that the levels of performance across the country are not difficult to meet for either market adoption as an industry standard practice (ISP) for specifications nor is the technology too expensive to cost-effectively manufacture the IGUs to meet the proposed performance.

This proposed change to the IECC standard will occur after Version 7 of the EnergyStar document is adopted, therefore, the performance levels proposed in this document establish the previous (Version 6) levels of EnergyStar performance as the basis of performance throughout much of the country and propose slightly better performance in the colder climate zones (in Climate Zones 4 through 8).

Bibliography:

EPA. (2019). EnergyStar Product Specification Residential Windows, Doors, and Skylights Eligibility Criteria Draft 1 Version 7.0. Retrieved from https://www.energystar.gov/sites/default/files/asset/document/ES_Residential_WDS_Draft%201_V7_Spec.pdf

EPA. (2019). EnergyStar Windows, Doors, and Skylights Version 7.0 Specification Discussion Guide. Retrieved from https://www.energystar.gov/sites/default/files/asset/document/ENERGY%20STAR%20Version%207%20Window%20Door%20Sk

EPA. (2021). EnergyStar Windows, Doors, and Skylights Version 7.0 Criteria Analysis Report.

NEEA. (2020). Thin Triple Pane Windows: A Market Transformation Strategy for Affordable R5 Windows. Retrieved from https://neea.org/resources/thin-triple-pane-windows-a-market-transformation-strategy-for-affordable-r5-windows

Cost Impact:

The code change proposal will increase the cost of construction.

The EPA analysis document for Version 7 of the WDS EnergyStar performance levels provides valuable information for incremental costs for a variety of U-Value levels compared to the baseline Version 6 window, which is proposed as the new performance level for the warmer climate zones in the IECC standard. (EPA, EnergyStar Windows, Doors, and Skylights Version 7.0 Criteria Analysis Report, 2021)

Table 1: U-Factor Incremental Cost Over Market Baseline for Windows

U-Factor	Most Common Technical Pathways	Incremental Consumer ('Retail') Cost Over the Market Baseline	
		SHGC > 0.25	SHGC ≤ 0.25
0.32–0.35	1 Low-e coating, air-filled IGU and basic frames	Market Baseline	$7.50
0.28–0.31	1 Low-e coating with argon-filled IGU	$6	$13.50
0.27	1 Low-e coating with argon-filled IGU and improved frames and spacers	$18	$25.50
0.24–0.26	2 Low-e coatings (room-side low-e) with argon-filled IGU	$29	$36.50
0.22–0.23	Triple-pane with 2 low-e coatings and argon-filled IGU	$54	$61.50

Table 1 above provides retail incremental costs for various levels of performance including both U-Factor and SHGC for a 15 square foot IGU. The cost data was collected in 2020 and 2021. Per the table, a 0.25 U-Factor window has about a $29 premium over the baseline window. This incremental cost is slightly lower than $3 per square foot of glazing. Similarly, for a 0.27 U-Factor window, the incremental cost is $18 per window, or about $1.20 per square foot of glazing.

At these pricing differences, using 0.25 U-Factor windows in a low-rise multifamily building in Climate Zone 6A will have a simple payback in the 5-to-14-year range, depending on the heating source employed and other variables. Each unit in the multifamily building will cost an additional $228 for the upgraded windows, and the occupants will benefit by reduced energy bills of between $16 and $40 per year, depending on the energy source used for heating.

Similarly, using 0.27 U-Factor windows in a single-family home in Climate Zone 3A will have a 14-to-33-year simple payback. The incremental cost for the residence will be $426 to meet the improved performance level and the occupants will benefit from reduced energy bills of between $13 and $30 per year, depending on the energy source used for heating.

REPI-29-21

REPI-30-21

IECC®: TABLE R402.1.2, TABLE R402.1.3

Proponents: John Woestman, representing Extruded Polystyrene Foam Association (XPSA) (jwoestman@kellencompany.com)

2021 International Energy Conservation Code

Delete and substitute as follows:

~~TABLE R402.1.2 MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS~~

~~CLIMATE ZONE~~	~~FENESTRATION U-FACTOR[f]~~	~~SKYLIGHT U-FACTOR~~	~~GLAZED FENESTRATION SHGC[d, e]~~	~~CEILING U-FACTOR~~	~~WOOD FRAME WALL U-FACTOR~~	~~MASS WALL U-FACTOR[b]~~	~~FLOOR U-FACTOR~~	~~BASEMENT WALL U-FACTOR~~	~~CRAWL SPACE WALL U-FACTOR~~
~~0~~	~~0.50~~	~~0.75~~	~~0.25~~	~~0.035~~	~~0.084~~	~~0.197~~	~~0.064~~	~~0.360~~	~~0.477~~
~~1~~	~~0.50~~	~~0.75~~	~~0.25~~	~~0.035~~	~~0.084~~	~~0.197~~	~~0.064~~	~~0.360~~	~~0.477~~
~~2~~	~~0.40~~	~~0.65~~	~~0.25~~	~~0.026~~	~~0.084~~	~~0.165~~	~~0.064~~	~~0.360~~	~~0.477~~
~~3~~	~~0.30~~	~~0.55~~	~~0.25~~	~~0.026~~	~~0.060~~	~~0.098~~	~~0.047~~	~~0.091[c]~~	~~0.136~~
~~4 except Marine~~	~~0.30~~	~~0.55~~	~~0.40~~	~~0.024~~	~~0.045~~	~~0.098~~	~~0.047~~	~~0.059~~	~~0.065~~
~~5 and Marine 4~~	~~0.30~~	~~0.55~~	~~0.40~~	~~0.024~~	~~0.045~~	~~0.082~~	~~0.033~~	~~0.050~~	~~0.055~~
~~6~~	~~0.30~~	~~0.55~~	~~NR~~	~~0.024~~	~~0.045~~	~~0.060~~	~~0.033~~	~~0.050~~	~~0.055~~
~~7 and 8~~	~~0.30~~	~~0.55~~	~~NR~~	~~0.024~~	~~0.045~~	~~0.057~~	~~0.028~~	~~0.050~~	~~0.055~~

~~For SI: 1 foot = 304.8 mm.~~

a. ~~Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.~~

b. ~~Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.~~

c. ~~In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.~~

d. ~~The SHGC column applies to all glazed fenestration.~~

~~**Exception:** In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.~~

e. ~~There are no SHGC requirements in the Marine Zone.~~

f. ~~A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:~~

1. ~~Above 4,000 feet in elevation above sea level, or~~
2. ~~In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.~~

TABLE R402.1.2 MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	**0**	**1**	**2**	**3**	**4 except Marine**	**5 and Marine 4**	**6**	**7 and 8**
FENESTRATION U-FACTOR[f]	0.50	0.50	0.40	0.30	0.30	0.30	0.30	0.30
SKYLIGHT U-FACTOR	0.75	0.75	0.65	0.55	0.55	0.55	0.55	0.55
GLAZED FENESTRATION SHGC[d,e]	0.25	0.25	0.25	0.25	0.40	0.40	NR	NR
CEILING U-FACTOR	0.035	0.035	0.026	0.026	0.024	0.024	0.024	0.024
WOOD FRAME WALL U-FACTOR	0.084	0.084	0.084	0.060	0.045	0.045	0.045	0.045
MASS WALL U-FACTOR[b]	0.197	0.197	0.165	0.098	0.098	0.082	0.060	0.057
FLOOR U-FACTOR	0.064	0.064	0.064	0.047	0.047	0.033	0.033	0.028
BASEMENT WALL U-FACTOR	0.360	0.360	0.360	0.091[c]	0.059	0.050	0.050	0.050
CRAWL SPACE WALL U-FACTOR	0.477	0.477	0.477	0.136	0.065	0.055	0.055	0.055

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in

Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation above sea level, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

~~TABLE R402.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]~~

~~CLIMATE ZONE~~	~~FENESTRATION *U*-FACTOR[b, i]~~	~~SKYLIGHT[b] *U*-FACTOR~~	~~GLAZED FENESTRATION SHGC[b, e]~~	~~CEILING *R*-VALUE~~	~~WOOD FRAME WALL *R*-VALUE[g]~~	~~MASS WALL *R*-VALUE[h]~~	~~FLOOR *R*-VALUE~~	~~BASEMENT[c,g] WALL *R*-VALUE~~	~~SLAB[d] *R*-VALUE & DEPTH~~	~~CRAWL SPACE[c,g] WALL *R*-VALUE~~
~~0~~	~~NR~~	~~0.75~~	~~0.25~~	~~30~~	~~13 or 0 & 10ci~~	~~3/4~~	~~13~~	~~0~~	~~0~~	~~0~~
~~1~~	~~NR~~	~~0.75~~	~~0.25~~	~~30~~	~~13 or 0 & 10ci~~	~~3/4~~	~~13~~	~~0~~	~~0~~	~~0~~
~~2~~	~~0.40~~	~~0.65~~	~~0.25~~	~~49~~	~~13 or 0 & 10ci~~	~~4/6~~	~~13~~	~~0~~	~~0~~	~~0~~
~~3~~	~~.30~~	~~0.55~~	~~0.25~~	~~49~~	~~20 or 13 & 5ci[h] or 0 & 15ci[h]~~	~~8/13~~	~~19~~	~~5ci or 13[f]~~	~~10ci, 2 ft~~	~~5ci or 13[f]~~
~~4 except Marine~~	~~.30~~	~~0.55~~	~~0.40~~	~~60~~	~~30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]~~	~~8/13~~	~~19~~	~~10ci or 13~~	~~10ci, 4 ft~~	~~10ci or 13~~
~~5 and Marine 4~~	~~0.30[i]~~	~~0.55~~	~~0.40~~	~~60~~	~~30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]~~	~~13/17~~	~~30~~	~~15ci or 19 or 13 & 5ci~~	~~10ci, 4 ft~~	~~15ci or 19 or 13 & 5ci~~
~~6~~	~~0.30[i]~~	~~0.55~~	~~NR~~	~~60~~	~~30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]~~	~~15/20~~	~~30~~	~~15ci or 19 or 13 & 5ci~~	~~10ci, 4 ft~~	~~15ci or 19 or 13 & 5ci~~
~~7 and 8~~	~~0.30[i]~~	~~0.55~~	~~NR~~	~~60~~	~~30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]~~	~~19/21~~	~~38~~	~~15ci or 19 or 13 & 5ci~~	~~10ci, 4 ft~~	~~15ci or 19 or 13 & 5ci~~

~~For SI: 1 foot = 304.8 mm.~~

~~NR = Not Required.~~
~~ci = continuous insulation.~~

a. ~~*R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.~~

b. ~~The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.~~

~~**Exception:** In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.~~

c. ~~"5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 & 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.~~

d. ~~R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab-edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.~~

e. ~~There are no SHGC requirements in the Marine Zone.~~

f. ~~Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.~~

g. ~~The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13 & 5" means R-13 cavity insulation plus R-5 continuous insulation.~~

h. ~~Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.~~

i. ~~A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:~~

1. ~~Above 4,000 feet in elevation, or~~
2. ~~In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.~~

TABLE R402.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	**0**	**1**	**2**	**3**	**4 except Marine**	**5 and Marine 4**	**6**	**7 and 8**
FENESTRATION U-FACTOR, MAXIMUM[b,i]	NR	NR	0.40	0.30	0.30	0.30	0.30	0.30
SKYLIGHT U-FACTOR, MAXIMUM[b]	0.75	0.75	0.65	0.55	0.55	0.55	0.55	0.55
GLAZED FENESTRATION SHGC, MAXIMUM[b,e]	0.25	0.25	0.25	0.25	0.40	0.40	NR	NR
CEILING R-VALUE	30	30	49	49	60	60	60	60
WOOD FRAME WALL R-VALUE[g]	13 or 0&10ci	13 or 0&10ci	13 or 0&10ci	20 or 13&5ci[h] or 0&15ci[h]	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]	30 or 20&5ci[h] or 13&10ci[h] or 0&20ci[h]
MASS WALL R-VALUE[h]	3/4	3/4	4/6	8/13	8/13	13/17	15/20	19/21
FLOOR R-VALUE	13	13	13	19	19	30	30	38
BASEMENT WALL R-VALUE[c,g]	0	0	0	5ci or 13[f]	10ci or 13	15ci or 19 or 13&5ci	15ci or 19 or 13&5ci	15ci or 19 or 13&5ci
SLAB R-VALUE & DEPTH[d]	0	0	0	10ci, 2 ft	10ci, 4 ft	10ci, 4 ft	10ci, 4 ft	10ci, 4 ft
CRAWL SPACE WALL R-VALUE[c,g]	0	0	0	5ci or 13[f]	10ci, or 13	15ci or 19 or 13&5ci	15ci or 19 or 13&5ci	15ci or 19 or 13&5ci

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 & 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab-edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13 & 5" means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

i. A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

Reason: Proposed Revisions & Reasons - Swap X and Y axes of Table R402.1.2 and Table R402.1.3 for consistency with IECC-C format; no changes to technical requirements or footnotes. In addition to swapping the X and Y axes on these two tables, Table R402.1.3 may be improved by

noting in the table row headings that Fenestration and Skylight U-factors are "maximum", and the SHGC is "maximum". Alternatively, "Maximum" could be inserted in the title of Table R402.1.3: "Insulation Minimum R-Values and Fenestration <u>Maximum</u> Requirements by Component[a] ".
The proposal also includes editorial movement of a couple footnote indicators to improve Table R402.1.3 editorially.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is editorial, and intended to improve the usability of the code.

REPI-31-21

IECC®: TABLE R402.1.2, TABLE R402.1.3

Proponents:

Dan Wildenhaus, representing Northwest Energy Efficiency Alliance (dwildenhaus@trccompanies.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.1.2 (N1102.1.2) MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

Portions of table not shown remain unchanged.

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR
0	~~0.50~~ 0.32	~~0.75~~ 0.50
1	~~0.50~~ 0.32	~~0.75~~ 0.50
2	~~0.40~~ 0.32	~~0.65~~ 0.50
3	~~0.30~~ 0.28	~~0.55~~ 0.50
4 except Marine	~~0.30~~ 0.24	~~0.55~~ 0.50
5 and Marine 4	~~0.30~~ 0.22	~~0.55~~ 0.45
6	~~0.30~~ 0.22	~~0.55~~ 0.45
7 and 8	~~0.30~~ 0.22	~~0.55~~ 0.45

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed ~~0.30~~ 0.25.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation above sea level, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

TABLE R402.1.3 (N1102.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

Portions of table not shown remain unchanged.

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR
0	~~NR~~ 0.32	~~0.75~~ 0.50
1	~~NR~~ 0.32	~~0.75~~ 0.50
2	~~0.40~~ 0.32	~~0.65~~ 0.50
3	~~.30~~ 0.28	~~0.55~~ 0.50
4 except Marine	~~.30~~ 0.24	~~0.55~~ 0.50
5 and Marine 4	~~0.30~~ 0.22[i]	~~0.55~~ 0.45
6	~~0.30~~ 0.22[i]	~~0.55~~ 0.45
7 and 8	~~0.30~~ 0.22[i]	~~0.55~~ 0.45

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

   Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed ~~0.30~~ 0.25.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 & 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab-edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, “13 & 5” means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

i. 1. Above 4,000 feet in elevation, or

2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

Reason Statement:

Windows are an important component of the energy performance of any house. In many new homes windows represent just 6-8% of the envelope area but 45 to 49% of the total envelope heat loss. As one of the primary barriers between indoor and out, the openings of the building envelope; high performance windows, doors, and skylights (fenestration) are essential to an energy efficient building. The typical ~R3 code compliant or ENERGY STAR™ v6 window in common use in the United States is double glazed and despite dramatic improvements in fenestration technologies in recent years, such as the adoption of Low-E window technology in the 1990s, a period when almost all windows installed in homes were clear glass, we only saw gains of a reduction of U factor down to a weighted average of 0.24. A shift from double to triple glazing, ~ R4.6 to 5.3, would reduce window heat loss and improve comfort. Unfortunately, this requires a potentially complex and expensive redesign of the entire window to move towards full triple pane windows, achieving U factors below 0.20, as these units are thicker, heavier, and require changes to trim and integration packages.

In recent years, research and development towards thinner triple pane windows have led the creation of widely available U of 0.22 weighted averages, with available options for safety/tempered glass, all fitting into the same IGU frame as most double pane windows (7/8-inch to 1 3/8-inch thickness), capable of being installed in both 2 x 4 and 2 x 6 walls with minimal changes to sill plates and support, trim packages, and integration techniques. Moving the Prescriptive requirements to this level makes use of technology already in the marketplace, driving adoption of triple pane windows in a more readily adoptable package.

The window improvements proposed here will pay off within roughly 8-11 years based on recent rigorous nationwide analysis conducted as part of the ENERGY STAR® Windows, Doors, and Skylights Version 7.0 update process. This is well within the useful life of the window (and the building itself). With the window market expected to be driven towards these values by ENERGY STAR and Programs (utility and market transformation programs) starting in early 2023, product availability will only increase by the time this requirement goes into effect several years later in adopting jurisdictions.

Climate Zone	Cost Savings ($/year)	Simple Payback (Years)
0-2 (i.e. EPA Southern)	$20.14	8.9
3 (i.e. EPA South-Central)	$35.85	9.0
4 (i.e. EPA North-Central)	$80.75	8.5
5-8 (i.e. EPA Northern) (Market Baseline)	$113.35	11.3

Source: Energy Star v7.0 Criteria Analysis Report, Table 19

Bibliography:

ENERGY STAR® Windows, Doors, and Skylights; Version 7.0 Criteria Analysis Report; July 2021 - ENERGY STAR Version 7.0 Residential Windows, Doors, and Skylights Draft 1 Criteria Analysis Report

ENERGY STAR® 1 Product Specification 2 Residential Windows, Doors, and Skylights 3 4 Eligibility Criteria 5 Draft 1 Version 7.0 - ENERGY STAR Version 7.0 Residential Windows, Doors, and Skylights Draft 1 Specification

Cost Impact:

The code change proposal will increase the cost of construction.

Cost Impact: Based on a manufacturer survey conducted as part of the recent rigorous nationwide research conducted as part of the ENERGY STAR® Windows, Doors, and Skylights Version 7.0 update process, the incremental costs per window vary by Climate Zone as indicated in the table. No other construction cost increases are anticipated aside from this retail cost increase, which will likely decrease by the time this code is being enforced in a given jurisdiction since the ENERGY STAR (and companion utility/market transformation) programs will help develop this market and build economies of scale that result in decrease prices.

Climate Zone	Incremental Consumer ('Retail') Cost Over the Market Baseline
0-2 (i.e. U-0.32, SHGC <= 0.25)	$7.50
3 (i.e. U-0.28, SHGC <= 0.25)	$13.50
4 (i.e. U-0.24, SHGC <= 0.40)	$29
5-8 (i.e. U-0.22, SHGC NR)	$54

Source: Energy Star v7.0 Criteria Analysis Report, Table 7

REPI-31-21

REPI-32-21

IECC®: TABLE R402.1.2, TABLE R402.1.3, R402.2.1, R402.2.2

Proponents: Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.1.2 (N1102.1.2) MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION *U-FACTOR*[f]	SKYLIGHT *U-FACTOR*	GLAZED FENESTRATION SHGC[d, e]	CEILINGS w/ AND w/o ATTICS *U-FACTOR*	ROOF ASSEMBLY *U-FACTOR*	WOOD FRAME WALL *U-FACTOR*	MASS WALL *U-FACTOR*[b]	FLOOR *U-FACTOR*	BASEMENT WALL *U-FACTOR*	CRAWL SPACE WALL *U-FACTOR*
0	0.50	0.75	0.25	0.035	0.039	0.084	0.197	0.064	0.360	0.477
1	0.50	0.75	0.25	0.035	0.039	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.25	0.026	0.039	0.084	0.165	0.064	0.360	0.477
3	0.30	0.55	0.25	0.026	0.039	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.30	0.55	0.40	0.024	0.032	0.045	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.40	0.024	0.032	0.045	0.082	0.033	0.050	0.055
6	0.30	0.55	NR	0.024	0.032	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	NR	0.024	0.028	0.045	0.057	0.028	0.050	0.055

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation above sea level, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

TABLE R402.1.3 (N1102.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILINGS w/ AND w/o ATTICS *R*-VALUE	ABOVE ROOF DECK R-VALUE	WOOD FRAME WALL *R*-VALUE[g]	MASS WALL *R*-VALUE[h]	FLOOR *R*-VALUE	BASEMENT[c,g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c,g] WALL *R*-VALUE
0	NR	0.75	0.25	30	25ci	13 or 0 & 10ci	3/4	13	0	0	0
1	NR	0.75	0.25	30	25ci	13 or 0 & 10ci	3/4	13	0	0	0
2	0.40	0.65	0.25	49	25ci	13 or 0 & 10ci	4/6	13	0	0	0
3	.30	0.55	0.25	49	25ci	20 or 13 & 5ci[h] or 0 & 15ci[h]	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]
4 except Marine	.30	0.55	0.40	60	30ci	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5 and Marine 4	0.30[i]	0.55	0.40	60	30ci	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	13/17	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
6	0.30[i]	0.55	NR	60	35ci	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	15/20	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
7 and 8	0.30[i]	0.55	NR	60	35ci	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	19/21	38	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 & 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab-edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, "13 & 5" means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

i. A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation, or

2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

R402.2.1 (N1102.2.1) Roofs and ceilings with attics. Where Section R402.1.3 requires R-49 insulation in the roofs and ceiling or attic, installing R-38 over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-49 insulation wherever the full height of uncompressed R-38 insulation extends over the wall top plate at the eaves. Where Section R402.1.3 requires R-60 insulation in the ceiling or attic, installing R-49 over 100 percent of the ceiling or attic area requiring insulation shall satisfy the requirement for R-60 insulation wherever the full height of uncompressed R-49 insulation extends over the wall top plate at the eaves. This reduction shall not apply to the insulation and fenestration criteria in and the Total UA alternative in Section R402.1.5.

R402.2.2 (N1102.2.2) Roofs and ceilings without attics. Where Section R402.1.3 requires insulation *R*-values greater than R-30 in the interstitial space above a ceiling and below the structural roof deck, and the design of the ~~roof/~~ceiling assembly does not allow sufficient space for the required insulation, the minimum required insulation *R*-value for such ~~roof/~~ceiling assemblies shall be R-30. Insulation shall extend over the top of the wall plate to the outer edge of such plate and shall not be compressed. This reduction of insulation from the requirements of Section R402.1.3 shall be limited to 500 square feet (46 m^2) or 20 percent of the total insulated ceiling area, whichever is less. This reduction shall not apply to the Total UA alternative in Section R402.1.5.

Reason: The genesis for this proposal came about during deliberations in April of 2019 at the ICC Group 'B' Code Hearings, Albuquerque, among roofing and insulation interests and hearing room testimony. Apparently, there is confusion regarding whether the provisions of Sections R402.2.1, R402.2.2 and associated Tables R402.1.2 and R402.1.3 were germane to low-sloped roof construction for one- and two-family dwellings, townhouses, two-flat, three-flat, and low-rise, multifamily buildings - all RESIDENTIAL BUILDINGS - within the scope of the IECC-R and IRC-R provisions. The allegation was simply, that due to the inadvertent omission of the word "ROOF" from affiliated headings, section titles and tabular columns, the provisions therein did not apply (never existed to apply) to low-sloped roofing on RESIDENTIAL BUILDINGS. NRCA offers these improvements to the coverage of low-sloped roof construction consistent with their "partner provisions" already existing in provisions for COMMERCIAL, Group-R BUILDINGS, and asks the Consensus Committee to effort these improvements to avert continued non-compliance, as alleged.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will neith increase nor decrease the cost of construction.

REPI-33-21

IECC®: TABLE R402.1.2, TABLE R402.1.3, R408.2, Table R408.2 (New), R408.2.1, R408.2.2, R408.2.3, R408.2.4, R408.2.5

Proponents:

Amanda Hickman, representing Leading Builders of America (LBA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.1.2 (TABLE R1102.1.2) MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]	CEILING *U*-FACTOR	WOOD FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
0	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
1	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.25	0.0~~26~~30	0.084	0.165	0.064	0.360	0.477
3	0.30	0.55	0.25	0.0~~26~~30	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.30	0.55	0.40	0.0~~24~~26	0.0~~45~~60	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.40	0.0~~24~~26	0.0~~45~~60	0.082	0.033	0.050	0.055
6	0.30	0.55	NR	0.0~~24~~26	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	NR	0.0~~24~~26	0.045	0.057	0.028	0.050	0.055

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. Mass walls shall be in accordance with Section R402.2.5. Where more than half the insulation is on the interior, the mass wall *U*-factors shall not exceed 0.17 in Climate Zones 0 and 1, 0.14 in Climate Zone 2, 0.12 in Climate Zone 3, 0.087 in Climate Zone 4 except Marine, 0.065 in Climate Zone 5 and Marine 4, and 0.057 in Climate Zones 6 through 8.

c. In warm-humid locations as defined by Figure R301.1 and Table R301.1, the basement wall *U*-factor shall not exceed 0.360.

d. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

e. There are no SHGC requirements in the Marine Zone.

f. A maximum *U*-factor of 0.32 shall apply in Marine Climate Zone 4 and Climate Zones 5 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation above sea level, or

2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

TABLE R402.1.3 (TABLE N1102.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[g]	MASS WALL *R*-VALUE[h]	FLOOR *R*-VALUE	BASEMENT[c,g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c,g] WALL *R*-VALUE
0	NR	0.75	0.25	30	13 or 0 & 10ci	3/4	13	0	0	0
1	NR	0.75	0.25	30	13 or 0 & 10ci	3/4	13	0	0	0
2	0.40	0.65	0.25	~~49~~38	13 or 0 & 10ci	4/6	13	0	0	0
3	.30	0.55	0.25	~~49~~38	20 or 13 & 5ci[h] or 0 & 15ci[h]	8/13	19	5ci or 13[f]	~~10ci, 2 ft~~0	5ci or 13[f]
4 except Marine	.30	0.55	0.40	~~60~~49	~~30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]~~ 20 or 13+5[h]	8/13	19	10ci or 13	10ci, ~~4~~2 ft	10ci or 13
5 and Marine 4	0.30[i]	0.55	0.40	~~60~~49	~~30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]~~ 20 or 13+5[h]	13/17	30	15ci or 19 or 13 & 5ci	10ci, 4~~~~2 ft	15ci or 19 or 13 & 5ci
6	0.30[i]	0.55	NR	~~60~~49	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	15/20	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
7 and 8	0.30[i]	0.55	NR	~~60~~49	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	19/21	38	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. Where insulation is installed in a cavity that is less than the label or design thickness of the insulation, the installed *R*-value of the insulation shall be not less than the *R*-value specified in the table.

b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.

Exception: In Climate Zones 0 through 3, skylights shall be permitted to be excluded from glazed fenestration SHGC requirements provided that the SHGC for such skylights does not exceed 0.30.

c. "5ci or 13" means R-5 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "10ci or 13" means R-10 continuous insulation (ci) on the interior or exterior surface of the wall or R-13 cavity insulation on the interior side of the wall. "15ci or 19 or 13 & 5ci" means R-15 continuous insulation (ci) on the interior or exterior surface of the wall; or R-19 cavity insulation on the interior side of the wall; or R-13 cavity insulation on the interior of the wall in addition to R-5 continuous insulation on the interior or exterior surface of the wall.

d. R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab-edge insulation *R*-value for slabs. as indicated in the table. The slab edge insulation for heated slabs shall not be required to extend below the slab.

e. There are no SHGC requirements in the Marine Zone.

f. Basement wall insulation is not required in warm-humid locations as defined by Figure R301.1 and Table R301.1.

g. The first value is cavity insulation; the second value is continuous insulation. Therefore, as an example, “13 & 5” means R-13 cavity insulation plus R-5 continuous insulation.

h. Mass walls shall be in accordance with Section R402.2.5. The second *R*-value applies where more than half of the insulation is on the interior of the mass wall.

i. A maximum *U*-factor of 0.32 shall apply in Climate Zones 3 through 8 to vertical fenestration products installed in buildings located either:

1. Above 4,000 feet in elevation, or
2. In windborne debris regions where protection of openings is required by Section R301.2.1.2 of the *International Residential Code*.

R408.2 (N1108.2) Additional efficiency package options.

Additional efficiency package options for compliance with Section R401.2.1 are set forth in ~~Sections~~ Table R408.2~~.1 through R408.2.5~~. A minimum of 1 of the numbered options shall be selected and installed from Table R408.2 for the applicable climate zone.

Add new text as follows:

Table R408.2 Climate Zone Specific Option Packages

Climate Zone 0 and 1
1.100% of ducts in conditioned space 2. 2.35 EF heat pump water heater

3. Improved air sealing and efficient ventilation system option in accordance with Section R408.2.1

4. ≥20% of annual household electrical consumption for a mixed fuel home, or the equivalent for an all-electric home shall be produced by a renewable power source.

Climate Zone 2

1. Improved air sealing and efficient ventilation system option in accordance with Section R408.2.1

2. 16 SEER, 10 HSPF Heat pump space heater and 2.35 EF heat pump water heater

3. 95 AFUE furnace and 96 EF tankless water heater

4. 2x6 wall construction with R21 wall insulation plus R5 exterior continuous insulation

5. 18 SEER air conditioner

6. ≥20% of annual household electrical consumption for a mixed fuel home, or the equivalent for an all-electric home shall be produced by a renewable power source.

Climate Zone 3

1. 2.35 EF heat pump water heater or 96 EF tankless water heater

2. 2x6 wall with R21 wall insulation and air leakage performance increase to 2 ACH50

3. Improved air sealing and efficient ventilation system option in accordance with Section R408.2.1

4. 95 AFUE furnace and 18 SEER air conditioner

5. ≥20% of annual household electrical consumption for a mixed fuel home, or the equivalent for an all-electric home shall be produced by a renewable power source.

Climate Zone 4

1. 95 AFUE furnace

2. 16 SEER air conditioner

4. 2.35 EF heat pump water heater

3. 2x6 wall with R21 wall insulation and air leakage performance increase to 2 ACH50

4. Improved air sealing and efficient ventilation system option in accordance with Section R408.2.1

5. ≥20% of annual household electrical consumption for a mixed fuel home, or the equivalent for an all-electric home shall be produced by a renewable power source.

Climate Zone 5

1. 96 AFUE furnace

2. 16 SEER air conditioner and 96 EF water heater

3. Air leakage performance increase to 2 ACH50

4. Improved air sealing and efficient ventilation system option in accordance with Section R408.2.1

5. ≥20% of annual household electrical consumption for a mixed fuel home, or the equivalent for an all-electric home shall

be produced by a renewable power source.
Climate Zone 6
1. 96 AFUE furnace 2. 16 SEER air conditioner and 96 EF water heater 3. Air leakage performance increase to 2 ACH50 4. Improved air sealing and efficient ventilation system option in accordance with Section R408.2.1 5. ≥20% of annual household electrical consumption for a mixed fuel home, or the equivalent for an all-electric home shall be produced by a renewable power source.
Climate Zone 7 and 8
1. 100% of ducts in conditioned space 2. 95 AFUE furnace 3. Air leakage performance increase to 2 ACH50 4. Improved air sealing and efficient ventilation system option in accordance with Section R408.2.1 5. ≥20% of annual household electrical consumption for a mixed fuel home, or the equivalent for an all-electric home shall be produced by a renewable power source.

Delete without substitution:
~~R408.2.1 Enhanced envelope performance option~~.
~~The total *building thermal envelope* UA, the sum of *U* factor times assembly area, shall be less than or equal to 95 percent of the total UA resulting from multiplying the *U* factors in Table R402.1.2 by the same assembly area as in the proposed building. The UA calculation shall be performed in accordance with Section R402.1.5. The area-weighted average SHGC of all glazed fenestration shall be less than or equal to 95 percent of the maximum glazed fenestration SHGC in Table R402.1.2.~~
~~R408.2.2 More efficient HVAC equipment performance option~~.
~~Heating and cooling *equipment* shall meet one of the following efficiencies:~~

1. Greater than or equal to 95 AFUE natural gas furnace and 16 SEER air conditioner.

2. Greater than or equal to 10 HSPF/16 SEER air source heat pump.

3. Greater than or equal to 3.5 COP ground source heat pump.

~~For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.~~
~~R408.2.3 Reduced energy use in service water-heating option~~.
~~The hot water system shall meet one of the following efficiencies:~~

1. Greater than or equal to 82 EF fossil fuel service water-heating system.

2. Greater than or equal to 2.0 EF electric service water-heating system.

3. Greater than or equal to 0.4 solar fraction solar water-heating system.

~~R408.2.4 More efficient duct thermal distribution system option~~.
~~The thermal distribution system shall meet one of the following efficiencies:~~

1. 100 percent of ducts and air handlers located entirely within the *building thermal envelope*.
2. 100 percent of ductless thermal distribution system or hydronic thermal distribution system located completely inside the *building thermal envelope*.
3. 100 percent of duct thermal distribution system located in *conditioned space* as defined by Section R403.3.2.

Revise as follows:

~~R408.2.5 (N1108.2.5)~~ R408.2.1 (N1108.2.1) Improved air sealing and efficient ventilation system option.
The measured air leakage rate shall be less than or equal to 3.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed. Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent Sensible Recovery Efficiency (SRE), less than or equal to 1.1 cubic feet per minute per watt (0.03 m^3/min/watt) and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent Latent Recovery/Moisture Transfer (LRMT).

Reason Statement:

This proposal increases the overall energy savings beyond the 2021 IECC but does so in a more balanced approach. In order to achieve the increased energy savings measures that we have proposed to R408, this code change adjusts prescriptive insulation levels to be more flexible and cost-effective.

Overwhelming data shows that energy savings gains are very dependent on climate zone. What saves energy in one area of the country may actually cost energy in another. A one size approach does not work from an energy savings point of view and it can also lead to egregious financial cost that can price many American families out of homeownership. Unfortunately, that it is exactly what the 2021 IECC did - and it is critical that is corrected.

Approving this proposal will ensure that the 2024 IECC does not only save more energy, but also preserves home affordability, and promotes code adoption.

Cost Impact:

The code change proposal will decrease the cost of construction.

The 2021 edition of the IECC contains provisions that were egregious in cost - some well over a 100 year paybacks. This proposal adjusts the levels for prescriptive envelope requirements, freeing up more to be spent in better cost effective measures that save more energy.

REPI-33-21

REPI-34-21

IECC®: R402.1.2, TABLE R402.1.2, TABLE R405.4.2(1)

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

R402.1.2 (N1102.1.2) Insulation and fenestration criteria.

The *building thermal envelope* shall meet the requirements of Table R402.1.2, based on the *climate zone* specified in Chapter 3. Assemblies shall have a *U*-factor or *F*-factor equal to or less than that specified in Table R402.1.2. Fenestration shall have a *U*-factor and glazed fenestration SHGC equal to or less than that specified in Table R402.1.2.

TABLE R402.1.2 (TABLE N1102.1.2) MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

Portions of table not shown remain unchanged.

CLIMATE ZONE	SLAB *F*-FACTOR	
	Unheated	Heated
0	0.73	0.74
1	0.73	0.74
2	0.73	0.74
3	0.70	0.66
4 except Marine	0.64	0.66
5 and Marine 4	0.64	0.66
6	0.64	0.66
7 and 8	0.64	0.66

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors and *F*-factors shall be obtained from measurement, calculation or an approved source.

TABLE R405.4.2(1) (TABLE N1105.4.2(1)) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Foundations	Type: same as proposed.	As proposed
	Foundation wall or slab extension ~~area~~ above ~~and below~~ grade: 1 ft (30 cm) Foundation wall or slab extension below grade: same as proposed Foundation wall or slab perimeter length: same as proposed ~~and s~~Soil characteristics: same as proposed.	As proposed
	Foundation wall *U*-factor or slab *F*-factor: as specified in Table R402.1.2	

Reason Statement:

F-factors for slabs on grade are missing from the IECC-R provisions, yet the Total UA approach (and REScheck) allow slab insulation to be changed (traded) with the presumption that F-factors are available. The ability to trade foundation insulation in Section C405 is also missing in the standard reference design for Table R405.4.2(1). This proposal also fixes that omission to make foundation insulation tradeable in the performance path. This proposal makes the appropriate F-factors available and is based on the same source for F-factors as used in the IECC-C provisions and in REScheck, namely Appendix A of ASHRAE 90.1.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal adds F-factors and makes this tradeable which will provide more options for compliance that may actually reduce cost.

REPI-34-21

REPI-35-21

IECC®: TABLE R402.1.3, R402.2.7

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.1.3 (TABLE N1102.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

Portions of table not shown remain unchanged.

CLIMATE ZONE	FLOOR *R*-VALUE[j]
0	13 or 7+5ci or 10ci
1	13 or 7+5ci or 10ci
2	13 or 7+5ci or 10ci
3	19 or 13+5ci or 15ci
4 except Marine	19 or 13+5ci or 15ci
5 and Marine 4	30 or 19+7.5ci or 20ci
6	30 or 19+7.5ci or 20ci
7 and 8	38 or 19+10ci or 25ci

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

j. "30 or 19+7.5ci or 20ci" means R30 *cavity insulation* alone or R19 *cavity insulation* with R7.5 *continuous insulation* or R20 *continuous insulation* alone.

R402.2.7 (N1102.2.7) Floors.

Floor ~~cavity~~ *insulation* shall comply with one of the following:

1. Installation shall be installed to maintain permanent contact with the underside of the subfloor decking in accordance with manufacturer instructions to maintain required *R*-value or readily fill the available cavity space.

2. Floor framing cavity insulation shall be permitted to be in contact with the top side of sheathing separating the cavity and the unconditioned space below. Insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.

3. A combination of cavity and continuous insulation shall be installed so that the cavity insulation is in contact with the top side of the continuous insulation that is installed on the underside of the floor framing separating the cavity and the unconditioned space below. The ~~combined~~ *R*-values of the cavity and continuous insulation components or the R-value of continuous insulation only shall equal the required insulation component *R*-values for floors. Cavity ~~I~~insulation shall extend from the bottom to the top of all perimeter floor framing members and the framing members shall be air sealed.

Reason Statement:

Reason Statement:

This proposal adds prescriptive R-value options to Table R402.1.3 for floors above unconditioned spaces (e.g., crawlspaces, floor overhangs, etc.) to align with the primary insulation options as done for above-grade walls. These options are cavity insulation only, cavity plus continuous insulation, and continuous insulation only. This proposal provides prescriptive solutions for a combination of cavity and continuous insulation as currently addressed in Item 3 of Section R402.2.7, but not implemented in Table R402.1.3. Thus, it addresses a gap in the current prescriptive R-value requirements in the code. Finally, it aligns Section R402.2.7 with changes to the table and corrects an error in indicating that cavity and insulation components can be simply summed to meet cavity insulation requirements (which conflicts with clear direction not to do this in Section R402.1.4).

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposal provides options for floor insulation and, therefore, may actually reduce cost.

REPI-35-21

REPI-36-21

IECC®: TABLE R402.1.3, R402.2.9.1

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.1.3 (TABLE N1102.1.3) INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

Portions of table not shown remain unchanged.

CLIMATE ZONE	SLAB[d] *R*-VALUE & DEPTH	
	Unheated	Heated
0	0	R-5 full slab
1	0	R-5 full slab
2	0	R-5 full slab
3	10ci, 2 ft	R10ci, 2 ft and R-5 full slab
4 except Marine	10ci, 4 ft	R10ci, 4 ft and R-5 full slab
5 and Marine 4	10ci, 4 ft	R10ci, 4 ft and R-5 full slab
6	10ci, 4 ft	R10ci, 4 ft and R-5 full slab
7 and 8	10ci, 4 ft	R10ci, 4 ft and R-5 full slab

For SI: 1 foot = 304.8 mm.

NR = Not Required.
ci = continuous insulation.

d. Slab insulation shall be installed in accordance with Section R402.2.9.1 ~~R-5 insulation shall be provided under the full slab area of a heated slab in addition to the required slab edge insulation *R* value for slabs. as indicated in the table~~. ~~The slab edge insulation for heated slabs shall not be required to extend below the slab.~~

R402.2.9.1 (N1102.2.9.1) Slab-on-grade floor insulation installation.
Where installed, the slab edge *continuous* *insulation* shall extend downward from the top of the slab on the outside or inside of the foundation wall. Insulation located below grade shall be extended the distance provided in Table R402.1.3 or the distance of the proposed design, as applicable, by any combination of vertical insulation, insulation extending under the slab or insulation extending out from the building. Insulation extending away from the building shall be protected by pavement or by not less than 10 inches (254 mm) of soil. The top edge of the insulation installed between the *exterior wall* and the edge of the interior slab shall be permitted to be cut at a 45-degree (0.79 rad) angle away from the *exterior wall*. Where installed, full slab insulation shall be continuous under the entire area of the slab-on-grade floor, except at structural column locations and service penetrations. Slab edge insulation required at the heated slab perimeter shall not be required to extend below the bottom of the heated slab and shall be continuous with the full slab insulation.

Reason Statement:

The purpose of this proposal is to coordinate the format of communicating slab insulation requirements in the IECC-R with the IECC-C by including heated slab insulation requirements in the R-value table instead of in a footnote. None of the requirements are changed for unheated and heated slabs. Also, full slab insulation installation requirements for heated slabs are added to Section R402.2.9.1 and are consistent with similar language included in Section C402.1.4.1 of the 2021 IECC-C. This also allows footnote ‘d’ to be simplified by pointing to complete installation requirements in Section R402.2.9.1. The current footnote ‘d’ is incomplete and does not include all of the relevant installation information in Section R402.2.9.1.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not change slab insulation requirements and merely provides a better format for communicating slab insulation requirements.

REPI-36-21

REPI-37-21

IECC®: R402.2.10, R402.2.10.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:
R402.2.10 (N1102.2.10) Crawl space walls.
Crawl space walls shall be insulated in accordance with Table R402.1.3.
Exception: Crawl space walls associated with a crawl space that is vented to the outdoors and the floor overhead is insulated in accordance with Table R402.1.3 and Section R402.2.7 floors.
R402.2.10.1 (N1102.2.10.1) Crawl space wall insulation installations.

Where crawl space wall insulation is installed, it shall be permanently fastened to the wall and shall extend downward from the floor to the finished grade elevation and then vertically or horizontally for not less than an additional 24 inches (610 mm). installed on either the exterior or interior side of the foundation wall and comply with the following:

1. Exterior Crawl space wall insulation shall be permanently fastened to the wall and extend downward from the sill plate to the base of the foundation system.

2. Interior Crawlspace wall insulation shall be permanently fastened to the foundation wall and extend downward from on top of the sill plate at the top of the foundation wall to the interior floor of the crawlspace.

Exposed earth in vented or unvented crawl space foundations shall be covered with a continuous Class I vapor retarder in accordance with the International Building Code or *International Residential Code*, as applicable. Joints of the vapor retarder shall overlap by 6 inches (153 mm) and be sealed or taped. The edges of the vapor retarder shall extend not less than 6 inches (153 mm) up stem walls and shall be attached to the stem walls.

Reason Statement:

Purpose: This proposal offers direction for installation of foundation insulation that performs, and which makes enforcement easier and more straight forward. The standing language does not address insulating from the outside and ambiguously speaks to insulating the rim joist or “the depth of the floor”.

Language that has been stricken is not enforced and is confusing creating situations where the crawl foundation wall may not be fully insulated especially at the top next to the sill plate connection and at the bottom connection with footings or soils. Performance and efficiency will be increased through consistent application which will benefit jurisdictions and the homeowner by ensuring continuous thermal envelopes that avoid thermal bridging.

There may be a perception that the removal of the requirement to insulate horizontally for 2’ over the dirt floor is a reduction in the stringency of the IECC, however, energy modeling has determined that the horizontal application of insulation inward for 2’ over the crawl dirt vapor retarder does not improve the energy performance of the home. This currently required detail is rarely enforced and or applied in the field. Proposals need to address cost of application and this proposal reduces cost by removing ineffective application.

The IECC has never specifically addressed the application of insulation on the exterior so this proposal clarifies that insulation shall extend above grade to the sill plate and below grade to the footing in this application. Frost protected shallow foundations that are constructed with horizontal insulation extending away from the foundation on the outside of the building are not prohibited by this change in language. As demonstrated in the Bibliography, this type of insulation technique takes the insulation horizontally from the bottom of the installed vertical installed insulation which in this case would be at the bottom of the foundation wall on the exterior.

Regardless of if the crawl space is vented or unvented, exposed earth needs to be covered with a class I vapor retarder. This proposal ensures that there is no confusion about this sound building durability and building science point.

Bibliography:

Shallow frost foundation guide

https://www.huduser.gov/publications/pdf/fpsfguide.pdf

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposal will not increase cost and should decrease cost as it is eliminating the requirement to install insulation 2’ horizontally on the interior of the foundation wall over the vapor retarder on the dirt floor.

REPI-37-21

REPI-38-21

IECC®: R402.2.11 (N1102.2.11) (New), TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Add new text as follows:

<u>R402.2.11 (N1102.2.11)</u> <u>Rim/band joist requirements</u>.

<u>At rim joist locations adjacent to the foundation, the junction of the sill plate to the foundation shall be sealed. Capillary break materials installed between the sill plate and the foundation shall not be used as air sealing materials unless specifically design for that use. For all rim and band joists, the rim board to the plate, and the rim board to the subfloor adjacent to the building thermal envelope shall be air sealed. Plates and rim boards which are part of the rim and band joist thermal envelope assembly shall be insulated at least to the same R-value as the above grade exterior wall and shall be enclosed on six sides of the assembly with an air barrier.</u>

Revise as follows:

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim<u>/band</u> joists	Rim/<u>band</u> joists shall include	Rim/band joist shall be insualted per Section

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
	an ~~exterior~~ air barrier.~~b~~ The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed per section R402.11	R402.2.11 ~~Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]~~
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other	All holes created by wiring, plumbing or other obstructions in	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
obstructions	the air barrier assembly shall be air sealed.	obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces ~~and at rim joists.~~

Reason:

Rim joist at foundations and between floor are notoriously leaky and difficult to insulate. A specific requirement section is needed to address them. This proposal deals with the air leakage issues and the insulation issue. For too long fibrous insulation has been allowed to be installed in location without complete enclosure/air barrier. Fibrous insulation in any cavity must be enclosed on six sides. This cavity is not tall, but convection through the material occurs because it is open to large volume spaces within the floor system of potentially the greater volume of the basement or crawl space.

Cost Impact:

The code change proposal will increase the cost of construction.

This will impact the first cost of construction as it is a new code requirment to enclose the fibrous insulation installed in the rim/band joist. However, performance will improve and operational cost and comfort will be impacted positively.

REPI-39-21

IECC®: R402.2.3 (N1102.2.3) (New), TABLE R402.4.1.1 (N1102.4.1.1) (New), TABLE R405.2, TABLE R406.2

Proponents: Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Add new text as follows:

R402.2.3 (N1102.2.3) Attic knee or pony wall. R402.2.3 Attic knee or pony wall. Attic knee or pony wall assemblies that seperate conditioned space from unconditioned attic spaces shall be constructed to be insulated to the R-value of the above grade wall described in Table R402.1.3. Knee or pony walls shall have a sealed air barrier to the unconditioned side of the assembly. Air permeable insulation installed in knee or pony wall cavities shall be enclosed on six sides of the cavity. Insulation installed in knee or pony wall cavities shall be installed in substantial contact with the air barrier. Knee or pony wall cavities defined by roof truss framing shall be insulated to the same level as other exterior above grade walls. Vertical or diagonal surfaces that are greater than 1 foot (305 mm) in height into a ventilated attic shall be considered a knee or pony wall. Vertical or diagonal surfaces that are 1 foot (305 mm) or less in height into a ventilated attic shall be buried with insulation to maintain the ceilings required R-value.

TABLE R402.4.1.1 (N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Knee or pony walls	Knee or pony walls shall be constructed to have a sealed air barrier on six sides of the wall assembly including to the unconditioned side of the assembly.	Insulation installed in a knee or pony wall shall be installed in accordance with Section R402.2.3.

Revise as follows:

TABLE R405.2 (TABLE N1105.2) REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3 ~~R402.2.3~~ R402.2. 4	Attic knee or pony wall Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration U-factor and SHGC
Mechanical	
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls

a. Reference to a code section includes all the relative subsections except as indicated in the table.

TABLE R406.2 (TABLE N1106.2) REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
General	
R401.2.5	Additional efficiency packages
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3 ~~R402.2.3~~ R402.2. 4	Attic knee or pony wall Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
Mechanical	
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R406.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

Reason: Attic knee walls, often named pony walls in the field, are a unique assembly that has been overlooked by the IECC. The assembly separates interior conditioned space from exterior unconditioned space, but it buffered from directly being connected to the ambient outdoors by a ventilated attic. The ventilated attic space often has harsher unconditioned side temperatures that normal above grade walls causing more significant heat loss or gain through the assembly than through normal insulated above grade walls. This being the case we see across the country in the field that attic knee or pony walls are often insulated to a lower R-value than the exterior walls associated with the same house. In addition, the IECC has not been clear about the need for attic side enclosed and sealed air barrier systems installation.
This proposal defines, describes how to address, and adds this unique assembly to the list of required assemblies that must be detailed in the requirements section of the IECC. It will ensure proper air barriers, insulation installation, air sealing of the assembly and will increase the performance of the home.

Cost Impact: The code change proposal will increase the cost of construction.
In theory, this assembly has been addressed as an above grade wall so this new section of code should not add cost to the construction of a home. In reality, this assembly has not been viewed in most of the country as a typical above grade wall so cost will be added to construction because of the realization of the significance of the assembly and the heat loss and gain that is driven through it because of it be adjacent to the ventilated attic.

The R-value of this part of the above grade wall assembly could traded off to a lower R-value, or the same R-value that is currently being installed when using the UA alternative, Total Building Performance, or ERI compliance pathways. This would lower the cost associated with this code proposal. However, as cost goes down implementation would still become better because the proposal would ensure that the installed insulation is enclosed in a six-sided air sealed cavity which performs to better mitigate heat loss and gain through the assembly.

REPI-40-21

IECC®: R402.2.6, TABLE R402.2.6, AISI (New)

Proponents:

Jonathan Humble, representing American Iron and Steel Institute (Jhumble@steel.org)

2021 International Energy Conservation Code

Revise as follows:
R402.2.6 (N1102.2.6) Steel-frame ceilings~~,~~ and walls ~~and floors~~.
Steel-frame ceilings~~,~~ and walls~~, and floors~~ shall comply with the ~~insulation requirements of Table R402.2.6 or the~~ *U*-factor requirements of Table R402.1.2. The ~~calculation of the~~ *U*-factor for a steel-frame envelope assembly shall ~~use a series-parallel path calculation method~~ be determined in accordance with AISI S250.
Delete without substitution:

~~TABLE R402.2.6 STEEL-FRAME CEILING, WALL AND FLOOR INSULATION R-VALUES~~

WOOD FRAME *R*-VALUE REQUIREMENT	COLD-FORMED STEEL-FRAME EQUIVALENT *R*-VALUE[a]
Steel Truss Ceilings[b]	
R-30	R-38 or R-30 + 3 or R-26 + 5
R-38	R-49 or R-38 + 3
R-49	R-38 + 5
Steel Joist Ceilings[b]	
R-30	R-38 in 2 × 4 or 2 × 6 or 2 × 8 R-49 in any framing
R-38	R-49 in 2 × 4 or 2 × 6 or 2 × 8 or 2 × 10
Steel-frame Wall, 16 inches on center	
R-13 + 4.2 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1	
R-13+5	R-0 + 15 or R-13 + 9 or R-15 + 8.5 or R-19 + 8 or R-21 + 7
R-13+10	R-0+20 or R-13 + 15 or R-15 + 14 or R-19 + 13 or R-21 + 13
R-20	R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-21 + 7.5
R-20 + 5	R-13 + 12.7 or R-15 + 12.3 or R-19 + 11.6 or R-21 + 11.3 or R-25 + 10.9
R-21	R-0 + 14.6 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or R-21 + 8.1 or R-25 + 7.7
Steel-frame Wall, 24 inches on center	
R-0 + 9.3 or R-13 + 3.0 or R-15 + 2.4	
R-13+5	R-0 + 15 or R-13 + 7.5 or R-15 + 7 or R-19 + 6 or R-21 + 6
R-13+10	R-0 + 20 or R-13 + 13 or R-15 + 12 or R-19 + 11 or R-21 + 11
R-20	R-0 + 14.0 or R-13 + 7.7 or R-15 + 7.1 or R-19 + 6.3 or R-21 + 5.9
R-20+5	R-13 + 11.5 or R-15 + 10.9 or R-19 + 10.1 or R-21 + 9.7 or R-25 + 9.1
R-21	R-0 + 14.6 or R-13 + 8.3 or R-15 + 7.7 or R-19 + 6.9 or R-21 + 6.5 or R-25 + 5.9
Steel Joist Floor	
R-13	R-19 in 2 × 6, or R-19 + 6 in 2 × 8 or 2 × 10
R-19	R-19 + 6 in 2 × 6, or R-19 + 12 in 2 × 8 or 2 × 10

a. The first value is cavity insulation *R*-value; the second value is continuous insulation *R*-value. Therefore, for example, “R-30 + 3” means R-30 cavity insulation plus R-3 continuous insulation.

b. Insulation exceeding the height of the framing shall cover the framing.

Add new standard(s) as follows:

AISI American Iron and Steel Institute 25 Massachusetts Avenue, NW, Suite 800 Washington DC 20001
AISI American Iron and Steel Institute.

AISI - S250 - 21 North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing

Attached Files

- **AISI_CFSD-Report-RP20-2-Final.pdf**
  http://localhost/proposal/106/879/files/download/23/
- **AISI S250-21&S250-21-C_s.pdf**
  http://localhost/proposal/106/879/files/download/22/

Reason Statement:

The purpose of this proposal is to address the issue of having to submit to the code official a request to use the alternative means and methods provisions for cold-formed steel framing designs that are not shown in the IECC. For example, Section C402.1.4.2 addresses only wall framing spacing for 16 and 24 inch on center spacing and is limited to cavity plus continuous insulation options only, whereas, in the market there are many more framing spacing and insulation options used.

This proposal recommends that the Section be modified to recognize the ANSI/AISI/COFS S250 standard. This standard covers cold-formed steel wall framing spacings from 6 inches to 24 inches on center, covers member sizes from 3.5 inches to 12 inches wide, and covers member thicknesses from 0.033 inches thick to 0.064 inches thick. This standard will provide greater latitude for the user of the IECC by mitigating the necessity of having to submit for approval under alternate means and methods provisions. Further, this standard also includes provisions for evaluation of wall assemblies where all the insulation is located outside the wall cavity, which is an option the IECC does not cover.

This standard also contains provisions for calculating ceiling assemblies constructed of cold-formed steel framing with either conventional c-shape framing members, or truss construction with insulation in the attic and with additional continuous insulation below the truss framing. Previous to this proposal we found users applying the 2003 IECC provisions, which contained the calculation procedures, as part of the alternative means and methods submission process to demonstrate compliance. This proposal is intended to mitigate that additional step.

The ANSI/AISI/COFS S250 was approved and published in September 2021.

As part of AISI's effort to make this document user friendly, an excel spread sheet containing all the necessary equations and background data was generated so that users would merely input the basic assembly materials data (e.g. R-values of insulations, sheathings, etc.) and allow the spread sheet to calculate within seconds the result. This excel spread sheet is available at no cost to any potential user (e.g. code official, design professional, building owner, etc.)

The proponent wishes to schedule time to present to the IECC Residential Committee this proposal, discuss, and to take questions from the Committee.

Bibliography:

AISI, "Development of a U-factor Calculation Procedure for Cold-Formed Steel C-Shaped Clear Wall Assemblies," American Iron and Steel Institute, Washington, DC, Research Report RP20-2, April 2020.

AISI, "North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing," American Iron and Steel Institute, Washington, DC, AISI S250-21.

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposed change we expect will decease the cost of construction by eliminating the need to prepare an application to the alternative means and methods process. This is because of the standards wider range of envelope assembly options that the user is permitted to calculate in order to demonstrate compliance.

REPI-40-21

REPI-41-21

IECC®: R402.2.8, R402.2.8.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:
R402.2.8 (N1102.2.8) Basement walls.
Basement walls shall be insulated in accordance with Table R402.1.3 or the installed R-value shall be in accordance with the compliance path that is defined at the time of obtaining the building permit.

Exception: *Basement walls* associated with unconditioned basements where all of the following requirements are met:

1. The floor overhead including the underside stairway stringer leading to the basement, is insulated in accordance with ~~Section~~ Table R402.1.3 and ~~applicable provisions of~~ Sections ~~R402.2 and~~ R402.2.7.
2. There are no uninsulated duct, domestic hot water, or hydronic heating surfaces exposed to the basement.
3. There are no HVAC supply or return diffusers serving the basement.
4. The walls surrounding the stairway and adjacent to *conditioned space* are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2.
5. The door(s) leading to the basement from conditioned spaces are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2, and weather stripped in accordance with Section R402.4.
6. The *building thermal envelope* separating the basement from adjacent conditioned spaces complies with Section R402.4.

R402.2.8.1 (N1102.2.8.1) Basement wall insulation installation.

~~Where *basement walls* are insulated, the insulation shall be installed from the top of the *basement wall* down to 10 feet (3048 mm) below grade or to the basement floor, whichever is less.~~

Walls associated with conditioned basements shall be insulated on either the exterior or the interior side of the assembly and comply with the following:

1. Exterior basement wall insulation shall be permanently fastened to the wall and extend downward from the sill plate to the footing or 10 feet (3048 mm), whichever is less.
2. Interior basement wall insulation shall extend downward from the interior edge of the sill plate to the finished floor below.

Reason Statement:

The R-value of the installed material will depend on the compliance path chosen and could vary.

The exception defines an unconditioned basement and refers to a section of code that is actually a table and then should point directly to floor insulation installation to separate the unconditioned basement from the conditioned living space above. The proposal fixes this confusion.

Foundation walls that define a basement can and often are insulated from the exterior. The language has been changed in this proposal to provide requirements for installation for not only interior application but also exterior insulation installation. Both installs require full coverage from the sill plate down ward as was done with the stricken language to ensure full coverage.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not impact the cost of construction. Instead, it provides greater flexibility in how basement assemblies can be insulated. It also better defines unconditioned basements and how to insulate from the interior or exterior.

REPI-41-21

REPI-42-21

IECC®: SECTION 202 (New), R402.3 (N1102.3) (New), ASTM Chapter 06 (New)

Proponents:

Wesley Hall, representing The Reflective Insulation Manufacturers Association - International (wes.hall@reflectixinc.com)

2021 International Energy Conservation Code

Add new definition as follows:
R202 RADIANT BARRIER. A material having a low emittance surface of 0.1 or less installed in building assemblies.
Add new text as follows:
R402.3 (N1102.3) Radiant barriers.

Where installed to reduce thermal radiation, radiant barriers shall be installed in accordance with ASTM C1743.

Add new standard(s) as follows:
ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

C1743-2019	Standard Pract ice f o r Inst allat io n and Use o f Radiant Barrier Syst ems (RBS) in Resident ialBuilding Co nst ruct io n

Reason Statement:

This proposal DOES NOT require the use of radiant barriers. But rather requires that WHEN radiant barriers are used, they comply with the appropriate ASTM standard. Furthermore this proposal provides important information to the code user and code enforcement community regarding radiant barriers.

The definition for Radiant Barrier is included in the 2021 IBC.

Radiant barriers are typically installed in attics to reduce summer heat gains through the roof. According to the DOE's website: https://www.energy.gov/energysaver/weatherize/insulation/radiant-barriers, Radiant barriers help to reduce cooling costs by reducing radiant heat gain. To be effective, radiant barriers are very dependent of their installationbecause their reflective surface must face an air space.

Radiant barriers follow two ASTM Standards – ASTM C1313/C1313M, "Standard Specification for Sheet Radiant Barriers for Building Construction Applications," and ASTM C1743, "Standard Practice for Installation and Use of Radiant BarrierSystems (RBS) in Residential Building Construction".

The proposed language is being included in this section specifically because the American Society for Testing andMaterials (ASTM) classifies radiant barriers as thermal insulation. The ASTM committee C16 on Thermal Insulation includespublished standards for this product. Subcommittee C16.21 deals specifically with reflective products, which include reflective insulation, radiant barrier and interior radiation control coatings. C16.21 develops standards and practices for these reflective building material thermal insulating products.

Radiant barrier products include a surface with an emittance of 0.1 or less that is installed in roof assemblies or attics with the low-emittance surface facing an open or ventilated air space. The low emittance material can be bonded to plastic film, woven fabric, reinforced paper, OSB or plywood. The thermal performance of radiant barriers depends on emittance and location in the attic, wall or roof assembly. Radiant barriers are predominantly installed in attic spaces below the roof deck. The low-emittance surface of radiant barrier products dramatically reduces the heat gain by radiation into the structure and attic HVAC ducts. For this reason, radiant barriers are especially effective in warm sunny climates where they provide reduced use of air conditioning. Radiant barrier products that are available include single-sheet material, multi-layer assemblies and wood sheathing with attached aluminum film or foil. The single sheet material is installed in roof assemblies by attaching directly to the roof deck, in between the rafters or trusses or to the underside of the rafters or trusses. The foil-faced sheathing is installed with the low-emittance side of the sheathing or panel facing toward the attic space to create a radiant barrier. Attic radiant barriers are in extensive use. These products have been on the market for several decades and are used by 87 of the top 100 US Builders. They have an established history and have been accepted into several regional code requirements. Over one billion square feet of the product is being installed annually.

IBC 2021

- Section 1510, Radiant Barriers Installed Above Deck

Hawaii Title 3, Chapter 181.1 2015

- Section 407.2 Requirements
- Table 407.1 Points Option

Texas

- City of Austin Ordinance No. 20210603-055, City Code Chapter 12-25, Article 12, R402.6

2020 Florida Building Code, Energy Conservation, 7th Edition

- R405.7.1 Installation criteria for homes claiming the radiant barrier option
- Figure R405.7.1 Acceptable attic radiant barrier configurations
- Table 303.2.1 Insulation Installation Standards

2019 California Title 24, Part 6

- Section 100.1 Definitions
- Section 110.8 Mandatory requirements for insulation, roofing products and radiant barriers

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will not increase the cost of construction because it only adds informational language regarding radiant barriers.

REPI-42-21

REPI-43-21

IECC®: R402.4, R402.4.1.2, ASTM Chapter 06 (New)

Proponents:

Theresa A Weston, The Holt Weston Consultancy, representing The Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
R402.4 Air leakage.
The *building thermal envelope* shall be constructed to limit air leakage in accordance with the requirements of Sections R402.4.1 through ~~R402.4.5~~ R402.4.6.
R402.4.1.2 Testing.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 ~~or~~ ASTM E1827 or E3158 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

Exception: When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 ~~or~~ ASTM E1827 or E3158 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single-family and multiple-family building *dwelling units*.

2. Buildings or *dwelling units* that are 1.500 square feet (139.4 m^2) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

Add new standard(s) as follows:

ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

<u>E3158-18</u>	<u>Standard Test Method for Measuring the Air Leakage Rate of a Large or Multizone Building</u>

Reason Statement:

This proposal adds an additional reference test method, ASTM E3158. This test method has already been included in the list of acceptable test methods for whole building air leakage testing in the IECC-C but was not added to the parallel section of the IECC-R.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does increase code requirements or introduce new code requirements. It only add an additional test protocol option to the current list of test protocol standards.

REPI-43-21

REPI-44-21

IECC®: R402.4.1.1

Proponents:

Charles Haack, representing NAIMA (chaack@naima.org); Ryan Meres, representing RESNET (ryan.meres@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.1 (N1102.4.1.1) Installation.
The components of the *building thermal envelope* as indicated in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions or Properly Installed as defined by ANSI/RESNET/ICC 301 Appendix A and the criteria indicated in Table R402.4.1.1, as applicable to the method of construction. Where required by the *code official,* an *approved* third party shall inspect all components and verify compliance.

Reason Statement:

As a result of comments received during the 2021 IECC code cycle, RESNET has overhauled RESNET/ICC Standard 301 Appendix A to include objective installation requirements. This update was designed to make the standard more amenable for adoption in the 2024 IECC, aids in development of clear and concise educational materials, and promotes better alignment between the RESNET standard, IECC requirements, and Manufacturer instructions. This revised Appendix A includes clear itemized requirements for all insulation types and creates a self-contained ANSI-approved standard for the assessment of insulation installation. It no longer includes outside reference to a laundry list of ASTM standards and is a succinct list of pass/fail items for the relevant insulation product being installed. No longer does the Appendix A document include descriptions of Grade II and III, but only Properly Installed and Not Properly Installed.

This effort was the result of manufacturer and home energy rater coordination through the RESNET-led ANSI process. Further, the insulation industry is creating comprehensive informative guidance that aligns with the requirements of Appendix A.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no cost increase in this code change as the code currently requires insulation to be installed to manufacturers installation instruction which is consistent with Grade I insulation installation requirements.

REPI-44-21

REPI-45-21

IECC®: TABLE R402.4.1.1

Proponents:

Megan Hayes, representing NEMA (Megan.Hayes@nema.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
floors above garages		insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical and communication boxes ~~/phone~~	The air barrier ~~shall be installed~~ extends behind ~~electrical and communication~~ boxes installed in the	Spaces behind boxes penetrating the thermal envelope shall have insulation cut or blown to fit or that readily conforms to

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
~~box on exterior walls~~	building thermal envelope. Boxes that penetrate the building thermal envelope shall be air sealed to the subfloor, wall covering, or ceiling penetrated by the box ~~Alternatively~~, or air-sealed boxes shall be installed.	the space around the box.
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

The information provided in Table 1102.4.1.1 (R402.1.1) is extremely vague and unclear when dealing with electrical and communication outlet boxes that penetrate the thermal envelope or air barrier of a building. The revised and new language proposed for the Table provides proper guidance on how air barrier, air sealing, and insulation installation should be handled at and around box penetration in walls, floors, and ceilings.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no increase or decrease cost in construction as this proposal simply adds clarity to the original intent of the table requirement for electrical and communication outlet boxes.

REPI-46-21

IECC®: TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (TABLE 1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
<u>Above grade</u> Walls	The junction of the foundation and sill plate shall be <u>air</u> sealed. <u>Capillary break materials placed under sill plates shall not replace air sealing unless specifically designed to do so.</u> The junction of ~~the~~ top plate<u>s</u> and drywall adjacent to unconditioned space ~~the top of exterior walls~~ shall be <u>air</u> sealed. <u>The junction of the bottom plate to the subfloor on exterior walls separating interior conditioned space from exterior unconditioned space shall be air sealed.</u> ~~Knee walls shall be sealed.~~	<u>Air permeable insulation installed in wall cavities shall be enclosed on six sides.</u> ~~Exterior~~ *<u>Building</u> thermal envelope* insulation for framed walls shall be installed in substantial contact and continuous alingment with the air barrier. ~~Cavities within c~~ <u>C</u>orners <u>in exterior</u> ~~and headers of~~ frame walls shall be insulated ~~by completely filling the cavity~~ with ~~a~~ material having a thermal resistance, *R*-value, of not less than R-3 per inch. <u>Headers on exterior walls shall be insulated to a minimum R-5.</u>
Windows,	The space between framing and	—

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
skylights and doors	skylights, and the jambs of windows and doors, shall be sealed.	
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

The objective of table R402.4.1.1 is to offer guidance for how to create an airtight home that meets the air leakage requirements of the IECC. Air barrier and insulation installation are part of the equation to be able to accomplish this goal, but air sealing is another part of it that has been missing from the title. The tables name now accurately reflects the air sealing goal.

Air barrier and air sealing criteria section:

- Clarification of the language requiring drywall to be sealed to the top plate is needed of all walls that are adjacent to unconditioned space. Believe it or not, in the field there is confusion regarding what exterior means. In a square house for example, does it mean four exterior walls, or does it mean top plates that are adjacent to unconditioned space, which would include interior walls that are adjacent to unconditioned space. The gained clarity of this air sealing activity addresses one of the largest air leakage sources on the high side of the home.

- NAIMA recently released "Five Priority Air Sealing Locations" from an Owens Corning study and listed the junction of the top plate and drywall adjacent to unconditioned spaces above as number one. They estimate that over 300 lineal feet of leakage is present. Multiply 300 feet by an 1/8" gap, and you get an almost 6060 window-sized hole to the outside at this location. Our field experience shows that the current language in this section of the code causes confusion because it says, "seal the junction of the top plate and exterior wall." Many incorrectly assume that this means the top plate of the 4 exterior walls and not all top plates connected to the exterior or unconditioned space in a square house for example. This code change clearly breaks up the many requirements in this section into bite-size bits of understandable code language that those in the field that are applying the code need. For example, insulated corners and headers were jumbled together in one long sentence. Now, they are separated and clarified so the requirement is clear and understandable.
- The junction of the bottom plate to the subfloor on exterior walls has not been addressed by the IECC as one of the larges sources of air leakage in homes and therefore I have added this low hanging air sealing opportunity to the table.

Insulation Installation Criteria:

- Air permeable insulation must be enclosed in an air barrier to trap pockets of air that are required to resist the flow of energy. This new language proposed for the table is in alignment with manufacture installation instruction and quickly expresses what is required to executed properly in the field.
- Corners and headers are significantly different assemblies to insulate. Headers, in particulate may not have a true cavity to insulate and may be better suited to insulate with foam board. This proposal breaks the two assemblies into separately addressed assemblies. This also makes these two existing requirements stand out for better understanding and enforcement.
- Adding the defined term Building Thermal Envelop ensures clarity
- Knee walls, or pony walls and many call them, are a unique assembly which need to be addressed on their own in this table. They have been removed from this section in favor of offering a separate knee or pony wall proposal to the 2024 IECC development committee.

Comments and recommendation that were made during the 2021 IECC development process, as well as discussions with others in the industry, were incorporated as well to streamline and search for better, more concise, and meaningful language to ensure clarity and reduce confusion.

Bibliography:

This proposal aligns with ENERGY STAR requirements that are the basis of the creation of this table and have been adopted by the IECC in the past.

ENERGY STAR Requirements:

https://www.energystar.gov/sites/default/files/Rater%20F%20v104%202018-07-10_Clean_fillable.pdf

2. Fully-Aligned Air Barriers 6 At each insulated location below, a complete air barrier is provided that is fully aligned as follows:

Walls: At exterior vertical surface of wall insulation in all climate zones; also at interior vertical surface of wall insulation in Climate Zones 4-8 8

2.2 Walls behind showers, tubs, staircases, and fireplaces

2.3 Attic knee walls and skylight shaft walls

2.4 Walls adjoining porch roofs or garages

2.5 Double-walls and all other exterior walls

Footnote 8

All insulated vertical surfaces are considered walls (e.g., above and below grade exterior walls, knee walls) and must meet the air barrier requirements for walls.

4. Air Sealing (Unless otherwise noted below, “sealed” indicates the use of caulk, foam, or equivalent material)

4.3 Above-grade sill plates adjacent to conditioned space sealed to foundation or sub-floor. Gasket also placed beneath above-grade sill plate if resting atop concrete / masonry & adjacent to cond. space

4.4 Continuous top plate or blocking is at top of walls adjoining unconditioned space, and sealed

4.5 Drywall sealed to top plate at all unconditioned attic / wall interfaces using caulk, foam, drywall adhesive (but not other construction adhesives), or equivalent material. Either apply sealant directly between drywall and top plate or to the seam between the two from the attic above.

Cost Impact:

The code change proposal will increase the cost of construction.

The proposed language will only **minimally** impact the cost of construction, but the increased clarity of existing requirements far outweighs any increase in cost. Only two new requirements have really been added by this proposal.

1. Sealing the bottom plate to the subfloor. This could add material and labor cost, however in order to meet the current level or air tightness is probably being done. In those areas that areas that are struggling to meet the air leakage requirement this low hanging fruit needs to be made clear.

2. The proposed requirement for headers to be insulated to R-5 will in cost neutral but adds greater flexibility for implementation. When three ply header is replaced with a two-ply header the 1.5” space is often insulated with a material that has an R-value of 3 per inch. On the other hand, when half inch spacers are replaced with R2.5 1/2” foam board the material can achieve R5 but is not an r3 per inch.

REPI-47-21

IECC®: TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	~~The~~ <u>A sealed</u> air barrier <u>shall be installed</u> in any dropped ceiling or soffit <u>to separate it from unconditioned space.</u> ~~shall be aligned with the insulation and any gaps in the air barrier shall be sealed.~~ Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be <u>air</u> sealed <u>with gasketing materials that allow for repeated entrance over time.</u>	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier. <u>Access hatches and doors shall be installed and insulated in accordance with Section R402.2.4</u> <u>Eave Baffles shall be installed in accordance with Section R402.2.3</u>
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
	the subfloor shall be air sealed.	
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on	The air barrier installed at exterior	Exterior walls adjacent to showers and tubs shall

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
exterior wall	walls adjacent to showers and tubs shall separate the wall from the shower or tub.	be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

Air barrier Criteria:

- This section of the code proposal removes insulation requirements that were placed on the wrong side of the table. They are also redundant to insulation requirements that are already in place on the insulation side of the table for this component.
- Driving home the concept of air barriers separating conditioned space from unconditioned space is important to continue here to clarify the requirement to bring drop ceilings into the conditioned space.
- In the field we are continuing to see hatches that are caulked shut and must be cut open. The requirement for air sealing hatches and doors now is clarified that a gasketing air sealing material must be installed that allows for repeated entrance without damaging the air seal.

Insulation Installation Criteria:

- There are many precedents in code language to point to sections for additional clarification, especially for installation guidance that is already in the code but are important to the section of code where the reference has been made. The specific referenced sections in this proposal describe the installation of measures in the requirement section of the code.

- These sections of code are important to reiterate in Table R402.4.1.1 due to the many compliance options that are available. In addition, traditionally Section R402.2.3 and R402.2.4 have been in the prescriptive section of the code. They are currently right after the discussion of prescriptive compliance. As jurisdiction adopt newer code it is important to ensure that although the word mandatory has been removed in the IECC that there are still installation requirements in this table that are explained in other sections of the code.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed language changes do not increase the cost of construction but rather removes redundancy and offers greater clarity of existing requirements.
Accessibility to attic spaces is new language but is not a new requirements so it should not increase cost but rather increase clarity.

REPI-48-21

IECC®: TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, separating conditioned from unconditioned space, including cantilevered floors and floors above	The air barrier shall be installed, and air sealed at any exposed edge of ~~insulation.~~ the insulated floor cavity adjacent to unconditioned space.	Air permeable insulation installed in floor cavities shall be enclosed in a six-sided cavity. Floor framing cavity insulation shall be

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
garages		installed <u>in accordance with the requirements of Section R402.2.7.</u> ~~to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.~~
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

This proposal comes back from the 2021 IECC development cycle with understanding and contemplation of the comments that were made during the process and afterward. The proposal has been simplified with the inclusion of Section R402.2.7 reference. (Floor Insulation Installation) However, it continues to ensure that the floor insulation installation requirements will be followed regardless of the compliance pathway that is chosen.This proposal aligns with programs such as ENERGY STAR that are the basis of the creation of this table that has been adopted by the IECC. (see bibliography)

Component: It needs to be clear that the floor cavities that are being addressed by this table are only floor that separate conditioned from unconditioned space. It is surprising how not all understand this.

Air barrier and air sealing criteria section: Floor cavities are wall cavities laid down, therefore, air permeable insulation installed inside the cavity also needs to be enclosed by the air barrier assembly. As the IECC allows alternative insulation techniques for insulating floors as seen in the exceptions detailed in Section R402.2.7 it becomes more important to ensure that the rim joist of the insulated floor not only get insulated but is air tight because the insulation no longer must be installed adjacent to the subfloor decking. The proposed language change brings this to light for builders and trades that are executing the code requirements.

Insulation Installation Criteria: The insulation installation criteria outlined in Section R402.2.7 clearly describes how insulation in floor systems must be installed. There is no need to further explain it in this table, but there is need to ensure that the installation criteria is used when assessing R405 and R406 compliance. This is also addressed in the requirements tables of Section R405 and R406 in a separate proposal.

Bibliography:

ENERGY STAR Requirements:

https://www.energystar.gov/sites/default/files/Rater%20F%20v104%202018-07-10_Clean_fillable.pdf

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed language does not increase the cost of construction but rather offers clarity of existing requirements for inspection and installation of insulation.

REPI-49-21

IECC®: TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope that is in alignment with the insulation on the conditioned and unconditioned sides of the assembly [b]. Penetrations, Breaks, or joints in the air barrier assembly shall be air sealed.	Air-permeable insulation shall not be used as an air sealing material. Air- permeable insulation shall be enclosed inside the air barrier assembly [b]. Verification or certification of insulation installation shall be in accordance with section R303.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
floors and floors above garages		underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

Air barrier and air sealing criteria section:

- This code change proposal is intended to offer clarification to this section of table R402.4.1.1 for those in the field that use it to build homes that are compliant with the air testing requirements of the IECC. In the 2018 IECC definitions section, air barriers and building thermal envelope where changed to recognize that the air barrier and building thermal envelope are an assembly of things that a boundary condition between conditioned and unconditioned space. This section of the proposal takes the definition to application to help ensure better energy performance from required installations of air barriers, air sealing, and insulation.
- Current Definitions
  - **AIR BARRIER.** One or more materials joined together in a continuous manner to restrict or prevent the passage of air through the *building thermal envelope* and its assemblies.
  - **BUILDING THERMAL ENVELOPE.** The *basement walls, exterior walls*, floors, ceiling, roofs and any other *building* element assemblies that enclose *conditioned space* or provide a boundary between *conditioned space* and exempt or unconditioned space.

- Air sealing measures are now called out in the Tables name and should be incorporate into the requirements as such.

Insulation Installation Criteria:

- Manufactures of air permeable insulation have begun to recognize that their installation literature must incorporate language and pictures showing that air permeable insulation must be enclosed inside of air barrier assemblies. This table promotes this installation instruction in location such as behind tubs, on attic knee walls, etc. Therefore, the general section should begin with an overarching statement that states how air permeable insulation shall be installed.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed language does not increase the cost of construction but rather offers clarity of existing requirements that are in alignment with manufacturer installation instructions.

REPI-50-21

IECC®: TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
		framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall	—

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
	be installed.	
HVAC register boots	HVAC supply and return register boots ~~that penetrate building thermal envelope~~ shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	Insulation shall be fitted tightly around HVAC supply and return register boots located in the *buildings thermal envelope to maintain its required assembly R-value per section R401.2*
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

This proposal requires that all supply and return registers be sealed to the surface they are penetrating. The origin of this air sealing requirement comes from ENERGY STAR, who has demonstrated that energy loss is associated with duct boot installation in three ways: 1) if the boot directly penetrates the thermal envelope, such as a duct boot coming from a ventilated attic into the house; 2) when air that should be delivered to the conditioned space is redirected into building cavities when it hits the register cover; 3) when Venturi pressure, sometimes called the Coanda effect, is created and pulls air into the building cavity as it is being delivered into the room. See Bibliography for more)

By not being able to deliver the HVAC designed volume of air to the rooms of the house, the occupant is often left with no other choice than to raise the thermostat set point temperature in the winter and to lower it in the summer. This causes energy inefficiencies while not correcting their comfort issue. In addition, building cavities are often connected to unconditioned space which increases duct leakage to the outside, as well as other inefficiencies. Therefore, I also believe that it is an important energy and building durability issue. This needs to be addressed at this time because many builders and contractors have experience implementing this in part, if not in whole and this proposal finished what the code has been intending when it barrowed this requirement from the Energy Star program.There have not been insulation requirements associated with duct boots in the past which continues to make this a significant code change proposal. Ensuring that our building cavities are insulated properly is imperative when duct boots are placed in them, and this proposal directly addresses that issue at the termination of the duct boot and the substrate it passes through.
Lastly, this proposal aligns with

ENERGY STAR requirements that are the basis of the creation of this table that has been adopted by the IECC.

6. Duct Quality Installation: See Bibliography from more information

6.4.1 In addition, all duct boots sealed to the finished surface, Rater-verified at final. 39

Bibliography:

Read more here, **https://www.achrnews.com/articles/128615-why-dirt-streaking-occurs-around-vents**

Cost Impact:

The code change proposal will increase the cost of construction.

As noted during the 2021 IECC development hearings, this proposal changes the scope of the requirement and therefore should slightly increase the cost of execution by the application of additional caulk, but the benefits to the energy performance of the system far out way the small incremental cost. In reality, this proposal, offers better clarity and expansion of existing requirements and for Energy Star builders there would be no increase in cost.

REPI-51-21

IECC®: TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (TABLE N1102.4.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
		top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register	HVAC supply and return register	—

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
boots	boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—
Area Separation Walls	Air sealants having ASTM E84 or UL 723 Listing shall be permitted for air sealing To limit air infiltration and create an air barrier between conditioned and unconditioned space, area separation/adiabatic walls shall be considered an exterior wall for the purposes of air sealing application of this Table (R402.4.1.1).	Insulation shall fully fill the stud cavity of area separation walls and be installed according to manufacture instructions. A 1 inch (25 mm) gap is allowed, but not required, between the cavity insulation/framing and the gypsum area separation wall.

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

Air Sealing Criteria:

- Area separation walls have extreme air leakage. The BXUV guide has been updated to allow air sealing and this should be reflected in the IECC and specifically in Table R402.4.1.1. Below is an example of the new language that has been added to the following Shaft Liner assemblies: U336, U347, U366, U373, U375

8. **Caulk/Sealant —** (Optional, Not Shown, Intended for use as an air barrier - Not intended to be used as fireblocking) — ASTM C834, Type OP, Grade 0° C or -18° C Latex Sealant at the Shaftliner and C-Track (Item 1) and H-Stud (Item 2) framing locations.

8A. **Caulking and Sealants* —** (Optional - Intended for use as an air barrier - Not intended to be used as fireblocking) - A bead of sealant applied around the partition perimeter in the 3/4 in. air space between wood framing (Item 4) and shaftliner panels (Item 3) to create an air barrier.

DUPONT DE NEMOURS, INC. — Great Stuff Gaps & Cracks, Great Stuff Pro Gaps & Cracks, Great Stuff Pro Window & Door

- Area Separation wall assemblies need to be treated like any other exterior wall that has a drop ceiling, tub or other air barrier issue associated with this table within it or adjacent to it. The 1" to ¾" gap between the framed portion of the assembly and the gypsum area separation portion of the assembly allows significant air flow between conditioned and unconditioned spaces which the requirements of Table R402.4.1.1 is designed to mitigate. If these issues are not addressed with area separation wall construction, it is even more difficult to achieve the air leakage requirements of the IECC.

Insulation Criteria:

- Insulation in area separations walls have traditionally been ignored as they are assumed to be an adiabatic wall with no heat loss or gain. In reality, a significant amount of air moves behind the interior drywall in these assemblies and therefore insulation installation makes a significant difference in their energy performance.

Bibliography:

See attached BXUV Guides for more information regarding air sealing of area separation walls

Cost Impact:

The code change proposal will increase the cost of construction.

Construction is expected to be impacted by this proposal because air sealing has not been allowed in most jurisdiction because of interpretations (right or wrong) or how area separation walls must be built. It is unclear how these assemblies used in town house and duplex construction, are complying with the air leakage requirements of the code. In the Colorado market most jurisdictions are allowing some level of air sealing and we are seeing compliance with air leakage requirements. So in Colorado, and other similar markets, cost of construction will remain the same, and in other markets construction cost will go up, but air leakage compliance will also go.

Attached Files

- **BXUV.U375 _ UL Product iQ.pdf**
  https://energy.cdpaccess.com/proposal/409/1029/files/download/111/
- **BXUV.U373 _ UL Product iQ.pdf**
  https://energy.cdpaccess.com/proposal/409/1029/files/download/110/
- **BXUV.U366 _ UL Product iQ.pdf**
  https://energy.cdpaccess.com/proposal/409/1029/files/download/109/
- **BXUV.U347 _ UL Product iQ.pdf**
  https://energy.cdpaccess.com/proposal/409/1029/files/download/108/
- **BXUV.U336 _ UL Product iQ.pdf**
  https://energy.cdpaccess.com/proposal/409/1029/files/download/107/

REPI-52-21

IECC®: TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
		installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower, tub, and fireplaces on exterior walls	~~The~~ An air barrier ~~installed at exterior walls adjacent to showers and tubs~~ shall separate the exterior insulated frame wall	Exterior framed walls adjacent to showers, ~~and~~ tubs and fireplaces shall be insulated.

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
	from the shower, ~~or~~ tub, or fireplace. Tub and shower drain trap penetrations through the subfloor shall be air sealed. Fireplace doors shall comply with the requirements of R402.4.2	
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

Component column:

- The 2012 IECC Air barrier and Insulation table was the last table that specifically referenced the void space behind fireplaces that are located on exterior walls. Just like behind tubs and shower pans a supplemental air barrier is needed on the interior side to enclose the insulation as the drywall plane has been moved to the front of the fireplace in a framed wall. The term Framed wall is intentional to ensure that there is no misinterpretation that masonry fireplaces have this detail and or requirement.

Air barrier criteria section:

- This first revision continues to require the installation of a supplemental air barrier in areas were drywall, tile backer, or other air impermeable material is not installed as the finished surface and is not in alignment with the insulation installed in the building's thermal envelope. The only addition, other than clarification, is the addition of the area behind framed fireplaces boxes on exterior walls.
- Air sealing the tub and shower drain trap penetration eliminates a significant leakage source especially when located in floor systems over unconditioned spaces. This air leakage often creates condensation on the back side of tubs and shower pans which leads to mold and other building durability issues.
- Fireplace door air sealing is outlined in the prescriptive section R402.4.2 and clearly describes that this component shall be air sealed. The instruction should not be limited to fireplaces that are installed using the prescriptive compliance options. Therefore, there is need to ensure that the installation criteria is used when assessing R405 and R406 compliance. The addition of this language does that.

Insulation Installation Criteria:

- Again, the term Framed wall is intentional to ensure that there is no misinterpretation that masonry fireplaces have this detail and or requirement.
- Fireplaces was added to this section for consistency.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed language does not increase the cost of construction, but rather offers clarity of existing requirements for better implementation and enforcement.

REPI-53-21

IECC®: TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	—
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and floors above	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking.

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
garages		Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on	The air barrier installed at	Exterior walls adjacent to showers and tubs

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
exterior wall	exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	shall be insulated.
~~Electrical/phone~~ box on exterior walls Utility Boxes (fan, Electrical, communication, etc.)	~~The~~ An air barrier shall be installed behind Utility Boxes installed within the *building thermal envelope.* ~~electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.~~ Utility boxes shall be sealed in accordance with Section R402.4.6 Utility boxes, that penetrate the building thermal envelope, shall be air sealed to the subfloor, wall, or ceiling penetrated by the box.	Insulation shall be fitted tightly around and behind utility boxes installed in the building's thermal envelope.
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

Component column:

- Although technically speaking, low voltage, speaker, or computer wire boxes are a form of electrical box many builders and trade partners only view true 20- or 15-amp power outlet or switch gang boxes as electrical boxes. By simply broadening the definition to utility box we can ensure that any such box that is installed in an exterior wall or ceiling is insulated, airtight, or air sealed properly.

Air barrier and air sealing criteria section:

- In this section the two requirements have been broken apart for greater clarity. First an airtight box of some sort must be installed and second the box must be and air tight box or air sealed, and must be sealed to the surface that it penetrates.

Insulation Installation Criteria:

- Currently there is not guidance in this table regarding insulating behind electrical boxes in any insulated assembly. This added language rectifies this.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

§ The proposed language does not increase the cost of construction, but rather offers clarity of existing requirements.

REPI-54-21

IECC®: TABLE R402.4.1.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be air sealed.	Insulation installed in framing around windows, skylights and doors shall be cut to fit the cavity or shall be filled with insulation that on installation readily conforms to the available cavity space.
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
		with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members.
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.10.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 and R402.2.7.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior	The air barrier shall be installed behind electrical and	—

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
walls	communication boxes. Alternatively, air-sealed boxes shall be installed.	
HVAC register boots	HVAC supply and return register boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

- a.

  Inspection of log walls shall be in accordance with the provisions of ICC 400.

- b.

  Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason:

Air barrier and air sealing criteria section:

- A simple adjective creates better clarity

Insulation installation criteria section:

- Often the framing around windows creates spaces that are odd sizes and shapes. I think of a recent house that I inspected that had several octangle widows fit into a square opening. The cavities that were created would not be defined as narrow cavities section of this table but would be addressed by the proposed language.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

§ The proposed language does not increase the cost of construction but rather offers clarity of requirements.

REPI-55-21

IECC®: R402.4.1.1, TABLE R402.4.1.1

Proponents:

Vladimir Kochkin, NAHB, representing NAHB (vkochkin@nahb.org)

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.1 (N1102.4.1.1) Installation.
The components of the *building thermal envelope* as indicated in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria indicated in Table R402.4.1.1, as applicable to the method of construction. Where required by the *code official,* an *approved* third party shall inspect all components and verify compliance.

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

Portions of table not shown remain unchanged.

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Rim joists	Rim joists shall include an ~~exterior~~ air barrier.~~[b]~~ ~~The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.~~	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b]

a. Inspection of log walls shall be in accordance with the provisions of ICC 400.

b. ~~Air barrier and I~~Insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

Reason Statement:

This proposal clarifies and simplifies this provision. The revised language allows the building designer the choice of selecting an air barrier based on the specific wall assembly design. Having the additional word "exterior" can lead to misinterpretation that the air barrier always must be outboard of the rim joist's exterior face. That was never the intent of this provision. Footnote b is revised to coordinate with the change in the table and to clarify that rim joist is not exempt from the air barrier requirements. The footnote is correct in stating that full enclosure of insulation at the rim is not required.

The first row in Table R402.4.1.1 clearly states "breaks and joints in the air barrier shall be sealed." Having the sentence requiring additional sealing of rim to the sill and subfloor can be interpreted that a secondary air barrier is required at those locations in addition to the primary air barrier method.

It is noted that a whole-building tightness test is required to verify the overall air tightness of the house. Exterior WRB is always required for frame construction.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This change primarily is a clarification of intent. The goal is to avoid misinterpretations of the provisions in the field.

REPI-55-21

REPI-56-21

IECC®: R402.4.1.1, TABLE R402.4.1.1, R402.4.1.2

Proponents:

Mark Lyles, representing New Buildings Institute (markl@newbuildings.org); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.1 (N1102.4.1.1) Installation.
The components of the *building thermal envelope* as indicated in Table R402.4.1.1 shall be installed in accordance with the manufacturer's instructions and the criteria indicated in Table R402.4.1.1, as applicable to the method of construction. ~~Where required by the *code official*, an *approved*~~ A certified third party professional approved by the *code official* shall inspect all components and verify compliance.

TABLE R402.4.1.1 (TABLE N1102.4.1.1) AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
General requirements	A continuous air barrier shall be installed in the building envelope. Breaks or joints in the air barrier shall be sealed.	Air-permeable insulation shall not be used as a sealing material. When installing batt, or loose-fill insulation, no more than 2% of the total insulated area shall be compressed below the thickness required to attain the labeled R-Value or contain gaps or voids in the insulation. These areas shall not be compressed more than 3/4 inch (19 mm) of the specified insulation thickness in any given location. When installing open or closed cell polyurethane spray foam, the average of all thickness measurements shall be greater than the specified thickness required to obtain the specified R-Value. No more than 2 percent of the insulated area shall contain voids or be more than ½ inch (13mm) below the specified thickness. The minimum installed thickness shall not be less than ¾ inch (19 mm) below the specified thickness at any point.
Ceiling/attic	The air barrier in any dropped ceiling or soffit shall be aligned with the insulation and any gaps in the air barrier shall be sealed. Access openings, drop down stairs or knee wall doors to unconditioned attic spaces shall be sealed.	The insulation in any dropped ceiling/soffit shall be aligned with the air barrier. Insulation shall extend to the inside face of the exterior wall below. These requirements can be met by using any available strategy, such as a raised-heel truss, alternate framing that provides adequate space, and / or high-density insulation. Batt and blanket insulation that is thicker than the framing depth shall be installed so that the insulation is in contact with adjacent insulation over each framing member, leaving no gaps. Batt and blanket insulation shall be placed below all platforms or cat-walks used for HVAC equipment installation and access, and installed to the full depth and rated R-value without gaps or compression. If necessary, HVAC platforms shall be raised to accommodate ceiling insulation. Below roof deck insulation consisting of batts that nominally fill the cavity space between roof framing members shall be stapled, or supported with cabling, tension rods, or other support measures which maintain the batt uniformly against the roof deck with limited

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
		compression. Below roof deck loose fill insulation shall be netted. In unvented attics, where insulation is applied directly to the underside of the roof deck, framing for gable ends that separate the unvented attic from the exterior or unconditioned space shall be insulated to meet or exceed the wall R-value of the adjacent exterior wall construction.
Walls	The junction of the foundation and sill plate shall be sealed. The junction of the top plate and the top of exterior walls shall be sealed. Knee walls shall be sealed.	Cavities within corners and headers of frame walls shall be insulated by completely filling the cavity with a material having a thermal resistance, *R*-value, of not less than R-3 per inch. Exterior thermal envelope insulation for framed walls shall be installed in substantial contact and continuous alignment with the air barrier. Edges of insulated sheathing not supported directly on structural sheathing or framing shall be tightly fitted to one another without substantial gaps. Faced batts shall be stapled to the face of the studs or side stapled to the studs with no buckling of the stapling tabs or the tabs shall be permitted to be left unstapled. Faced batt products without tabs and friction fit products shall not be required to be stapled when installed in walls. When side stapled, compression is permitted only along edges to the depth of the stapling tab. For loose fill insulation, containment fabric or system that is side stapled shall not be stapled more than ½ inch (13mm) back from the face of the stud. For spray foam insulation, installers shall meet the manufacturer's recommended training requirements and shall complete the online health and safety training for SPF provided by the Center for Polyurethanes Industry. Spray foam shall be well-bonded to the substrate, including framing and sheathing. When insulation extends beyond the wall cavity it shall be trimmed to allow installation and contact with interior sheathing or finish material.
Windows, skylights and doors	The space between framing and skylights, and the jambs of windows and doors, shall be sealed.	All single-member window and door header that are less than the full width of the wall framing shall be insulated to a minimum of R-3 for a 2X4 framing, and a minimum of R-5 for all other assemblies. Insulation is to be placed between the interior face of the header and inside surface of the interior wall finish.
Rim joists	Rim joists shall include an exterior air barrier.[b] The junctions of the rim board to the sill plate and the rim board and the subfloor shall be air sealed.	Rim joists shall be insulated so that the insulation maintains permanent contact with the exterior rim board.[b] For rim or band joist applications, insulation shall be in substantial and permanent contact with rim or band joist framing and tightly fitted to intersecting solid floor joists, wood i-joists or extend continuously through open web floor trusses.
Floors, including cantilevered floors and floors above garages	The air barrier shall be installed at any exposed edge of insulation.	Floor framing cavity insulation shall be installed to maintain permanent contact with the underside of subfloor decking. Alternatively, floor framing cavity insulation shall be in contact with the top side of sheathing, or continuous insulation installed on the underside of floor framing and extending from the bottom to the top of all perimeter floor framing members. The cavity insulation between floor joists, beams or other horizontal floor supports that create cavities under the subfloor shall be permitted to be in direct contact with any additional continuous insulation attached to the underside of the horizontal supports.

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Basement crawl space and slab foundations	Exposed earth in unvented crawl spaces shall be covered with a Class I vapor retarder/air barrier in accordance with Section R402.2.10 . Penetrations through concrete foundation walls and slabs shall be air sealed. Class 1 vapor retarders shall not be used as an air barrier on below-grade walls and shall be installed in accordance with Section R702.7 of the *International Residential Code*.	Crawl space insulation, where provided instead of floor insulation, shall be installed in accordance with Section R402.2.10. Conditioned basement foundation wall insulation shall be installed in accordance with Section R402.2.8.1. Slab-on-grade floor insulation shall be installed in accordance with Section R402.2.~~10~~9.
Shafts, penetrations	Duct and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value. Compression of insulation at penetrations shall be limited to more than 30% of its nominal thickness.
Narrow cavities	Narrow cavities of 1 inch or less that are not able to be insulated shall be air sealed.	Batts to be installed in narrow cavities shall be cut to fit or narrow cavities shall be filled with insulation that on installation readily conforms to the available cavity space.
Garage separation	Air sealing shall be provided between the garage and conditioned spaces.	Insulated portions of the garage separation assembly shall be installed in accordance with Sections R303 ~~and R402.2.7~~.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.4.5 .	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried or surrounded with insulation.
Plumbing, wiring or other obstructions	All holes created by wiring, plumbing or other obstructions in the air barrier assembly shall be air sealed.	Insulation shall be installed to fill the available space and surround wiring, plumbing, or other obstructions, unless the required *R*-value can be met by installing insulation and air barrier systems completely to the exterior side of the obstructions. Compression of insulation at penetrations shall be limited to no more than 30% of its nominal thickness. Batt and blanket insulation that is split or delaminated to fit around electrical wires and plumbing runs through a wall must ensure that the full thickness of the insulation is installed between the obstruction and the finish material covering the framing.
Shower/tub on exterior wall	The air barrier installed at exterior walls adjacent to showers and tubs shall separate the wall from the shower or tub.	Exterior walls adjacent to showers and tubs shall be insulated.
Electrical/phone box on exterior walls	The air barrier shall be installed behind electrical and communication boxes. Alternatively, air-sealed boxes shall be installed.	—
	HVAC supply and return register	

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
HVAC register boots	boots that penetrate building thermal envelope shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	—
Concealed sprinklers	Where required to be sealed, concealed fire sprinklers shall only be sealed in a manner that is recommended by the manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.	—

a. Inspection of log walls shall be in accordance with the provisions of ICC 400.

b. Air barrier and insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

R402.4.1.2 (N1102.4.1.2) Testing.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). W~~here required by the *code official*, t~~<u>T</u>esting shall be conducted by ~~an *approved*~~ <u>a</u> third party <u>certified professional approved by the *code official*</u>. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.

2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.

3. Interior doors, where installed at the time of the test, shall be open.

4. Exterior or interior terminations for continuous ventilation systems shall be sealed.

5. Heating and cooling systems, where installed at the time of the test, shall be turned off.

6. Supply and return registers, where installed at the time of the test, shall be fully open.

Exception: When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot

[0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single-family and multiple-family building *dwelling units*.

2. Buildings or *dwelling units* that are 1.500 square feet (139.4 m^2) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

Reason Statement:

This measure will add elements of ANSI/RESNET/ICC 301-2019, California Title 24 Residential Appendix 3.5.3.2 (Quality Insulation Installation/QII), and the ENERGY STAR National Rater Field Checklist (formerly Thermal Bypass Checklist) into IECC Table R402.4.1.1 to help ensure the design envelope UA targets are met.

This proposal addresses the following:

- Requires stricter insulation installation quality as determined by a certified third party inspector or home rater.
- Removes reference to R402.2.7 (Floors) under "Garage separation", which appears to be obsolete or in error. Corrects reference to Section R402.2.9 for slab insulation.
- Adds several new criteria in Table R402.4.1.1 based on key elements of ANSI/RESNET/ICC 301-2019 and Title 24 RA3.5 (QII) that are expected to be highly cost-effective and that are not already covered by the installation requirements of the 2021 IECC.
- Requires that the air leakage rate be determined by a certified third party tester.
- No change is recommended for mandatory air barrier installation measures, because the overall air leakage rate must be tested and shown to meet relatively strict requirements. Air leakage compliance is effectively performance based, and adding further mandatory elements would not necessarily save energy.

This proposal helps ensure that design UA requirements are met in reality, and not undermined by poor installation practices or lack of attention to detail. The measure leverages consensus measures from the existing ANSI/RESNET/ICC Standard 301 and Title 24 QII requirements. Although the measure introduces a significant first cost for third party inspection and leakage testing, the expected energy cost savings for homeowners justifies the investment.

The energy savings for Quality Insulation Installation (QII) in a typical single-family home in California was estimated to be 70 kWh/year for electricity and 25 therms/year for natural gas (Dakin & German, 2017). In other parts of the U.S. with more extreme climates, these savings projections would likely be much higher. However, the prescriptive QII requirements in California Title 24 are significantly more strict than the proposed installation quality requirements. Assuming these competing effects are of the same magnitude, and using an average electricity price of $0.13/kWh and a natural gas price of $1.01/therm (Energy Information Administration, 2021), the total energy cost savings is approximately $34/year.For multifamily housing, savings for an 8-unit prototype were estimated to be 124 kWh/year for electricity and 40 therms/year for natural gas. Using the same price assumptions, this equals approximately $57/year in energy cost savings for the building, or $7/year per dwelling unit.

Bibliography:

Dakin, B., & German, A. (2017). *Quality Insulation Installation (QII) – Final Report.* California Utilities Statewide Codes and Standards Team.

Energy Information Administration. (2021). *Homepage*. Retrieved from https://www.eia.gov/RESNET. (2018). ANSI/RESNET/ICC 301-2019: Standard for the Calculation and Labeling of the Energy Performance of Dwelling and Sleeping Units using an Energy Rating Index.

Cost Impact:

The code change proposal will increase the cost of construction.

The first cost impact for third-party verification of quality insulation installation in a single-family home is estimated to be $616 based on a HERS rater performing both an inspection and air leakage test. A 50% sampling rate, if deemed acceptable by the code official, would reduce the cost to $308. For multifamily housing sampled at 25%, the first cost is estimated to be $525 per building ($66/unit). (Dakin & German, 2017).

Preliminary cost-effectiveness analysis indicates a payback period of 9 years for both single-family and multifamily applications, assuming 50% and 25% sampling rates respectively.

REPI-56-21

REPI-57-21

IECC®: R402.4.1.2

Proponents:

Lisa Rosenow, representing Self (lrosenow@evergreen-tech.net); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.2 (N1102.4.1.2) Building thermal envelope testing.

The *building* or *dwelling unit* thermal envelope shall be tested for air leakage in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 . The maximum air leakage rate for any *building* or *dwelling unit* under any approved test method and compliance path shall not exceed 5.0 air changes per hour or 0.28 cfm/ft^2 (1.4 L/s × m^2) ~~cubic feet per minute (CFM) per square foot [0.0079 m^3/(s × m^2)]~~ of building or dwelling unit enclosure area. ~~Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported~~ at a pressure of 0.2 inch ~~w.g.~~ water gauge (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

   Exception: ~~When testing individual *dwelling units*,~~ An air leakage rate not exceeding ~~0.30 cubic feet per minute per square foot [0.008 m^3/(s × m^2)]~~ 0.30 cfm/ft^2 (1.5 L/s × m^2) of the building or dwelling unit enclosure area~~, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported~~ at a pressure differential of 0.2 inch ~~w.g~~ water gauge (50 Pascals), shall be permitted in all climate zones for the following building types:

1. Attached single-family ~~and multiple-family building~~ *dwelling units*.

2. ~~Buildings or~~ *D*~~d~~*welling units* that are ~~1.500~~1,500 square feet (139.4 m^2) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

Reason Statement:

Purpose of proposed changes is to clarify code intent and align terminology with the commercial air barrier testing provisions.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The intent of this proposal is to improve code language clarity only.

REPI-57-21

REPI-58-21

IECC®: R402.4.1.2

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.2 (N1102.4.1.2) Testing.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

~~Exception~~ Exceptions:

1. When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:
   1.1. Attached single and multiple family building *dwelling units*.
   1.2. Buildings or *dwelling units* that are 1,500 square feet (139.4 m^2) or smaller.
2. For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

~~**Exception:** When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot~~

~~[0.008 m^3/(s × m^2)] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:~~

~~1. Attached single-family and multiple-family building *dwelling units*.~~

~~2. Buildings or *dwelling units* that are 1,500 square feet (139.4 m^2) or smaller.~~

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

Reason Statement:

The purpose of this code change proposal is to make an editorial change. Specifically, this proposal moves the air leakage testing exception for small dwelling units to be directly following Section R402.4.1.2, which outlines the air leakage testing requirements for all residential buildings. The exception is currently located at the end of a list of instructions for carrying out an air leakage test, and code users may not understand that the exception allows an alternative to the metric used to measure air leakage under Section R402.4.1.2. This proposal is not intended to change any code requirements, but rather to make the *IECC* more user-friendly.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Because the proposal is only an editorial improvement, there is no cost impact.

COST-EFFECTIVENESS

Because this proposal does not impact code stringency or cost, a cost-effectiveness analysis is not applicable.

REPI-58-21

REPI-59-21

IECC®: R402.4.1.2

Proponents:

Robby Schwarz, BUILDTank, Inc., representing Colorado Chapter of the ICC (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.2 (N1102.4.1.2) Testing.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

~~Exception~~ Exceptions:

1. For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.
2. When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:
   ~~1~~ 2.1. Attached single-family and multiple-family building *dwelling units*.
   ~~2~~ 2.2. Buildings or *dwelling units* that are 1.500 square feet (139.4 m^2) or smaller.

~~During testing:~~

1. ~~Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.~~
2. ~~Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.~~
3. ~~Interior doors, where installed at the time of the test, shall be open.~~
4. ~~Exterior or interior terminations for continuous ventilation systems shall be sealed.~~
5. ~~Heating and cooling systems, where installed at the time of the test, shall be turned off.~~
6. ~~Supply and return registers, where installed at the time of the test, shall be fully open.~~

~~Exception:~~

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

Reason Statement:

This proposal is intended to make sense of what occurred during the 2021 code development process. Three proposals passed and the correlation of the proposals created confusing language that created a situation where there are exceptions to an exception. Restructuring the language, as demonstrated, clarifies the requirement.

Continuing with clarification, this proposal deletes the "During Testing" language of the code because the language is incorporated within the standards that are required to be followed by the language of Section R402.4.1.2 Testing (ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827). Referring to the specifics of the standard being used is the most accurate means of determining what needs to be done "during testing" and should be encouraged rather than inferring that all one needs to do during the test has been laid out in the body of the code. In addition, other sections of the code that refer to the use of a standard do not also layout the procedures called out within the standard in the body of the code.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will not increase cost of construction because it does not change any current requirement, Rather it makes the code language more understandable.

REPI-59-21

REPI-60-21

IECC®: R402.4.1.2, R402.4.1.3

Proponents:

Robby Schwarz, BUILDTank, Inc., representing Colorado Chapter of the ICC (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.2 (N1102.4.1.2) Testing.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed ~~5.0~~ **3.0** air changes per hour or ~~0.28~~ **0.19** cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

Exception: When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single-family and multiple-family building *dwelling units*.
2. Buildings or *dwelling units* that are 1.500 square feet (139.4 m^2) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.

Delete without substitution:

~~R402.4.1.3~~ ~~Leakage rate~~.

~~When complying with Section R401.2.1, the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 0, 1 and 2, and 3.0 air changes per hour in Climate Zones 3 through 8, when tested in accordance with Section R402.4.1.2.~~

Reason Statement:

This proposal is intended to make sense of what occurred during the 2021 code development process. Three proposals passed and the correlation of the proposals created confusing language that left the impression that the three and five air leakage rates depending on climate zone has been relaxed to 5 ACH50 across the country.

Because of that confusion it became apparent that this code change proposes should propose a single air leak rate for all climate zones. Building science research and application has determined that tight building envelopes are beneficial to all homes not just homes located in heating dominated climates. Homes in cooling dominated climates also gain efficiency and durability benefits from tight building envelopes. 3 ACH50 is a nationally achievable air leakage rate, and this proposal continues the 2021 IECC leeway by offering leakage concession to two housing types, attached and small dwelling units, that have at times struggled to achieve the leakage target. That being said, there is also a new allowance to use a CFM per square foot of shell area air leakage compliance metric that better assesses the leakage of a home as it is not based on volume but rather actual holes in the building envelope.

This proposal makes sense as demonstrated by the quick brand recognition and dominance of YETI coolers. As with houses, airtight and well insulated coolers keep their contents cold in the summer. If needed they would also keep their contents warm in the winter. The code recognizes this reality in heating dominated climates and it is time it is also recognized in cooling dominated climates. Lastly, with recent extreme weather events we will see a better ability to shelter in place during excessive cold and hot periods when homes are built tighter.

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal will increase code of construction in some cooling dominated climate projects that have not already incorporated sound building science-based construction practices that are not only being incorporated into the code but also being advanced by industry.

REPI-60-21

REPI-61-21

IECC®: R402.4.1.4 (New)

Proponents:

Aaron Gary, representing Seft (aaron.gary@texenergy.org)

2021 International Energy Conservation Code

Add new text as follows:
R402.4.1.4 Sampling for R2 multifamily dwelling units.

For buildings with eight or more testing units complying with R402.1.2 or R402.1.3, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit, a middle floor unit, and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional three units shall be tested, including a mixture of testing unit types and locations. Where buildings have fewer than eight testing units, each testing unit shall be tested.

Reason Statement:

Aligns with the commercial provisions of the 2021 IECC and RESNET sampling guidelines so that envelope leakage testing requirements for a multi-family (R2 classification) project that is 3 stories or lower in height (and that falls under the Residential provisions of the IECC) will be tested at the same rate as apartment building that is 4 stories or taller in height (and falls under the Commercial provisions of the IECC). Sampling provisions were approved as part of the 2021 IECC for Commercial multifamily (R2 classifications) projects because it is very costly and time consuming to test each dwelling unit for projects where there may be dozens of dwelling units in each building. Considering that the same tradesman generally constructs a building, it is reasonable to deem that construction practices are consistent and that if a reasonable sampling of units tested pass, then all units would pass.

Cost Impact:

The code change proposal will decrease the cost of construction.

For multifamily projects that are built and test well, sampling provisions such as those approved in the Commercial provisions of the 2021 IECC will reduce the cost and time required for testing and verification. Projects that do not meet their testing thresholds will understandably be tested as a higher rate, potentially test each, until they too are meeting the required standards consistently and as such will may not see a reduction in testing and verification costs or timelines.

REPI-61-21

REPI-62-21

IECC®: R402.4.1.2, R402.4.1.3, R403.6, R403.6.1, R502.3.1, R503.1.1

Proponents:

seth wiley, representing architect, self

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.2 Testing.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed ~~5.0~~ 3.0 air changes per hour or ~~0.28~~ 0.23 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: ~~For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.~~

When testing individual dwelling units, an air leakage rate not exceeding 0.23 cubic feet per minute per square foot [0.008 m^3/(s*m^2)] of dwelling unit enclosed area, tested in accordance with ANSI/RESNET/ICC 380, ASTM 779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be an accepted alternative permitted in all climate zones for:

1. Attached single-family and multiple-family building dwelling units.
2. Buildings or dwelling units that are 5,000 square feet (39.4 m^2) or smaller.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

Exception: When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM

E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single-family and multiple-family building *dwelling units*.

2. Buildings or *dwelling units* that are 1.500 square feet (139.4 m^2) or smaller.

~~Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.~~Mechanical ventilation shall be provided, as applicable, in accordance with Section M1505 of the International Residential Code, Section 403.3.2 of the International Mechanical Code, or with other approved means of ventilation, in compliance with International Energy Code Section R403.6 and ASHRAE 62.2.

R402.4.1.3 Leakage rate.

When complying with Section R401.2.1, the building or dwelling unit shall have an air leakage rate not exceeding ~~5.0~~3.0 air changes per hour in Climate Zones 0, 1 and 2~~,~~ ; ~~and 3.0~~ 2.5 air changes per hour in Climate Zones 3 ~~through 8,~~ and 4; 2.0 air changes per hour in Climate Zones 5 through 7; and 1.5 air changes per hour in Climate Zone 8, when tested in accordance with Section R402.4.1.2.

Exception: Buildings and dwelling units may utilize air leakage rates not exceeding 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s*m^2)$] of dwelling unit enclosure area in Climate Zones 0, 1 and 2, and 3.0 air changes per hour in Climate Zones 3 through 8, provided such buildings and dwelling units include basement, crawl space, and attic full encapsulation against moisture and air infiltration using Class I vapor retarder materials in compliance with Section R702.7.

R403.6 Mechanical ventilation.

~~The *buildings* complying with Section R402.4.1 shall be provided with ventilation that complies with the requirements of Section M1505 of the International Residential Code or *International Mechanical Code* , as applicable, or with other *approved* means of *ventilation*. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the *ventilation* system is not operating.~~

Buildings and dwelling units shall be provided with mechanical ventilation that complies with the requirements of the *International Residential Code* or *International Mechanical Code*, as applicable, or with other approved means of ventilation, in compliance with ASHRAE 62.2. Mechanical ventilation shall include air filtration using MERV 13 or higher air filters. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not working. Outdoor air intakes shall be located a minimum of 10 feet (3048 mm) from contamination sources.

Exception: MERV 8 or higher air filters shall be an acceptable alternative to MERV 13 air filters provided that heat or energy recovery ventilation per Section 403.6.1 is provided.

R403.6.1 Heat or energy recovery ventilation .

~~*Dwelling units* shall be provided with a heat recovery or energy recovery ventilation system in Climate Zones 7 and 8. The system shall be balanced with a minimum sensible heat recovery efficiency of 65 percent at 32°F (0°C) at a flow greater than or equal to the design airflow.~~Dwelling units shall be provided with a heat recovery or energy recovery ventilation system in Climate Zones 4, 5, 6, 7, and 8. The system shall be balanced with a minimum sensible heat recovery efficiency of 65 percent at 32ºF (0ºC) at a flow rate greater than or equal to the design airflow. In Climate Zone 4, the system shall be permitted to be designed and installed according to the requirements of Section M1505.4 of the 2021 *International Residential Code* (IRC) that uses the return side of the building's heating and/or cooling system air handler to supply outdoor air. When the outdoor air supply is ducted to the heating and/or cooling system air handler, the mixed air temperature shall not be less than that permitted by the heating equipment manufacturer's installation instructions. Heating and/or cooling system air handlers used to distribute outdoor air shall be field-verified to not exceed an efficacy of 45 W/CFM if using furnaces for heating and 58 W/CFM if using other forms of heating. In the balanced system design, an equivalent exhaust air flow rate shall be provided simultaneously by one or more exhaust fans, located remotely from the source of supply air. The balanced system's exhaust and supply fans shall be interlocked for operation, sized to provide equivalent air flow at a rate greater than or equal to that determined by IRC Table M1505.4.3(1) and shall have their fan capacities adjusted for intermittent run time per Table M1505.4.3(2). Continuous operation of the balanced ventilation system shall not be permitted.

R502.3.1 Building envelope.

New *building* envelope assemblies that are part of the *addition* shall comply with Sections R402.1, R402.2, R402.3.1 through R402.3.5, and R402.4.

~~**Exception:** New envelope assemblies are exempt from the requirements of Section R402.4.1.2.~~

R503.1.1 Building envelope.

Building envelope assemblies that are part of the *alteration* shall comply with Section R402.1.2 ~~or R402.1.4~~and R402.4.1.3, Sections R402.2.1 through R402.2.12, R402.3.1, R402.3.2, R402.4.3 and R402.4.5.

Exception: The following alterations shall not be required to comply with the requirements for new construction provided that the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.

2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.

3. Construction where the existing roof, wall or floor cavity is not exposed.

4. Roof recover.

5. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.

6. Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided that the code does not require the glazing or fenestration assembly to be replaced.

Attached Files

- **IECC-2024_Proposal_Air-Leakage-and-Mechanical-Ventilation_2021-09-27.pdf**
  http://localhost/proposal/331/595/files/download/72/

Reason Statement:

To improve occupant health and safety, improve energy efficiency, and decrease greenhouse gas emissions

Bibliography:

Based on professional knowledge and experience, feedback from other professionals, established research, and established local and national construction quality frameworks

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code chance proposal is understood to neither increase nor decrease the cost of construction

REPI-62-21

REPI-63-21

IECC®: R402.4.1.2, R402.4.1.3, TABLE R405.4.2(1)

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.2 (N1102.4.1.2) Testing and maximum air leakage rate.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

Exception: When testing individual *dwelling units*, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single-family and multiple-family building *dwelling units*.
2. Buildings or *dwelling units* that are 1.500 square feet (139.4 m^2) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.
R402.4.1.3 (N1102.4.1.3) Prescriptive air l~~L~~eakage rate.

When complying with Section R401.2.1, the building or dwelling unit shall have an air leakage rate not exceeding 4.0~~5.0~~ air changes per hour in Climate Zones 0, 1 and 2, and 3.0 air changes per hour in Climate Zones 3 through 8, when tested in accordance with Section R402.4.1.2.

TABLE R405.4.2(1) (TABLE N1105.4.2(1)) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	The air leakage rate at a pressure of 0.2 inch w.g. (50 Pa) shall be Climate Zones 0 through 2: 4.0~~5.0~~ air changes per hour. Climate Zones 3 through 8: 3.0 air changes per hour.	The measured air exchange rate.[a]
	The mechanical ventilation rate shall be in addition to the air leakage rate and shall be the same as in the proposed design, but not greater than $0.01 \times CFA + 7.5 \times (N_{br} + 1)$ where: CFA = conditioned floor area, ft^2. N_{br} = number of bedrooms. The mechanical ventilation system type shall be the same as in the proposed design. Energy recovery shall not be assumed for mechanical ventilation.	The mechanical ventilation rate[b] shall be in addition to the air leakage rate and shall be as proposed.

For SI: 1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US) = 3.785 L, °C = (°F – 32)/1.8, 1 degree = 0.79 rad.

a. Where required by the code official, testing shall be conducted by an approved party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals,* or the equivalent, shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals,* page 26.24 and the “Whole-house Ventilation” provisions of 2001 ASHRAE *Handbook of Fundamentals,* page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

For a proposed design home without a proposed cooling system, an electric air conditioner having the prevailing federal

f. minimum efficiency shall be assumed for both the standard reference design and the proposed design.

g. For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater having the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For a proposed design without a proposed water heater, a 40-gallon storage-type water heater having the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.

h. For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:

. $AF = A_s \times FA \times F$

. where:

. AF = Total glazing area.

. A_s = Standard reference design total glazing area.

. FA = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).

. F = (above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.

. and where:

. Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.

. Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.

. Below-grade boundary wall is any thermal boundary wall in soil contact.

. Common wall area is the area of walls shared with an adjoining dwelling unit.

The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the “hot water rectangle”) divided by the floor area of the dwelling.

1. Sources of hot water include water heaters, or in multifamily buildings with central water heating systems, circulation loops or electric heat traced pipes.
2. The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping.
3. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.

i.

4. Where there is more than one water heater and each water heater serves different plumbing fixtures and appliances, it is permissible to establish a separate hot water rectangle for each hot water distribution system and add the area of these rectangles together to determine the compactness ratio.

5. The basement or attic shall be counted as a story when it contains the water heater.

6. Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and *HWDS* factor.

Attached Files

- **R4 table pix_cost.PNG**
  http://localhost/proposal/312/931/files/download/178/
- **R4 table pix.PNG**
  http://localhost/proposal/312/931/files/download/177/

Reason Statement:

The purpose of this code change proposal is to improve the efficiency and resiliency of homes in climate zones 0 through 2 through improved building air tightness. Specifically, the proposal modifies the prescriptive air tightness requirement and the performance path baseline from ≤5.0 ACH50 to ≤4.0 ACH50. The proposal still retains the trade-off flexibility of the 2021 *IECC* for these climate zones, which will allow code users to trade back up to ≤5.0 ACH50 in the performance path, as long as efficiency losses are accounted for elsewhere in the building.

The envelope air tightness requirement for the southernmost climate zones has not changed since the air leakage test requirement was first incorporated into the 2012 *IECC*. In the meantime, air leakage testing has become a far more common step in new construction, and the techniques and products used to achieve tight envelopes have become more commonplace in all climate zones, including zones 0-2. According to a recent DOE Residential Field Study in Texas, nearly 1/3 of the homes in climate zone 2 sampled for air leakage testing already achieved 4.0 or lower air leakage, even though the local code requirements ranged from ≤5.0 to ≤7.0 ACH50. *See* https://www.energycodes.gov/residential-energy-code-field-studies . These homes would already be compliant with the air tightness requirement proposed above at no additional cost or effort, and the remainder of the homes would not have to undergo radical changes to achieve it.

Although a tighter envelope will have a more pronounced effect on energy conservation in climate zones with a larger difference between indoor and outdoor temperatures, reasonable envelope air tightness is still extremely important in moderate climates.

- Improving air tightness from ≤5.0 to ≤4.0 ACH50 will not substantially increase the cost of construction, but it will save homeowners money over the home's useful life;
- A significant number of counties in climate zones 0-2 are classified as warm/humid, and a tighter envelope will help cooling systems operate efficiently and manage indoor humidity, improving the long-term durability of buildings;
- A tighter building envelope, along with adequate fresh air through dedicated mechanical ventilation, will help maintain healthier indoor air quality for the home's occupants;
- More efficient building envelopes will generally help maintain occupant comfort and passive survivability in the event of extreme weather events or extended power outages, such as the recent power outage in Texas.

As building practices and materials improve, it is important to set code requirements that help optimize building operation and efficiency. Air tightness levels in homes in climate zones 0-2 have already been improved as a result of market transformation: More builders have learned how to improve air tightness as a part of quality construction, and manufacturers have tuned products to meet the growing national demand for tighter homes.

Beyond the direct energy and cost savings associated with reduced air leakage, we expect that occupants will experience improved comfort, and as a result, will be less likely to adjust the thermostat to counteract a "drafty home." Below is a summary of estimated energy use increases associated with adjusting a thermostat 1 degree higher or lower, broken out by climate zone.

[R4 table pix.png]

Increased Energy Use Resulting from Thermostat Adjustment									
Measure	Nat'l Avg	1	2	3	4	5	6	7	
+1 Degree Heating	4.1%	0.5%	3.0%	4.2%	4.4%	4.7%	4.5%	4.0%	2
-1 Degree Cooling	3.2%	7.8%	5.3%	3.9%	2.6%	1.8%	1.4%	0.7%	(

We believe the envelope air tightness requirement in these climate zones could be improved with little additional effort, and that homeowners will benefit from these improvements for many years.

Bibliography:

(1) www.energycodes.gov/residential-energy-code-field-studies; (2) www.energycodes.gov/methodology

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal will increase the cost of construction in some cases. As noted above, many buildings that achieve ≤5.0 ACH50 already achieve ≤4.0 ACH50 as well, or would not require substantial additional cost to achieve this improvement. We believe it is reasonable to assume an average increase in construction costs of $108 per dwelling unit based on cost data from NREL's BEopt modeling software. For many builders, any incremental costs to achieve these gains will be reduced or eliminated over time as new techniques and quality assurance are adopted into standard practices. But for purposes of this code change proposal, a $108 incremental cost per dwelling unit is a reasonable and conservative estimate.

COST-EFFECTIVENESS

This proposal is clearly cost-effective to the homeowner. Based on modeling using NREL's BEopt software and following the residential building cost-effectiveness methodology developed by the U.S. DOE (*see* www.energycodes.gov/methodology), the analysis conducted by EECC found that this proposal will save homeowners significant energy cost and will result in clear life-cycle cost effectiveness for homeowners. The analysis estimated that this proposal will produce a positive net life cycle benefit of $225-836 over the first 30 years of the building's useful life (using the average $108 incremental cost from BEopt referenced above), depending on climate zone. A summary table of this cost-effectiveness analysis is below.

[R4 table pix_cost.png]

Climate Zone	ACH50	Incremental Cost Upgrade	Annual Energy Savings	Present Value Costs	Present Value Benefits	Life Cycle Net Benefit
1	4.0	$108	$8	$245	$469	$225
2	4.0	$108	$20	$245	$1080	$836

REPI-63-21

REPI-64-21

IECC®: R402.4.1.2, R402.4.1.3, TABLE R405.4.2(1), R408.2.5

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:
R402.4.1.2 (N1102.4.1.2) Testing and maximum air leakage rate.

The *building* or *dwelling unit* shall be tested for air leakage. The maximum air leakage rate for any *building* or *dwelling unit* under any compliance path shall not exceed 5.0 air changes per hour or 0.28 cubic feet per minute (CFM) per square foot [0.0079 $m^3/(s \times m^2)$] of dwelling unit enclosure area in climate zones 0, 1, and 2, and 4.0 air changes per hour or 0.22 cubic feet per minute (CFM) per square foot [0.0063 $m^3/(s \times m^2)$] of dwelling unit enclosure area in climate zones 3 through 8. Testing shall be conducted in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the *code official*, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*. Testing shall be performed at any time after creation of all penetrations of the *building thermal envelope* have been sealed.

Exception: For heated, attached private garages and heated, detached private garages accessory to one- and two-family dwellings and townhouses not more than three stories above *grade plane* in height, building envelope tightness and insulation installation shall be considered acceptable where the items in Table R402.4.1.1, applicable to the method of construction, are field verified. Where required by the code official, an *approved* third party independent from the installer shall inspect both air barrier and insulation installation criteria. Heated, attached private garage space and heated, detached private garage space shall be thermally isolated from all other habitable, *conditioned spaces* in accordance with Sections R402.2.12 and R402.3.5, as applicable.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond the intended weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond intended infiltration control measures.
3. Interior doors, where installed at the time of the test, shall be open.
4. Exterior or interior terminations for continuous ventilation systems shall be sealed.
5. Heating and cooling systems, where installed at the time of the test, shall be turned off.
6. Supply and return registers, where installed at the time of the test, shall be fully open.

Exception: When testing individual *dwelling units*, an air leakage rate not exceeding 0.24~~0.30~~ cubic feet per minute per square foot [0.0064 ~~0.008~~ $m^3/(s \times m^2)$] of the dwelling unit enclosure area, tested in accordance with ANSI/RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pa), shall be permitted in all climate zones for:

1. Attached single-family and multiple-family building *dwelling units*.

2. Buildings or *dwelling units* that are 1.500 square feet (139.4 m^2) or smaller.

Mechanical ventilation shall be provided in accordance with Section M1505 of the *International Residential Code* or Section 403.3.2 of the *International Mechanical Code*, as applicable, or with other *approved* means of ventilation.
R402.4.1.3 (N1102.4.1.3) Prescriptive air leakage ~~Leakage~~ rate.

When complying with Section R401.2.1, the building or dwelling unit shall have an air leakage rate not exceeding 5.0 air changes per hour in Climate Zones 0, 1 and 2, and 2.0 ~~3.0~~ air changes per hour in Climate Zones 3 through 8, when tested in accordance with Section R402.4.1.2.

TABLE R405.4.2(1) (TABLE N1105.4.2(1)) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	The air leakage rate at a pressure of 0.2 inch w.g. (50 Pa) shall be Climate Zones 0 through 2: 5.0 air changes per hour. Climate Zones 3 through 8: 2.0 ~~3.0~~ air changes per hour.	The measured air exchange rate.[a]
	The mechanical ventilation rate shall be in addition to the air leakage rate and shall be the same as in the proposed design, but not greater than $0.01 \times CFA + 7.5 \times (N_{br} + 1)$ where: CFA = conditioned floor area, ft^2. N_{br} = number of bedrooms. The mechanical ventilation system type shall be the same as in the proposed design. Energy recovery shall not be assumed for mechanical ventilation.	The mechanical ventilation rate[b] shall be in addition to the air leakage rate and shall be as proposed.

For SI: 1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US) = 3.785 L, °C = (°F – 32)/1.8, 1 degree = 0.79 rad.

a. Where required by the code official, testing shall be conducted by an approved party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals,* or the equivalent, shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals,* page 26.24 and the "Whole-house Ventilation" provisions of 2001 ASHRAE *Handbook of Fundamentals,* page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

f. For a proposed design home without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

g. For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater having the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For a proposed design without a proposed water heater, a 40-gallon storage-type water heater having the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.

h. For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:

. $AF = A_s \times FA \times F$

. where:

. AF = Total glazing area.

. A_s = Standard reference design total glazing area.

. FA = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).

. F = (above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.

. and where:

. Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.

. Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.

. Below-grade boundary wall is any thermal boundary wall in soil contact.

. Common wall area is the area of walls shared with an adjoining dwelling unit.

The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the “hot water rectangle”) divided by the floor area of the dwelling.

1. Sources of hot water include water heaters, or in multifamily buildings with central water heating systems, circulation loops or electric heat traced pipes.

2. The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping.

3. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.

i.

4. Where there is more than one water heater and each water heater serves different plumbing fixtures and appliances, it is permissible to establish a separate hot water rectangle for each hot water distribution system and add the area of these rectangles together to determine the compactness ratio.

5. The basement or attic shall be counted as a story when it contains the water heater.

6. Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and *HWDS* factor.

R408.2.5 (N1108.2.5) Improved air sealing and efficient ventilation system option.
The measured air leakage rate shall be less than or equal to 2.0 ~~3.0~~ ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed. Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent Sensible Recovery Efficiency (SRE), less than or equal to 1.1 cubic feet per minute per watt (0.03 m^3/min/watt) and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent Latent Recovery/Moisture Transfer (LRMT).

Attached Files

- **R2 table pix_cost.PNG**
  http://localhost/proposal/299/924/files/download/175/
- **R2 table pix.PNG**
  http://localhost/proposal/299/924/files/download/174/

Reason Statement:

The purpose of this code change proposal is to improve the energy efficiency and resiliency of homes in climate zones 3-8 through improved building envelope air tightness. Specifically, the proposal improves the prescriptive envelope air tightness requirement and performance path baseline from ≤3.0 ACH50 to ≤2.0 ACH50 for climate zones 3-8. It will also make a corresponding change to the Additional Efficiency Package Option that awards credit for reduced air leakage and the installation of an HRV/ERV. In order to maintain the level of trade-off flexibility allowed under the 2021 *IECC*, the proposal allows code users in climate zones 3-8 to trade up to ≤4.0 ACH50 in the performance path, as long as the efficiency losses are accounted for elsewhere in the home. The proposal also makes a corresponding improvement to the alternative air tightness requirement for smaller dwelling units.

The prescriptive envelope air tightness requirement of ≤3.0 ACH50 for climate zones 3-8 has not changed since the mandatory air leakage test requirement was first incorporated into the 2012 *IECC*. In the meantime, air leakage testing has become a far more common step in new construction, and the techniques and products used to achieve tight envelopes have become more commonplace in all climate zones. Tighter building envelopes provide a range of benefits to homeowners at relatively low cost:

- Improving air tightness from ≤3.0 to ≤2.0 ACH50 will not substantially increase the cost of construction, but it will save homeowners money over the home's useful life;
- A tighter envelope will help both heating and cooling systems operate more efficiently and manage indoor humidity, improving the long-term durability of buildings;
- A tighter building envelope, along with adequate fresh air through dedicated mechanical ventilation, will help maintain healthier indoor air quality for the home's occupants;
- More efficient building envelopes will generally help maintain occupant comfort and passive survivability in the event of extreme weather events or extended power outages.

Across the country, the envelope tightness in new buildings has improved in recent years as a result of market transformation. More builders have learned how to improve air tightness as a part of quality construction, and manufacturers have tuned products to meet the growing national demand for tighter homes. Above-code programs such as Energy Star require blower door testing, and it is a core element of energy ratings. Now that builders have had experience achieving the code requirement of ≤3.0 ACH50 under the *IECC* for nearly a decade, we believe the envelope air tightness requirement could be moderately improved with little additional effort.

Beyond the direct energy and cost savings associated with reduced air leakage, we expect that occupants will experience improved comfort, and as a result, will be less likely to adjust the thermostat to counteract a "drafty home." Below is a summary of estimated energy use increases associated with adjusting a thermostat 1 degree higher or lower, broken out by climate zone.

[R2 table pix.png]

Increased Energy Use Resulting from Thermostat Adjustment									
Measure	Nat'l Avg	1	2	3	4	5	6	7	8
+1 Degree Heating	4.1%	0.5%	3.0%	4.2%	4.4%	4.7%	4.5%	4.0%	2.9%
-1 Degree Cooling	3.2%	7.8%	5.3%	3.9%	2.6%	1.8%	1.4%	0.7%	0.4%

There is no question that homeowners will benefit from a tighter building envelope for many years, and we urge the adoption of this straightforward efficiency improvement.

Bibliography:

www.energycodes.gov/methodology

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal will increase the cost of construction in some cases. Some builders who achieve 3.0 ACH50 may already achieve 2.0 ACH50 with no additional cost. Those buildings that do not currently achieve 2.0 ACH50 should not require major additional cost to achieve this improvement. We believe it is reasonable to assume an average increase in construction costs of $198 per dwelling unit based on cost data from NREL's BEopt modeling software. For many builders, any incremental costs to achieve these gains will be reduced or eliminated over time as new techniques and quality assurance are adopted into standard practices. But for purposes of this code change proposal, a $198 average incremental cost per dwelling unit is a reasonable and conservative estimate.

COST-EFFECTIVENESS

This proposal is clearly cost-effective to the homeowner. Based on modeling using NREL's BEopt software and following the residential building cost-effectiveness methodology developed by the U.S. DOE (*see* www.energycodes.gov/methodology), the analysis conducted for EECC found that this proposal will save homeowners substantial energy cost and will result in clear life-cycle cost effectiveness. The analysis estimated that this proposal will produce a positive net life cycle benefit of $378-$5,044 over the first 30 years of the building's useful life, using the average incremental cost of $198 identified above and depending on climate zone. A summary table of this cost-effectiveness analysis is below.

[R2 table pix_cost.png]

Climate Zone	ACH50	Incremental Cost Upgrade	Annual Energy Savings	Present Value Costs	Present Value Benefits	Life Cycle Net Benefit
3	2.0	$198	$15	$448	$845	$397
4	2.0	$198	$37	$448	$827	$378
5	2.0	$198	$27	$448	$1,468	$1,020
6	2.0	$198	$34	$448	$1,831	$1,383
7	2.0	$198	$57	$448	$3,077	$2,629
8	2.0	$198	$103	$448	$5,492	$5,044

REPI-64-21

REPI-65-21

IECC®: R402.4.2.1 (N1102.4.2.1) (New), ANSI Chapter 06 (New), CSA Chapter 06 (New)

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new text as follows:
R402.4.2.1 (N1102.4.2.1) Gas fireplace efficiency.

All gas fireplace heaters rated to ANSI Z21.88 shall be listed and labeled with a fireplace efficiency (FE) rating of 50 percent or greater in accordance with CSA P.4.1. Vented gas fireplaces (decorative appliances) certified to ANSI Z21.50 shall be listed and labeled, including their FE ratings, in accordance with CSA P.4.1.

Add new standard(s) as follows:

ANSI American National Standards Institute 25 West 43rd Street, 4th Floor New York NY 10036

Z21-50-2019/CSA 2.22-19 Vented Decorative Gas Appliances

ANSI American National Standards Institute 25 West 43rd Street, 4th Floor New York NY 10036

Z21.88-2019/CSA 2.23-19 Vented Gas Fireplace Heaters

CSA CSA Group 8501 East Pleasant Valley Road Cleveland OH 44131-5516

P.4.1-2021 Testing method for measuring fireplace efficiency

Attached Files

- **Gas Fireplace Efficiency Proposal Support.docx**
  http://localhost/proposal/82/872/files/download/192/

Reason Statement:

The IECC does not currently address gas fireplace efficiency (though section 402.4.2 does reference safety standards for wood-burning fireplaces). Gas-burning fireplaces have a wide range of efficiency levels, from 28% to 90% and greater. Gas-fireplaces are most commonly used as secondary heating sources but may still be used for a significant number of hours per heating season.

This proposal establishes a minimum efficiency performance threshold for fireplaces based on the Canadian FE Standard. (https://www.nrcan.gc.ca/energy/products/energuide/label/reading/13718).

We suggest using the FE metric in lieu of AFUE because it more accurately reflects annual heating consumption of the fireplace (taking into account cycling losses, heating and non-heating season efficiency, pilot light contribution, etc.). Additionally the FE rating serves as the basis for efficiency for several utility programs throughout the US offering incentives for fireplaces with high FE ratings.The minimum performance threshold of 50% FE aligns with the BC Ministry of Energy, Mines, and Petroleum Resources regulations that mandates all vented gas fireplace heaters be listed and labeled with a minimum FE score of 50%. Decorative fireplaces, which comprise the bulk of fireplace sales, do not have an FE threshold but are required to be listed and labeled with an FE score. This proposal language is available in WA, NV, BC and in WA, NV, BC, and forthcoming legislation in CAGas Fireplace Efficiency

https://energy.cdpaccess.com/proposal/82/872/files/download/192/
https://energy.cdpaccess.com/proposal/82/872/files/download/122/

Bibliography:

Z21-50-2016/CSA 2.22-16 -Vented Decorative Gas Appliances R402.4.2.1

Z21.88-2017/CSA 2.23-17 - Vented Gas Fireplace Heaters R402.4.2.1

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Market analysis has shown that the minimum efficiency level for vented gas heaters is above 50% FE currently, and this proposal would set a minimum threshold to remove the worst performers from the market. Additionally, vented gas heaters make up a smaller portion of the market compared to decorative gas fireplaces which are exempt from this efficiency requirement, even though they need to have an FE rating (which aligns with BC standards, and legislation in NV, WA and forthcoming in CA.)

REPI-65-21

REPI-66-21

IECC®: CHAPTER 4 [RE], R402.4.6

Proponents:

Megan Hayes, representing NEMA (Megan.Hayes@nema.org)

2021 International Energy Conservation Code

CHAPTER 4 [RE] RESIDENTIAL ENERGY EFFICIENCY

Revise as follows:

R402.4.6 (N1102.4.6) Air-Sealed Electrical and communication boxes ~~(air-sealed boxes)~~.
Where selected for installation as permitted by Table R402.4.1.1, air-sealed electrical and communication boxes ~~installed in~~ that penetrate the building thermal envelope shall be sealed to limit air leakage between conditioned and unconditioned spaces. Air-sealed ~~Electrical and communication outlet~~ boxes shall be tested in accordance with NEMA OS 4, *Requirements for Air-Sealed Boxes for Electrical and Communication Applications*, and shall have an air leakage rate of not greater than 2.0 cubic feet per minute (0.944 L/s) at a pressure differential of 1.57 psf (75 Pa). ~~Electrical and communication outlet~~ Air-sealed boxes shall be marked “NEMA OS 4” or “OS 4” in accordance with NEMA OS 4. ~~Electrical and communication outlet~~ Air-sealed boxes shall be installed per the manufacturer's instructions and with any supplied components required to achieve compliance with NEMA OS 4.

Reason Statement:

This editorial revision better aligns the language being used in Table R402.1.1 by clarifying the requirements only apply where air-sealed boxes are selected as permitted by the table and applies to those boxes that penetrate the thermal envelope thus necessitating the need for an air barrier or air-sealed box.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no increase or decrease cost in construction as this proposal simply adds clarify to the original intent of R402.4.6.

REPI-66-21

REPI-67-21

IECC®: R402.4.6

Proponents:

Robert DeVries, representing Self (rdevries@nuwool.com)

2021 International Energy Conservation Code

Revise as follows:

~~R402.4.6 (N1102.4.6) Electrical and communication outlet boxes (air-sealed boxes)~~.

~~Electrical and communication outlet boxes installed in the building thermal envelope shall be sealed to limit air leakage between conditioned and unconditioned spaces. Electrical and communication outlet boxes shall be tested in accordance with NEMA OS 4, *Requirements for Air-Sealed Boxes for Electrical and Communication Applications*, and shall have an air leakage rate of not greater than 2.0 cubic feet per minute (0.944 L/s) at a pressure differential of 1.57 psf (75 Pa). Electrical and communication outlet boxes shall be marked "NEMA OS 4" or "OS 4" in accordance with NEMA OS 4. Electrical and communication outlet boxes shall be installed per the manufacturer's instructions and with any supplied components required to achieve compliance with NEMA OS 4.~~

Reason Statement:

This code proposal did not include any evidence of saving any energy when originally submitted and during the DOE required review it was not used stating that "Savings not captured in quantitative analysis because maximum ACH50 is unchanged.

The original proposal misstated the cost impact saying there would be no change in the cost of construction. It appears there was some confusion to the current use of vapor barrier boxes being required when in fact they are not. Device boxes meeting the required standard are up to or more than ten times the cost of standard device boxes.

Proposal Number[a]	Code Section(s)[b]	Description of Change(s)	Impact on Energy Efficiency	Included in Energy Analysis	
RE73	Table R402.4.1.1 (IRC N1102.4.1.1)	Clarification of requirements for sealing and insulating around penetrations	Administrative	No	
RE74	Table R402.4.1.1 (IRC N1102.4.1.1)	Editorial changes to air sealing table (crawl space walls, basement walls, and slabs).	Administrative	No	
RE82	Table R402.4.1.1 (IRC N1102.4.1.1)	Editorial changes to air sealing table (rim joists).	Administrative	No	
RE86	Table R402.4.1.1 (IRC N1102.4.1.1)	Editorial changes to air sealing table (shafts and penetrations).	Administrative	No	
RE88	R202 (IRC N1101.6) R402.4.1.2 (IRC N1102.4.1.2) R403.6 (IRC N1103.6)	Adds definition for Dwelling Unit Enclosure Area and allows 0.30 cfm25/ft² of Dwelling Unit Enclosure Area as an exception to 3 or 5 ACH50 for air leakage.	Administrative	No	Only allowed f and buildings c ft². The cfm25/ area removes homes.
RE98	R402.4.1.2 (IRC N1102.4.1.2) TABLE R405.5.2(1) [IRC N1105.5.2(1)]	Adds additional digit to the air leakage rate of the Standard Reference Design in Table R405.5.2(1) to eliminate roundoff error.	Administrative	No	This clarificatic compliance de
RE103	R402.4.2 (New) R402.4.6 (New)	Adds explicit requirement for use of air-sealed electrical and communication outlet boxes.	Administrative	No	Explicitly requi tested using N maximum air l captured in qu maximum ACH

Appendix A

Cost Impact:

The code change proposal will decrease the cost of construction.

By returning to the use of standard device boxes the cost of construction will be reduced.

REPI-67-21

REPI-68-21

IECC®: SECTION 202 (New), R402.6 (N1102.6) (New), TABLE R402.6 (TABLE N1102.6) (New), R402.6.1 (N1102.6.1) (New), TABLE R405.4.2(1), R407.2, R503.1.1, ASTM Chapter 06 (New), CRRC Chapter 06 (New)

Proponents:

Elizabeth McCollum, representing on behalf of the California Statewide Utility Codes and Standards Team (iecc-cool-roof@2050partners.com); Mark Lyles, representing New Buildings Institute (markl@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:
R202 LOW-SLOPED ROOF. A roof giving a slope less than 2 units vertical in 12 units horizontal.
R202 STEEP-SLOPED ROOF.

A roof giving a slope greater than or equal to 2 units vertical in 12 units horizontal.

Add new text as follows:
R402.6 (N1102.6) Roof Reflectance.

Roofs shall comply with one or more of the options in Table R402.6

Exceptions: The following roofs and portion of roofs are exempt from the requirements of Table R402.6:

1. Roofs in climate zones 6-8
2. Roofs where more than 75 percent of roof area complies with one or more of the exceptions below
3. Portions of the roof that are covered by the following:
   3.1 Photovoltaic systems or components
   3.2 Solar air or water heating systems or components
   3.3.Vegetative roofs or landscaped roofs
   3.4 Above roof decks or walkways
   3.5 Skylights
   3.6 HVAC systems and components, and other opaque objects mounted above the roof
4. Portions of roof shaded during the peak sun angle on the summer solstice by permanent features of the building or by permanent features of adjacent buildings.
5. Portions of roofs that are ballasted with a minimum stone ballast of 17 pounds per square foot (74kg/m^2) or 23 psf (117kg/m^2) pavers.

TABLE R402.6 (TABLE N1102.6) MINIMUM ROOF REFLECTANCE[a]

Roof Slope	**Three-year aged solar reflectance index[b]**
Low-sloped roof	75[b,c]
Steep-sloped roof	16

a. The use of area-weighted averages to comply with these requirements shall be permitted. Materials lacking 3-year-aged tested values for solar reflectance shall be assigned a 3-year-aged solar reflectance in accordance with Section R402.6.1
b. Aged solar reflectance tested in accordance with ASTM C1549, ASTM E903 or ASTM E1918 or CRRC-S100.
c. Solar reflectance index (SRI) shall be determined in accordance with ASTM E1980 using a convection coefficient of 2.1 Btu/h × ft 2 × °F (12 W/m 2 × K). Calculation of aged SRI shall be based on aged tested values of solar reflectance and thermal emittance.

R402.6.1 (N1102.6.1) Aged solar reflectance .

Where an aged solar reflectance required by Section R402.6 is not available, it shall be determined in accordance with Equation 4-1.

$R_{aged}=[0.2+0.7(R_{initial}-0.2)]$

(Equation 4-1)

where:
R_{aged}=The aged solar reflectance
$R_{initial}$=The initial solar reflectance determined in accordance with CRRC-S100

Revise as follows:

TABLE R405.4.2(1) (TABLE N1105.4.2(1)) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Roofs	Type: ~~composition shingle on wood sheathing.~~ *Low-sloped roof*: modified bitumen *Steep-sloped roof*: asphalt shingles	As proposed
	Gross area: same as proposed.	As proposed
	Low-sloped roof: (Aged) Solar ~~absorptance~~reflectance = 0.63~~0.75~~. *Steep-sloped roof*: (Aged) Solar reflectance = 0.2	As proposed
	Thermal Emittance = ~~0.90~~0.75.	As proposed

R407.2 (N1107.2) Tropical climate region.

Compliance with this section requires the following:

1. Not more than one-half of the *occupied* space is air conditioned.
2. The *occupied* space is not heated.
3. Solar, wind or other renewable energy source supplies not less than 80 percent of the energy for service water heating.
4. Glazing in *conditioned spaces* has a *solar heat gain coefficient* (SHGC) of less than or equal to 0.40, or has an overhang with a projection factor equal to or greater than 0.30.
5. Permanently installed lighting is in accordance with Section R404.
6. The exterior roof surface complies with one of the options in Table R402.6~~C402.3 of the *International Energy Conservation Code*–Commercial Provisions~~ or the roof or ceiling has insulation with an *R-value* of R-15 or greater. Where attics are present, attics above the insulation are vented and attics below the insulation are unvented.
7. Roof surfaces have a slope of not less than $^{1}/_{4}$ unit vertical in 12 units horizontal (21-percent slope). The finished roof does not have water accumulation areas.
8. Operable fenestration provides a ventilation area of not less than 14 percent of the floor area in each room. Alternatively, equivalent ventilation is provided by a ventilation fan.
9. Bedrooms with *exterior walls* facing two different directions have operable fenestration on exterior walls facing two directions.

10. Interior doors to bedrooms are capable of being secured in the open position.

11. A ceiling fan or ceiling fan rough-in is provided for bedrooms and the largest space that is not used as a bedroom.

R503.1.1 (N1111.1.1) Building envelope.

Building envelope assemblies that are part of the *alteration* shall comply with Section R402.1.2 or R402.1.4, Sections R402.2.1 through R402.2.12, R402.3.1, R402.3.2, R402.4.3,R402.6 and R402.4.5.

Exception: The following alterations shall not be required to comply with the requirements for new construction provided that the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.

2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.

3. Construction where the existing roof, wall or floor cavity is not exposed.

4. Roof recover where the new roofing meets the reflectance requirements under R402.6.

5. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.

6. Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided that the code does not require the glazing or fenestration assembly to be replaced.

Add new standard(s) as follows:

ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

ASTM C1549-2016	Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer

ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

ASTM E903-2012	Standard Test Method for Solar Absorptance, Reflectance and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005)

ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

ASTM E1918-06(2016)	Standard Test Method for Measuring Solar Reflectance of Horizontal or Low-sloped Surfaces in the Field

ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

ASTM E1980- 11	Standard Practice for Calculating Solar Reflectance of Horizontal and Low-sloped Opaque Surfaces

CRRC Cool Roof Rating Council 2435 North Lombard Street Portland OR 97217

ANSI/CRRC-S100-2020	Standard Test Methods for Determining Radiative Properties of Materials

Reason Statement:

A cool roof is a relatively inexpensive energy conservation measure to passively reduce cooling load in warmer regions. Cool roofs strongly reflect sunlight and efficiently radiate heat away from the roof surface. Cool roofs are generally light colors like white or grey, but also are available in a variety of traditional colors by using cool-colored pigments. Installing a cool roof reduces the conduction of heat into the building, thus reducing the need for air-conditioning in conditioned spaces. Minimizing the need for air conditioning saves energy and money, and the decreased load helps to moderate peak grid demand during heat waves and very hot summer afternoons, thereby reducing the risk of power outages. Decreasing the convection of heat into the building also offers increased occupant comfort in unconditioned buildings.

The reflectance and TE values degrade over time, hence 3-year aged values are used for the performance benchmark referred to as aged solar reflectance (ASR) and TE. For the current IECC Cool Roof proposal, the proposal team defined the code requirements above in terms of SRI, which is a combination of ASR and TE. SRI provides more flexibility in terms of product selection than specifying minimum ASR and TE. The proposed 75 SRI value excludes product selections with unacceptably low ASR or TE. In addition to energy benefits, cool roofs also help reduce air temperature, lowering urban heat island effects and peak electricity demand, reducing the potential for rotational load shedding in extreme weather.

Cool roof is required in IECC 2021 commercial new construction requirements for climate zones 0 to 3 per Section C402.3. The proposed change aligns residential requirements in R402.6 with the commercial new construction requirements in Section C402.3, and extends the requirement to Climate Zones 4 and 5. The proposed cool roof requirements are based on California's 2022 Title 24 residential new construction cool roof requirements. Cool roofs were shown to be cost effective in select warmer California climate zones that are a subset of IECC climate zones 2 and 3. 2022 Title 24, Part 6 requires an aged solar reflectance index (SRI) of 75 in low sloped roof buildings and a SRI of 16 in steep sloped roof buildings. The 2022 Title 24 code expanded the applicability of cool roof requirements in single family alterations to a broader set of CEC climate zones (as compared to 2019 Title 24, Part 6 requirements) based on the 2022 CASE Report (Frontier Energy et. al., 2020).

A wide range of cool roof products are available in the market for both low-sloped and steep-sloped roof applications. There are approximately 3000 roofing products listed with Cool Roof Rating Council (CRRC) and a majority of those are appropriate for both low-sloped and steep-sloped installations. These products include single-ply, fluid applied membrane, asphaltic membrane, and metal coating products and modified bitumen-based products that are commonly used for cool roof installations and are available in a range of colors. The proposal team based the material selection and associated costs on the 2022 Title 24 California Statewide Codes and Standards Enhancement (CASE) Report (Frontier Energy et. al., 2020) conducted in 2020 for single family alterations. The CASE report is the latest reference on cool roof cost available that refers to other external studies (Freedonia group, 2019) (TRC, 2016a) (TRC, 2016b) for both material selection and cost estimates.

Bibliography:

Freedonia group. (2019). *Low Slope Roofing.* Retrieved from https://www.freedoniagroup.com/industry-study/low-slope-roofing-3762.htm

Frontier Energy et. al. (2020). *2022 CASE Report: Residential Energy Savings and Process Improvements for Additions and Alterations.* Retrieved from https://title24stakeholders.com/wp-content/uploads/2020/08/SF-Additions-and-Alterations_Final_-CASE-Report_Statewide-CASE-Team.pdf

TRC. (2016a). *Title 24 Codes and Standards Local Ordinances: Cost-Effectiveness Study for Cool Roof, Final Report for All Climate Zones.*

TRC. (2016b). *City of Palo Alto 2016 Building Energy Efficiency Reach Code Cost Effectiveness Study.*

Cost Impact:

The code change proposal will increase the cost of construction.

Cool roofs reflect higher amounts of incident solar radiation and radiate a higher amount of absorbed heat. This reduces the cooling load and consequently the energy consumed by cooling energy systems, resulting in cooling energy savings. This translates to net building energy savings for buildings in warmer, cooling dominant regions.

The proposal team estimates energy cost savings over the estimated useful life of the roof product that offset incremental measure costs based on analysis conducted by the California Statewide CASE team for the 2022 Title 24, Part 6 update cycle (Frontier Energy et. al., 2020). The analysis estimated 4-66 kWh/yr savings per dwelling unit for existing buildings with steep slope roofs and 25-700 kWh/yr savings per dwelling unit in existing buildings with low sloped roofs. Given the milder climate zones analyzed in California, this estimate is conservative for IECC Climate Zones 0 through 3. The proposal team will provide supporting documentation that includes savings analysis for the proposed IECC climate zones for presentation in IECC committee meetings.The Residential Energy Savings and Process Improvements for Additions and Alterations CASE Report (Frontier Energy et. al., 2020) includes estimated incremental costs for cool roof products meeting the proposed SRI through ASR and TE as shown in Table 1.

Table 1: Incremental Cool Roof Costs from Residential Energy Savings and Process Improvements for Additions and Alterations CASE Report

Roof slope	Baseline	Proposed	Estimated Incremental Cost (per square foot)
Low-sloped	0.1 ASR, 0.85 TE (equivalent SRI 4)	0.63 ASR, 0.75 TE (equivalent SRI 72)	$0.17-$0.84
Steep-sloped	0.1 ASR, 0.85 TE (equivalent SRI 4)	0.2 ASR, 0.75 TE (equivalent SRI 11)	$0.00-$0.55

All CRRC-rated products that meet the minimum aged SRI of 72 have an aged SRI of 75 or greater, so we expect a similar incremental cost for the proposed requirement as listed in Table 1 above. The proposal team will provide supporting documentation that includes evidence of simple payback within the estimated useful life of the roof in advance of IECC committee meetings.

REPI-68-21

REPI-69-21

IECC®: SECTION 202 (New), R403.1 (N1103.1) (New), R403.1, R403.6.1, R403.8, R404.2 (N1104.2) (New), R404.2, R404.3 (N1104.3) (New), R404.3, R404.4 (N1104.4) (New)

Proponents:

Kimberly Newcomer, representing NBI (kim@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:
R202 COMMON AREA.

All portions of *Group R occupancies* that are not *dwelling units* or *sleeping units*.

Add new text as follows:
R403.1 (N1103.1) General.

Systems serving individual *dwelling units* shall comply with Section R403. Systems serving *common areas or* two or more*dwelling units* shall comply with Sections C403 and C404 of the International Energy Conservation Code – Commercial Provisions instead of Section R403.

Revise as follows:
~~R403.1~~ R403.2 (N1103.2) Controls.

Not less than one thermostat shall be provided for each separate heating and cooling system.

R403.6.1 (N1103.6.1) Heat or energy recovery ventilation.

Dwelling units shall be provided with a heat recovery or energy recovery ventilation system ~~in Climate Zones 7 and 8~~. The system shall be balanced with a minimum sensible heat recovery efficiency of 65 percent at 32°F (0°C) at a flow greater than or equal to the design airflow.

Exceptions:

1. Dwelling units in single and two-family buildings in Climate Zones 0-6.

2. Dwelling units in Group-R occupancies that comply with Section C403.7.4.1.

Delete without substitution:
~~R403.8 Systems serving multiple dwelling units .~~
~~Systems serving multiple *dwelling units* shall comply with Sections C403 and C404 of the *International Energy Conservation Code – Commercial Provisions* instead of Section R403.~~
Add new text as follows:
R404.2 (N1104.2) Interior lighting controls..

Lighting serving individual *dwelling units* shall comply with Section R404.2.1. Lighting serving *common areas* shall comply with Sections C405.2 of the International Energy Conservation Code – Commercial Provisions instead of Section R404.2.1.

Revise as follows:
~~R404.2~~ R404.2.1 (N1104.2.1) ~~Interior lighting controls~~Controls for individual dwelling units.
Permanently installed lighting fixtures shall be controlled with either a dimmer, an occupant sensor control or other control that is installed or built into the fixture.

Exception: Lighting controls shall not be required for the following:

1. Bathrooms.

2. Hallways.

~~3. Exterior lighting fixtures.~~

3~~4~~. Lighting designed for safety or security.

Add new text as follows:
R404.3 (N1104.3) Exterior lighting controls.

Exterior lighting controlled from within individual *dwelling units* shall comply with Section R404.3.1. Controls for all other exterior lighting shall comply with Sections C405.2.7 of the International Energy Conservation Code – Commercial Provisions instead of Section R404.3.1.

Revise as follows:
~~R404.3~~ R404.3.1 (N1104.3.1) ~~Exterior lighting controls~~ Controls for individual dwelling units.
Where the total permanently installed exterior lighting power is greater than 30 watts, the permanently installed exterior lighting shall comply with the following:

1. Lighting shall be controlled by a manual on and off switch which permits automatic shut-off actions.

   ~~**Exception:** Lighting serving multiple *dwelling units*.~~

2. Lighting shall be automatically shut off when daylight is present and satisfies the lighting needs.

3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

Add new text as follows:
R404.4 (N1104.4) Electrical Power Systems.

Group R occupancies shall comply with Sections C405.6 through C405.12.

Reason Statement:

This combination of proposals seeks to align the requirements of multifamily dwelling units across the two sides of the code. Currently there are large discrepancies in terms of system design, control and stringency between a 3-story MF building and a 4-story MF building. This leads to market confusion, enforcement inconsistencies, and large potential untapped energy savings. This revision and its companion seek to close these gaps and create a common set of requirements for multifamily buildings.

The 2022 version of Title 24 has created a new section to regulate MF buildings - similar to a more "omnibus" proposal submitted by NBI previously. Based on feedback from that submission to not create a new section, this proposal instead works to align the sections that currently exist.

Bibliography:

https://newbuildings.org/resource/multifamily-building-guide/

https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

Cost Impact:

The code change proposal will increase the cost of construction.

Low-rise multifamily buildings will see an increase in first cost. Since these same provisions have been deemed to be acceptable for cost effectiveness for 4 story MF buildings, the same should apply to 3 story buildings.

REPI-69-21

REPI-70-21

IECC®: SECTION 202 (New), R403.1.1, R403.5.4 (New), CTA (New), IEC (New), OpenADR (New)

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Add new definition as follows:
R202 DEMAND-RESPONSIVE CONTROL. An automatic control that can receive and automatically modify building electric load in response to requests from a utility, electrical system operator, or third-party.
Revise as follows:
R403.1.1 Programmable thermostat.

The thermostat controlling the primary heating or cooling system of the *dwelling unit* shall be capable of controlling the heating and cooling system on a daily schedule to maintain different temperature set points at different times of the day and different days of the week. This thermostat shall include the capability to set back or temporarily operate the system to maintain *zone* temperatures of not less than 55°F (13°C) to not greater than 85°F (29°C). The thermostat shall be programmed initially by the manufacturer with a heating temperature setpoint of not greater than 70°F (21°C) and a cooling temperature setpoint of not less than 78°F (26°C). The thermostat shall be provided with Demand-Responsive Control capable of increasing the cooling setpoint by no less than 4 °F (2.2 °C) and decreasing the heating setpoint by no less than 4 °F (2.2 °C) in response to a DR request.

Demand responsive controls shall comply with all of the following:

1. All demand responsive controls shall be either:
   - 1.1. A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification, or
   - 1.2. Certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b Virtual End Node by automatically implementing the control functions requested by the Virtual End Node for the equipment it controls, or
   - 1.3. Comply with IEC 62726-10-1, an international standard for the open automated demand response system interface between the smart appliance, system, or energy management system and the controlling entity, such as a utility or service provider, or
   - 1.4. Comply with the communication protocol required by a controlling entity, such as a utility or service provider, to participate in an automated demand response program.
2. All demand responsive controls shall be capable of communicating to the VEN using one or more of the following: Wi-Fi, ZigBee, BACnet, Ethernet, or hard-wiring any other bi-directional communication pathway.
3. When communications are disabled or unavailable, all demand responsive controls shall continue to perform all other control functions provided by the control.

Add new text as follows:
R403.5.4 Demand-responsive water heating.

All electric storage water heaters with a storage tank capacity greater than 20 gallons (76 L) shall be provided with demand-responsive controls that comply with CTA-2045 or another demand-responsive control approved by the Authority Having Jurisdiction.

Add new standard(s) as follows:

CTA	Consumer Technology Association Technology & Standards Department 1919 S Eads Street Arlington VA 22202

CTA Consumer Technology Association Technology & Standards Department.

ANSI/CTA-2045-B – 2018: Modular Communications Interface for Energy Management

IEC Regional Centre for North America

IEC 446 Main Street 16th Floor

Worcester MA 01608

IEC IEC Regional Centre for North America.

IEC 62746-10-1 - 2018: Systems interface between customer energy management system and the power management system - Part 10-1: Open automated demand response

OpenADR Alliance

OpenADR 111 Deerwood Road, Suite 200

San Ramon CA 94583

OpenADR OpenADR Alliance.

OpenADR 2.0a and 2.0b – 2019: Profile Specification Distributed Energy Resources

Reason Statement:

As buildings account for over 70% of U.S. electricity use, effectively managing their loads can greatly facilitate the transition towards a clean, reliable grid. Grid-interactive efficient buildings (GEBs) combine efficiency and demand flexibility with smart technologies and communication to provide occupant comfort and productivity while serving the grid as a distributed energy resource (DER). In turn, GEBs can play a key role in ensuring access to an affordable, reliable, sustainable and modern U.S. electric power system. Their national adoption could provide $100-200 billion in U.S. electric power system cost savings over the next two decades. The associated reduction in CO_2 emissions is estimated at 6% per year by 2030.[1]

Building codes represent standard design practice in the construction industry and continually evolve to include advanced technologies and innovative practices. Historically, national model energy codes establish minimum efficiency requirements for new construction.[2] Expanding codes to support GEB capabilities is a pivotal step towards realizing demand flexibility in support of a clean grid by addressing capabilities to improve interoperability between smart building systems, the grid, and renewable energy resources. Realizing GEBs requires buildings with automated demand response (DR) capabilities that enable standardized control, subject to explicit consumer consent, of energy smart appliances on an electricity network. This is achieved through communication between appliances and a controlling entity that is in communication with the consumer participants.

Energy codes can support DR communication standardization and advance the deployment of flexible load technologies such as smart home energy management systems, energy storage, behind-the-meter generation, and electric vehicles (EVs). Incorporating automated demand response capabilities in energy codes provides many benefits to consumers and society. Specifically, it matches intermittent renewable energy sources to building electric loads, decreases peak load on the electric grid, allows buildings to respond to utility price signals, supports electrical n etwork reliability and market growth of products and processes aligned with clean economic growth.

The incorporation of DR into the model residential energy codes was considered for the 2021 International Energy Conservation Code (IECC) code development cycle. The scope of this proposal includes two strategies for DR in residential buildings: 1) smart thermostats with demand-responsive control and 2) electric water heating incorporating demand-responsive controls and communication.

[1] DOE (U.S. Department of Energy). 2021. *A National Roadmap for Grid-Interactive Efficient Buildings.* Washington DC. Accessed on June 9, 2021 at https://gebroadmap.lbl.gov/

[2] While advanced codes can be considered model codes, in this document, the term "model energy code" refers to the current published version of the International Energy Conservation Code-Residential and ASHRAE Standard 90.1, as those documents are referenced by Energy Conservation and Production Act as modified by the Energy Policy Act of 1992 as the minimum requirements for states adopting energy codes. https://www.govinfo.gov/content/pkg/USCODE-2011-title42/pdf/USCODE-2011-title42-chap81-subchapII.pdf.

[3] https://www.iccsafe.org/building-safety-journal/bsj-technical/code-development-a-process-of-evolution-and-improvement/

Bibliography:

Salcido V, Y Chen, B Taube, E Franconi, and M Rosenberg. 2021. *Demand Response in Residential Energy Code.* Pacific Northwest National Laboratory, Richland, Washington. PNNL-31994

Cost Impact:

The code change proposal will increase the cost of construction.

The costs associated with installing residential DR control strategies highlighted in this technical brief are discussed below. The installed costs for smart thermostats and electric water heaters with DR control are modest and depend on the design of the home.

The cost of a standard programmable thermostat required in the 2021 IECC ranges from $20 to $100 based on costs at local home improvement stores. A smart thermostat can range from $120 to $400 based on brand, model, and level of sophistication. The cost to install a programmable or smart thermostat ranges from $112 to $255, with the national average cost of $175. Thus, the incremental cost of upgrading from a standard programmable thermostat to a smart thermostat with DR controls is anywhere between $100 and $300.

Electric resistance water heaters supplied with CTA-2045 communication have been manufactured but are not widely available. HPWHs have taken over the energy efficiency segment of the water heater market, and brands at local home improvement stores include the CTA-2045 communication ports. The average cost for a 50-gallon electric resistance heater is $400, while the average cost for a 50-gallon HPWH is $1,300 at local home improvement stores (Salcido et al. 2021). The incremental cost of $900 plus additional condensate removal equipment of $75 results in a total cost differential of $975. Therefore, for buildings already including HPWHs in the original design, the incremental increase in cost is $0. If the building specified an electric resistance water heater, the most straightforward way to implement the CTA-2045 communication for DR control is to switch to an HPWH with an incremental cost of $975.

While DR control functionality will reduce costs to utilities as well as electric costs to consumers, it is difficult to estimate or calculate the actual cost savings. DR will present cost-saving opportunities for buildings as more homeowners take advantage of time-of-use or real-time pricing controls as they become more widely available. Adding DR controls in model energy codes can help homeowners have the capability of participating in DR programs with alternative utility pricing structures whether they exist now or in the future. When DR requirements are part of the model energy code, it will not require homeowners or buildings to participate in any DR programs but will guarantee that residential buildings are capable of participating in DR programs

REPI-70-21

REPI-71-21

IECC®: SECTION 202 (New), R403.1.1.1 (New), R407.2, AHRI Chapter 06 (New)

Proponents:

Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Josh Keeling, representing Cadeo Group (jkeeling@cadeogroup.com); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Matt Tidwell, representing Portland General Electric (matthew.tidwell@pgn.com); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Amber Wood, representing ACEEE (awood@aceee.org)

2021 International Energy Conservation Code

Add new definition as follows:
R202 GRID-INTEGRATED CONTROL. An automatic control that can receive, automatically respond to demand response requests from and send information back to a utility, electrical system operator, or third-party demand response program provider.
Add new text as follows:
R403.1.1.1 Grid-integrated thermostat controls.

The thermostats shall be provided with grid-integrated controls that comply with AHRI 1380 capable of the following:

1. Automatically increasing the zone operating cooling set points by a minimum of 4°F (2.2°C)
2. Automatically decreasing the zone operating heating set points by a minimum of 4°F (2.2°C)
3. Automatically decreasing the zone operating cooling set points by a minimum of 2°F (1.1°C)
4. Automatically increasing the zone operation heating set points by a minimum of 2°F (1.1°C)
5. Both ramp-up and ramp-down logic to prevent the building peak demand from exceeding that expected without the DR implementation.

The thermostat shall be capable of performing all other functions provided by the control when the grid-integrated controls are not available.

Exception: Assisted living facilities.
Revise as follows:
R407.2 Tropical climate region.

Compliance with this section requires the following:

1. Not more than one-half of the *occupied* space is air conditionedand is controlled by a thermostat in accordance with Section R403.1.1.
2. The *occupied* space is not heated.
3. Solar, wind or other renewable energy source supplies not less than 80 percent of the energy for service water heating.
4. Glazing in *conditioned spaces* has a *solar heat gain coefficient* (SHGC) of less than or equal to 0.40, or has an overhang with a projection factor equal to or greater than 0.30.
5. Permanently installed lighting is in accordance with Section R404.
6. The exterior roof surface complies with one of the options in Table C402.3 of the *International Energy Conservation Code*–Commercial Provisionsor the roof or ceiling has insulation with an *R-value* of R-15 or greater. Where attics are present,

attics above the insulation are vented and attics below the insulation are unvented.

7. Roof surfaces have a slope of not less than $^{1}/_{4}$ unit vertical in 12 units horizontal (21-percent slope). The finished roof does not have water accumulation areas.

8. Operable fenestration provides a ventilation area of not less than 14 percent of the floor area in each room. Alternatively, equivalent ventilation is provided by a ventilation fan.

9. Bedrooms with *exterior walls* facing two different directions have operable fenestration on exterior walls facing two directions.

10. Interior doors to bedrooms are capable of being secured in the open position.

11. A ceiling fan or ceiling fan rough-in is provided for bedrooms and the largest space that is not used as a bedroom.

Add new standard(s) as follows:

AHRI Air-Conditioning, Heating, & Refrigeration Institute 2111 Wilson Blvd, Suite 500 Arlington VA 22201

AHRI 1380-2019	Demand Response through Variable Capacity HVAC Systems in Residential and Small Commercial Applications

Reason Statement:

According to a new report from the National Association of Home Builders (NAHB), in 2021, homeowners will be seeking out features for their homes that improve comfort, wellness and efficiency. One of these common home features homeowners are seeking out are ways to improve their overall home energy use. To help lower energy bills, home builders install a smart thermostat to regulate temperatures and install ENERGY STAR appliances. Major builders D.R. Horton and Toll Brothers are both partners with smart home technology which are installed in the homes they build (these include smart thermostats).

Grid-integrated controls for thermostats are added based on language from California Title 24 and integrated into the current requirement for thermostats. Any thermostat listed as “Title 24 compliant” would meet this requirement, and are available directly through major retailers.

Smart thermostat demand response is becoming one of the most pervasive utility offering throughout the country. In their 2019 Demand Response Market Snapshot, SEPA found that 58 utilities had smart thermostat offerings, comprising 1 GW of connected load. In their assessment of US national potential for load flexibility, Brattle found that smart thermostats were the largest single program offering in their estimated 200 GW of potential by 2030. As shown in the figure below, LBNL modeling for the DOE GEB roadmap shows that demand response thermostats can reduce building peak demand by up to 30%. The substantial savings impact variability is because LBNL modeled impacts at times driven by typical utility peak hours based on the utility grid region but that does not necessarily align with building peak hours. If the two are aligned, the impacts are maximized; if impacts are misaligned impacts may be shown as negative. Therefore, these impacts should not be considered to be “typical” or “maximum” in each case.

To ensure the inclusion of demand response controls are treated as mandatory the thermostat requirements are added to the tropical compliance list under R407.2.

Bibliography:

A National Roadmap for Grid-Interactive Efficient Buildings, U.S. Department of Energy, 17 May 2021, https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf.

Final CASE Report: Upgradeable Setback Thermostats, California Statewide Codes and Standards Enhancement (CASE) Program, October 2011, https://title24stakeholders.com/wp-content/uploads/2020/01/2013_CASE-Report_Upgradeable-Setback-Thermostats.pdf

SupplyHouse. “T3700 - Venstar T3700 - Explorer T3700 Residential Digital Thermostat (2 Heat, 1 Cool).” SupplyHouse.com, www.supplyhouse.com/Venstar-T3700-Explorer-T3700-Residential-Digital-Thermostat-2-Heat-1-Cool.

SupplyHouse. “T1010 - Venstar T1010 –Single Day Programmable Digital Thermostat” SupplyHouse.com, https://www.supplyhouse.com/Venstar-T1010-Venstar-T1010-Single-Day-Programmable-Digital-Thermostat

DR Horton Smart Home https://www.drhorton.com/Smart-Home

Toll Brothers Smart Home Solutions https://www.tbismarthomesolutions.com/technology

Cost Impact:

The code change proposal will increase the cost of construction.

In 2011, grid-integrated thermostats (which were estimated to cost $68 more than a programmable thermostat) were found to be extremely cost effective.3 It was estimated that for every dollar spent on a grid-integrated thermostat in 2011 yielded between $2 to $9 in operating cost savings over a 15-year period. In the 10 years since, equipment prices have decreased. One can purchase a basic grid-integrated thermostat for $63 compared to a basic 7-day programmable thermostat which costs $42. Including labor costs and a 35% markup to account for direct and indirect costs of construction, the incremental construction cost of installing a demand responsive thermostat is currently estimated to be $40 making this measure even more cost effective than estimated previously.

Not only will this measure result in cost savings to consumers, but it will also result in other significant societal benefits. According to DOE’s report, “A National Roadmap for Grid-Interactive Efficient Buildings”, every watt in peak demand savings was found to create 17 cents in annual electric grid system value. This value included energy savings, capacity savings, transmission deferral and ancillary services. A single-family home with a grid-integrated thermostat which is estimated to reduce peak demand savings between 0.26 to 1.09kW would result in $43 to $181 in annual electric grid system value. Grid-integrated thermostats which allow grid operators to reduce demand on the grid during the times when the carbon intensity of the electric grid is high also results in reduced carbon emissions generating additional significant societal benefits.

REPI-71-21

REPI-72-21

IECC®: R403.1.2

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
R403.1.2 Heat pump supplementary heat.

Heat pumps having supplementary electric-resistance heat shall have controls that~~, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.~~ limit supplemental heat operation to only those times when one of the following applies:

1. The vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
2. The heat pump is operating in defrost mode.
3. The vapor compression cycle malfunctions.
4. The thermostat malfunctions.

Reason Statement:

This proposal will make the language in the Residential Energy Code consistent with the language approved for the 2021 Commercial Energy Code in Section C403.4.1.1 for heat pump supplementary heat.

This proposal is also technically consistent with how heat pumps operate, and will ensure that in the case of malfunctions, the occupants will still be able to have heating in their homes.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not change or impact the material, labor, or installation costs of heat pumps, and therefore will not have any impact on the cost of construction.

REPI-72-21

REPI-73-21

IECC®: R403.1.2

Proponents:

Ryohei Hinokuma, Daikin U.S. Corporation, representing Daikin U.S. Corporation (ryohei.hinokuma@daikinus.com)

2021 International Energy Conservation Code

Revise as follows:
R403.1.2 Heat pump supplementary heat (Mandatory).

Heat pumps having supplementary electric-resistance heat shall have controls that, ~~except during defrost,~~ prevent supplemental heat operation when the capacity of the heat pump ~~compressor~~ can meet the heating load. The controls shall permit supplemental heat operation only during heat pump capacity shortage, defrost operation or for emergency use when the heat pump is not operational. To ensure the use of electric-resistance heat for supplementary use only, the space heating design ambient temperature shall be used to switch operation from heat pumps to resistance heat.

Attached Files

- **2021.10.12_Daikin Comments - 2024 IECC_Final.pdf**
  http://localhost/proposal/530/1008/files/download/206/

Reason Statement:

DAIKIN U.S. CORPORATION
601 13TH STREET NW, SUITE 200 SOUTH
WASHINGTON, DC 20005
PHONE: (202) 383-8740

R408.2 Additional efficiency package options.

Buildings meeting the requirements Additional efficiency package options for compliance with Section 401.2.1 are set forth in Sections R408.2.1 through R408.2.

R408.2.2 More efficient HVAC equipment performance option.

Heating and cooling equipment shall meet one of the following efficiencies:

Centrally Ducted Systems

1. Greater than or equal to 95 AFUE natural gas furnace and ~~16 SEER~~ 16.9 SEER2[7] air conditioners.
2. Greater than or equal to 95 AFUE natural gas furnace and 8.5 HSPF2/16.9 SEER2 air source heat pump.
~~2.~~ 3. Greater than or equal to ~~10 HSPF/16 SEER~~ 8.5 HSPF2[8]/16.9 SEER2 air source heat pump.

~~3.~~ 4. Greater than or equal to 3.5 COP ground source heat pump.

Ductless Systems

1. Single Zone: 8.5 HSPF2/16.9 SEER2 variable speed air source heat pump.
2. Multi Zone: 8.5 HSPF2/16.9 SEER2 variable speed air source heat pump (Non-Ducted Indoor Units).
3. Multi Zone: 8.5 HSPF2/15.2 SEER2 variable speed air source heat pump (Ducted or Mixed Indoor Units)

For multiple cooling system, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

[7] SEER2 per 10CFR 430.32 (effective 1/1/2023)

[8] HSPF2 per 10CFR 430.32 (effective 1/1/2023)

The use of electric resistance heaters as backup heating devices can significantly increase winter energy consumption, and air source heat pumps can effectively provide heating without such devices including the cold climate regions in the United States. Also, Daikin has observed that it’s common for heat pumps to be installed with electric resistance heaters configured to operate in conditions where sufficient heating capacity is available from the heat pump alone. This results in reducing the operation hours of heat pumps and increasing the operation hours of electric-resistance heaters. Such setting of heat pump systems will fail to yield expected reduction of GHG emissions and result in higher energy consumption and longer peak demand events. Therefore, Daikin proposes to revise R403.1.2, which defines the use of electric resistance heaters as supplementary heat for heat pumps, to prevent such practice.

See attached letter for more background information justifying this modification.

DAIKIN U.S. CORPORATION
601 13TH STREET NW, SUITE 200 SOUTH
WASHINGTON, DC 20005
PHONE: (202) 383-8740

October 12, 2021

The International Code Council
500 New Jersey Ave NW 6th Floor
Washington, DC 20001
Re: 2024 International Energy Conservation Code (IECC) Code Change Proposal

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Daikin U.S. Corporation ("Daikin") hereby submits the following code change proposal in response to the development process of 2024 International Energy Conservation Code (IECC). Daikin U.S. Corporation is a subsidiary of Daikin Industries, Ltd., the world's largest air conditioning equipment manufacturer. The Daikin Group includes Daikin Applied, Daikin North America LLC, and Goodman Manufacturing Company, L.P.

I. Introduction

Buildings account for 40 percent of all US energy consumption and 24 percent of its greenhouse gas (GHG) emissions[1]. Out of those, 22 percent of the consumption and 12 percent of the emissions come from residential buildings[2]. Under the Biden Administration, the United States targets to reduce its GHG emission by 50-52 percent by 2030. To achieve the decarbonization goal, energy efficiency as well as building electrification will need to play a critical role.

Replacement of lower efficiency or carbon intensive HVAC equipment with heat pumps are an effective solution to drive energy efficiency and building electrification and thus building decarbonization. Within heat pumps, variable speed heat pumps have demonstrated superior energy performance over single and two-stage equipment. For instance, the United States Environmental Protection Agency (U.S. EPA) notes that variable speed equipment and modulating systems specifically provide additional customer comfort advantages by following load, provide

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1 Use of energy in explained - U.S. Energy Information Administration, https://www.eia.gov/energyexplained/use-of-energy/

2 Fast Facts on Transportation Greenhouse Gas Emissions | US EPA, https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

capacities (i.e., less than 100% capacity). When operating at part-load, it can be significantly more efficient. As shown in Figure 1, variable speed equipment's efficiency increases significantly as its load reduces below 100%. This exceeds the performance of both single and two-stage equipment as load reduces. According to computer simulations, validated by the Electric Power Research Institute (EPRI), when variable speed HVAC equipment reduces its cooling capacity by 25% it results in a 43% reduction in power consumption while for single-speed equipment it would yield only a 25% reduction in power consumption[4]. However, according to National Resource Defense Council (NRDC), "current test procedures do not adequately capture the impact of a variable [speed] unit's control logic, which can have a large impact on efficiency[5]." Lastly, Daikin would like to point out that ductless systems can further improve energy performance of HVAC systems by allowing homeowners to turn off indoor units in unoccupied zones.

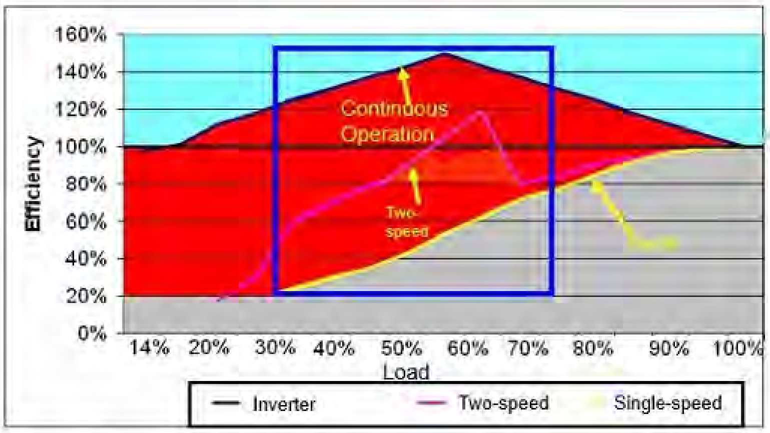

Figure 1: HVAC Equipment Efficiency at Various Part-Loads

[3] U.S. EPA, ENERGY STAR Residential Air Source Heat Pump and Central Air Conditioning Equipment Version 6.0 Discussion Guide dated August 3, 2018, https://www.energystar.gov/sites/default/files/

[4] HRAI and AHRI, Letter to U.S. EPA Regarding ENERGY STAR Residential Air Source Heat Pump and Central Air Conditioning Equipment Version 6.0 Discussion Guide dated September 21, 2018, https://www.energystar.gov/sites/default/files/AHRI_HRAI_Comments_CAC_ASHP_Discussion%20Guide_09%2021%202018.pdf

[5] NRDC, NRDC Comments on ENERGY STAR Program Requirements for Air Source Heat Pump and Central Air Conditioner Equipment Version 6.0, Draft 1 dated May 23, 2019, https://www.energystar.gov/sites/default/files/NRDC%20Comments%20on%20CACASHP%20Draft%201%20V6.0.pdf

DAIKIN

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However, heat pumps currently account for only 12 percent of the space heating install base in the United States, whilst a significant portion of space heating installed consists of combustion equipment such as furnaces and boilers (76 percent of total)[6]. To significantly boost the proportion of heat pumps, especially variable speed heat pumps including the ones in ductless configuration, effective and aggressive market transformation will be required. Daikin believes that building codes should play a critical role in accelerating the adoption of such technologies in the United States.

Hereby, to execute the forementioned market transformation, Daikin would like to make the following code change proposals for the development process of 2024 IECC:

II. Code Change Proposal to R403.1.2 Heat Pump Supplementary Heat

The use of electric resistance heaters as backup heating devices can significantly increase winter energy consumption, and air source heat pumps can effectively provide heating without such devices including the cold climate regions in the United States. Also, Daikin has observed that it's common for heat pumps to be installed with electric resistance heaters configured to operate in conditions where sufficient heating capacity is available from the heat pump alone. This results in reducing the operation hours of heat pumps and increasing the operation hours of electric heaters. Such setting of heat pump systems will fail to yield expected reduction of GHG emissions and result in higher energy consumption and longer peak demand events. Therefore, Daikin proposes to revise R403.1.2, which defines the use of electric resistance heaters as supplementary heat for heat pumps, to prevent such practice as following:

> **R403.1.2 Heat pump supplementary heat** <u>**(Mandatory).**</u>
> Heat pumps having supplementary electric-resistance heat shall have controls that, ~~except during defrost,~~ prevent supplemental heat operation when the <u>capacity of the</u> heat pump ~~compressor~~ can meet the heating load. <u>The controls shall permit supplemental heat operation only during heat pump capacity shortage, defrost operation, or for emergency use when heat pump is not operational. To ensure the use</u>

6 Statistics Office

of electric-resistance heat for supplementary use only, the space heating design ambient temperature shall be used to switch operation from heat pumps to the resistance heat.

III. Code Change Proposal to R408.2 Additional Efficiency Package Options

The 2021 IECC has implemented a new section, R408 Additional Efficiency Package Options, which defines requirements to achieve additional energy efficiency to be selected from one of the following five options: 1. Enhanced envelope performance option., 2. More efficient HVAC equipment performance option., 3. Reduced energy use in servicing water-heating option., 4. More efficient duct thermal distribution system option., and 5. Improved air sealing and efficient ventilation system option. Daikin requests that the 2024 version of IECC retains the section to continue effectively driving builders and users to optimize the energy performance of their homes.

As mentioned in our Introduction, variable speed heat pumps provide superior energy performance over single and two-stage equipment due to their higher efficiency attained during partial load operation. Also, ductless systems with variable speed compressors provide~~s~~ homeowners opportunities to further save energy consumption by turning off individual indoor units in unoccupied zones. For the 2024 IECC, Daikin proposes the following changes to R408.2 to accurately capture the energy performance superiority of variable speed air source heat pumps in both centrally ducted and ductless systems.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Requiring the use of the switchover temperature controls will not increase nor decrease the cost of construction - however, it will result in energy savings and lower utilities costs for the end -user.

REPI-73-21

REPI-74-21

IECC®: SECTION 202 (New), R403.1.3 (New), ANSI Chapter 06 (New)

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new definition as follows:
R202 PILOT LIGHT, CONTINUOUSLY BURNING. A small gas flame used to ignite gas at a larger burner. Once lit, a continuously pilot light remains in operation until manually interrupted. Pilot light ignition systems with the ability to switch between intermittent and continuous mode are considered continuous.
R202 PILOT LIGHT, INTERMITTENT. A pilot which is automatically ignited when an appliance is called on to operate and which remains continuously ignited during each period of main burner operation. The pilot is automatically extinguished when each main burner operating cycle is completed.
R202 PILOT LIGHT, INTERRUPTED. A pilot which is automatically ignited prior to the admission of fuel to the main burner and which is automatically extinguished after the main flame is established.
R202 PILOT LIGHT, ON-DEMAND. A pilot which, once placed into operation, is intended to remain ignited for a predetermined period of time following an automatic or manual operation of the main burner gas valve.
Add new text as follows:
R403.1.3 Continuously Burning Pilot Light.

Gas fireplace systems are not permitted to be equipped with a *continuously burning pilot light*.

Exception: Any fireplace equipped with an *on-demand*, *intermittent* or *interrupted ignition pilot light* (as defined in ASNI Z21.20) is not considered to have a *continuously burning pilot light*.
Add new standard(s) as follows:
ANSI American National Standards Institute 25 West 43rd Street, 4th Floor New York NY 10036

ANSI Z21.20-2005 (R2016)	Automatic Gas Ignition Systems And Components R403.1.3

Attached Files

- **Pilot light prohibition proposal support.docx**
  http://localhost/proposal/81/871/files/download/188/

Reason Statement:

Standing pilot lights are no longer necessary with many gas-fired appliances offering alternative ignition methods. Some models rely completely on intermittent ignition, while others allow standing pilots to operate for a few hours after shutdown and then use electronic ignition to re-start. This proposal saves energy by eliminating the wasted energy of a pilot light during the numerous hours per year when the appliance is non-operational.

With an average heat output of 946 btu/h for a continuously burning pilot light, analysis has shown an energy savings of 28 therms/yr if switching from a continuous pilot light to an intermittent pilot light. This is based on studies that looked at average fireplace use over the course of the year of 3,700 hours. Meaning, homeowners who use their fireplace less than this can stand to save more as the pilot light wastes energy as it sits idle.

Furthermore, the The Hearth, Patio & Barbecue Association (HPBA), based just outside of Washington, DC, is the North American industry association for manufacturers, retailers, distributors, representatives, service firms, and allied associates for all types of fireplace, stove, heater, barbecue, and outdoor living appliances and accessories. They also agree the continuous pilot lights are not necessary as the technology has moved on to intermittent or on-demand pilot lights that can accommodate various climates and user preferences. The HPBA shares the same position to discontinue the use of continuous pilots as demonstrated by their policy statement available on their website, as follows:Position Statement: New technologies now exist that can more adequately replace continuous pilots, which provided an important safety feature, but have required consumers to manually extinguish the pilot on their gas appliances. A phasing out of continuous pilots saves homeowners money and achieves energy conservation when appliances are not in frequent use.

https://energy.cdpaccess.com/proposal/81/871/files/download/188/

Cost Impact:

The code change proposal will increase the cost of construction.

This prohibition is not expected to add significant cost to any gas-fired appliance listed in the proposal. Past efficiency studies have shown $100 increase in price for fireplaces in particular to move from a standard continuously lit pilot light to an intermittent ignition system.

REPI-74-21

REPI-75-21

IECC®: R403.3, R403.3.1, R403.3.2, R403.3.3, R403.3.3.1

Proponents:

Robby Schwarz, BUILDTank, Inc., representing Colorado Chapter of the ICC (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:
R403.3 Ducts and air handlers.

Ducts and air handlers shall be installed in accordance with Sections R403.3.1 through R403.3.7.

R403.3.1 Ducts and air handlers located outside conditioned space.

Air handlers shall not be installed outside conditioned space. Supply and return ducts located outside *conditioned space* shall be insulated to an *R*-value of not less than R-8 and shall comply with Section R403.3.3 Ducts within ceiling insulation.

~~for ducts 3 inches (76 mm) in diameter and larger and not less than R-6 for ducts smaller than 3 inches (76 mm) in diameter. Ducts buried beneath a building shall be insulated as required per this section or have an equivalent *thermal distribution efficiency*. Underground ducts utilizing the *thermal distribution efficiency* method shall be listed and *labeled* to indicate the *R*-value equivalency.~~

R403.3.2 Ducts and air handlers located in conditioned space.

For ductwork and air handlers to be considered inside ~~a~~ *conditioned space,* they ~~it~~ shall comply with ~~one of~~ the following:

1. The duct and air handler systems shall be located completely within the *continuous air barrier* and within the building thermal envelope.

2. Ductwork in ventilated attic spaces shall be buried within ceiling insulation in accordance with Section R403.3.3 and all of the following conditions shall exist:

   2.1. The air handler is located completely within the *continuous air barrier* and within the *building thermal envelope*.

   2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the *building thermal envelope* in accordance with Section R403.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* served by the duct system.

   ~~2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.~~

3. Ductwork in floor cavities located over unconditioned space shall comply with ~~all of~~ the following:

   3.1. A *continuous air barrier* installed between unconditioned space and the duct.

   3.2. Insulation installed in accordance with Section R402.2.7.

   3.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.

Ductwork located within *exterior walls* of the *building thermal envelope* shall comply with the following:

4.1. A *continuous air barrier* installed between unconditioned space and the duct.

4.

4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.

4.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

R403.3.3 Ducts ~~buried~~ within ceiling insulation.

~~Where~~ Supply and return air ducts located in unconditioned attic or ceiling spaces ~~are partially or completely buried in ceiling insulation, such ducts~~ shall comply with ~~all of~~ the following:

1. The supply and return ducts shall have an insulation *R*-value not less than R-8.
2. The duct shall be installed on the truss bottom cord or ceiling joist closest to the finished material separating conditioned space from unconditioned space and ~~At all points along each duct,~~ the sum of the ceiling insulation *R*-value ~~against and~~ above the top of the duct, and against ~~and below the bottom of~~ the sides of the duct, shall be equal to that required in table R402.1.3 for ceilings. ~~not less than R-19, excluding the *R*-value of the duct insulation.~~
3. ~~In Climate Zones 0A, 1A, 2A and 3A, the supply ducts shall be completely buried within ceiling insulation, insulated to an *R*-value of not less than R-13 and in compliance with the vapor retarder requirements of Section 604.11 of the International Mechanical Code or Section M1601.4.6 of the International Residential Code, as applicable.~~

   ~~**Exception:** Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.~~

R403.3.3.1 Effective R-value of deeply buried ducts.
Where using the Total Building Performance or Energy Rating Index Compliance Option in accordance with Section R401.2.2 , ~~sections of~~ ducts that are installed in accordance with Section R403.3.3, ~~located directly on or within 5.5 inches (140 mm) of the ceiling, surrounded with blown-in attic insulation having an *R*-value of R-30 or greater and located such that the top of the duct is not less than 3.5 inches (89 mm) below the top of the insulation,~~ shall be considered as having an effective duct insulation *R*-value of R-25.

Reason Statement:

It has been confirmed through numerous studies that locating ductwork and air handler equipment outside the buildings thermal envelope significantly impact their operational efficiency and delivered efficiency. This proposal begins by tackling half of the efficiency issue by requiring that all air handlers be installed within the building thermal envelope. In Colorado’s Climate Zone 5 this has proven not to be an issue for house that have single or multiple systems. The mechanical heating and cooling system is removed from the harsh exterior environment, often a ventilated attic space, and performs significantly better and closer to its rated efficiency.

This proposal does not change the allowance to install duct work in unconditioned spaces but does change some of the requirements to determine if the builder and inspector can consider the duct and air handler to be inside conditioned space. In other words, how do you install ducts outside the building envelope in such a way that achieves delivered performance that is equivalent to being installed within the conditioned space. This section now only allows the duct work to be installed in unconditioned spaces not the air handler. It continues to require less duct leakage and insulation to be mounded over the duct.

Ducts within ceiling insulation addresses a more defined way to install duct in an unconditioned space to ensure that it will perform as if it is inside conditioned space and for the performance compliance paths of R405 and R406 to model the duct with additional R-value.

The Duct insulation R-value has been assigned at R8 because only ducts that are 3” of smaller were allowed something less. This is a small upgrade as the majority of HVAC duct work that supplies air to a home is bigger than 3”.

Cost Impact:

The code change proposal will increase the cost of construction.

In some climate zone and in some housing types, this proposal will increase the cost of construction due to the requirement that the air handing equipment be installed inside conditioned space of a home. The upside to the cost is significant improvement in achieving the rated efficiency of the mechanical equipment that no longer has to overcome extreme temperature swings. Al other proposed changes to this section of code better define the installation of ducts and air handlers in conditioned space. It is still an option to install duct outside in a manner that impact its performance and therefore cost is not impacted.

REPI-75-21

REPI-76-21

IECC®: R403.3, R403.3.2, R403.7, R403.7.1 (New)

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

R403.3 Ducts and air handlers.

Ducts and air handlers shall be installed in accordance with Sections R403.3.1 through R403.3.7.

R403.3.2 Ducts and air handlers located in conditioned space.

The air handler shall be located completely within the *continuous air barrier* and within the *building thermal envelope.* For ductwork to be considered inside a *conditioned space,* it shall comply with one of the following:

1. The duct system shall be located completely within the *continuous air barrier* and within the building thermal envelope.

2. Ductwork in ventilated attic spaces shall be buried within ceiling insulation in accordance with Section R403.3.3 and all of the following conditions shall exist:

   ~~2.1.~~ ~~The air handler is located completely within the *continuous air barrier* and within the *building thermal envelope.*~~

   ~~2.2~~ 2.1. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the *building thermal envelope* in accordance with Section R403.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* served by the duct system.

   ~~2.3~~ 2.2. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.

3. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:

   3.1. A *continuous air barrier* installed between unconditioned space and the duct.

   3.2. Insulation installed in accordance with Section R402.2.7.

   3.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.

4. Ductwork located within *exterior walls* of the *building thermal envelope* shall comply with the following:

   4.1. A *continuous air barrier* installed between unconditioned space and the duct.

   4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.

   4.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

R403.7 Equipment sizing, location and efficiency rating.
Heating and cooling *equipment* shall be sized in accordance with ACCA Manual S based on *building* loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies. New or replacement heating and cooling *equipment* shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the *equipment* is installed.

Add new text as follows:

R403.7.1 Air handler location.

Air handlers shall be located completely within the *continuous air barrier* and within the *building thermal envelope*.

Exception: Replacement heating and cooling *equipment*.

Reason Statement:

This has been a commonly used compliance option in the past under the ducts-inside requirement. This proposal now mandates the air handler should be located inside the thermal envelope and continuous air barrier, both under the ducts in conditioned space area as well as a new section under equipment sizing. There are energy savings based on building pressure balancing and the highest priority leaks are now located inside the thermal envelope, allowing any remaining leaks to contribute to the space conditioning.

Numerous studies have shown that the the highest-pressure leaks are closest to the air handler and that these matter the most in terms of wasted energy. By locating the air handler inside the thermal envelope and continuous air barrier the wasted energy is minimized. This proposal also adds a clarification to the charging language of R403.3 that it applies to ducts and air handlers, and not just ducts.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

A 2013 report from US DOE Building America shows that while home configurations can vary depending on the location of the air handler and ductwork, the average cost to include ducts inside (of which a small portion of the cost would include the air handler) was less than $500 total, or about $0.40 per square foot of floor area for an average size home. That cost includes the redesign costs of locating ducts and air handling equipment inside, the additional drywall and framing for the duct chases, or additional louvers and enclosures for the air handler closet. More information can be found in the reports here:

https://www.energy.wsu.edu/documents/aht_aceee%20ducts%20inside[1].pdf

https://www.energy.gov/sites/prod/files/2014/01/f6/1_1g_ba_innov_ductsconditionedspace_011713.pdf

This proposal focuses solely on the air handler and as such the cost of mandating it to be located inside the conditioned space is a small fraction of the total cost for locating all ducts inside. In addition, as a builder still has the alternate option to locate ducts outside of the thermal envelope and conditioned space, this provision reduces the cost of requiring R-8 insulation on ducts, thereby reducing the net cost to locate them inside.

REPI-76-21

REPI-77-21

IECC®: SECTION 202 (New), R403.3, TABLE R403.3 (New), R403.3.2, R403.3.3, TABLE R403.3.2 (New), R403.3.3.1, TABLE R405.4.2(1)

Proponents:

David Springer, representing on behalf of the California Statewide Utility Codes and Standards Team (iecc-ducts2@2050partners.com); Mark Lyles, representing New Buildings Institute (markl@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:
HIGH PERFORMANCE ATTIC. A vented attic with insulation at the roof deck having an insulation value of not less than R-19 and insulation at the ceiling in compliance with Table R402.1.3.
Revise as follows:
R403.3 Ducts.

Ducts and air handlers shall be installed in accordance with Table R403.3 and Sections R403.3.1 through R403.3.7.

Add new text as follows:

TABLE R403.3 DUCT LOCATION[a,b]

CLIMATE ZONE	DUCT LOCATION
0A, 1A, 2A, 3A	R403.3.1 or R403.3.3
0B, 1B	R403.3.1 or R403.3.3
4A, 5A	R403.3.1 or R403.3.2
2B, 3B, 3C, 4B, 4C, 5B, 5C	R403.3.1, R403.3.2, or within a *high performance attic*
6A, 6B, 7, 8	R403.3.1 or R403.3.3

a. Where the air handler is located outside of conditioned space, up to 10 feet of ductwork shall be allowed to be installed outside of conditioned space. Ductwork outside of conditioned space shall be insulated to an R-value of not less than R-8.

b. Ducts buried beneath a building shall be insulated to an R-value of not less than R-8.

Revise as follows:
R403.3.1 ~~R403.3.2~~ Ducts located in conditioned space.

For ductwork to be considered inside a *conditioned space,* it shall comply with one of the following:

1. The duct system shall be located completely within the *continuous air barrier* and within the building thermal envelope, including within a non-vented attic space.

2. Ductwork in ventilated attic spaces shall be buried within ceiling insulation in accordance with Section R403.3.3 ~~and all of the following conditions shall exist:~~

   ~~2.1. The air handler is located completely within the *continuous air barrier* and within the *building thermal envelope*.~~

   ~~2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the *building thermal envelope* in accordance with Section R403.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m²) of *conditioned floor area* served by the duct system.~~

   ~~2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.~~

3\. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:

3.1. A *continuous air barrier* installed between unconditioned space and the duct.

3.2. Insulation installed in accordance with Section R402.2.7.

3.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.

4\. Ductwork located within *exterior walls* of the *building thermal envelope* shall comply with the following:

4.1. A *continuous air barrier* installed between unconditioned space and the duct.

4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.

4.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

R403.3.2 ~~R403.3.3~~ Ducts buried within ceiling insulation.

Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return ducts shall have an insulation *R*-value not less than ~~R-8~~ R-13 for ducts 10 inches (76 mm) in diameter and larger and not less than R-8 for ducts smaller than 10 inches (76 mm) in diameter.
2. At all points along each duct, ~~the sum of the ceiling insulation *R*-value against and above the top of the duct, and against and below the bottom of the duct, shall be not less than R-19, excluding the *R*-value of the duct insulation.~~ the ducts shall be located directly on or within 5.5 inches (140 mm) of the ceiling.
3. ~~In Climate Zones 0A, 1A, 2A and 3A, the supply ducts shall be completely buried within ceiling insulation, insulated to an *R*-value of not less than R-13 and in compliance with the vapor retarder requirements of Section 604.11 of the International Mechanical Code or Section M1601.4.6 of the International Residential Code, as applicable.~~

   ~~**Exception:** Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.~~

Add new text as follows:

TABLE R403.3.2 EQUIVALENT DUCT R-VALUE FOR BURIED DUCTS

	LARGEST NOMINAL DUCT SIZE (R-8)								
CEILING R-VALUE	**6**	**8**	**9**	**10**	**12**	**14**	**16**	**18**	**20**
R-30	R-13	R-13	R-13	R-8	R-8	R-8	R-8	R-8	R-8
R-38	R-18	R-13	R-13	R-13	R-13	R-8	R-8	R-8	R-8
R-49	R-26	R-18	R-18	R-13	R-13	R-13	R-8	R-8	R-8
R-60	R-26	R-26	R-26	R-26	R-26	R-18	R-18	R-13	R-13

Revise as follows:

R403.3.3 ~~R403.3.3.1~~ ~~Effective R-value of deeply~~ Deeply buried ducts.

Where supply and return air ducts are required to be deeply buried, such ducts shall comply with all of the following:

1. The air handler is located completely within the *continuous air barrier* and within the *building thermal envelope*.

2. <u>The duct leakage, as measured either by a rough-in test of the ducts or a postconstruction total system leakage test to outside the *building thermal envelope* in accordance with Section R403.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m2) of *conditioned floor area* served by the duct system.</u>

3. ~~Where using the Total Building Performance Compliance Option in accordance with Section R401.2.2 , sections of ducts that are installed in accordance with Section R403.3.3,~~ <u>The ducts shall be</u> located directly on or within 5.5 inches (140 mm) of the ceiling, surrounded with blown-in attic insulation having an *R*-value of R-30 or greater and located such that the top of the duct is not less than 3.5 inches (89 mm) below the top of the insulation, shall be considered as having an effective duct insulation *R*-value of R-25.

4. <u>In Climate Zones 0A, 1A, 2A, and 3A the supply ducts shall be encapsulated with 1½" of closed cell spray urethane foam insulation.</u>

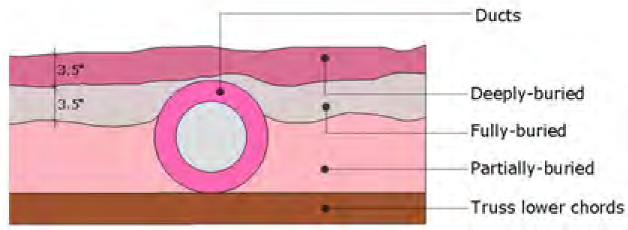
TABLE R405.4.2(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

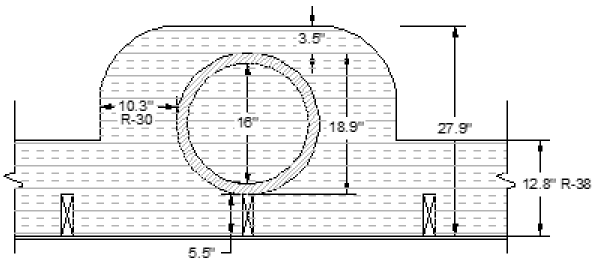
BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Thermal distribution systems	Duct insulation: in accordance with Section R403.3.1. A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. Duct location: same as proposed design. **Exception:** For nonducted heating and cooling systems that do not have a fan, the standard reference design thermal distribution system efficiency (DSE) shall be 1. For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of *conditioned floorarea* at a pressure of differential of 0.1 inch w.g. (25 Pa).	Duct location: as proposed. <u>For ducts complying with Section R403.3.3, ducts shall be considered in conditioned space.</u> Duct insulation: as proposed. <u>For ducts complying with Section R403.3.2, the effective R-value of the duct shall be considered as listed in Table R403.3.2. For ducts complying with Section R403.3.3 the effective R-value shall be R-25.</u> As tested or, where not tested, as specified in Table R405.4.2(2).

Reason Statement:

This measure would increase stringency for duct distribution efficiency and encourage ducts in conditioned space and other distribution efficiency alternatives by adding a table that specifies prescriptive requirements for different duct locations and insulation requirements by climate zone. Another table is added that describes effective R-values for partially or fully buried ducts. The exclusion of duct insulation requirements (Section 403.3) is eliminated from the Total Building Performance table. Requirements for fully buried ducts that qualify them as ducts in conditioned space were clarified, as well as for ducts in a non-vented attic that qualify as ducts in conditioned space.
IECC Section 403.3.1 requires minimum R-8 duct insulation and allows ducts to be installed in a vented attic, which is less stringent than the California Title 24 prescriptive requirement that ducts must be located in a High-Performance Ventilated Attic (HVPA) or in Conditioned Space (DCS). HPVAs are a lower cost alternative to DCS for reducing duct loss in warmer, drier climate zones, but in cold climates they are susceptible to water damage resulting from condensation on or within roof decks.

For Prescriptive and Total Building compliance, IECC requires at least one "Additional Efficiency Package" to be selected. This list includes ducts and air handlers installed in conditioned space (R408.2.4). The added Table 403.3 allows DCS as a prescriptive option while allowing lower cost options, without precluding DCS from being used as an Additional Efficiency Package measure.

As of 2018 the IECC recognizes buried ducts, but unlike Title 24 (Alternative Calculation Manual 2.4.4.10), IECC apparently provides no performance credit for partially or fully buried ducts, nor does it require a duct design. Deeply buried ducts continue to qualify as DCS and are given an R-value of 25 if they meet specific requirements that are included 2021 IECC Sections R403.3.2(2), R403.3.3(3), and R403.3.3.1The first figure below (from Shapiro 2013) illustrates differences between partially, fully, and deeply buried ducts. The second figure shows a 16-inch R-8 deeply buried duct installed in an R-38 attic that meets the requirements of R403.3.3.1. Covering the top of the duct with 3.5 inches of blown-in insulation would make the depth of insulation surrounding the duct nearly 28 inches deep. It could be difficult to fit this assembly into a low attic, and insulation to that depth would have to be mounded several feet laterally around the duct to prevent slough-off. In humid climate zones it is necessary to encapsulate the duct in 1.5 inches of spray foam to prevent surface condensation. The 2021 IECC leakage to outside limitation of 1.5 cfm per 100 ft^2 of conditioned floor area may also be difficult to attain, though encapsulation will reduce leakage. 



For the Total Building Performance compliance option in Section R405, the standard reference design Distribution System Efficiency (DSE) is 0.88 in Table R405.4.2(1), regardless of climate zone or duct location. For the proposed design, the DSE is either as tested or the default value of 0.88 if ducts are in conditioned space, and as tested if any part of the distribution system is outside conditioned space. The Prescriptive compliance option requirements in Section R403.3.6 require duct testing, but Tables R405.2 (Total Building Performance) and R406.2 (ERI) exclude this requirement.
The following code language changes are recommended to improve clarity and add options for improved distribution efficiency:

- Add prescriptive alternatives for partially/fully buried ducts and for ducts in high performance attics for all climate zones and include a table in R403.3 that provides a single, conservative equivalent duct insulation value for partially or fully covered ducts given the attic insulation R-value and the diameter of the largest duct.
- Change the current requirement for R-13 duct insulation in Zones 0A-3A when ducts are fully buried to a requirement to encapsulate them in 1.5 inches of closed cell spray foam insulation.
- Consolidate all deeply buried duct requirements (qualifying it as DCS) in one code section, including insulation requirements and duct leakage.
- Explicitly add ducts and air handlers in a non-vented attic that is inside the *continuous air barrier* as a DCS option.

The proposed code change provides clear duct location and insulation options that vary by climate zone that add flexibility and that can reduce costs of systems with higher distribution effectiveness. This will encourage more thoughtful and appropriate duct design and installation practices that will result in significant energy savings and comfort improvements over the currently allowed R-8 attic ducts. The language will also be easier for builders and code officials to follow.

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Cost Impact:

The code change proposal will increase the cost of construction.

Distribution effectiveness will be improved by requiring enhancements that reduce losses from R-8 ducts in standard vented attics. This will reduce heating and cooling energy use and hot climate peak loads. Simulations by the Consortium for Advanced Residential Buildings predicted annual energy savings of 5% to 20% for deeply buried ducts (Hoeschele 2015). To quantify annual savings prototype houses must be modeled in each climate zone and for each duct system type.

Costs will vary by climate zone, distribution system type, construction details, system size, and other factors. Reduced loads open the possibility of specifying lower capacity systems which can save on equipment costs. Costs can also be minimized by applying creative solutions such as designing trusses to accommodate a plenum space for ducts, and advanced equipment approaches such as multi-split heat pumps or distributed hydronic fan coils supplied by air-to-water heat pumps.

Ducts in Conditioned Space. Hoeschele (2015) cites cost components for various methods for moving ducts into conditioned space, including the value of floor space for locating heating and cooling equipment indoors, the cost of sealing duct chases, cost savings for reducing the size of equipment due to reduced loads, costs for dropping ceilings or creating attic chases to house the ducts, and cost savings for compact duct designs. The study estimated the range of costs for moving ducts to conditioned space, either by creating attic duct chases or furring out duct chases below the ceiling was from \$373 to \$3,129 for a 2,100 ft^2 one story prototype and \$286 to \$2,388 for a two-story 2,700 ft^2 prototype. Costs for dropped ceilings were lower than for attic chases. Use of “plenum trusses” demonstrated in Building America projects could reduce these costs.

Non-Vented Attics. Hoeschele (2015) used actual costs from a production builder to estimate costs for 2,100 ft2 one-story and 2,700 ft2 two-story prototype houses based on R-30 foam roof deck insulation. Net costs including air conditioner savings. Estimated costs were \$1.37 and \$0.69 per square foot for the two prototypes, respectively.

High-Performance Attics. A Codes and Standards Enhancement report (CEC 2015) prepared for the California Energy Commission to support a 2016 Title 24 standards change estimated incremental costs for a “blended” 2,430 ft^2 house of \$589 to \$1,042, depending on climate zone.

Buried Ducts. Proposed changes will have no impact on costs and may reduce insulation costs and simplify compliance and verification by eliminating the need to provide R-19 insulation under or over larger ducts that are not fully buried in attic insulation.

Deeply Buried Ducts. Shapiro (2013) determined that buried ducts in humid climates must be encapsulated in ccSPF insulation to prevent condensation. Hoeschele (2015) estimated total incremental costs of \$1,383 and \$1,059 for the 2,100 and 2,700 ft^2 prototypes, respectively. Costs included increasing attic insulation from R-30 to R-60 to achieve a weighted average duct R-value of 20.

REPI-77-21

REPI-78-21

IECC®: SECTION 202, R403.3.1, TABLE R405.4.2(1)

Proponents:

David Springer, representing on behalf of the California Statewide Utility Codes and Standards Team (iecc-ducts2@2050partners.com); Mark Lyles, representing New Buildings Institute (markl@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:

IECC2021P1E_RE_Ch02_SecR202_DefTHERMAL_DISTRIBUTION_EFFICIENCY_TDE_ ~~THERMAL~~ DISTRIBUTION SYSTEM EFFICIENCY (~~TDE~~ DSE). ~~The resistance to changes in air heat as air is conveyed through a distance of air duct. TDE is a heat loss calculation evaluating the difference in the heat of the air between the air duct inlet and outlet caused by differences in temperatures between the air in the duct and the duct material. TDE is expressed as a percent difference between the inlet and outlet heat in the duct.~~The ratio of the thermal energy transferred to or from the conditioned space to the thermal energy transferred at the equipment distribution system heat exchanger. Energy delivered to or from the conditioned space includes distribution system losses to the conditioned space.

R403.3.1 Ducts located outside conditioned space.

Supply and return ducts located outside *conditioned space* shall be insulated to an *R*-value of not less than R-8 for ducts 3 inches (76 mm) in diameter and larger and not less than R-6 for ducts smaller than 3 inches (76 mm) in diameter. Ducts buried beneath a building shall be insulated as required per this section or have an equivalent ~~*thermal*~~ *distribution* *system* *efficiency*. Underground ducts utilizing the ~~*thermal*~~ *distribution**system* *efficiency* method shall be listed and *labeled* to indicate the *R*-value equivalency.

TABLE R405.4.2(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Thermal distribution systems	Duct insulation: in accordance with Section R403.3.1. A ~~thermal~~ distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems. Duct location: same as proposed design. **Exception:** For nonducted heating and cooling systems that do not have a fan, the standard reference design ~~thermal~~ distribution system efficiency (DSE) shall be 1. For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of *conditioned floorarea* at a pressure of differential of 0.1 inch w.g. (25 Pa).	Duct location: as proposed. Duct insulation: as proposed. As tested or, where not tested, as specified in Table R405.4.2(2).

Reason Statement:

Thermal Distribution System Efficiency (TDSE) defined in Section R202 is inconsistent with the term (DSE) used in Table R405.4.2(1). The change to Distribution System Efficiency (DSE) is to provide consistency. This definition is from the ASHRAE Standard 152, a consensus standard titled “Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems.”

Bibliography:

ANSI/ASHRAE Standard 152-2014: Method Of Test For Determining The Design And Seasonal Efficiencies Of Residential Thermal Distribution Systems, ASHRAE, https://webstore.ansi.org/standards/ashrae/ansiashraestandard1522014.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not increase the cost of construction.

REPI-78-21

REPI-79-21

IECC®: R403.3.2

Proponents:

Craig Conner, representing self (craig.conner@mac.com); Joseph Lstiburek, representing Building Science Corporation (joe@buildingscience.com)

2021 International Energy Conservation Code

Revise as follows:
R403.3.2 Ducts located in conditioned space.

For ductwork to be considered inside a *conditioned space,* it shall comply with one of the following:

1. The duct system shall be located completely within the *continuous air barrier* and within the building thermal envelope.
2. Ductwork in ventilated attic spaces <u>or sealed attic with vapor diffusion port</u> shall be buried within ceiling insulation in accordance with Section R403.3.3 and all of the following conditions shall exist:
   2.1. The air handler is located completely within the *continuous air barrier* and within the *building thermal envelope*.
   2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the *building thermal envelope* in accordance with Section R403.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* served by the duct system.
   2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.
3. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:
   3.1. A *continuous air barrier* installed between unconditioned space and the duct.
   3.2. Insulation installed in accordance with Section R402.2.7.
   3.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.
4. Ductwork located within *exterior walls* of the *building thermal envelope* shall comply with the following:
   4.1. A *continuous air barrier* installed between unconditioned space and the duct.
   4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.
   4.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

Reason Statement:

Research done by the Department of Energy through the Building America Program shows that sealed attics with vapor diffusion ports significantly reduce the risk of condensation on ductwork. The existing IRC language allows sealed attics with vapor diffusion ports. This language makes it clear that the buried duct language for vented attics also applies to sealed attics with vapor diffusion ports.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This allows another option. It does not add costs.

REPI-79-21

REPI-80-21

IECC®: R403.3.2

Proponents:

Vladimir Kochkin, NAHB, representing NAHB (vkochkin@nahb.org)

2021 International Energy Conservation Code

Revise as follows:
R403.3.2 Ducts located in conditioned space.

For ductwork to be considered inside a *conditioned space,* it shall comply with one of the following:

1. The duct system shall be located completely within the *continuous air barrier* and within the building thermal envelope.
2. Ductwork in ventilated attic spaces shall be buried within ceiling insulation in accordance with Section R403.3.3 and all of the following conditions shall exist:
   - 2.1. The air handler is located completely within the *continuous air barrier* and within the *building thermal envelope*.
   - 2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the *building thermal envelope* in accordance with Section R403.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* served by the duct system.
   - 2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.
3. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:
   - 3.1. A *continuous air barrier* installed between unconditioned space and the duct.
   - 3.2. Insulation installed in accordance with Section R402.2.7.
   - 3.3. A minimum ~~R-19~~R-10 insulation installed in the cavity width separating the duct from unconditioned space.
4. Ductwork located within *exterior walls* of the *building thermal envelope* shall comply with the following:
   - 4.1. A *continuous air barrier* installed between unconditioned space and the duct.
   - 4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.
   - 4.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

Reason Statement:

The provision for R19 insulation was added in the 2021 IECC without justification. Apparently, the requirement was copied from a drawing intended for CZ 3 applications where R-19 floor insulation is a requirement. There is no basis for having a separate requirement for insulation at duct locations in floor cavities that is more restrictive than the floor insulation R-value requirement (CZ 0, 1, 2 require R13 floor insulation). Furthermore, duct insulation requirement for ducts in unconditioned space is R6 or R8 depending on the duct diameter. The proposed modification aligns the requirement for ducts in floors with a similar requirement for ducts in exterior walls where ducts must be separated by R-10 (see R403.3.2(4) of 2021 IECC). It is noted that floor insulation installation is always required to be in compliance with Section R402.2.7 and the floor is required to include an air barrier between unconditioned space and the duct.

There are no energy use implications associated with this change. The R19 requirement can add cost for constructing a bulkhead to accommodate the added insulation in the floor.

Cost Impact:

The code change proposal will decrease the cost of construction.

In certain floor assembly configurations in Climate Zones 0, 1, and 2, this change will reduce costs by avoiding the need for bulkhead construction.

REPI-80-21

REPI-81-21

IECC®: R403.3.3

Proponents:

Craig Conner, representing self (craig.conner@mac.com); Joseph Lstiburek, representing Building Science Corporation (joe@buildingscience.com)

2021 International Energy Conservation Code

Revise as follows:
R403.3.3 (N1103.3.3) Ducts buried within ceiling insulation.

Where supply and return air ducts are ~~partially or~~ completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return ducts shall have an insulation *R*-value not less than R-8.
2. At all points along each duct, the sum of the ceiling insulation *R*-value against and above the top of the duct, and against and below the bottom of the duct, shall be not less than R-19, excluding the *R*-value of the duct insulation.
3. In Climate Zones 0A, 1A, 2A and 3A, the supply ducts shall be completely buried within ceiling insulation, insulated to an *R*-value of not less than R-13 and in compliance with the vapor retarder requirements of Section 604.11 of the International Mechanical Code or Section M1601.4.6 of the International Residential Code, as applicable.

   Exception: Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.

Reason Statement:

This language makes it clear that the buried duct language does not apply for partially buried ducts.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This corrects the code. It does not increase costs.

REPI-81-21

REPI-82-21

IECC®: R403.3.3

Proponents:

Craig Conner, representing self (craig.conner@mac.com); Joseph Lstiburek, representing Building Science Corporation (joe@buildingscience.com)

2021 International Energy Conservation Code

Revise as follows:

R403.3.3 (N1103.3.3) Ducts buried within ceiling insulation.

Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return ducts shall have an insulation *R*-value not less than R-8.
2. At all points along each duct, the sum of the ceiling insulation *R*-value against and above the top of the duct, and against and below the bottom of the duct, shall be not less than R-19, excluding the *R*-value of the duct insulation.
3. In Climate Zones 0A, 1A, 2A and ~~3A~~, the supply ducts shall be completely buried within ceiling insulation, insulated to an *R*-value of not less than R-13 and in compliance with the vapor retarder requirements of Section 604.11 of the International Mechanical Code or Section M1601.4.6 of the International Residential Code, as applicable.

   Exception: Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.

4. In Climate Zones 0A, 1A, 2A and 3A when installed in a sealed attic with vapor diffusion port, the supply ducts shall be completely buried within ceiling insulation, insulated to an R-value of not less than R-8 and in compliance with the vapor retarder requirements of Section 604.11 of the International Mechanical Code or Section M1601.4.6 of the International Residential Code, as applicable..

   Exception: Sections of the supply duct that are less than 3 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.

   4.1. Air permeable insulation installed in sealed attics shall be in compliance with the requirements of Section R806.5.2 of the International Residential Code.

Reason Statement:

Additional research done by the Department of Energy through the Building America Program has shown that Climate Zone 3A should not have been included in this section. Some condensation has been noted in some instances in Climate Zone 3A. However, with a sealed attic with vapor diffusion ports the issue of condensation is resolved. The additional language in 4. Makes it clear that this also applies to Climate Zones 0A, 1A, 2A and 3A.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is a correction to the code. It will not increase costs.

REPI-82-21

REPI-83-21

IECC®: R403.3.3.1

Proponents:

Craig Conner, representing self (craig.conner@mac.com); Joseph Lstiburek, representing Building Science Corporation (joe@buildingscience.com)

2021 International Energy Conservation Code

Revise as follows:

R403.3.3.1 (N1103.3.3.1) Effective R-value of deeply buried ducts.

Where using the Total Building Performance Compliance Option in accordance with Section R401.2.2 , sections of ducts that are installed in accordance with Section R403.3.3~~, located directly on or within 5.5 inches (140 mm) of the ceiling,~~ surrounded with blown-in attic insulation having an *R*-value of R-30 or greater and located such that the top of the duct is not less than 3.5 inches (89 mm) below the top of the insulation, shall be considered as having an effective duct insulation *R*-value of R-25.

Reason Statement:

There are many cases with stick framed attics where 2x10 and 2x12 framing is used and ducts may be laying over framing that is higher than 5.5 inches of the ceiling. The remaining language is sufficient as it addresses R403.3.3 language for installation, states the ducts must be surrounded with insulation and can't have less than 3.5" of insulation above the duct. If that duct is higher than 5.5" from the ceiling, there will be no negative temperature or condensation impact.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This clarifies the effective R-value of deeply buried ducts. It does not add costs.

REPI-83-21

REPI-84-21

IECC®: R403.3.5, R403.3.6

Proponents:

Robby Schwarz, BUILDTank, Inc., representing Colorado Chapter of the ICC (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:
R403.3.5 Duct testing.

Ducts shall be pressure tested in accordance with ANSI/RESNET/ICC 380 or ASTM E1554 to determine air leakage by one of the following methods:

1. Rough-in test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. ~~Registers shall be taped or otherwise sealed during the~~ All portions of the Duct system, including air handler, filter box, supply and return boots, shall be tested.
2. Postconstruction test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. ~~Registers shall be taped or otherwise sealed during the test~~. All portions of the Duct system, including air handler, filter box, supply and return boots, shall be tested.

A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*.

Exception: A duct air-leakage test shall not be required for ducts serving ventilation systems that are not integrated with ducts serving heating or cooling systems.

R403.3.6 Duct leakage.

The total leakage of the duct~~s,~~ system, where measured in accordance with Section R403.3.5, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* where the air handler is installed at the time of the test. ~~Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 m²) of *conditioned floor area.*~~

   Exceptions:
   1. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 m2) of *conditioned floor area*.
   2. If the HVAC duct system is serving less than or equal to 1,200 square feet of conditioned floor area, the allowable duct leakage shall be 50 cubic feet per minute or less.
2. Postconstruction test: Total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area*.

   Exception: If the HVAC duct system is serving less than or equal to 1,200 square feet of conditioned floor area, the allowable duct leakage shall be 50 cubic feet per minute or less.
3. ~~Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the *building thermal envelope*, total leakage shall be less than or equal to 8.0 cubic feet per minute (226.6 L/min) per 100 square feet (9.29 m²) of *conditioned floor area.*~~

Reason Statement:

This code change proposal begins by defining a duct leakage test of the entire system, including the duct, the air handler, filter box and supply and return boots. The entire system is what is tested and what needs to pass the requirements of the IECC. This is important to make clear as we are seeing significant leakage at duct boots for example, that many feel are exempt as they are not specifically called out. In addition, although manufacturers are supposed to be delivering tight air handler boxes the reality that they either are not or when they are installed, they continue to leak. Testing the entirety of the HVAC system as installed leads to better efficiency and performance.

An allowance to have ducts that leak as much as 8 CFM per 100 sqft of conditioned floor area has been removed by this proposal as this allowance does not take into consideration the inefficiencies that arise from ductwork that leaks within the building thermal envelope. First, since the code does not require a duct leakage to outside test it is unable to quantify how much of the leakage that is supposed to be leaking inside the envelope is actually leaking outside. Second, duct leakage as high as 8 CFM means that rooms with specific design flows are not being heated or cooled to the design parameters. This causes the occupant to adjust the thermostat to try to compensate for comfort issues associated with duct leakage. This causes more leakage and potential increased stratification of temperature in the home, building durability and potential safety problems in the house. Sticking with efficiency of the system, the thermostat adjustment leads to short cycling as the system that was design to specific set point temperatures tries to achieve arbitrary set points. A consistent duct leakage allowance requirement of 4CFM across the board regardless of duct location simplifies things for contractors and ensure better performance of ducts locating both inside and outside the building.

The duct leakage section of the proposal restructures the requirement with exceptions, one of which is currently awkwardly in the body of the code and one of which is being proposed. For duct work servicing small square footages it become unreasonable to require the duct to be tighter than 50 CFM. At 1200 sqft the 4 CFM duct leakage target would be 48 CFM, so this appeared to be the perfect starting point for this exception.

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal may increase cost in jurisdiction that have not concentrated on total system duct leakage and that have allowed ducts to leak more if they are within the building envelope. The increased cost comes down quickly as installers better understand installation techniques that ensure tighter systems and are also mitigated by better system performance, efficiency, and fewer call backs.

REPI-84-21

REPI-85-21

IECC®: R403.3.5, R403.3.6, R403.3.7 (New), R403.3.7

Proponents:

Aaron Gary, representing Seft (aaron.gary@texenergy.org)

2021 International Energy Conservation Code

Revise as follows:
R403.3.5 Duct testing.

Ducts shall be pressure tested in accordance with ANSI/RESNET/ICC 380 or ASTM E1554 to determine air leakage by one of the following methods:

1. Rough-in test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. Registers shall be taped or otherwise sealed during the test.

2. Postconstruction test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.

A written report of the results of the test shall be signed by the party conducting the test and provided to the *code official*.

Exception: A duct air-leakage test shall not be required for ducts serving ventilation systems that are not integrated with ducts serving heating or cooling systems.

R403.3.6 Duct leakage .

The total leakage of the ducts, where measured in accordance with Section R403.3.5, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area*.

2. Postconstruction test: Total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area*.

3. Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the *building thermal envelope*, total leakage shall be less than or equal to 8.0 cubic feet per minute (226.6 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area*.

Add new text as follows:
R403.3.7 Sampling for R2 multifamily dwelling units.
For buildings with eight or more testing units complying with R403.3.5, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit, a middle floor unit, and a unit with the largest testing unit floor area. For each tested unit that exceeds the maximum duct leakage rate, an additional three units shall be tested, including a mixture of testing unit types and locations. Where buildings have fewer than eight testing units, each testing unit shall be tested.
Revise as follows:
R403.3.8 ~~R303.3.7~~ Building cavities.
Building framing cavities shall not be used as ducts or plenums.

Reason Statement:

The concept of using a sample of tested apartment units to demonstrate compliance for the whole of the multifamily apartment building was approved as part of the Commercial provisions of the 2021 IECC. This proposals applies that previously approved concept to multifamily apartment buildings that fall under the Residential provisions of the IECC. It also slightly updates the sampling method specified in the Commercial provisions of the 2021 IECC to better align with the updated RESNET multifamily sampling guidelines.

Cost Impact:

The code change proposal will decrease the cost of construction.

For multifamily projects that are built and test well, sampling provisions such as those approved in the Commercial provisions of the 2021 IECC will reduce the cost and time required for testing and verification. Projects that do not meet their testing thresholds will understandably be tested as a higher rate, potentially test each, until they too are meeting the required standards consistently and as such will may not see a reduction in testing and verification costs or timelines.

REPI-85-21

REPI-86-21

IECC®: R403.3.6, TABLE R405.2

Proponents: David Springer, representing on behalf of the California Statewide Utility Codes and Standards Team (iecc-ducts2@2050partners.com); Mark Lyles, representing New Buildings Institute (markl@newbuildings.org); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

R403.3.6 Duct leakage. The total leakage of the ducts, where measured in accordance with Section R403.3.5, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4.0 cubic feet per minute (~~113.3~~ 85 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to ~~3.0~~ 2.0 cubic feet per minute (~~85~~ 57 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area*.
2. Postconstruction test: Total leakage shall be less than or equal to ~~4.0~~ 3.0 cubic feet per minute (~~113.3~~ 85 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area*.
3. Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the *building thermal envelope*, total leakage shall be less than or equal to 8.0 cubic feet per minute (226.6 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area*.

TABLE R405.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration U-factor and SHGC
Mechanical	
R403.1	Controls
R403.3~~, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.6~~	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Reason: IECC Section R403.3.6 limits total leakage to 4.0 cfm per 100 ft^2 of conditioned space for ducts outside the thermal envelope and 8.0 cfm per 100 ft^2 for ducts inside the thermal envelope. The proposed change would reduce allowable duct leakage from 4 to 3 cfm per 100 square feet of conditioned floor area if an air handler is installed, and from 3 to 2 cfm per 100 square feet if no air handler is installed at the time of testing.
IECC Table R405.2 is poorly written making it unclear whether Section R403.3.6 is excluded from Total Building Performance requirements. This amendment clarifies this requirement.

When ducts are located in unconditioned space, return duct leakage effectively draws air from attic spaces or outdoors, increasing heating and cooling load. Supply duct leakage creates a pressure deficit which increases infiltration and heating and cooling load, and reduces system capacity, resulting in longer run times.

Proper practices of duct sealing include use of UL 181, UL 181A, and UL 181B approved pressure sensitive tapes and mastic to seal sheet metal seams and joints and flex duct connections to collars and boots in accordance with ANSI/SMACNA-006-2006. In addition to sealing, drawbands or clamps should be used to secure flexible duct connections.

The proposed leakage rate is readily achievable and has been demonstrated by California Title 24 compliance experience. Since the 2005 version of Title 24 was implemented, residential ducts have been required to be verified by HERS raters to have leakage rates at 25 Pa pressurization of no greater than 6 percent of total fan flow (as measured or using a 400 cfm per ton default). Test results are required to be recorded in HERS registries. The 2019 Title 24 standards reduced the maximum leakage rate to 5 percent of fan flow. Relating Title 24 leakage requirements to the IECC requirements, for an 1800 square foot home with a two-ton air conditioner, the maximum leakage rate at 5 percent is 40 cfm, or 2.2 cfm per 100 square feet, which is 27% more stringent than this proposal.

Bibliography: 2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings. California Title 24, Part 6.
https://www.energy.ca.gov/publications/2008/2019-building-energy-efficiency-standards-residential-and-nonresidential
Hoeschele, M., R. Chitwood, et al. 2015. “High Performance Ducts in Hot-Dry Climates”. Department of Energy Building America report.
https://www.nrel.gov/docs/fy15osti/64366.pdf

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Based on field studies and computer simulations completed in a hot-dry climate, the proposed code change would result in annual site energy savings of approximately 2% depending on fuel source. Savings are highly dependent on heating and cooling system operating hours, climates, and duct leakage impacts on infiltration.

If industry standard practices for duct installation are followed there should be no additional cost for duct sealing to achieve the proposed leakage rate.

REPI-87-21

IECC®: R403.4.1

Proponents:

Howard Ahern, representing Airex Manufacturing (howard.ahern@airexmfg.com)

2021 International Energy Conservation Code

Revise as follows:
R403.4.1 Protection of piping insulation.
Piping insulation exposed to weather shall be protected from damage, including that caused by sunlight, moisture~~, equipment maintenance~~ physical damage, and wind. The protection shall provide shielding from solar radiation that can cause degradation of the material and shall be removable for the first 6 feet (1828 mm) from the equipment for maintenance. Adhesive tape shall be prohibited

Attached Files

- **Impact and Advantages of proper insulation cover Saum Nour.pdf**
  http://localhost/proposal/36/624/files/download/210/

Reason Statement:

Reason:

Purpose of code change:

This proposal will clarify the intent of Section R403.4.1 The intent of these sections is not only protection of pipe insulation from weather but to insure the insulations thermal conductivity energy savings integrity lasts the life of the mechanical system as

per the intent of the code. To remove the opportunity for misunderstanding so that the code has will have its intended result, the term "equipment maintenance" must be clarified that it is for physical damage. The 2012,2015, & 2018 IECC Code and Commentary both state that Equipment maintenance is to protect from physical damage to the pipe insulation.

"The piping insulation should be protected from sunlight, moisture, wind and solar

radiation but also from personal who may step on it, run in to it with equipment, etc. and cause it to be damaged. "

Protective covering must also protect from physical damage so if the protection covering does get

damaged from stepping on it, dropping tools on it, birds, lawn trimmers etc.it can be repaired or replaced.

Keeping the insulations thermal conductivity integrity and insuring the insulation system last the

life of the mechanical system and avoiding the costly replacement of the insulation. Repairing pipe insulation is

done with adhesives and then adhesive seams are left to weather exposure leading to degradation. The seams

open sun and moisture damage the insulation system.

Removable protection is vital to ensure insulation can retard heat and condensation to provide energy savings and safety.

Some insulation manufactures are now stating that gel coated or plastic coated insulation while it may be UV resistance , it will only protect for about a year without additional protection, or stating for protection longevity the coated insulation must have additional protection. Cracks in the protection , seams splitting or unprotected ends allow moisture to damage the insulation and It only takes a 1% moisture gain to equal to a 7.5 % loss in thermal efficiency.

Pipe insulation is sold in minimum 6 foot sections at Contractor supply Distributors

This proposal states that protection be removable no less than 6 feet from the equipment to allow equipment maintenance without having to destroy the insulation or purchase additional pipe insulation to replace.

Removable protection comes in many forms and from many manufactures it can be as simple as bent sheet metal, piping covers, jackets, pre fit channel systems & gutter systems, preformed covers, cladding, pipe , etc.

The intent is in the original 2012 IECC code proposal, the proponent's reason statement of this requirement EC207-09/10 stated this was to Harmonize the IECC with ASHRAE 90.1 the 2012 code the reason statement also stated -“All AC

units require periodic maintenance. The frequency varies with how hard the unit operates, exterior temperature,

preventive maintenance program, and many others. On every occasion, every maintenance provides an excuse for the

Freon line insulation to be touched and removed.” The intent is clear that the protection be removable and independent

of the pipe insulation for maintenance without damaging the pipe insulation.

Removing protection without damaging the insulation is stated in EC207-09/10 “Adhesives Tape is not

permitted as it will limit maintenance and damage insulations permeability characteristics. Removal

of tape damages the integrity of the original insulation into pieces, specially, if the insulation

has reached thermo set state.

The main reason for pitting and corrosion of the piping in refrigerant lines is moisture intrusion into the pipe insulationfrom the termination point that are not protected. The gap between the piping and insulation creates a pathway formoisture to run the length and damage the system. “The most likely area of intrusion is at the insulation system penetration Points,gauges, attachments etc. If the integrity or exterior of the insulation system is not

installed correctly and moisture sources are present, moisture will more than likely penetrate the

insulation system. Moisture intrusion can negatively affect all aspects of the insulation system such as

thermal values, which can have a direct impact on process control, energy cost, condensation,

control, safety, the potential of mold development etc. Not to mention the potential of corrosion

under the insulation (CUI).” Insulation, the Forgotten Technology for Energy Conservation 2007 ACEE

https://energy.cdpaccess.com/proposal/36/624/files/download/210/

Bibliography:

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Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This change will not increase the cost of construction as removable protection has been used before and snice the IECC2012 when protection was required. In fact this will decrease the cost of construction on future equipment replacement and maintenance by not having to replace pipe insulation.

REPI-87-21

REPI-88-21

IECC®: R403.5, R403.5.4 (New)

Proponents:

Nicholas O'Neil, representing NEEA (noneil@energy350.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:
R403.5 Service hot water systems.

Energy conservation measures for service hot water systems shall be in accordance with Sections R403.5.1 through R403.5.~~3~~4.

Add new text as follows:
R403.5.4 Water heater installation location.

Service hot water systems that utilize electric-resistance heating elements as the primary heating source shall be installed in a conditioned space.

Exceptions:

1. Where the hot water system efficiency is greater than or equal to 2.0 UEF.
2. Where the nominal capacity of the water heater is less than 40 gallons.
3. Hot water systems installed in *Climate Zones* 6, 7 or 8 that are placed on an insulated surface with a minimum thermal resistance of R-10, and a minimum compressive strength of 40 psi or engineered to support the appliance.

Reason Statement:

Standby losses on electric resistance tanks continue to be a source of wasted energy, and occur year-round regardless of location. By requiring water heating tanks that rely on electric resistance heating to be located inside conditioned spaces, similar to locating heating ducts inside, the standby losses are minimized as they are absorbed into the conditioned space. While tank manufacturers have increased tank insulation levels in the past several years, water heaters still lose heat to the space throughout the year and provide an unnecessary source of wasted energy.

Exceptions are given for 1) efficient water heaters that can operate in unconditioned spaces where the net benefit of standby losses is overcome by the efficiency of the unit performance, 2) smaller tanks where standby losses are extremely minor, or 3) to water heaters installed in colder climate zones provided they are mounted on an insulated base.

Modeling has also shown that while electric resistance water heaters installed in the warmest climate zones (Climate Zones 0, 1 & 2) could contribute to space air conditioning loads, the impact is minimal on an annual basis, between 20-30kWh. To avoid this, a builder still has a choice to install the tank outside provided one of the exceptions apply.

This proposal has the added benefit of saving carbon emissions if the builder chose to install a tank with a higher UEF when in an unconditioned space in lieu of locating the electric resistance tank inside. Similarly, if a gas water heater were chosen to satisfy this code requirement, the carbon emissions are also less than installing an electric resistance tank (using US average grid emission intensity of 0.92 lbs CO_2 per kWh and EIA estimates of 117 lbs CO_2 per MMBtu).

Description	Value	Unit
US Grid Avg. Emission Intensity	0.91	lbs CO2 per kWh
Reference Load	50	gallons hot water
Density of Water	8.34	lbs/gallon
City Water Temp	55	°F
Hot Water Temp	120	°F
Hot Water Load	27,105	Btu
Gas Water Heater		
UEF	0.62	
CO2 Combustion	117	lbs Co2 per MMBtu
Emissions per 50 gallons	**5.1**	**lbs CO2**
Electric Resistance Water Heater		
UEF	0.92	
Electricity Consumption	9	kWh
Emissions per 50 gallons	**7.9**	**lbs CO2**
UEF 2.0 Water Heater		
UEF	2.0	
Electricity Consumption	4	kWh
Emissions per 50 gallons	**3.6**	**lbs CO2**

Bibliography:

Carbon emissions factors:

Electricity - EIA: https://www.eia.gov/tools/faqs/faq.php?id=74&t=11
Natural Gas - EIA: https://www.eia.gov/environment/emissions/co2_vol_mass.php

(based on Carbon factors provided by the U.S. Environmental Protection Agency, Inventory of U.S. Greenhouse Gas Emissions and Sinks, Tables A-32, A-38, and A-232)

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There are no cost increases expected as part of this proposal. Builders and consumers still have a choice of water heater products and fuels to utilize, provided they are placed in the correct locations.

In lieu of installing an electric water heater inside the conditioned space, the cost to install a minimum UEF 2.0 water heater is $0.33/sqft (Based on 2020 US Census data of 2,261 sqft for the average size new single family home) and the cost to install an insulated base in colder climate zones is $0.01/sqft. Both of these exceptions are cost-effective alternatives to installing an electric resistance tank indoors if the builder so chooses.

https://www.census.gov/construction/chars/highlights.html

REPI-88-21

REPI-89-21

IECC®: R403.5.2, TABLE C403.12.3, TABLE R405.2, TABLE R406.2

Proponents: Gary Klein, representing on behalf of the California Statewide Utility Codes and Standards Team (iecc-pipe-insulation@2050partners.com); Mark Lyles, representing New Buildings Institute (markl@newbuildings.org); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

R403.5.2 Hot water pipe insulation. Insulation for service hot water piping ~~with a thermal resistance, *R*-value, of not less than R-3~~ shall comply with Table R403.5.1 and be applied to the following:

1. Piping $^3/_4$ inch (19.1 mm) and larger in nominal diameter located inside the *conditioned space*.

~~2. Piping serving more than one dwelling unit.~~

2.~~3.~~ Piping located outside the *conditioned space*.

3.~~4.~~ Piping from the water heater to a distribution manifold.

4.~~5.~~ Piping located under a floor slab.

5.~~6.~~ Buried piping.

6.~~7.~~ Supply and return piping in ~~circulation and recirculation systems~~ *circulating hot water systems.* ~~other than cold water pipe return demand recirculation systems.~~

Exception: Cold water pipe returns in *demand recirculation water systems.*

TABLE R403.5.2 MINIMUM PIPE INSULATION THICKNESS

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		MINIMUM PIPE INSULATION THICKNESS (in inches)
	Conductivity Btu × in./(h × ft^2 × °F)[a]	Mean Rating Temperature, °F	
141–200	0.25–0.29	125	1.0
105–140	0.21–0.28	100	1.0

For SI: 1 inch = 25.4 mm, °C = [(°F) – 32]/1.8.

a For insulation outside the stated conductivity range listed in Table R403.5.2, the minimum thickness (T) listed in Table R403.5.2, shall be determined as follows:

$$T = r\,[(1 + t/r)^{K/k} - 1]$$

where:

T = Minimum insulation thickness.

r = Actual outside radius of pipe.

t = Insulation thickness listed in the table for applicable fluid temperature and pipe size; 1-inch.

K = Conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu × in/h × ft^2 × °F).

k = The upper value of the conductivity range listed in Table R403.5.2 for the applicable fluid temperature.

TABLE R405.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
Mechanical	
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.2	Hot water pipe insulation
R403.5.3	Drain water heat recovery units

TABLE R406.2 REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
	Mechanical
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.2	Hot water pipe insulation
R403.5.3	Drain water heat recovery units

Reason: The proposal will update the requirements for the hot water pipe insulation from insulation level R-3 to a thickness of 1 inch. The proposal will apply to service hot water pipes of all diameter sizes, though most distribution pipes are unlikely to exceed 1 ½ inch in diameter. At service hot water temperatures, a 1-inch insulation thickness on a 1-inch diameter pipe translates to an R-value level of R-7.7. The proposed 1-inch insulation thickness is consistent with pipe insulation requirements in Table C403.12.3 *Minimum Pipe Insulation Thickness (in inches)*, applicable to systems serving multiple dwelling units. This is the case for the 105 and 140°F temperature and the "<1" and "1 to < 1½" nominal pipe size (inch) ranges.

Both the IECC commercial section and ASHRAE standards specify pipe insulation requirements in terms of pipe insulation thickness. California's Title 24, Part 6 specifies both the insulation R-value and thickness, allowing buildings to show compliance using either requirement. The proposal team recommends changing the requirement to insulation thickness, to be consistent with the IECC commercial section, ASHRAE, and California's requirements. Table 1 summarizes pipe insulation requirement formats across energy standards. The team further recommends defining how insulation thickness shall be determined for alternative materials, the same method as described under C403.12.3 and for Table C403.12.3.
Table 1: Pipe Insulation Requirement Formats across Energy Standards

Energy Standards	IECC Residential	IECC Commercial	ASHRAE	CA Title 24 Part 6
Specifies Insulation R-value	Current	No	No	Yes
Specifies Insulation Thickness	As Proposed	Yes	Yes	Yes

Currently text in both IEEC sections R403.5.2 and R403.8 imply applicability for piping serving "more than one dwelling unit" (or "multiple dwelling units"). The proposal team recommends clarifying language such that service hot water systems serving anything other than a one single-family home or one dwelling unit would follow R403.8 and comply with commercial sections C403 and C404. This raises concerns that two-dwelling unit buildings covered by the IRC will now be directed to commercial sections.

Bibliography: Statewide CASE Initative. (2020, September). *2022 Title 24 Final CASE Report - Multifamily Domestic Hot Water Distribution.* Retrieved from Title24Stakeholders: https://title24stakeholders.com/wp-content/uploads/2020/09/2022_T24_Final-CASE-Report-MF-DHW-Dist.pdf
Statewide CASE Initiative. (2011, October). *Water and Space Heating ACM Improvement.* Retrieved from Title24Stakeholders: http://title24stakeholders.com/wp-content/uploads/2017/10/2013_CASE-Report_Water-and-Space-Heating-ACM-Improvement.pdf

Cost Impact: The code change proposal will increase the cost of construction.
The pipe insulation prices shown in Table 2 were collected in support of the 2022 Title 24, Part 6 update to pipe insulation requirements and do not include pricing for 1/2 inch insulation, but demonstrate a cost trend across increasing insulation thickness (Statewide CASE Initative, 2020).

Table 2: Insulation Cost per Linear Foot at Different Pipe Sizes and Insulation Thicknesses

Pipe Size (inch)	Insulation Thickness (inches)			
	1/2	1	1 1/2	2
3/4	TBD	$14	NA	NA
1	TBD	$14.75	$15.75	NA
1 1/2	TBD	NA	$18	$21.75

The proposal team will perform detailed cost analyses on the insulation thickness proposal based on the typical pipe length found in single-family homes and multifamily dwelling units in advance of IECC committee meetings.

REPI-90-21

IECC®: SECTION 202 (New), R403.5.4 (New), ANSI Chapter 06 (New)

Proponents:

Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Josh Keeling, representing Cadeo Group (jkeeling@cadeogroup.com); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Matt Tidwell, representing Portland General Electric (matthew.tidwell@pgn.com); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Amber Wood, representing ACEEE (awood@aceee.org); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com)

2021 International Energy Conservation Code

Add new definition as follows:
R202 GRID-INTEGRATED CONTROL.

An automatic control that can receive, automatically respond to demand response requests from and send information back to a utility, electrical system operator, or third-party demand response program provider.

Add new text as follows:
R403.5.4 Grid-integrated water heating.

Electric storage water heaters with a storage tankcapacity between 37 (140 L) and 120 gallons (454 L) shall beprovided with *grid-integrated controls* that comply with ANSI/CTA-2045-B Level 2.

Add new standard(s) as follows:

ANSI American National Standards Institute 25 West 43rd Street, 4th Floor New York NY 10036

ANSI/CTA 2045-B February 2021	Modular Communications Interface for Energy Management

Reason Statement:

With increasing penetrations of intermittent renewable energy, volatile wholesale power prices, and subsequent growth in dynamic rates/demand response programs, grid-interactive end uses present an opportunity to help homes manage their bills, participate in programs, and support efficient grid operations. Water heaters can provide many services to the grid, including generation, transmission, and distribution capacity, energy arbitrage, and ancillary services. In their assessment of the National Potential for Load Flexibility, Brattle estimated that across all measures these services could provide as much as $15 billion per year in value to the electric system.

As electricity systems transform to include more variable wind and solar energy, demand flexibility becomes increasingly critical to both grid operation and further transformation. Building systems that can use energy when it is abundant, clean, and low-cost not only help decarbonize the entire energy system, they also insulate their owners from future increases in demand charges and peak hour energy rates – a current and accelerating trend. Water heaters offer an unparalleled opportunity for load shifting: tanks full of hot water are inherently energy storage devices. Including the controls necessary to take advantage of this opportunity is relatively simple and affordable in new construction. Compared to other energy storage technologies such as batteries, smart, grid-integrated water heater controls can deliver substantial dispatchable (that is, reliable to the grid operator) energy flexibility. The controls specified by ANSI/CTA-2045-B ensure negligible risk of occupant disruption (that is, the hot water will not run out). Water heaters provide a particularly attractive option as they have inherent thermal storage that allows energy consumption to be shifted with little to no impact to the end user. This capability has been demonstrated in several contexts, most recently through regional demonstrations conducted by EPRI and BPA.

In their Grid-interactive and Efficient Buildings (GEBs) Roadmap, the US Department of Energy estimates that approximately 15 GW of additional load flexibility is expected to be added to the system under reference case assumptions. Combined with energy efficiency, this is expected to provide $13 billion/year of peak demand savings to the power system and its customers. Through a comprehensive literature review and interviewing dozens of national experts, the USDOE team found that one of the biggest barriers was the lack of interoperability. A key tool to solve this problem is building codes, which can help to ensure that interoperable devices and controls are installed at the time of construction. USDOE cited explicitly the use of codes and standards as one of its recommended pathways to enable greater adoption of GEBs technologies.

ANSI/CTA-2045-B standardizes the socket, and communications protocol, for electric water heaters so they can communicate with the grid, and with demand response signal providers. In addition, 2045-B adds control and communications requirements for mixing valves in water heaters, which enable them to provide greater storage capacity to support increased load shifting while eliminating scalding risk.

Versions of this standard are included in codes or other requirements in California, Oregon, and Washington and are referenced explicitly by ENERGY STAR.

Bibliography:

[1] Brattle, The National Potential for Load Flexibility (2019) https://brattlefiles.blob.core.windows.net/files/16639_national_potential_for_load_flexibility_-_final.pdf

[2] BPA, CTA-2045 Water Heater Demonstration Report (2018) https://www.bpa.gov/EE/Technology/demand-response/Documents/Demand%20Response%20-%20FINAL%20REPORT%20110918.pdf

EPRI, CEA-2045 Field Demonstrations Project Description (2014) https://www.epri.com/research/products/000000003002004009

[3] USDOE, A National Roadmap for Grid-Interactive Efficient Buildings (2021) https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf

[4] Washington State Revised Code of Washington, Title 19, Chapter 19.260, Section 19.260.080, available at https://app.leg.wa.gov/RCW/default.aspx?cite=19.260.080

Oregon Department of Energy, Energy Efficiency Standards Rulemaking https://www.oregon.gov/energy/Get-Involved/Pages/EE-Standards-Rulemaking.aspx

U.S. EPA Energy Star Program, Connected Criteria for ENERGY STAR Products, https://www.energystar.gov/products/spec/connected_criteria_energy_star_products_pd

Cost Impact:

The code change proposal will increase the cost of construction.

To enable grid-interactive controls, there are two sources of costs: the incremental cost to ensure that equipment is interoperable with CTA-2045-B and the cost of the control module installed in that device. The incremental manufacturing cost is in the range of a few dollars, and negligible at higher volumes. The current incremental cost to include a CTA-2045-B compliant control module ranges from about $60 (direct current, hard-wired connection) to $160 (alternating current, wireless cellular connection); this is expected to decline as manufacturing lines are brought up to larger scale (source: Advanced Water Heating Initiative). The major determinant of cost if the chosen radio pathway as chipset costs vary considerably between different frequencies/standards.

In the BPA report, manufacturers stated a range of $2-$30 for regional deployment, but noted that there would be economies of scale for a national rollout. The main cost was development of firmware/hardware to accommodate the standard, but these costs have already been incurred to meet codes/standards in OR, WA, and CA.

REPI-90-21

REPI-91-21

IECC®: R403.5.4 (New), R403.5.4.1 (New)

Proponents:

Dan Wildenhaus, representing Northwest Energy Efficiency Alliance (dwildenhaus@trccompanies.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new text as follows:
R403.5.4 Compact Hot Water Distribution systems (CHWD).

Where installed, CHWD systems shall comply with the provisions of section R403.5.4.1.

R403.5.4.1 Water Volume in Pipe Method.

The hot water distribution system shall store not more than 0.5 gallons (1.9 liters) of water in any piping/manifold between the hot water source and any hot water fixture when calculated using approved engineering calculations. These calculations will use the nominal diameter and length of the piping or tubing, and the longest pipe run from water heater, including both horizontal and vertical run of pipe, shall not be more than 20 feet.

Reason Statement:

Language needs to be introduced into the prescriptive portion of the code's Systems section in order to be referenced in new R408 Additional Efficiency Package Options.

Inefficient hot water distribution systems have been recognized as a problem for many years as they result in energy and water waste, and result in long hot water delay times that are the cause of a significant number of complaints by new home buyers. Recirculation systems are a solution to two of the three problems (water and wait time), but the thermal energy impact of different recirculation system options has already been addressed in section **R403.5.1.1 Circulation system**.[1]

In all non-recirculation distribution options, water heater energy consumption and hot water waste are correlated. A decrease in water heater energy consumption follows a reduction in wasted water; therefore, improving insulation and reducing the piping length and/or pipe diameter have equal benefits for energy and water waste. In recirculation systems, water heater energy consumption and wasted hot water are independent, and often have an inverse effect (when recirculation is not demand based).[2]

This distribution system problem exists for a variety of factors including:

- An outdated pipe sizing methodology in the plumbing code that results in oversized hot water distribution systems since the assumed fixture flow rates are much higher than current requirements.
- Municipalities with design recommendations that force plumbers and designers to assume low supply water pressure, resulting in larger distribution piping, which waste more water and energy.
- Increasing efforts to conserve water has resulted in the realization of water savings due to improvements in showerhead and lavatory maximum flow rates; however, reduced flow rates often result in increased wait times if the hot water distribution system is not designed to accommodate lower flows.
- Increasing popularity of gas instantaneous water heaters, which offer improved operating efficiency, but can result in increased water waste when starting from a "cold start up" situation.
- Inefficient plumbing installations that are not focused on minimizing pipe length or pipe diameters.

The IECC has already addressed pipe insulation and Circulation systems in the 2021 IECC Residential provisions.

1

Residential Compact Domestic Hot Water Distribution Design: Balancing Energy Savings, Water Savings, and Architectural Flexibility
Farhad Farahmand, TRC Companies Yanda Zhang, ZYD Energy

[2] *Evaluating Domestic Hot Water Distribution System Options With Validated Analysis Models* E. Weitzel and M. Hoeschele Alliance for Residential Building Innovation

https://energy.cdpaccess.com/proposal/445/976/files/download/134/
https://energy.cdpaccess.com/proposal/445/976/files/download/133/
https://energy.cdpaccess.com/proposal/445/976/files/download/132/
https://energy.cdpaccess.com/proposal/445/976/files/download/131/
https://energy.cdpaccess.com/proposal/445/976/files/download/130/

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· *Residential Compact Domestic Hot Water Distribution Design: Balancing Energy Savings, Water Savings, and Architectural Flexibility* Farhad Farahmand, TRC Companie;Yanda Zhang, ZYD Energy

· *Evaluating Domestic Hot Water Distribution System Options With Validated Analysis Models* E. Weitzel and M. Hoeschele Alliance for Residential Building Innovation

· California Energy Codes & Standards Case Report for *Compact Hot Water Distribution*; Measure Number: 2019-RES-DHW1-F, Residential Plumbing

· Home Innovation Research Labs Annual Builder Practices Survey, 2021

· Department of Energy Zero Energy Ready Home National Program Requirements (Rev. 07) [footnote 15]

· Efficient hot water distribution system – USBGC LEED BD+C: Homes v4 – LEED v4

· Residential Hot Water Distribution Systems: Roundtable Session; JD Lutz, Lawrence Berkely National Laboratory; G Klein, California Energy Commission; D Springer, Davis Energy Group; BD Howard, Building Environmental Science & Technology

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Incremental first costs to builders, designers, and plumbers are design based and each builder will need to determine potential cost impacts based on existing designs and measures in use. Depending on current practices and paths taken for IECC compliance this measure may result in small incremental cost increases or decreases. These potential cost differences relative to standard practices are likely to be:

· Reduced cost of PEX or copper tubing due to less material installed.

· Reduced cost to pipe insulation due to smaller plumbing layout.

· Reduced or neutral cost in labor hours for plumber.

· Increased water heating venting costs, if a gas water heater or electric heat pump water heater is centrally located.

· Increased venting labor costs, if a gas water heater or electric heat pump water heater is located is centrally located and not on a garage wall.

This measure should not have maintenance costs associated with it compared to standard practices.

REPI-91-21

REPI-92-21

IECC®: R403.6.1, SECTION C202

Proponents:

Mike Moore, Stator LLC, representing The Home Ventilating Institute (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:
R403.6.1 Heat or energy recovery ventilation.

Heat or energy recovery ventilation systems shall be provided as specified in either Section R403.6.1.1 or R403.6.1.2, as applicable.

R403.6.1.1 Group R-2 occupancy dwelling units adjoining a corridor. Within Group R-2 buildings, dwelling units adjoining a corridor shall be provided with a balanced ventilation system having an enthalpy recovery ratio of not less than 50 percent at cooling design condition and not less than 60 percent at heating design condition.

Exceptions:

1. Dwelling units in Climate Zone 3C.

2. Dwelling units with not more than 500 square feet (46 m^2) of *conditioned floor area* in Climate Zones 1A, 2B, 3B, and 3C.

3. Enthalpy recovery ratio requirements at heating design condition in Climate Zones 0, 1 and 2.

4. Enthalpy recovery ratio requirements at cooling design condition in Climate Zones 4, 5, 6, 7 and 8.

R403.6.1.2 All other dwelling units. All other *dwelling units* shall be provided with a heat recovery or energy recovery ventilation system in Climate Zones 7 and 8. The system shall be balanced with a minimum sensible heat recovery efficiency of 65 percent at 32°F (0°C) at a flow greater than or equal to the design airflow.
SECTION C202 GENERAL DEFINITIONS.

ENTHALPY RECOVERY RATIO. Change in the enthalpy of the outdoor air supply divided by the difference between the outdoor air and entering exhaust air enthalpy, expressed as a percentage.

Attached Files

- **HERV Cost Effectiveness Scalars.png**
  http://localhost/proposal/321/937/files/download/118/
- **MF OA Rates.png**
  http://localhost/proposal/321/937/files/download/117/

Reason Statement:

This proposal establishes a requirement for a balanced ventilation system with heat recovery (i.e., an HRV or an ERV) for low-rise dwelling units that adjoin a corridor in Group R-2 buildings based on a cost effectiveness analysis.

Bibliography:

1. Sontag et al. 2020. Time Dependent Valuation of Energy for Developing Building Efficiency Standards. Prepared by Energy and Environmental Economics, Inc. for the California Energy Commission. See especially p. 47-48.
2. Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990. Interagency Working Group on Social Cost of Greenhouse Gases, United States Government. February 2021.
3. Bohac D., and Sweeney L. 2020. Energy Code Field Studies: Low-Rise Multifamily Air Leakage Testing. Prepared by the Center for Energy and Environment, Ecotope, and The Energy Conservatory. Prepared for the U.S. Department of Energy Office of Energy Efficiency & Renewable Energy.

https://www.energycodes.gov/sites/default/files/documents/LRMF_AirLeakageTesting_FinalReport_2020-07-06.pdf. [See Table 45, which shows average leakage to “common” area of 42%. The report also notes, “for buildings in this study, “common areas” are made up almost completely of corridors and a few small rooms such as mechanical closets and elevator rooms.]
4. Lstiburek, J.W. 2019. Compartmentalization, Distribution and Balance. ASHRAE Journal: Vol. 61, no. 7.
5. Brelih, N. and Seppänen, O. 2011. Ventilation rates and IAQ in European standards and national regulations. Proceedings of the 32nd AIVC Conference and 1st TightVent Conference in Brussels, Belgium.
6. Sundell et al. 1994. Sick Building Syndrome (SBS) in Office Workers and Facial Skin Symptoms among VDT-Workers in Relation to Building and Room Characteristics: Two Case-Referent Studies. Indoor Air, 4: 83-94.
7. Milton et al. 2000. Risk of Sick Leave Associated with Outdoor Air Supply Rate, Humidification, and Occupant Complaints. Indoor Air, 10:212-221.
8. Bornehag, C & Sundell, Jan & Hägerhed, Linda. (2003). Asthma and allergy among children and the association to ventilation rate at home, a case control study. Epidemiology. 14. 10.1097/00001648-200309001-00224.
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10. Tejsen et al. 2016. The effects of bedroom air quality on sleep and next-day performance. Indoor Air, 26:679-686.
11. LBNL. Indoor Air Quality Scientific Findings Resource Bank. Building Ventilation. Accessed May 6, 2021. https://iaqscience.lbl.gov/vent-summary#:~:text=Just%20over%20half%20of%20studies,improve%20with%20increased%20ventilation%20rates.

Cost Impact:

The code change proposal will increase the cost of construction.

The cost effectiveness analysis justifying this proposal was based on the ASHRAE 90.1 scalar method (values < 12.5 were considered cost effective) and also included considerations for the monetization of carbon emissions. The included table highlights cost-effective applications in green. Key assumptions:

ASHRAE 62.2 ventilation rates (comparable to IMC high-rise dwelling unit rates and tentatively approved for low-rise dwelling R-2 dwelling units in the 2024 IMC pending final approval through the OGCV of M19-21); these rates are ~30% lower than ASHRAE 62.1 and European rates (see additional rationale below)

- Balanced ventilation as the minimum code-compliant reference system (see additional rationale below)
- Fan efficacy compliant with the 2021 IECC
- 1000 ft2, 2-bed/2-bath and 500 ft2 1-bed/1-bath dwelling units
- Energy prices determined from 5-year national average of EIA data
- Effect of carbon price analyzed at four levels. This analysis was performed to permit the committee to identify the final climate zone exceptions that are appropriate in this section, based on the committee’s final selection of a carbon price. See the following table for cost effectiveness under the four carbon pricing scenarios evaluated.
  - $0/metric ton
  - Cap and Trade: $29.63/metric ton[1] (used to justify cost effectiveness for this proposal)
  - IWG Social Cost of Carbon: $51/metric ton[2]
  - CEC Emissions Abatement Cost: $106/metric ton[1]
- Simulation and cost effectiveness analysis documents can be found at the following address: https://www.dropbox.com/sh/yuodjpuvkwrefwl/AADK5WsKTfh1VrlGSCGbqsPVa?dl=0.

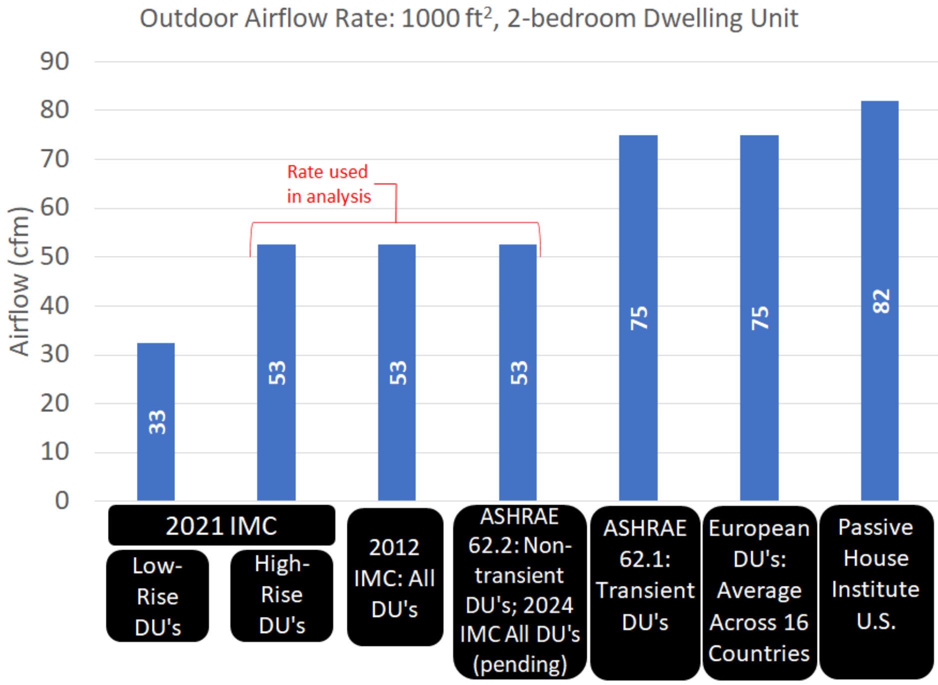
Climate Zone	Scalar Ratio Calculation							
	Carbon @ $0/metric ton		Carbon @ $29.63/metric ton		Carbon @ $51/metric ton		Carbon @ $106/metric ton	
	500 ft²	1000 ft²	500 ft²	1000 ft²	500 ft²	1000 ft²	500 ft²	1000 ft²
0A	4.4	1.5	4.0	1.4	3.7	1.3	3.2	[illegible]
0B	13.7	4.0	12.5	3.6	11.8	3.4	10.2	[illegible]
1A	44.7	8.0	40.8	7.3	38.4	6.8	33.3	[illegible]
1B	9.1	2.9	8.2	2.6	7.7	2.5	6.7	[illegible]
2A	13.7	3.9	12.4	3.6	11.6	3.4	10.0	[illegible]
2B	42.7	7.8	36.4	6.9	32.8	6.4	26.3	[illegible]
3A	10.6	3.3	9.1	2.8	8.3	2.6	6.7	[illegible]
3B	23.5	5.7	19.9	4.9	18.0	4.5	14.3	[illegible]
3C	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings	No annual savings	No annual saving
4A	5.0	2.0	4.3	1.7	4.0	1.6	3.2	[illegible]
4B	9.5	3.4	8.2	3.0	7.4	2.7	5.9	[illegible]
4C	6.6	2.5	5.6	2.2	5.1	2.0	4.1	[illegible]
5A	4.0	1.6	3.4	1.4	3.1	1.3	2.5	[illegible]
5B	5.9	2.3	5.1	2.0	4.6	1.8	3.7	[illegible]
5C	4.8	1.9	4.2	1.7	3.8	1.5	3.1	[illegible]
6A	3.2	1.3	2.7	1.2	2.5	1.1	2.0	[illegible]
6B	3.9	1.6	3.3	1.4	3.0	1.3	2.5	[illegible]
7	2.5	1.0	2.1	0.9	1.9	0.8	1.6	[illegible]
8	1.9	0.8	1.6	0.7	1.5	0.6	1.2	[illegible]

Why choose balanced ventilation as the reference system?

Recent research has documented significant leakage pathways between the walls of newer, tight dwelling units and adjacent corridors in Group R-2 occupancies, with approximately 40% of dwelling unit leakage area to the corridor.[3] Based on this finding, operating an unbalanced outdoor air ventilation system in a dwelling unit with a wall adjacent to a corridor is expected to establish a pressure differential with respect to the corridor. When a supply ventilation system is specified for the dwelling unit, this is expected to pressurize the dwelling unit, transferring air from the dwelling unit to the corridor. When an exhaust system is specified for the dwelling unit, this is expected to depressurize the dwelling unit, transferring air from the corridor to the dwelling unit. Transferring air to or from the corridor and an adjoining dwelling unit is a violation of IBC Section 1020.5 and IMC 601.2, which prohibit corridors from serving as “supply, return, exhaust, relief, or ventilation air ducts.” Physically speaking, to comply with these requirements in the IBC and IMC, an outdoor air ventilation system must be balanced. Joe Lstiburek provides pages of rationale supporting this concept in his article, “Compartmentalization, Distribution and Balance” – which in 2019 laid out a game plan for energy efficient, construction and ventilation of multifamily dwelling units to achieve the building code’s fire safety, IAQ, and energy efficiency objectives.[4] Perhaps for such reasons, prior to 2015, any dwelling unit having mechanical ventilation was required to provide mechanical ventilation “by a method of supply and return or exhaust air,” where “the amount of supply air shall be approximately equal to the amount of return and exhaust air” (2012 IMC 403.1). As such, for the cost effectiveness analysis, this proposal assumes a balanced ventilation system for Group R-2 occupancy dwelling units adjoining a corridor.

Why choose ASHRAE 62.2-2019 Ventilation Rates?

Within the cost effectiveness study supporting this proposal, ASHRAE 62.2-2019 ventilation rates were selected for dwelling units in low-rise Group R-2 occupancies. ASHRAE 62.2-2019 ventilation rates are roughly equivalent to: the 2012 IMC ventilation rates for all dwelling units, the 2021 IMC ventilation rates for high-rise residential dwelling units in the 2021 IMC, and the pending 2024 IMC ventilation rates for all R-2 dwelling units (pending final action on M19-21). These rates are also more conservative (~30% lower) than European rates,[5] ASHRAE 62.1 rates, and Passive House rates. The 2015-2021 IMC rates for low-rise R-2 dwelling units are incredibly low – and are based on an old ASHRAE 62.2 formula for leaky, single-family, detached homes that is not relevant for tight, multifamily construction with higher occupant density and higher indoor air pollution concentration than single-family detached homes.



Additionally, the rates promulgated by ASHRAE 62.2-2019 and the IMC are recognized as rates needed to provide *minimum acceptable indoor air quality*. It is expected that members of the public seeking improved IAQ may elect to use higher rates to reduce pollutant concentration and support better productivity and health outcomes, which have also been linked to increases in wages. Studies that have shown better health outcomes or improved performance for building occupants as a function of higher ventilation rates include:

- Sundell[6]: Sick building syndrome declines as ventilation rate increases.2. Milton[7]: Sick leave decreases as ventilation rate increases.
- Bornehag[8]: Risk of asthma for children increases with decreasing ventilation rate in homes.
- Seppänen[9]: Productivity decreases with decreasing ventilation rate.
- Tejsen[10]: Productivity increases with increasing residential ventilation rate.

While some of these studies were conducted in commercial buildings, LBNL's[11] analysis of residential studies concluded that, "Just over half of (residential) studies report one or more statistically significant health benefits of increased ventilation rates." LBNL noted that, "The findings of research on how ventilation rates in homes affect health are mixed," but that "overall… the number of reported statistically significant improvements in health with increased ventilation rates far exceeded the anticipated chance improvements in health."

REPI-92-21

REPI-93-21

IECC®: R403.6.1

Proponents:

Marian Goebes, representing n behalf of the California Statewide Utility Codes and Standards Team (iecc-sf-hrv-erv@2050partners.com); Mark Lyles, representing New Buildings Institute (markl@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:
R403.6.1 Heat or energy recovery ventilation.

Dwelling units shall be provided with a heat recovery or energy recovery ventilation system ~~in Climate Zones 7 and 8~~. The system shall be balanced with a minimum sensible heat recovery efficiency of 65 percent at 32°F (0°C) at a flow greater than or equal to the design airflow.

Exceptions:

1. Dwelling units in single- and two-family dwellings and townhouses in Climate Zones 0-4.

2. Dwelling units in Group R occupancies in Climate Zone 3C.

Reason Statement:

The current residential requirement is to provide dwelling units with HRVs or ERVs only in Climate Zones 7 and 8. This proposed change will expand the requirement for HRVs and ERVs to Climate Zones 5 through 8 for single- and two-family dwelling units and all Climate Zones except 3C for multifamily dwelling units.

The proposed requirement for single-family homes builds on the current requirement that is based on the PNNL (2018) analysis, and expands the requirements by

1. Assuming a “better case” cost estimate for an ERV or HRV than was assumed in the PNNL (2018) report,
2. Assuming a higher sensible recovery efficiency for the HRV: 67% instead of 65%,
3. Accounting for the cost of carbon, and
4. under one scenario) including savings when accounting for increased tightness (in a separate proposal led by another stakeholder to move from 3 ACH50 to 2 ACH50 in climate zones 3 through 8).

The proposed analysis will include scenarios with and without a tighter envelope requirement (#4) in case that proposal does not move forward.

In short, the proposal team anticipates finding increased cost-effectiveness in single-family homes compared to PNNL (2018) because of lower costs (#1) and higher savings (#2 through #4).

For the proposed multifamily (MF) requirement, the proposal seeks to align the requirements of multifamily dwelling units across the two sides of the code. Currently there are large discrepancies in terms of system design, control and stringency between a 3-story MF building and a 4-story MF building. This leads to market confusion, enforcement inconsistencies, and untapped energy savings. This proposed revision seeks to close these gaps and create a common set of requirements for multifamily buildings. The ERV/HRV measure is an example where there is inconsistencies, since ASHRAE 90.1-2019 requires heat or energy recovery for high-rise multifamily dwelling units except in Climate Zone 3C.

The 2022 version of Title 24 has created a new section to regulate MF buildings - similar to a more "omnibus" proposal submitted by NBI previously. Based on feedback on NBI’s submission suggesting that future proposals not create a new section, this proposal instead works to align the sections that currently exist.

Bibliography:

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U.S. Government Interagency Working Group on Social Cost of Greenhouse Gases, Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990, 2021 https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf

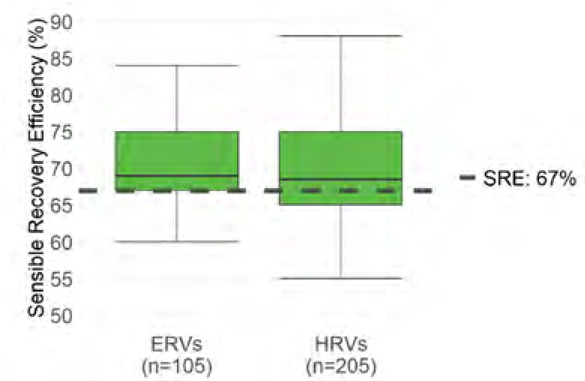
Cost Impact:

The code change proposal will increase the cost of construction.

The proposal team will identify additional savings compared to the PNNL (2018) analysis by including a higher sensible recovery efficiency (SRE), including the abated cost of greenhouse gas emissions, and (under one scenario) assuming a tighter building envelope than the current IECC-R requirements.

The proposed analysis will assume a higher sensible recovery efficiency (SRE) for the HRV: 67% instead of 65% at 32F (assumed in PNNL 2018). This new assumption is based on typical values for HRVs and ERVs in the Home Ventilating Institute (HVI) database shown in Figure 1, which show that most ERVs and HRVs meet or exceed an SRE of 67%.

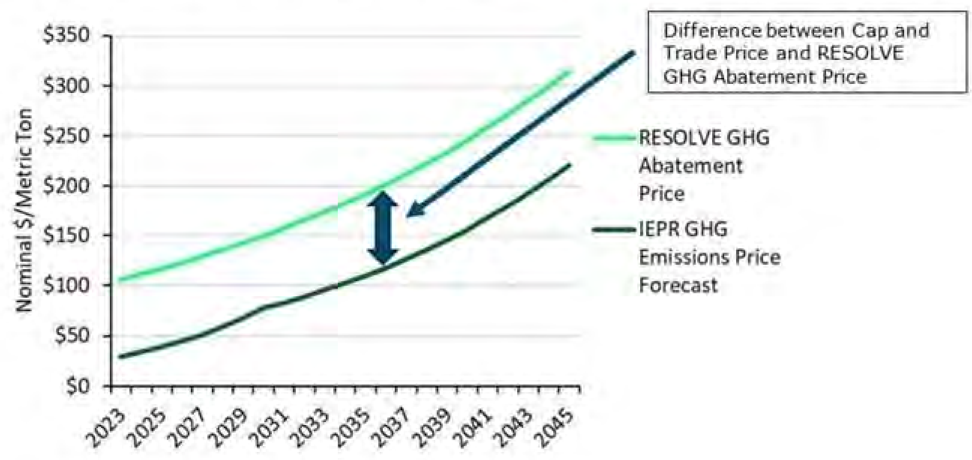
Figure 1: Boxplot of SRE of ERVs and HRVs (30-100cfm) from the HVI Certified Products database (Source: TRC 2020 pdf p. 86)



The proposed analysis will include the abated cost of greenhouse gas emissions from reduced energy use. The analysis may use the Integrated Energy Policy Report (IEPR) emissions price forecast, which estimates the current cost of cap-and-trade carbon as $29 and the societal cost of $106, or the estimate of $51 assumed by the U.S. Government Interagency Working Group (2021). The proposal team will follow the latest guidance from the IECC on incorporating the cost of carbon, or the U.S. Government Interagency Working Group (2021) estimate if the IECC is still deliberating on this issue. In addition, the proposal team will assume an increase in the cost of carbon, as demonstrated in Figure 2.

Figure 2: Current and Predicted Price of the Avoided Cost of Carbon (Source: E3 2020)

Figure 23. Incremental GHG Abatement Priced Used to Evaluate GHG Adder



Finally, the proposed analysis will investigate the impacts of tightening the building envelope to 2 ACH50, since another stakeholder may propose this requirement. This analysis will be considered separately, in case the 2 ACH50 proposal does not move forward.

In advance of IECC committee meetings, the proposal team will conduct single-family simulations to investigate the energy savings from an HRV.

The proposal team anticipates findings lower costs than what PNNL (2018) assumed, based on new market research.

The PNNL (2018) report found lifecycle cost savings of $824 and $3,111 in Climate zones 7 and 8, respectively, as shown in Table 1, assuming a first cost of $1,500 for an HRV and a sensible recovery effectiveness of 65%. PNNL did not find the HRV to be cost effective in climate zone 6 or lower under these assumptions. Assuming a “best-case” cost assumption of $500 for the HRV, PNNL found the HRV to be cost effective in climate zones 5 through 8. As stated in PNNL (2018), “The cost of HRV equipment ranges from about $500 to a few thousand dollars, depending on the manufacturer, capacity, configuration, and the base design of the home.”

While PNNL (2018) assumed a total measure cost of $1,500, several studies have used a lower estimate, including two studies that cited $1,300: NREL (2018) and TRC (2017), and one study that cited $1050 (Oregon Department of Consumer and Business Services - Building Codes Division 2021). These costs include equipment and labor costs for both the HRV appliance itself as well as related ductwork.

In advance of IECC committee meetings, the proposal team will revisit costs for an HRV (including ducting and the appliance) for a “better case” scenario that is between what PNNL assumed ($1,500), and the best case that PNNL found ($500).

REPI-93-21

REPI-94-21

IECC®: R403.6.1

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

R403.6.1 Heat or energy recovery ventilation .

Dwelling units shall be provided with a heat recovery or energy recovery ventilation system in Climate Zones 7 and 8. The system shall be a balanced ventilation system with a ~~minimum~~ sensible ~~heat~~ recovery efficiency of no less than 65 percent at 32°F (0°C) at ~~a~~an airflow ~~flow~~ greater than or equal to the design airflow. The SRE shall be determined from a listed value or from interpolation of listed values.

Reason Statement:

This proposal is intended to clarify the existing requirements in this section. "Balanced ventilation system" is a term that is now defined in the 2024 IRC and IMC. The industry term for sensible heat recovery efficiency is "sensible recovery efficiency" (SRE). For any given heat or energy recovery ventilator, the SRE generally improves as airflow is reduced. By interpolating, a specifier can obtain a closer estimate of the unit's performance at the design airflow. As a point of reference, interpolation of the SRE was recently vetted by the California Energy Commission and approved for inclusion in Part 6 of Title 24-2022.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal clarifies the application of existing requirements and does not affect construction cost.

REPI-94-21

REPI-95-21

IECC®: R403.6.2, TABLE R403.6.2, CSA Chapter 06 (New), ASHRAE Chapter 06 (New)

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:
R403.6.2 Whole-dwelling mechanical ventilation system fan efficacy.

Fans used to provide whole-dwelling mechanical ventilation shall meet the efficacy requirements of Table R403.6.2 at one or more rating points. Fans shall be tested in accordance with ~~HVI 916~~ the test procedure referenced by Table C403.8.5 and listed. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ~~ERC~~ERV, balanced, and in-line fans shall be determined at a static pressure of not less than 0.2 inch w.c. (49.85 Pa). Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure of not less than 0.1 inch w.c. (24.91 Pa).

TABLE R403.6.2 WHOLE-DWELLING MECHANICAL VENTILATION SYSTEM FAN EFFICACY[a]

~~FAN LOCATION~~ SYSTEM TYPE	AIRFLOW RATE ~~MINIMUM~~ (CFM)	MINIMUM EFFICACY (CFM/WATT)	TEST PROCEDURE
HRV, ~~or~~ERV, or balanced	Any	1.2 ~~cfm/watt~~	CAN/CSA 439-18
Range hood	Any	2.8	ASHRAE 51
In-line supply or exhaust fan	Any	3.8 ~~cfm/watt~~	ASHRAE 51
Other exhaust fan	< 90	2.8 ~~cfm/watt~~	ASHRAE 51
	≥ 90 and < 200	3.5 ~~cfm/watt~~	
	≥ 200	4.0	
Air-handler that is integrated to tested and *listed* HVAC equipment	Any	1.2 ~~cfm/watt~~	Outdoor airflow as specified. Air-handler fan power determined in accordance with the test method referenced by Table C403.3.2(1) of the IECC-Commercial Provisions.

For SI: 1 cubic foot per minute = 28.3 L/min.

a. Design outdoor airflow rate/watts of fan used.

Add new standard(s) as follows:

CSA CSA Group 8501 East Pleasant Valley Road Cleveland OH 44131-5516

CAN/CSA-C439-18 Laboratory methods of test for rating the performance of heat/energy-recovery ventilators

ASHRAE ASHRAE 180 Technology Parkway NW Peachtree Corners GA 30092

ASHRAE Standard 51-16 / ANSI/AMCA Standard 210-16 Laboratory Methods Of Testing Fans For Certified Aerodynamic Performance Rating

Reason Statement:

Approval of this proposal and coordinating proposals submitted to the IECC-C will improve alignment of the residential fan efficacy table, the commercial fan efficacy table, the ASHRAE 90.1 fan efficacy table, and the ENERGY STAR Ventilating Fans v4.1 specification. It will also incorporate errata that are needed to the 2021 IECC based on final action on proposals RE133-19, RE137-19, and RE178-19, approved in the previous code cycle. The test procedures referenced are those referenced by ASHRAE 90.1 and the

IECC-C and are those used by industry for testing and listing.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The only element of this proposal that may affect first costs is the introduction of a fan efficacy requirement for exhaust fans exceeding 200 cfm. This requirement aligns with ENERGY STAR criteria and has already been vetted by ASHRAE 90.1, which has cost effectiveness requirements. Additionally, a small sample of internet retail pricing for units that would be affected by this requirement showed that price was not heavily correlated with efficacy:

Compliant:
Model A: 300 cfm, 7.3 cfm/watt, $185
Model B: 200 cfm, 11.4 cfm/watt, $179

Not Compliant:

Model C: 200 cfm, 3.5 cfm/watt, $159
Model D: 200 cfm, 3.6 cfm/watt, $212
Pricing gathered October 2021 from airxheat, ecomfort, homedepot, and amazon.

REPI-95-21

REPI-96-21

IECC®: R403.6.3, 403.6.2.1 (New), 403.6.2.2 (New)

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:
R403.6.3 Testing.
Mechanical ventilation systems shall be tested and verified to provide the minimum ventilation airflow rates required by Section R403.6, using a device in compliance with R403.6.2.1 or R403.6.2.2. ~~Testing shall be performed according to the ventilation *equipment* manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals or grilles, outlet terminals or grilles, or in the connected ventilation ducts. Where required by the code official, testing shall be conducted by an *approved* third party.~~ A written report of the results of the test shall be signed by the party conducting the test and provided to the code official.

Exception: Kitchen range hoods that are ducted to the outside with ducting having a diameter of 6-inch (152 mm) or larger ~~duct~~, a length of 10 feet or less, and not more than ~~one~~ two 90-degree (1.57 rad) elbows or equivalent ~~in the duct run~~.

Add new text as follows:
403.6.2.1 External airflow testing device.
Where an airflow testing device having one or more components that are external to the ventilation equipment is used to determine the airflow, testing shall be performed according to the ventilation equipment manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals or grilles, outlet terminals or grilles, or in the connected ventilation ducts. The device shall have an airflow rate accuracy within the greater of 10% or 5 CFM. Where required by the code official, testing shall be conducted by an approved third party.
403.6.2.2 Integrated airflow verification device.
Where an airflow verification device that is a component of the ventilation equipment is used to determine the airflow, airflow verification shall be performed according to the ventilation equipment manufacturer's instructions. The device shall be verified to provide the following: programmable and self-modulating airflow rate, airflow rate accuracy within the greater of 10% or 5 CFM, and a user interface that communicates if the selected airflow rate is achieved. Verification of the device shall be supported by data furnished by a laboratory approved for airflow testing by an ISO/IEC 17065 accredited certification body.

Reason Statement:

Verification of ventilation system airflow rate is critical to ensuring systems meet minimum code requirements. This modification to the original proposal is in keeping with the objective of verifying airflow rate, but it adds another option for doing so by encouraging innovation of products that are verified to modulate airflow to the user's selected rate and communicate via a user-interface whether the user's selected rate is achieved. To encourage the development and specification of such verified, self-modulating systems, this proposal waives any requirement for third-party field verification of the airflow rate when such a device is used. To verify that the device meets the criteria of Section 403.6.2.2, results from laboratory testing must be provided by a laboratory that is approved by a certification body that is accredited to ISO/IEC 17065, Conformity assessment — Requirements for Bodies Certifying Products, Processes and Services. ISO/IEC 17065 is the cornerstone for certification body accreditation; referencing it clarifies compliance requirements for manufacturers and relieves building officials from the burden of subjective approval.

This proposal also modifies the kitchen range hood testing exception to stipulate a maximum length of duct that can be used to be eligible for the exception while adding more flexibility in terms of the number of elbows. The allowance proposed for length and elbows aligns with the Home Ventilating Institute's new airflow metric for range hoods, Nominal Installed Airflow (see HVI 920 for more information), which is intended to provide a better approximation of real-world airflow than the traditional range hood airflow rating at 0.1" w.c.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposal will not increase the cost of construction. The proposal can help reduce costs by providing additional compliance options.

REPI-96-21

REPI-97-21

IECC®: R403.6.3, R403.6.4 (New)

Proponents:

Aaron Gary, representing Seft (aaron.gary@texenergy.org)

2021 International Energy Conservation Code

R403.6.3 Testing.
Mechanical ventilation systems shall be tested and verified to provide the minimum ventilation flow rates required by Section R403.6. Testing shall be performed according to the ventilation *equipment* manufacturer's instructions, or by using a flow hood or box, flow grid, or other airflow measuring device at the mechanical ventilation fan's inlet terminals or grilles, outlet terminals or grilles, or in the connected ventilation ducts. Where required by the code official, testing shall be conducted by an *approved* third party. A written report of the results of the test shall be signed by the party conducting the test and provided to the code official.

Exception: Kitchen range hoods that are ducted to the outside with 6-inch (152 mm) or larger duct and not more than one 90-degree (1.57 rad) elbow or equivalent in the duct run.

Add new text as follows:
R403.6.4 Sampling for R2 multifamily dwelling units.
For buildings with eight or more testing units complying with R403.6.3, the greater of seven units or 20 percent of the testing units in the building shall be tested, including a top floor unit, a ground floor unit, a middle floor unit, and a unit with the largest testing unit floor area. For each tested unit that does not meet the minimum ventilation rate, an additional three units shall be tested, including a mixture of testing unit types and locations. Where buildings have fewer than eight testing units, each testing unit shall be tested.

Reason Statement:

The concept of using a sample of tested apartment units to demonstrate compliance for the whole of the multifamily apartment building was approved as part of the Commercial provisions of the 2021 IECC. This proposals applies that previously approved concept to multifamily apartment buildings that fall under the Residential provisions of the IECC. It also slightly updates the sampling method specified in the Commercial provisions of the 2021 IECC to better align with the updated RESNET multifamily sampling guidelines.

Cost Impact:

The code change proposal will decrease the cost of construction.

For multifamily projects that are built and test well, sampling provisions such as those approved in the Commercial provisions of the 2021 IECC will reduce the cost and time required for testing and verification. Projects that do not meet their testing thresholds will understandably be tested as a higher rate, potentially test each, until they too are meeting the required standards consistently and as such will may not see a reduction in testing and verification costs or timelines.

REPI-97-21

REPI-98-21

IECC®: R403.7, R403.7.2 (New)

Proponents:

Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:
R403.7 Equipment sizing and efficiency rating.

Heating and cooling *equipment* shall be sized in accordance with ACCA Manual S based on *building* loads calculated in accordance with ACCA Manual J or other *approved* heating and cooling calculation methodologies.

<u>ACCA manual D shall be used to size and design the HVAC systems associated supply and return duct system ensuring that proper flow and pressures are maintained to accommodate a minimum MERV 13 filter installed in the system.</u>

<u>**Exception:** replacement HVAC system shall not be required to redesign the duct system or install a minimum MERV 13 filter.</u>

New or replacement heating and cooling *equipment* shall have an efficiency rating equal to or greater than the minimum required by federal law for the geographic location where the *equipment* is installed.

Add new text as follows:
<u>R403.7.2</u> <u>HAVC System Cleaning</u>.
<u>Prior to certificate of occupancy, all dwelling units governed by the International Residential Code shall have the entirety of the HVAC system cleaned, and documentation of such cleaning shall be provided at final inspection.</u>

Reason Statement:

· Significant efficiency is lost from a HVAC system when the static pressure across the air filter is not properly considered during the design process. The language in Section R403.7 addresses the heat load calculation but not the duct design which is crucial for the delivery of the heating and cooling load. Filter selection impact air handler delivery and since the IECC is also a health and safety code Post Covid the purpose is to ensure health of the air circulated within the home. A MERV 13 filter can easily be designed into the system of a newly constructed home and a MERV 13 filter has the capability to filter out viruses this helping to increase health in the home while the design requirement improves delivery and efficiency.

The efficiency of the HVAC system suffers when HVAC system is operated during construction and is saturated with drywall dust and other filth during the construction process. In theory this voids the warranty but in reality, systems are being delivered to the homebuyer that are filthy and underperforming. Delivered efficiency is increased by cleaning the system before occupancy but health is as well.

Cost Impact:

The code change proposal will increase the cost of construction.

Requirements to install a MERV 13 filter increase first cost but operational cost are about the same as MERV 8 and lower filters should be replace monthly and 4” pleated MERV 13 filter can be replaced quarterly.

The requirement for cleaning the HVAC system obviously increases first time costs but is mitigated by efficiency and health gains.

REPI-98-21

REPI-99-21

IECC®: SECTION R403, R403.7.1 (New)

Proponents:

David Baylon, representing Northwest Energy Efficiency Alliance (david@davidbaylon.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

SECTION R403 SYSTEMS

Add new text as follows:

R403.7.1 Electric resistance zone heated units.

All detached one- and two-family dwellings and multiple single-family dwellings (townhouses) up to three stories in height above grade plane using electric zonal heating as the primary heat source shall install an inverter-driven ductless mini-split heat pump in the largest zone in the dwelling. The heat pump shall meet the performance requirements in Table C403.3.2(2). Building permit drawings shall specify the heating equipment type and location of the heating system.

Exception: Total installed heating capacity of 2 kW per dwelling or less.

Reason Statement:

The use of a split system DHP system (less than 36,000 BTU heating) has shown itself to provide significant savings in the field trials and large-scale market evaluations in the Pacific Northwest. Savings have been demonstrated in all three climate zones in the region (4C, 5B, and 6B). These savings derive from the ability of the heat pump to perform over a wide range of outdoor temperature conditions (down to -10°F) and provide significant heating to the home with C.O.P. greater than 2.5. The unit is meant to displace the electric heat when conditions allow often in swing seasons. The savings largely depend on the unit to fully heat the zone or zones where they are installed. The primary electric heating is sized to meet the design heating requirements in accordance with R403.7 so this additional equipment is designed to provide savings when it is operating. The variable speed compressors can also provide significant cooling to the zone and typically have SEER ratings above 16. In many cases this can be the primary cooling in the dwelling and obviate the need for further zone level cooling using much less efficient equipment.

Detailed metering of about 100 electric resistance zonal homes showed a reduction of about 3000 kwh/yr. Even in homes that used supplemental stoves such as wood or propane fired average savings was almost 2000 kwh/yr in subsequent billing analysis done on almost 4000 homes throughout the region.

While this region had small cooling loads in the few areas where substantial seasonal cooling is required, savings of about 300 kwh/yr were observed. In most cases these savings were the result of replacing window air conditioners that provided zone cooling for the home.

Bibliography:

Baylon, et al, 2014, *Ductless Heat Pump Impact and Process Evaluation, Billing Analysis Report*, Northwest Energy efficiency Alliance, Portland, OR

https://neea.org/resources/ductless-heat-pump-impact-process-evaluation-billing-analysis-report

Baylon, et al, 2012, *Ductless Heat Pump Impact and Process Analysis, Field Metering Report,* Northwest Energy Efficiency Alliance, Portland, OR.

https://ecotope.com/ecotope-publications-database/

Lubliner, Et al, 2016, Performance and Costs of Ductless Heat Pumps in Marine Climate High-Performance Homes—Habitat for Humanity the Woods, USDOE Building America Program, Golden, CO

http:/www.osti.gov/scitech/

Cost Impact:

The code change proposal will increase the cost of construction.

The installation costs of DHP were documented as part of the detailed field and market evaluation in the Pacific Northwest. The cost of a DHP installation in new construction (townhouses) varied from $2500 to $3500. The installed DHPs were generally 1 nominal 1 ton. The costs for DHPs as a retrofit varied substantially. The retrofit costs were generally between $3500 and $4500 and were sized between 1 ton and 2.5 tons nominal.

REPI-99-21

REPI-100-21

IECC®: SECTION 202, R404.1

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

IECC2021P1E_RE_Ch02_SecR202_DefHIGH_EFFICACY_LIGHT_SOURCES HIGH-EFFICACY LIGHT SOURCES. Any lamp with an efficacy of not less than 65 lumens per watt, or luminaires with an efficacy of not less than ~~45~~ 50 lumens per watt.
R404.1 (N1104.1) Lighting equipment.

~~All~~ No less than 90 percent of all permanently installed lighting fixtures, excluding kitchen appliance lighting fixtures, shall contain only high-efficacy light ~~lighting~~ sources .

Reason Statement:

This proposal makes a few changes. to increase lighting efficiency and provide lighting design flexibility.

It revised the definition of "high-efficacy light sources" to increases the minimum efficacy for fixtures to align with the latest US EPA Energy Star specifications for luminaires (version 2.2, August 2019).

It also revises the language is R404.1 to match the definition (from high-efficacy lighting sources to high-efficacy light sources).

It also modifies the requirement to be consistent with the requirement shown in C405.1.1 for lighting in dwelling units.

A review of Sections 9.1 and 9.2 of the updated Energy Star specifications (available at https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf) shows that the range of specifications for Energy Star luminaires is from 50 to 70 lumens/Watt, depending on the type of luminaire and the lighting technology being used (fluorescent or LED).

Bibliography:

US EPA, *ENERGY STAR® Program Requirements for Luminaires*, Washington DC, August 25, 2019 (available at https://www.energystar.gov/sites/default/files/Luminaires%20V2.2%20Final%20Specification.pdf)

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

According to the EPA Energy Star web site (https://www.energystar.gov/productfinder/product/certified-light-fixtures/results), there are over 27,000 indoor luminaires that meet the most recent specifications, including:

- Accent/Track Lighting (729 products)
- Bath Vanity Lights (422 products)
- Ceiling Fan Light Kits (75 products)
- Ceiling Mount and Pendants (11,825 products)
- Chandeliers (40 products)
- Portable Lighting (table/desk/floor lamps) (169 products)
- Post Lights (34 products)
- Recessed Lighting (14,987 products)

The 11.1% increase in luminaire minimum lighting efficacy may or will increase the cost of construction, but the modification of 100% to 90% will increase design flexibility and may or will lower the cost of construction. In my judgement, these two factors "cancel out" and do not change the cost of construction.

REPI-100-21

REPI-101-21

IECC®: R404.1

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:
R404.1 (N1104.1) Lighting equipment.

All permanently installed lighting fixtures, excluding kitchen appliance lighting fixtures <u>and antimicrobial lighting fixtures</u>, shall contain only high-efficacy lighting sources .

Reason Statement:

The lighting efficacy requirements of this section were only developed to apply to luminaires that provide lighting for illumination. This exception clarifies the section's intent in regard to lighting that is used for germicidal or antimicrobial purposes and is aligned with the IECC-C Section C405.3.1 exception for antimicrobial lighting.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change will provide clarity to code officials and designers regarding how to apply the requirements of this section to germicidal or antimicrobial lighting. No effect is expected with regard to construction costs.

REPI-101-21

REPI-102-21 Part I

IECC®: SECTION 202, R404.1

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

THIS IS A 2 PART PROPOSAL. PART I & II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:

IECC2021P1E_RE_Ch02_SecR202_DefHIGH_EFFICACY_LIGHT_SOURCES ~~HIGH-EFFICACY LIGHT SOURCES~~. ~~Any lamp with an efficacy of not less than 65 lumens per watt, or luminaires with an efficacy of not less than 45 lumens per watt.~~

R404.1 Lighting equipment.

All permanently installed luminaires ~~lighting fixtures~~, excluding kitchen appliance lighting equipment ~~fixtures~~, shall be capable of operation with and efficacy of not less than 45 lumens per watt or shall contain lamps~~only high-efficacy lighting sources~~ capable of operation at 65 lumens per watt or greater.

REPI-102-21 Part I

REPI-102-21 Part II

IRC: SECTION 202, N1104.1

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Residential Code

Revise as follows:
IRC2021P1E_Pt04_Ch11_SecN1101.6_DefHIGH_EFFICACY_LIGHT_SOURCES ~~HIGH-EFFICACY LIGHT SOURCES~~. ~~Any lamp with an efficacy of not less than 65 lumens per watt, or luminaires with an efficacy of not less than 45 lumens per watt.~~
N1104.1 Lighting equipment.

All permanently installed luminaires ~~lighting fixtures~~, excluding kitchen appliance lighting equipment ~~fixtures~~, shall be capable of operation with and efficacy of not less than 45 lumens per watt or shall contain lamps~~only high-efficacy lighting sources~~ capable of operation at 65 lumens per watt or greater.

Reason Statement:

This editorial revision corrects the terminology used to describe lightning equipment and relocates the efficacy criteria from the definition of “high-efficacy light sources” to R404.1 to improve clarity for the user and proper enforcement of the code. By including the lighting efficacy requirements in R404.1, there is no need for the definition. Additionally, color tunable light sources are capable of operation outside of those used for general lighting applications (e.g., red color operation). It’s appropriate to ensure tunable sources are capable of providing white light at the efficacies shown above.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no increase or decrease cost in construction as this proposal is primarily editorial. It moves requirements that were in the definitions to the main body of the code. And the proposal adds clarity for new lighting technology (e.g, tunable lighting) so that this technology can also comply with the efficacy thresholds.

REPI-102-21 Part II

REPI-103-21

IECC®: SECTION R202, SECTION 202, SECTION R404, R404.1

Proponents:

Megan Hayes, representing NEMA (Megan.Hayes@nema.org); Harold Jepsen, representing NEMA (harold.jepsen@legrand.us)

2021 International Energy Conservation Code

SECTION R202 GENERAL DEFINITIONS
Delete without substitution:
~~IECC2021P1E_RE_Ch02_SecR202_DefHIGH_EFFICACY_LIGHT_SOURCES HIGH-EFFICACY LIGHT SOURCES~~. ~~Any lamp with an efficacy of not less than 65 lumens per watt, or luminaires with an efficacy of not less than 45 lumens per watt.~~
SECTION R404 ELECTRICAL POWER AND LIGHTING SYSTEMS
Revise as follows:
R404.1 (N1104.1) Lighting equipment.

All permanently installed luminaires ~~lighting fixtures~~, excluding kitchen appliance lighting ~~fixtures,~~ equipment, shall have an efficacy of not less than 45 lumens per watt or shall contain lamps ~~only high-efficacy lighting sources~~ . with an efficacy of not less than 65 lumens per watt.

Reason Statement:

This editorial revision corrects the terminology used to describe lighting equipment and relocates the efficacy criterial from the definition of "high-efficacy light sources" to R404.1 to improve clarity for the user and proper enforcement of the code. By including the lighting efficacy requirements in R404.1, there is no need for the definition.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

There is no increase or decrease cost in construction as this proposal simply corrects the terminology being used and relocates compliance criterial from the definition section to R404.1.

REPI-103-21

REPI-105-21

IECC®: TABLE R404.1 (TABLE N1104.1) (New), R404.1.1, R404.1.2 (N1104.1.1) (New), R404.1.3 (N1104.1.2) (New), R404.1.4 (N1104.1.3) (New), R404.1.5 (N1104.1.4) (New)

Proponents:

Vladimir Kochkin, NAHB, representing NAHB (vkochkin@nahb.org)

2021 International Energy Conservation Code

Add new text as follows:

TABLE R404.1 (TABLE N1104.1) LIGHTING POWER ALLOWANCES FOR BUILDING EXTERIORS

Base site allowance	400 watts
Uncovered parking areas and drives	0.4 W/ft2
Building Grounds	
Walkways and ramps less than 10 feet wide	0.50 W/linear foot
Walkways and ramps 10 feet wide or greater, plaza areas, special feature areas	0.10 W/ft2
Dining areas	0.65 W/ft2
Stairways	0.70 W/ft2
Pedestrian tunnels	0.12 W/ft2
Landscaping	0.04 W/ft2
Building Entrances and Exits	
Pedestrian and vehicular entrances and exits	14 W/linear foot of opening
Entry canopies	0.25 W/ft2

For SI: 1 watt per square foot = 10.76 w/m2, 1 foot = 304.8 mm.

Revise as follows:
R404.1.1 Exterior lighting.
Connected exterior lighting for Group R-2, R-3,and R-4 residential buildings shall comply with Sections R404.1.2 through R404.1.5. ~~C405.4.~~

Exceptions:

1. Detached one- and two- family dwellings.

2. Townhouses.

3. Group R-3 buildings that do not contain more than 2 dwelling units.

4~~3~~. Solar-powered lamps not connected to any electrical service.

5~~4.~~ Luminaires controlled by a motion sensor.

6~~5~~. Lamps and luminaires that comply with Section R404.1.

Add new text as follows:
R404.1.2 (N1104.1.1) Exterior lighting power requirements.

The total exterior connected lighting power shall be not greater than the exterior lighting power allowance calculated in accordance with Section R404.1.3. The total exterior connected lighting power shall be the total maximum rated wattage of all lighting that is powered through the energy service for the building.

Exception: Lighting used for the following applications shall not be included.

1. Lighting approved because of safety considerations.
2. Exit signs.
3. Specialized signal, directional and marker lighting associated with transportation.
4. Temporary lighting.
5. Lighting for water features and swimming pools.
6. Lighting controlled from within dwelling units.

R404.1.3 (N1104.1.2) Exterior Lighting Power Allowance.

The total area or length of each area type multiplied by the value for the area type in Table R404.1 shall be the lighting power (watts) allowed for each area type. For area types not listed, the area type that most closely represents the proposed use of the area shall be selected. The total exterior lighting power allowance (watts) shall be the sum of the base site allowance plus the watts from each area type.

R404.1.4 (N1104.1.3) Additional exterior lighting power.

Additional exterior lighting power allowance shall be available for the building facades at 0.075 W/ft2 (0.807 w/m^2) of gross above-grade wall area. This additional power allowances shall be used only for the luminaires serving the facade and shall not be used to increase any other lighting power allowance.

R404.1.5 (N1104.1.4) Gas lighting.

Gas-fired lighting appliances shall not be equipped with continuously burning pilot ignition systems.

Reason Statement:

The 2021 IECC Residential Provisions include a new section for exterior lighting that points the user to the commercial energy code. This format is counter to the framework of residential energy provisions intended to serve as a standalone set of criteria. This proposal extracts the relevant provisions applicable to residential occupancies from the commercial energy provisions and places these requirements directly within the residential provisions. The additional item under exceptions is intended to cover one- and two-unit R-2 buildings that may fall outside of the scope of the IRC for unrelated reasons and will need to be designed using the IBC but effectively are the same as the buildings already exempt under the first two items.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposal copies the relevant requirements from the commercial code.

REPI-105-21

REPI-106-21

IECC®: SECTION 202 (New), R404.2, 404.2.1 (N1104.2.1) (New), 404.2.2 (N1104.2.2) (New)

Proponents:

Megan Hayes, representing NEMA (Megan.Hayes@nema.org)

2021 International Energy Conservation Code

Add new definition as follows:
R202 HABITABLE SPACE. A space in a building for living, sleeping, eating or cooking. Bathrooms, toilet rooms, closets, halls, storage, or utility spaces and similar areas are not considered *habitable spaces*.
Revise as follows:
R404.2 (N1104.2) Interior lighting controls.

All permanently installed luminaires ~~lighting fixtures~~ shall be controlled as required in 404.2.1 and 404.2.2. ~~with either a dimmer, an occupant sensor control or other control that is installed or built into the fixture.~~

~~**Exception:** Lighting controls shall not be required for the following:~~

1. ~~Bathrooms~~.

2. ~~Hallways.~~

3. ~~Exterior lighting fixtures~~.

4. ~~Lighting designed for safety or security.~~

Add new text as follows:
404.2.1 (N1104.2.1) Habitable spaces.
All permanently installed luminaires in habitable spaces shall be controlled with a dimmer or an occupant sensor control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a manual control to allow occupants to turn the lights on or off.
404.2.2 (N1104.2.2) Specific locations.

All permanently installed luminaires in bathrooms, hallways, garages, basements, laundry rooms, and utility rooms shall be controlled by an occupant sensor control that automatically turns off lights within 20 minutes after all occupants have left the space and shall incorporate a manual control to allow occupants to turn the lights on or off.

Reason Statement:

This proposal extensively revises R404.2 to correct terminology and to clarify application of lighting controls in residential occupancies. The revised rule adds a separate lighting control requirement for habitable spaces that includes both automatic and non-automatic control function and adds automatic occupant sensor control only to specific, non-habitable spaces of a residence where lighting tends to remain on when no occupants are using the spaces, thus reducing energy conservation. The revised language also includes provisions to ensure the occupants can manually turn the lighting on and off independently of the occupant sensor control. Approval of this proposal will more closely align R404.2 with C405.2 of the IECC and improve enforceability of the requirement.

Cost Impact:

The code change proposal will increase the cost of construction.

The code change proposal will increase the cost of construction by removing the four exempt spaces in the current rule but will also increase the effective use and conservation of energy consumed by lighting in residential occupancies.

REPI-107-21 Part I

IECC®: R404.2

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

THIS IS A 2 PART PROPOSAL. PART I & II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:
R404.2 Interior lighting controls.
Permanently installed lighting fixtures shall be controlled with either a dimmer~~,~~ or an ~~occupant sensor~~ automatic shutoff control ~~or other control that is installed or built into the fixture~~.

Exception: Lighting controls shall not be required for the following:

~~1. Bathrooms.~~

~~2. Hallways.~~

~~3.~~1. Exterior lighting fixtures.

~~4~~2. Lighting designed for safety or security.

3. Spaces where the total maximum lighting power is less than 20 watts.

REPI-107-21 Part I

REPI-107-21 Part II

IRC: N1104.2

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Residential Code

Revise as follows:
N1104.2 Interior lighting controls.
Permanently installed lighting fixtures shall be controlled with either a dimmer~~,~~ or an ~~occupant sensor~~ automatic shutoff control ~~or other control that is installed or built into the fixture~~.

Exception: Lighting controls shall not be required for the following:

~~1. Bathrooms.~~

~~2. Hallways.~~

~~3~~1. Exterior lighting fixtures.

~~4~~2. Lighting designed for safety or security.

3. Spaces where the total maximum lighting power is less than 20 watts.

Reason Statement:

The proposal adds flexibility to the control options. It allows for scheduled timeclock control or count-down timers or other automatic shutoff controls (e.g., smart bulbs that can be automatically turned off using geofencing or scheduled off with an app) to comply in addition to occupancy sensors. The proposals also cleans-up the language. No need to allow for a control that is built into the fixture, just to provide automatic shutoff control whether or not the control is built into the fixture. The CEE Lighting Market Characterization show that timers or timeclocks save an average of about 40 kwh/yr depending on room and lamp type. So, the IECC should allow for these additional automatic shutoff controls not just limit the solution to occupancy sensors for the shutoff control. This will help provide more flexibility in the design and for the users.

Additionally, an exception has been added to allow for spaces that have less than 20-watt of lighting power. This 20-watt threshold was been shown to meet the cost-effective criteria per CA Title 24 2022 (for use of dimmers). Basically, the analysis shows that shows from a building level perspective, using the connected lighting load distribution (W/unit) and the average lighting usage hours (h/day) taken from the CEE Residential Lighting Controls Market Characterization report, dimmers in typical 3-bedroom, 2-bathroom home are cost effective in 50.2% of the cases (i.e. Benefit-to-Cost Ratio greater than 1.0). The cost effectiveness improves if we use 3-hours per day usage (per the Lighting Facts label) instead of 1.69 hours per day, and/or a 3% discount rate instead of 5%. However, if each room needs to be cost-effective, 20-watts has a 1.02 Benefit-to-Cost ratio for use of dimmer which passes the CEC criteria for cost effectiveness. See links in the Bibliography and attachment for details.

There is no need for an exception for bathrooms or hallways now with addition of the wattage exception and maintaining the safety/security exception.

https://energy.cdpaccess.com/proposal/465/988/files/download/167/

Bibliography:

CEE Residential Lighting Market Characterization:

https://library.cee1.org/system/files/library/11458/CEE_LightingMarketCharacterization.pdf

Lutron comments on CA Title 24 2022 Pre-express Terms (see fig. 1 and 2): https://efiling.energy.ca.gov/GetDocument.aspx?tn=237133&DocumentContentId=70314

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

No increase in cost of construction from what is required today; proposal allows for additional control options to be used for automatic shutoff and adds an exception for space using low lighting power.

REPI-107-21 Part II

REPI-108-21

IECC®: R404.2

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
R404.2 (N1104.2) Interior lighting controls.
Permanently installed interior lighting fixtures shall be controlled with either a dimmer, an occupant sensor control or other control that is installed or built into the fixture.

Exception: Lighting controls shall not be required for the following interior lighting fixtures:

1. Bathroom~~s~~ lighting.

2. Hallway~~s~~ lighting.

~~3. Exterior lighting fixtures.~~

~~4~~ 3. Lighting designed for safety or security.

Reason Statement:

As currently written, the exception in 404.2 appears that exempts lighting controls for exterior lighting fixtures appears to conflict with the requirements for exterior lighting controls in 404.3.

This proposal clarifies that the control requirements of 404.2 only apply to interior lighting fixtures and removes the language about exterior lighting fixtures to prevent any confusion.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This is an editorial correction that will have no impact on the cost of construction.

REPI-108-21

REPI-109-21 Part I

IECC®: R404.3

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

THIS IS A 2 PART PROPOSAL. PART I & II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:
R404.3 Exterior lighting controls.
Where the total permanently installed exterior lighting power is greater than 30 watts, the permanently installed exterior lighting shall comply with the following:

1. Lighting shall be controlled by a manual on and off switch which permits automatic shut-off actions.

   Exception: Lighting serving multiple *dwelling units.*

2. Lighting shall be automatically shut off <u>during daylight hours or </u>when daylight is present and satisfies the lighting needs.

3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

REPI-109-21 Part I

REPI-109-21 Part II

IRC: N1104.3

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Residential Code

Revise as follows:
N1104.3 Exterior lighting controls.
Where the total permanently installed exterior lighting power is greater than 30 watts, the permanently installed exterior lighting shall comply with the following:

1. Lighting shall be controlled by a manual on and off switch that permits automatic shut-off actions.

   Exception: Lighting serving multiple *dwelling units*.

2. Lighting shall be automatically shut off <u>during daylight hours or</u> when daylight is present and satisfies the lighting needs.

3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

Reason Statement:

This language modification will clarify that astronomical timeclocks can also be used to comply when they are programmed to turn outdoor lighting off during daytime. Astronomical timeclocks not only work on a time schedule but also can be programmed for astronomical events like sunrise or sunset each day.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal simply allows for astronomical timeclock (i.e. timeswitch) to also comply by scheduling the lighting to turn off during daylight hours.

REPI-109-21 Part II

REPI-110-21

IECC®: R404.3

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
R404.3 (N1104.3) Exterior lighting controls.
Where the total permanently installed exterior lighting power is greater than 30 watts, the permanently installed exterior lighting shall comply with the following:

1. Lighting shall be controlled by a manual on and off switch which permits automatic shut-off actions.

   ~~Exception~~ Exceptions:

   1. Lighting serving multiple *dwelling units.*
   2. Solar-powered light fixtures not connected to any electrical service.

2. Lighting shall be automatically shut off when daylight is present and satisfies the lighting needs.
3. Controls that override automatic shut-off actions shall not be allowed unless the override automatically returns automatic control to its normal operation within 24 hours.

Reason Statement:

This proposal creates an exception for solar-powered fixtures that are not connected to any building electrical service.

There are multiple solar-powered exterior lighting fixtures on the market today, and a significant number of them are rated at 30 Watts or higher (for example, see https://www.homedepot.com/p/eLEDing-30-Watt-4800-Lumen-Gray-Solar-Ultra-Powerful-Motion-Activated-Outdoor-Integrated-LED-Path-Walkway-Area-Light-EE850W-SH30/300975097).

Such systems are self-contained with a solar panel, LED lamps, a battery, and a photocell. They are designed to charge the battery during daylight and discharge the battery to power the lamps at night. They are not designed to be controlled by exterior controls, even basic manual on/off switches. Under the current language in 404.3, such fixtures would be required to be controlled by a manual on/off switch (which allows automatic shut off actions).

Such a control is not needed or cost-effective for solar power light fixtures. The energy and energy cost savings of shutting off a solar fixture with no electric service backup is 0 kWh and $0.00.

Cost Impact:

The code change proposal will decrease the cost of construction.

This will reduce construction costs by eliminating the requirement of control switches for exterior solar-powered lighting fixtures that are not connected to any electrical service.

REPI-110-21

REPI-111-21

IECC®: R404.4 (N1104.4) (New), R404.4.1 (N1104.4.1) (New), R404.4.2 (N1104.4.2) (New), R404.4.3 (N1104.4.3) (New), R404.4.4 (N1104.4.4) (New), TABLE R405.2, TABLE R406.2

Proponents: Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Add new text as follows:

R404.4 (N1104.4) Electric readiness. Systems using gas or propane water heaters, dryers, or conventional cooking equipment to serve individual dwelling units shall comply with the requirements of Sections R404.4.1 through R404.4.3. All water heating systems shall comply with Section R404.4.4.

R404.4.1 (N1104.4.1) Household Ranges and Cooking Appliances. An individual branch circuit outlet with a minimum rating of 250-volts, 40-amperes shall be installed within three feet of each gas or propane range or permanently installed cooking appliance.

R404.4.2 (N1104.4.2) Household Clothes Dryers and Water Heaters. An individual branch circuit outlet with a minimum rating of 250-volts, 30-amperes shall be installed within three feet of each gas or propane household clothes dryer and water heater.

R404.4.3 (N1104.4.3) Electrification-ready circuits. The unused conductors required by Section s R404.2.1 or R404.2.2 shall be labeled with the word “spare.” Space shall be reserved in the electrical panel in which the branch circuit originates for the installation of an overcurrent device. Capacity for the circuits required by Sections R404.2.1 or R404.2.2 shall be included in the load calculations of the original installation.

R404.4.4 (N1104.4.4) Water heater space. An indoor space that is at least 3 feet (914 mm) by 3 feet (914 mm) by 7 feet (2134 mm) high shall be available surrounding or within 3 feet (914 mm) of the installed water heater.

Exception: The water heater space requirement does not need to be met where a heat pump water heater or tankless water heater is installed.

Revise as follows:

TABLE R405.2 REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

Portions of table not shown remain unchanged.

SECTION[a]	TITLE
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R404.4	Electric Readiness

a. Reference to a code section includes all the relative subsections except as indicated in the table.

TABLE R406.2 REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R404.4	Electric Readiness
R406.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

Reason: This proposal enhances customer choice by making it easy for homeowners to choose either electric or gas appliances and water heating equipment. By ensuring that a home built with gas or propane can easily accommodate future electric appliances and equipment, this proposal protects homeowners from future costs, should natural gas become less affordable or even unavailable over the life of the building. As the electric grid becomes cleaner, and high-efficiency electric heat pump technology increasingly offers utility bill and pollution reduction benefits over gas, more customers may want to transition from natural gas to electric space and water heating. Federal, state, and local environmental and public health policies may also encourage, or even require the transition in some areas over the life of the building. Electric-ready requirements will protect customers from potential high retrofit costs.

Bibliography: Group 14 Engineering. 2020. *Electrification of Commercial and Residential Buildings: An Evaluation of the System Options, Economics, and Strategies to Achieve Electrification of Buildings.* Prepared for Community Energy, Inc.
Franconi, E and V Salcido. 2021. *Electric Readiness in Residential Energy Code*. Pacific Northwest National Laboratory. Richland, Washington. https://www.energycodes.gov/sites/default/files/2021-10/TechBrief_Electric_Readiness.pdf

Cost Impact: The code change proposal will increase the cost of construction.
The cost of meeting these electric-ready requirements when the house is being built, walls are open, and the trades are already on-site, is marginal. In comparison, the cost of retrofitting a building for these requirements can be orders of magnitude higher and act as a barrier for the homeowner to choose electric appliances. An electrification engineering study reports that the electrical modifications needed to install a HP heating system and a HPWH is $2,100 as a retrofit compared to $500 as an original install for a single family home (Group-14 2020). Not making new buildings electric-ready would leave homeowners exposed to potentially high retrofit costs in the future and will greatly inhibit customer choice.

REPI-112-21 Part I

IECC®: R404.4 (New)

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

THIS IS A 2 PART PROPOSAL. PART I & II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Add new text as follows:

R404.4 Large home lighting control system.

Dwelling units with greater than 5000 ft^2 (460 m^2) of conditioned floor area shall have a lighting control system that has the capability to turn off all permanently installed interior luminaires from a control located at an exit door or have a lighting control system that has the capability to turn off all permanently installed interior lighting from remote locations.

Exception: Up to 5% of the total lighting power may remain uncontrolled.

REPI-112-21 Part I

REPI-112-21 Part II

IRC: N1104.4 (New)

Proponents:

Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2021 International Residential Code

Add new text as follows:
N1104.4 Large home lighting control system.
Dwelling units with greater than 5000 ft^2 (460 m^2) of conditioned floor area shall have a lighting control system that has the capability to turn off all permanently installed interior luminaires from a control located at an exit door or have a lighting control system that has the capability to turn off all permanently installed interior lighting from remote locations.
Exception: Up to 5% of the total lighting power may remain uncontrolled.

Reason Statement:

This proposal is similar to what's in ASHRAE 90.2. The intent to require lighting in large homes to have a control system or smart light fixtures such that the lighting can be shutoff from the exit or remote locations (e.g., using a phone app). This control strategy will save energy by allowing occupants to shutoff the lighting as they leave (or while they are away) so that unneeded lighting is not left on when no one is home. Note that the intent is for lighting to have the capability to be shutoff, not mandate lighting be shutoff.

Bibliography:

ASHRAE 90.2 section 7.5.3.

Cost Impact:

The code change proposal will increase the cost of construction.

The code change proposal will increase the cost of construction (but many of these large homes will install a lighting control system or smart light fixtures anyway so may not be an increase in real world application).

REPI-112-21 Part II

REPI-113-21

IECC®: R404.4 (N1104.4) (New), TABLE R405.2, TABLE R406.2, R407.2, IEEE Chapter 06 (New), UL Chapter 06 (New)

Proponents: Kimberly Newcomer, representing NBI (kim@newbuildings.org); Josh Keeling, representing Cadeo Group (jkeeling@cadeogroup.com); Matt Tidwell, representing Portland General Electric (matthew.tidwell@pgn.com)

2021 International Energy Conservation Code

Add new text as follows:

R404.4 (N1104.4) Solar and energy storage inverters. Where buildings have installed direct current-to-alternating current inverters serving *on-site renewable energy* systems, or electrical energy storage systems, all inverters serving the systems shall be compliant with IEEE 1547-2018a and UL 1741 .

Revise as follows:

TABLE R405.2 (TABLE N1105.2) REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration U-factor and SHGC
Mechanical	
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
<u>R404.4</u>	<u>Solar and energy storage inverters</u>

a. Reference to a code section includes all the relative subsections except as indicated in the table.

TABLE R406.2 (TABLE N1106.2) REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
General	
R401.2.5	Additional efficiency packages
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
Mechanical	
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R404.4	Solar and energy storage inverters
R406.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

R407.2 (N1107.2) Tropical climate region. Compliance with this section requires the following:

1. Not more than one-half of the *occupied* space is air conditioned.
2. The *occupied* space is not heated.
3. Solar, wind or other renewable energy source supplies not less than 80 percent of the energy for service water heating.
4. Glazing in *conditioned spaces* has a *solar heat gain coefficient* (SHGC) of less than or equal to 0.40, or has an overhang with a projection factor equal to or greater than 0.30.
5. Permanently installed lighting is in accordance with Section R404.
6. The exterior roof surface complies with one of the options in Table C402.3 of the *International Energy Conservation Code*–Commercial Provisions or the roof or ceiling has insulation with an *R-value* of R-15 or greater. Where attics are present, attics above the insulation are vented and attics below the insulation are unvented.
7. Roof surfaces have a slope of not less than $^1/_4$ unit vertical in 12 units horizontal (21-percent slope). The finished roof does not have water accumulation areas.
8. Operable fenestration provides a ventilation area of not less than 14 percent of the floor area in each room. Alternatively, equivalent ventilation is provided by a ventilation fan.
9. Bedrooms with *exterior walls* facing two different directions have operable fenestration on exterior walls facing two directions.

10. Interior doors to bedrooms are capable of being secured in the open position.

11. A ceiling fan or ceiling fan rough-in is provided for bedrooms and the largest space that is not used as a bedroom.

12. <u>Where buildings have installed direct current-to-alternating current inverters serving on-site renewable energy systems, or electrical energy storage systems, the building is compliant with Section R404.4.</u>

Add new standard(s) as follows:

IEEE

Institute of Electrical and Electronic Engineers
3 Park Avenue, 17th Floor
New York, NY 10016

<u>1547-2018a</u>	<u>IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces</u>

UL

UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096

<u>1741</u>	<u>UL Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources</u>

Reason: IEEE 1547-2018a governs requirements for the interconnection of distributed energy resources that operate in parallel to the electric grid. This standard (and its implementation at the device level through (UL 1741) ensure that these resources can support and potentially enhance grid stability, thereby improving reliability, reducing curtailments, stabilizing voltage, and maintaining power quality. Requirements to implement IEEE 1547-2018 are being explored in several states and the standard is already required as a part of California's Rule 21 interconnection requirements. The National Association of Regulatory Utilities Commissioners (NARUC) has already recommended that state utility commissions require implementation of IEEE1547-2018a as a part of their interconnection requirements.
While commission rulemaking will help to accelerate adoption, codifying the requirement within building code will provide further clarity to DER installers and provide consistency across unregulated (consumer-owned/public) utility service areas. This will help to avoid inconsistency and requirements and/or potentially future retrofit costs if a non-compliant unit must be retrofitted later at interconnection.

Smart inverter functionality can provide several benefits, with potentially significant cost advantage over traditional solutions. While the primary purpose of smart inverter functionality is grid stability, there are several additional benefits to the grid and its stakeholders. When operating in volt-VAR mode supporting reactive power, these inverters can actually provide energy savings, particularly when operating within distribution networks already operating conservation voltage reduction schemes. Additionally, smart inverters can help to increase DER hosting capacity of distribution networks, enabling greater access to renewable energy systems while maintaining safety and reliability.

Changes are added to sections R405, R406 and R407 as this measure is intended to be treated as mandatory.

Bibliography: [1]IEEE 1547-2018 Status of Adoption across the U.S. (2021) https://sagroups.ieee.org/scc21/wp-content/uploads/sites/285/2021/09/IEEE-1547-2018_States-and-ISOs-RTOs-Adoption_IEEE-Format.pdf
[2] CPUC, Rule 21 Rulemaking, https://www.cpuc.ca.gov/Rule21/

[3] NARUC, Recommending State Commissions Act to Adopt and Implement Distributed Energy Resource Standard IEEE 1547-2018 (2021) https://pubs.naruc.org/pub/E86EF74B-155D-0A36-3138-B1A08D20E52B

[4] IEEE PES, Impact of IEEE 1547 Standard on Smart Inverters and the Applications in Power Systems (2020) https://www.nrel.gov/grid/ieee-standard-1547/assets/pdfs/smart-inverters-applications-in-power-systems.pdf

[5]

PG&E, EPIC 2.03A: Test Smart Inverter Enhanced Capabilities – Photovoltaics (PV): Smart Inverter Modeling Report (2019) https://www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/PGE-EPIC-Project-2.03A_Modeling-Report.pdf

[6] EPRI, The Economic Impact of Real Power Management of Solar Photovoltaic Systems (2019) https://www.epri.com/research/products/000000003002013325

[7] NREL, Photovoltaic Impact Assessment of Smart Inverter Volt-VAR Control on Distribution System Conservation Voltage Reduction and Power Quality (2016) https://www.nrel.gov/docs/fy17osti/67296.pdf

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
In an economic assessment of 1547-2018 functionality, EPRI found that an increase of 25% in distribution hosting capacity for solar could be achieved at a savings of $20,000/year per feeder in the reference case and could reach as high as $100,000/year. In its assessment of smart inverter benefits in high DER areas, NREL found an additional energy savings of up to 1% from smart inverters when coupled with traditional conservation voltage regulation (baseline savings of 1.5%-3%) while also improving power quality scores by up to 0.26. A study by PG&E of a set of representative feeders found deferred distribution upgrade costs of up to $200,000 per feeder at the highest levels of DER penetration and that smart inverter functionality was cost-effective across a wide range of scenarios.

Given the growing prevalence of smart inverter requirements, this is likely to have a low to no incremental cost. While communication with utility and/or third-party systems is enabled by IEEE 1547-2018a, it is not required and smart inverters can provide much of their value autonomously based on their operating setpoint. Individual utilities or jurisdictions may dictate specific setpoints and/or communications integration with utility/third-party systems as they see fit based on the specific grid context, like how loads might be integrated for demand response programs. The physical communication pathway for smart inverters is typically wi-fi, which is standard for inverters already for the purposes of system monitoring and commissioning.

REPI-114-21

IECC®: SECTION 202 (New), R404.4 (N1104.4) (New), R404.4.1 (N1104.4.1) (New), 404.4.2 (N1104.4.2) (New), R404.4.3 (N1104.4.3) (New), TABLE R405.2, TABLE R406.2, R406.3.2, TABLE R406.5

Proponents:

Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Add new definition as follows:
R202 POTENTIAL SOLAR ZONE AREA. The combined area of any low-sloped roofs and any steep-sloped roofs oriented between 90 degrees and 300 degrees of true north where the annual solar access is 70 percent or greater. Annual solar access is the ratio of “annual solar insolation with shade” to the the “annual solar insolation without shade”. Shading from obstructions located on the roof or any other part of the building shall not be included in the determination of annual solar access
Add new text as follows:
R404.4 (N1104.4) On-site renewable energy.

The building shall comply with the requirements of R404.4.1 or R404.4.2

R404.4.1 (N1104.4.1) One- and two- family dwellings and townhouses.

Install an on-site renewable energy system with a nameplate DC power rating measured under standard test conditions, of no less than 2kW.

Exceptions:

1. A building with a permanently installed domestic solar water heating system with a minimum solar savings fraction of 0.5.
2. A building in climate zone 4C, 5C or 8.
3. A building where the *potential solar zone area* is less than 300 square feet.

404.4.2 (N1104.4.2) Group R Occupancies.

Buildings in Group R-2, R-3 and R-4 shall install an on-site renewable energy system with a rated capacity of not less than 0.75 W/ft2 multiplied by the gross conditioned floor area.

Exceptions:

1. A building with a permanently installed domestic solar water heating system with a minimum solar savings fraction of 0.5.
2. A building in climate zone 4C, 5C or 8.
3. A building where the *potential solar zone area* is less than 300 square feet.

R404.4.3 (N1104.4.3) Renewable energy certificate documentation.
Documentation shall be provided to the code official that indicates that renewable energy certificates (RECs) associated with the on-site renewable energy will be retained and retired by or on behalf of the owner or tenant.
Revise as follows:

TABLE R405.2 (TABLE N1105.2) REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

Portions of table not shown remain unchanged.

SECTION[a]	TITLE
General	
R404.4	On-site renewable energy

TABLE R406.2 (TABLE N1106.2) REQUIREMENTS FOR ENERGY RATING INDEX

Portions of table not shown remain unchanged.

SECTION[a]	TITLE

R404.2 Interior lighting controls

R404.4 On-site renewable energy

R406.3 Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

R406.3.2 (N1106.3.2) On-site renewables are included.
Where additional on-site renewable energy, above the minimum requirements of R404, is included for compliance using the ERI analysis of Section R406.4, the *building thermal envelope* shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2015 *International Energy Conservation Code*.

TABLE R406.5 (TABLE N1106.5) MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX
0-1	~~52~~47
2	~~52~~46
3	~~51~~41
4	~~54~~45
5	~~55~~51
6	54
7	53
8	53

Reason Statement:

On-site electricity generation using photovoltaics is a key technology for reducing greenhouse gas emissions associated with Commercial and Residential buildings. According to the most recent assessment by the National Renewable Energy Lab (NREL) the cost of installed photovoltaics in 2020 was 3% lower than in 2019 and 65-70% lower than the cost of similar sized systems in 2010. With the continued drop in cost of installing on-site PV the cost per kilowatt hour of PV generated electricity is at parity with grid purchased electricity in many States throughout the country.

The Solar Energy Industries Association 2020 Solar Market Insight Year in Review reported a 10% increase in installed on-site residential solar PV capacity in 2020 compared to 2019, which was down from the 16% increase in 2019 compared to 2018. More recently in the SEIA 2021 Q3 Solar Insight Report they reported that new installed residential solar PV is on track to grow an additional 21% in 2021 with installed capacity expected to reach 3.9GW. The demand for Residential on-site solar PV is expected to grow despite the phaseout of incentive tax credits. The continued growth of Residential solar PV demonstrates that is it is a an effective technology for reducing the energy cost and greenhouse gas emissions of buildings.
This proposal describes requirements for prescriptive solar PV that must be installed at the time of construction. Analysis by PNNL shows that on-site renewable electricity generation is cost effective across all low-rise multifamily buildings and most single family and one or two unit townhouses. The analysis was done using each of PNNL's Residential prototypes in each climate zone. The capacity requirements were established by calculating the highest on-site solar PV capacity that limited electricity export back to the grid. The threshold used for determining these capacities was a grid export limit of less than 0.5% of total annual building electricity consumption. A review of the hourly results showed it was unrealistic to set a hard limit of zero overproduction. When calculating cost effectiveness, no credit was taken for electricity that was exported back to the grid. The calculation of grid exports was done on an hourly basis. The proposed requirements reduce purchased energy from the electrical grid which will help reduce greenhouse gas (GHG) emissions and energy costs for building owners.

The approach used for this proposal requires that building owners incorporate a modest amount of cost effective on-site solar PV. This approach addresses the management and dispatch challenge faced by Utilities when distributed solar resource export large amounts of unused electricity back into the grid by setting the required capacity to minimize exports. Where solar-PV is required by this proposal, no less than 99.5% of the generated electricity will be used directly by the building. Distributed generation also helps reduce transmission losses and the burden for new transmission infrastructure to centralized renewable resources.

On-site solar PV provides substantial benefits to the consumer and society by helping to reduce GHG emissions associated with electricity generation. PV market growth combined with a cleaner grid will support goals of reduced GHG emissions established across the U.S. and others by federal agencies, as well as many states and local governments.

Cost Impact:

The code change proposal will increase the cost of construction.

For this analysis of residential building solar PV cost effectiveness was calculated using the life cycle cost methodology (https://www.energycodes.gov/methodology) established by the U.S. Department of Energy (DOE) and Pacific Northwest National Lab (PNNL) for determining the cost effectiveness of the building energy codes. The DOE methodology accounts for the benefits of energy-efficient home construction over the life of a typical mortgage, balancing initial costs against longer term energy savings. The methodology provides a full accounting over a 30-year period of the cost savings, considering energy savings, the initial investment financed through increased mortgage costs, tax impacts, maintenance costs, replacement costs and residual values of energy efficiency measures. The installed cost of solar PV was based on costs reported in the U.S. Solar Photovoltaic System and Energy Storage Cost Benchmark: Q1 2020 published by NREL in 2021. Installed costs were scaled based on solar PV capacity from 2kW up to 200kW and applied based on the calculated capacity required for each prototype in each climate zone.

The proposed solar PV capacities were shown to be cost effective for R occupancies in each climate zone except for climate zone 8 and for single family residences in all climate zones except 4C, 5C and 8.

REPI-114-21

REPI-115-21

IECC®: SECTION 202 (New), R404.4 (N1104.4) (New), R404.4.1 (N1104.4.1) (New), R404.4.2 (N1104.4.2) (New), R404.4.3 (N1104.4.3) (New)

Proponents:

Joseph Cain, representing Solar Energy Industries Association (SEIA) (JoeCainPE@gmail.com)

2021 International Energy Conservation Code

Add new definition as follows:

ENERGY STORAGE SYSTEM (ESS) READY INTERCONNECTION EQUIPMENT. Equipment, including but not limited to an ESS ready panelboard, that can accommodate the connection of a distributed energy resource or an ESS capable of either automatic or manual isolation from the utility power source.

ENERGY STORAGE SYSTEM (ESS) READY PANELBOARD. A panelboard that can accommodate either automatic or manual switching between a utility power source to a distributed energy resource or an energy storage system, such as a split bus panelboard.

Add new text as follows:

R404.4 (N1104.4) Energy Storage System (ESS) Ready.

One- and two-family dwellings and townhouse units, and Group R-3 occupancies, shall comply with this section and with NFPA 70 National Electrical Code. At least one of the following shall be provided:

1. ESS ready connection equipment with a minimum backed-up capacity of 60 amps and a minimum of four ESS supplied branch circuits.
2. A dedicated raceway from the main service to a panelboard (subpanel) that supplies the branch circuits in Section R404.4.1. All branch circuits are permitted to be supplied by the main service panel prior to the installation of an ESS. The trade size of the raceway shall be not less than one inch. The panelboard that supplies the branch circuits (subpanel) shall be labeled "Subpanel shall include all backed-up load circuits."

R404.4.1 (N1104.4.1) Branch circuits.

Branch circuits shall comply with all of the following:

1. A minimum of four branch circuits shall be identified and have their source of supply collocated at a single panelboard suitable to be supplied by the ESS.
2. At least one circuit shall supply a refrigerator.
3. At least one lighting circuit near the primary egress.
4. At least one circuit shall supply a sleeping room receptacle outlet.

R404.4.2 (N1104.4.2) Main panelboard.

The main panelboard shall have a minimum busbar rating of 225 amps.

R404.4.3 (N1104.4.3) System isolation equipment.

Sufficient space shall be reserved to allow future installation of system isolation equipment / transfer switch within 3 feet (305 mm) of the main panelboard. Raceways shall be installed between the panelboard and the system isolation equipment / transfer switch location to allow the connection of a backup power source.

Reason Statement:

As deployment of distributed energy resources such as solar photovoltaic systems increases, so does the need for distributed energy storage resources to minimize grid impacts. Solar PV systems are known to be an intermittent power source, with peak power generation at mid-day and reduced power generation in the late afternoon and into early evening. Energy storage systems such as Battery Energy Storage Systems charge during the peak PV generation hours, and begin to discharge in late afternoon and evening as the sun sets. Considering these energy storage systems reduce the backfeed into the grid, they help with grid management, as well as provide a financial buffer for differing net energy metering policies by states and utilities. In an ideal case, a home with PV and ESS can be nearly "invisible" to the grid.

In recent news we have seen extended grid power outages in multiple regions of the U.S. owing to severe environmental events such as fire, wind, hurricanes, and flooding. Many homeowners in regions with a history of recurring grid power outages have acquired gas-powered generators to serve as their backup power source. People need power to keep food from spoiling in refrigerators and freezers, as well as to refrigerate their medicines. Many people need to power medical devices, which can be as common and simple as CPAP machines. And of course, basic communications means a need for charging cell phones and other electronics.

Solar photovoltaic systems paired with battery storage systems can operate to serve these basic needs indefinitely. Stand-alone battery storage systems can serve short-term needs. Manufacturers of electric vehicles are providing more options for connecting vehicle batteries to home electrical systems.

The cost of battery storage systems is declining. As the market expands, the cost will continue to drop. During the years the 2024 IECC will be in effect, it will help to have storage readiness, to provide for reduced cost of ESS installation, and dedicated circuits to direct backup power where it is needed the most.

This proposal is based on the ESS Ready provisions that will appear in California's 2022 Building Energy Efficiency Standards as a mandatory measure. The specific requirements -- and the cost consideration -- have been prepared by the California Energy Commission.

Cost Impact:

The code change proposal will increase the cost of construction.

The proposed requirements are based on mandatory measures in California Energy Commission's 2022 Building Energy Efficiency Standards. The goal of the CEC was an estimated cost for ESS readiness of no more than about $200 to $250 per home, which will vary by location and builder. For any homes that have ESS installed in the future, ESS readiness will save more money at the time of installation than money spent in the cost of readiness.

REPI-115-21

REPI-116-21

IECC®: R405.1, R405.2, TABLE R405.4.2(1)

Proponents: Jeremy Williams, representing U.S. Department of Energy (jeremy.williams@ee.doe.gov)

2021 International Energy Conservation Code

Revise as follows:

R405.1 (N1105.1) Scope. This section establishes criteria for compliance using total building performance analysis. Such analysis shall include heating, cooling, mechanical ventilation, ~~and~~ service water-heating , and on-site renewable energy only.

R405.2 (N1105.2) Performance-based compliance. Compliance based on total building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table R405.2.
2. The building thermal envelope efficiency requirements shall comply with one of the following: ~~be greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 *International Energy Conservation Code.*~~

   2.1. Where on-site renewable energy is included for compliance using the Total Building Performance of Section R405.2, the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.1 or Table R402.1.3 of the 2015 International Energy Conservation Code.

   2.2. Where on-site renewable energy is NOT included for compliance using Total Building Performance of Section R405.2, the building thermal envelope shall be greater than or equal to the levels of efficiency in Table R402.1.1 or R402.1.3 of the 2012 International Energy Conservation Code.

3. An annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations.

   Exception: The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

TABLE R405.4.2(1) (TABLE N1105.4.2(1)) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Dehumidistat	Where a mechanical ventilation system with latent heat recovery is not specified in the proposed design:None.Where the proposed design utilizes a mechanical ventilation system with latent heat recovery: Dehumidistat type: manual, setpoint = 60% relative humidity. Dehumidifier: whole-dwelling with integrated energy factor = 1.77 liters/kWh.	Same as standard reference design.
On-site renewable energy	None	As-Proposed

Reason: The Total Building Performance compliance path only considers heating, cooling, ventilation and service water heating energy only. Renewable energy is not considered toward compliance. Currently in the 2021 IECC, there is no possible way for an architect or builder to prove that a home is net zero energy other than using the ERI compliance path. By allowing on-site renewable energy to be considered, a building can show net zero energy with adequate onsite power generation. There may be concern that by allowing renewable energy as part of the total building performance compliance path there may be a reduction in the efficiency of the building envelope. As part of this change, if a proposed design includes on-site renewable energy, all components will need to minimally comply with the envelope requirements of 2015 International Energy Conservation Code. The proposed change does not increase or decrease the required stringency of the Standard Reference Design therefore there is no direct cost impact. Since section R405 is an optional compliance path that allows trade-offs of prescriptive requirements any changes in construction cost due to these trade-offs are at the discretion of the builder. For those not considering on-site renewable energy, this may provide incentive to include such technologies and enable expanded utilization of performance-based codes as renewable energy technologies experienced increased market share.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed change does not increase or decrease the required stringency of the Standard Reference Design therefore there is no direct cost impact. Since section R405 is an optional compliance path that allows trade-offs of prescriptive requirements any changes in construction cost due to these trade-offs are at the discretion of the builder.

REPI-117-21

IECC®: R405.2

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
R405.2 (N1105.2) Performance-based compliance.

Compliance based on total building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table R405.2.
2. The building thermal envelope shall be greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 *International Energy Conservation Code*.
3. An annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations.

   ~~Exception~~ Exceptions:

   1. The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.
   2. The energy use based on site energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost for an all-electric building using 100% renewable energy.

Reason Statement:

A new exception is needed for those buildings that are using 100% renewable energy. When a building is using 100% renewable energy, the source multiplier has the same value for the standard reference design and the proposed design.

Under the "captured energy" approach, the source multiplier for renewable electricity is 1.0. If the standard reference design uses 100 kWh, that is equal to 341,200 site Btu's and 341,200 "source" Btu's. If the proposed design uses 70 kWh, that is equal to 238,840 site Btu's and 238,840 "source" Btu's. There is no difference in the results. Even if another value, such as 1.05 were used, the difference / percentage reduction would still be the same (30%), as the ratio would be (70 * 1.05) / (100 * 1.05) = 70/100.

Under the "infinite energy" approach, the source multiplier for renewable electricity is 0.0. In this scenario, by using the "source" value, the standard reference design uses 0.0 "source" Btu's and the proposed design uses 0.0 "source" Btu's. For this situation, it is analytically necessary to use site energy as the basis of comparison.

Bibliography:

ASHRAE Standard 105-2021, *Standard Methods for Determining, Expressing, and Comparing Building Energy Performance and Greenhouse Gas Emissions*, Appendix J and Appendix K, 2021, Atlanta, GA

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposed change only adds an exception for the building performance analysis and has no impact on construction costs.

REPI-117-21

REPI-118-21

IECC®: R405.2

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:
R405.2 (N1105.2) Performance-based compliance.

Compliance based on total building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table R405.2.
2. The proposed total building thermal envelope UA, which is the sum of *U*-factor times assembly area, shall be less ~~greater~~ than or equal to the building thermal envelope UA using the prescriptive *U*-factors from Table R402.1.2 multiplied by 1.15 in accordance with Equation 4-1. ~~levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 *International Energy Conservation Code*.~~ The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

   $$UA_{\text{Proposed design}} = 1.15 \times UA_{\text{Prescriptive reference design}}$$

   (Equation 4-1)

3. An annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations.

   Exception: The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

Attached Files

- **R6 table pix.PNG**
  http://localhost/proposal/315/934/files/download/182/

Reason Statement:

The purpose of this code change proposal is to improve the mandatory thermal envelope trade-off backstop applicable to the performance compliance path. This proposal improves the efficiency and usability of the *IECC* by combining two successful concepts incorporated into the 2021 *IECC:*

- First, it adds some flexibility to the performance path backstop by changing the thermal envelope backstop from values in the 2009 *IECC* prescriptive tables to a calculation based on a percentage (115%) of the Total UA of the current code's envelope requirements. This would make the performance path backstop consistent with the ERI backstop for projects without on-site generation in Section R406.3.1. The ERI backstop, which was originally based on the 2009 *IECC* in the 2015 and 2018 editions of the *IECC*, was changed to a Total UA-based backstop in the 2021 *IECC* as a result of Proposal No. RE150-19 (as modified by the Committee). We believe that code users would benefit from both trade-off backstops working in the same way.
- Second, this proposal will improve efficiency and streamline future code development by replacing a reference to envelope requirements from an older code edition with a reference to the current code requirements. Basing the calculation on the current code helps ensure that improvements to the code baseline each cycle will be reflected in the backstop without a need for

additional code change proposals in the future. This will also simplify compliance and enforcement efforts by reducing the need to refer to other code books.

An effective thermal envelope backstop is crucial to ensure that the home retains reasonable envelope performance (U-factor and SHGC) (similar to the prescriptive path) under alternative compliance paths (such as the performance path, ERI, etc.) and that the envelope is not unduly traded-off for other measures. Trading off envelope and associated occupant comfort can have direct impacts on energy usage. For example, if the occupant responds to discomfort from a “cold” or “hot” room due to an inadequate building envelope by adjusting the thermostat, the additional energy use from the adjusted thermostat can be substantial. Below is a summary of estimated energy use increases associated with adjusting a thermostat 1 degree higher or lower, broken out by climate zone.

[R6 table pix.png]

Increased Energy Use Resulting from Thermostat Adjustment

Measure	Nat'l Avg	1	2	3	4	5	6	7	
+1 Degree Heating	4.1%	0.5%	3.0%	4.2%	4.4%	4.7%	4.5%	4.0%	2
-1 Degree Cooling	3.2%	7.8%	5.3%	3.9%	2.6%	1.8%	1.4%	0.7%	0

An effective envelope trade-off backstop can help improve occupant comfort and can save significant energy and energy cost.

As the *IECC* is improved in 2024 and future cycles to meet the nation’s demand for more efficient and resilient buildings and reduced greenhouse gas production, we believe that improved and streamlined trade-off backstops play a very important role. These backstops are critical consumer protections that will maintain a minimum level of building thermal envelope efficiency across all new homes, providing long-term comfort and energy savings for homeowners, and more broadly, reducing peak demand and greenhouse gas production at the state and national level.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not increase the baseline stringency of the *IECC*, and whether the proposal results in increased or decreased costs ultimately depends on compliance choices made by the code user in each case (including the choice of compliance path). The added flexibility of moving to a UA-based backstop will allow builders to use what they conclude is the optimal combination of envelope measures to meet the building thermal envelope UA under the code, which may reduce construction costs as compared with the current backstop in some cases.

COST-EFFECTIVENESS

This proposal does not increase or otherwise affect the stringency of the prescriptive code values or necessarily result in increased costs. Instead, the performance path thermal envelope backstop only places limits on choices under an alternative compliance path (which is optional), so a cost-effectiveness analysis does not apply.

The ICC Board of Directors set the 2021 *IECC* as the baseline for future *IECC* development – and by extension made the 2021 *IECC* the basis for cost-effectiveness analyses. This means for purposes of analyzing code proposals, the existing provisions of the 2021 *IECC* are considered cost-effective and reasonable, since they are the starting point for analyses of code changes and no rollbacks are permitted. It should also be noted that US DOE found the entire 2021 *IECC* cost effective, including section R406. *See* Pacific Northwest National Laboratory, *National Cost Effectiveness of the Residential Provisions of the 2021 IECC* (June 2021). Changes to trade-off backstops like this code change proposal (which utilizes U-factors and SHGCs less stringent than the prescriptive measures of the 2021 *IECC*) do not increase the stringency of that baseline or impose any additional costs to meet specific measures. In addition, if the prescriptive values are cost-effective, then the backstop values would be cost-effective. These backstops serve only as a consumer protection against excessive trade-offs, but do not require anything more than what would be required for base code compliance. Thus, a cost-effectiveness analysis would be difficult or impossible to apply and would not be informative.

REPI-118-21

REPI-119-21

IECC®: TABLE R405.2, TABLE R406.2

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

TABLE R405.2 (TABLE N1105.2) REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.9.1	Slab-on-grade floor insulation installation
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration U-factor and SHGC
Mechanical	
R403.1	Controls
R403.3, including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls

a. Reference to a code section includes all the relative subsections except as indicated in the table.

TABLE R406.2 (TABLE N1106.2) REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
General	
R401.2.5	Additional efficiency packages
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
<u>R402.2.9.1</u>	<u>Slab-on-grade insulation installation</u>
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
Mechanical	
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R406.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

Reason: Provisions for slab-on-grade floor insulation installation where added in a new subsection R402.2.9.1 in the 2021 IECC-R. While similar crawl space wall insulation installation provisions where included in the mandatory tables by referencing R402.2.10.1, the provisions in R402.2.9.1 for slab-on-grade floors were missed. These installation requirements are applicable to compliance with the performance paths of Sections R405.2 and R406.2. This proposal may be considered a “clean-up” of the re-formatting of mandatory provisions in the past code development cycle.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The installation practices are minimum requirements regardless of the compliance path. The ability to trade-off insulation criteria (i.e., R-value or depth) is not restricted or changed. Therefore, this proposal will not affect cost of compliance.

REPI-120-21

IECC®: TABLE R405.2, TABLE R406.2

Proponents: Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R405.2 (TABLE N1105.2) REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE

SECTION[a]	TITLE
General	
R401.2.5	Additional energy efficiency
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.8	Basement Walls
R402.2.8.1	Basment wall insulation installation
R402.2.9.1	Slab-on-grade floor insulation installation
R402.2.10.1	Crawl space wall insulation installations
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.4.2	Fireplaces
R402.4.3	Fenestration air leakage
R402.4.4	Rooms containing fuel burning appliances
R402.4.5	Recessed Lighting
R402.4.6	Electrical and communication outlet boxes(air sealed boxes)
R402.5	Maximum fenestration U-factor and SHGC
Mechanical	
R403.1	Controls
R403.2	Hot Water boiler temperature reset
R403.3, ~~including R403.3.1, except Sections R403.3.2, R403.3.3 and R403.6~~	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls

a. Reference to a code section includes all the relative subsections except as indicated in the table.

TABLE R406.2 (TABLE N1106.2) REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
General	
R401.2.5	Additional efficiency packages
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.8	Basement walls
R402.2.8.1	Basement wall insulation installation
R402.2.9.1	Slab-on-grade floor insulation installation
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.4.2	Fireplaces
R402.4.3	Fenetration air leakage
R402.4.4	Rooms containing fuel burning appliances
R402.4.5	Recessed lighting
R402.4.6	Electrical and communication outlet boxes (air sealed boxes)
Mechanical	
R403.1	Controls
R403.2	Hot water boiler temperature reset
R403.3 ~~except Sections R403.3.2, R403.3.3 and R403.3.6~~	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R406.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

Reason: Performance paths R405 and R406 really are the same in terms of how the energy model compares the as built home is modeled against a reference home. One's metric of compliance is energy cost and one is an ERI score but both have to be better than.
The objective of the different compliance paths is to offer flexibility to trade off components of the building thermal envelope. Primarily R-values and U-values. Section R405 and R406 allow some greater trade off opportunities which increases flexibility in choosing building assemblies and R-values and U-values primarily.

The intent how ever is that how the IECC calls out for things to be installed is consistent throughout the compliance path options. The pre 2021 IECC prescriptive and mandatory approach did not make this clear enough so the word requirements was adopted and these tables were created to demonstrate that the requirements pertained to all compliance approach choices.

This proposal fills out the table to better ensure parity between the different compliance approaches. Eave baffles was the main example used in the 2021 code development cycle. Just because one can trade off the R-value if attic insulation does not mean that you don’t have to install attic eave baffles in a ventilated attic assembly. In the same way the requirements added to the tables in this proposal all have to do with an installation requirement not an R-value or U-value that can be traded. These types of requirements need to be the same regardless of the compliance path chosen.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not increase cost but rather ensures that requirements of the IECC are equally required regardless of the compliance path option chosen.

REPI-121-21

IECC®: R405.2, CHAPTER 6 [RE], ASHRAE Chapter 06 (New)

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
R405.2 (N1105.2) Performance-based compliance.

Compliance based on total building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table R405.2.
2. The building thermal envelope shall be greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 *International Energy Conservation Code*.
3. An annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations.

   Exception: The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multipliers for ~~electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1~~ all energy sources shall be obtained from ASHRAE Standard 105 (Tables K2-A, K3-A, or K5) or Table 701.5.2 in the *International Green Construction Code* or from another data source *approved* by the *code official.*

CHAPTER 6 [RE] REFERENCED STANDARDS

Add new standard(s) as follows:

ASHRAE ASHRAE 180 Technology Parkway NW Peachtree Corners GA 30092

ASHRAE - 2021	ASHRAE 105 - 2021 Standard Methods for Determining, Expressing, and Comparing Building Energy Performance and Greenhouse Gas Emissions

Staff Note: Proponent unable to provide required copies prior to printing of monograph.

Reason Statement:

The current values in the code are not correct, as they have not been updated and do not account for regional or international differences and different key inputs. ASHRAE has updated these estimates on a regular basis, with explanations of how the estimates were derived. This proposal provides the locations of the updated estimates without reprinting the large tables into the IECC.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This only affects estimates of source energy used for total building performance analysis, and does not have any impact on construction costs.

REPI-121-21

REPI-122-21

IECC®: R405.2, R405.4, R405.4.1, R405.4.2, TABLE R405.4.2(1)

Proponents: Vladimir Kochkin, NAHB, representing NAHB (vkochkin@nahb.org)

2021 International Energy Conservation Code

Revise as follows:

R405.2 (N1105.2) Performance-based compliance. Compliance based on total building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table R405.2.
2. The building thermal envelope shall be greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 *International Energy Conservation Code*.
3. <u>The proposed total building thermal envelope UA, which is the sum of U-factor times the assembly area shall be less than or equal to the UA of the building thermal envelope using the prescriptive U-factors from Table R402.1.4 multiplied by 1.15 in accordance with Equation 4-1.</u>

   <u>Equation 4-1: $UA_{proposed\ design} <= 1.15 \times UA_{prescriptive\ reference}$ design.</u>

~~3~~ <u>4</u>. An annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. Code officials shall be permitted to require time-of-use pricing in energy cost calculations.

R405.4 (N1105.4) Calculation procedure. Calculations of the performance design shall be in accordance with Sections R405.4.1 and R405.4.2.

R405.4.1 (N1105.4.1) General. Except as specified by this section, the *standard reference design* and *proposed design* shall be configured and analyzed using identical methods and techniques.

R405.4.2 (N1105.4.2) Residence specifications. The *standard reference design* and *proposed design* shall be configured and analyzed as specified by Table R405.4.2(1). Table R405.4.2(1) shall include, by reference, all notes contained in Table R402.1.3.

TABLE R405.4.2(1) (TABLE N1105.4.2(1)) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS
Portions of table not shown remain unchanged.

<table>
<tr><th>BUILDING COMPONENT</th><th>STANDARD REFERENCE DESIGN</th><th colspan="3">PROPOSED DESIGN</th></tr>
<tr><td rowspan="7">Heating systems[d, e, i]</td><td>~~For other than electric heating without a heat pump: as proposed.~~
~~Where the proposed design utilizes electric heating without a heat pump, the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the IECC—Commercial Provisions.~~
~~Capacity: sized in accordance with Section R403.7.~~</td><td colspan="3">~~As proposed~~</td></tr>
<tr><td>Fuel Type/Capacity: Same as proposed design</td><td colspan="3">As proposed</td></tr>
<tr><td>Product class: Same as proposed design</td><td colspan="3">As proposed</td></tr>
<tr><td>Efficiencies:</td><td colspan="3"></td></tr>
<tr><td>Heat pump: Complying with 10 CFR §430.32 (2021)</td><td colspan="3">As proposed</td></tr>
<tr><td>Furnaces: Complying with 10 CFR §430.32 (2021)</td><td colspan="3">As proposed</td></tr>
<tr><td>Boilers: Complying with 10 CFR §430.32 (2021)</td><td colspan="3">As proposed</td></tr>
<tr><td rowspan="3">Cooling systems[d, f]</td><td>~~As proposed.~~
~~Capacity: sized in accordance with Section R403.7.~~</td><td colspan="3">~~As proposed~~</td></tr>
<tr><td>Fuel Type/Capacity: Same as proposed design</td><td colspan="3">As proposed</td></tr>
<tr><td>Efficiencies: Complying with 10 CFR §430.32 (2021)</td><td colspan="3">As proposed</td></tr>
<tr><td rowspan="7">Service water heating[d, g]</td><td rowspan="7">~~As proposed.~~
Use, in units of gal/day = 25.5 + (8.5 × N_{br})
where: N_{br} = number of bedrooms.</td><td colspan="3">~~As proposed~~
Use, in units of gal/day = 25.5 + (8.5 × N_{br}) × (1 – $HWDS$)
where:
N_{br} = number of bedrooms.
$HWDS$ = factor for the compactness of the hot water distribution system.</td></tr>
<tr><th colspan="2">Compactness ratio[i] factor</th><th rowspan="2">HWDS</th></tr>
<tr><td>1 story</td><td>2 or more stories</td></tr>
<tr><td>> 60%</td><td>> 30%</td><td>0</td></tr>
<tr><td>> 30% to ≤ 60%</td><td>> 15% to ≤ 30%</td><td>0.05</td></tr>
<tr><td>> 15% to ≤ 30%</td><td>> 7.5% to ≤ 15%</td><td>0.10</td></tr>
<tr><td>< 15%</td><td>< 7.5%</td><td>0.15</td></tr>
<tr><td></td><td>Fuel Type: Same as proposed design</td><td colspan="3">As proposed</td></tr>
<tr><td></td><td>Rated Storage Volume: Same as proposed design</td><td colspan="3">As proposed</td></tr>
<tr><td></td><td>Draw Pattern: Same as proposed design</td><td colspan="3">As proposed</td></tr>
<tr><td></td><td>Efficiencies: Uniform Energy Factor complying with 10 CFR §430.32 (2021)</td><td colspan="3">As proposed</td></tr>
<tr><td></td><td>Tank Temperature: 120° F (48.9° C)</td><td colspan="3">Same as standard reference design</td></tr>
</table>

g. For a proposed design ~~with a nonstorage-type water heater, a 40-gallon storage-type water heater having the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For a proposed design~~ without a proposed water heater, ~~a 40-gallon storage-type water heater having the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed~~ the following assumptions shall be made for both the proposed design and standard reference design.
Fuel Type: Same as the predominant heating fuel type
Rated Storage Volume: 40 Gallons
Draw Pattern: Medium
Efficiency: Uniform Energy Factor complying with

j. Electric resistance heating must use Split Systems-Heat Pumps HSPF2 found in 10 CFR §430.32 (2021) as the standard reference design.

Reason: The 2021 IECC introduced equipment with efficiencies above federal minimums as prescriptive compliance options (Section R408) for use with both performance and prescriptive paths. This proposed change improves the usability and consistency of the performance paths by including energy neutral equipment trade-offs directly within the performance path. The change will provide energy modelers the option to demonstrate code compliance fully through Section 405 (Performance Path) without the burden of combining performance design with a limited choice of prescriptive packages in Section R408, which in many respects defeats the purpose of the performance design.
There is a major inconsistency in Section R401.2.5 (Item 2) of 2021 IECC for the performance compliance path: Item 2.1 allows the use of high efficiency equipment for compliance through Section 408, whereas the parallel option - Item 2.2 - does not allow the use of higher efficiency equipment for compliance. There is no basis for this disparity and is a significant oversight.

Furthermore, the goals set out in the new IECC framework cannot be reasonably achieved without the option to use higher efficiency mechanical systems. Building envelope requirements are already at the levels that exceed rational cost effectiveness criteria, even on a life-cycle basis. Therefore, equipment efficiency must be a design choice in the performance path.

This proposal provide a balanced approach to energy neutral trade-offs by including an additional thermal envelope backstop via a UA calculation. (We leave it to the judgment of the committee whether the current backstop to 2009 IECC is already sufficient or if both backstops are needed.) The UA calculation will be performed internally with the compliance software. It is an easy calculation as all the necessary information is already entered (component area and U-factors/R-values) and a similar calculation is done for windows. Energy neutral equipment trade-offs had been in the IECC residential section in the past. Equipment trade-offs are included in every other energy code/standard and above code program in the United States:

IECC Commercial

ASHRAE 90.1

IgCC

National Green Building Standard

LEED Commercial

LEED for Homes

EnergyStar

RESNET 301

Cost Impact: The code change proposal will decrease the cost of construction.
This change will help achieve higher performing dwellings while adding flexibility. It will provide an option to optimize performance and increase cost-effectiveness.

REPI-123-21

IECC®: TABLE R405.4.2(1)

Proponents:

Amanda Hickman, representing Leading Builders of America (LBA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R405.4.2(1) (TABLE N1105.4.2(1)) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Above-grade walls	Type: mass where the proposed wall is a mass wall; otherwise wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	U-factor: as specified in Table R402.1.2.	As proposed
	Solar absorptance = 0.75.	As proposed
	Emittance = 0.90.	As proposed
Basement and crawl space walls	Type: same as proposed.	As proposed
	Gross area: same as proposed.	As proposed
	U-factor: as specified in Table R402.1.2 , with the insulation layer on the interior side of the walls.	As proposed
Above-grade floors	Type: wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	U-factor: as specified in Table R402.1.2.	As proposed
Ceilings	Type: wood frame.	As proposed
	Gross area: same as proposed.	As proposed
	U-factor: as specified in Table R402.1.2.	As proposed
Roofs	Type: composition shingle on wood sheathing.	As proposed
	Gross area: same as proposed.	As proposed
	Solar absorptance = 0.75.	As proposed
	Emittance = 0.90.	As proposed
Attics	Type: vented with an aperture of 1 ft^2 per 300 ft^2 of ceiling area.	As proposed
Foundations	Type: same as proposed.	As proposed
	Foundation wall area above and below grade and soil characteristics: same as proposed.	As proposed

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Opaque doors	Area: 40 ft^2.	As proposed
	Orientation: North.	As proposed
	U-factor: same as fenestration as specified in Table R402.1.2 .	As proposed
Vertical fenestration other than opaque doors	Total area[h] = (a) The proposed glazing area, where the proposed glazing area is less than 15 percent of the conditioned floor area. (b) 15 percent of the conditioned floor area, where the proposed glazing area is 15 percent or more of the conditioned floor area.	As proposed
	Orientation: equally distributed to four cardinal compass orientations (N, E, S & W).	As proposed
	U-factor: as specified in Table R402.1.2.	As proposed
	SHGC: as specified in Table R402.1.2 except for climate zones without an SHGC requirement, the SHGC shall be equal to 0.40.	As proposed
	Interior shade fraction: 0.92 – (0.21 × SHGC for the standard reference design).	Interior shade fraction: 0.92 – (0.21 × SHGC as proposed)
	External shading: none	As proposed
Skylights	None	As proposed
Thermally isolated sunrooms	None	As proposed
Air exchange rate	The air leakage rate at a pressure of 0.2 inch w.g. (50 Pa) shall be Climate Zones 0 through 2: 5.0 air changes per hour. Climate Zones 3 through 8: 3.0 air changes per hour.	The measured air exchange rate.[a]
	The mechanical ventilation rate shall be in addition to the air leakage rate and shall be the same as in the proposed design, but not greater than $0.01 \times CFA + 7.5 \times (N_{br} + 1)$ where: CFA = conditioned floor area, ft^2. N_{br} = number of bedrooms. The mechanical ventilation system type shall be the same as in the proposed design. Energy recovery shall not be assumed for mechanical ventilation.	The mechanical ventilation rate[b] shall be in addition to the air leakage rate and shall be as proposed.
Mechanical ventilation	Where mechanical ventilation is not specified in the proposed design: None Where mechanical ventilation is specified in the proposed design, the annual vent fan energy use, in units of kWh/yr, shall equal $(1/e_f) \times [0.0876 \times CFA + 65.7 \times$	As proposed

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	$(N_{br}+1)]$ where: e_f = the minimum fan efficacy, as specified in Table 403.6.2, corresponding to the system type at a flow rate of $0.01 \times CFA + 7.5 \times (N_{br}+1)$ CFA = conditioned floor area, ft^2. N_{br} = number of bedrooms.	
Internal gains	IGain, in units of Btu/day per dwelling unit, shall equal $17{,}900 + 23.8 \times CFA + 4{,}104 \times N_{br}$ where: CFA = conditioned floor area, ft^2. N_{br} = number of bedrooms.	Same as standard reference design.
Internal mass	Internal mass for furniture and contents: 8 pounds per square foot of floor area.	Same as standard reference design, plus any additional mass specifically designed as a thermal storage element[c] but not integral to the building envelope or structure.
Structural mass	For masonry floor slabs: 80 percent of floor area covered by R-2 carpet and pad, and 20 percent of floor directly exposed to room air.	As proposed
	For masonry basement walls: as proposed, but with insulation as specified in Table R402.1.3, located on the interior side of the walls.	As proposed
	For other walls, ceilings, floors, and interior walls: wood frame construction.	As proposed
Heating systems[d, e]	~~For other than electric heating without a heat pump: as proposed.~~ ~~Where the proposed design utilizes electric heating without a heat pump, the standard reference design shall be an air source heat pump meeting the requirements of Section C403 of the IECC—Commercial Provisions.~~ ~~Capacity: sized in accordance with Section R403.7.~~ Fuel Type/Capacity: Same as proposed design Efficiencies: Electric: air source heat pump complying with prevailing federal minimum standards. Nonelectric furnaces: natural gas furnace complying with prevailing federal minimum standards. Nonelectric boilers: natural gas boiler complying with	~~As proposed~~ As proposed As proposed As proposed As proposed

<table>
<tr><th>BUILDING COMPONENT</th><th>STANDARD REFERENCE DESIGN</th><th>PROPOSED DESIGN</th></tr>
<tr><td></td><td>prevailing federal minimum efficiencies.</td><td></td></tr>
<tr><td>Cooling systems[d, f]</td><td>~~As proposed.~~
~~Capacity: sized in accordance with Section R403.7.~~

Fuel Type/Capacity:Same as proposed design

Efficiency: complying with federal minimum standards</td><td>~~As proposed~~

As proposed

As proposed</td></tr>
<tr><td>Service water heating[d, g]</td><td>~~As proposed.~~
~~Use, in units of gal/day = 25.5 + (8.5 × N_{br})~~
~~where: N_{br} = number of bedrooms.~~

Fuel type: Same as proposed design

Efficiency: complying with prevailing federal minimum standards

Use: gal/day = 30 + 10 x Nbr

Tank temperature: 120°F (48.9°C)</td><td>~~As proposed~~
~~Use, in units of gal/day = 25.5 + (8.5 × N_{br}) × (1 – *HWDS*)~~
~~where:~~
~~N_{br} = number of bedrooms.~~
~~*HWDS* = factor for the compactness of the hot water distribution system.~~

As proposed

As proposed

Same as standard reference

Same as standard reference
<table>
<tr><th colspan="2">Compactness ratio[i] ~~factor~~</th><th>HWDS</th></tr>
<tr><td>1 story</td><td>2 or more stories</td><td></td></tr>
<tr><td>> 60%</td><td>> 30%</td><td>0</td></tr>
<tr><td>> 30% to ≤ 60%</td><td>> 15% to ≤ 30%</td><td>0.05</td></tr>
<tr><td>> 15% to ≤ 30%</td><td>> 7.5% to ≤ 15%</td><td>0.10</td></tr>
<tr><td>< 15%</td><td>< 7.5%</td><td>0.15</td></tr>
</table></td></tr>
<tr><td>Thermal distribution systems</td><td>Duct insulation: in accordance with Section R403.3.1.
A thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies for all systems other than tested duct systems.
Duct location: same as proposed design.
Exception: For nonducted heating and cooling systems that do not have a fan, the standard reference design thermal distribution system efficiency (DSE) shall be 1.
For tested duct systems, the leakage rate shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of *conditioned*</td><td>Duct location: as proposed.

Duct insulation: as proposed.

As tested or, where not tested, as specified in Table R405.4.2(2).</td></tr>
</table>

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
	floorarea at a pressure of differential of 0.1 inch w.g. (25 Pa).	
Thermostat	Type: Manual, cooling temperature setpoint = 75°F; Heating temperature setpoint = 72°F.	Same as standard reference design.
Dehumidistat	Where a mechanical ventilation system with latent heat recovery is not specified in the proposed design: None. Where the proposed design utilizes a mechanical ventilation system with latent heat recovery: Dehumidistat type: manual, setpoint = 60% relative humidity. Dehumidifier: whole-dwelling with integrated energy factor = 1.77 liters/kWh.	Same as standard reference design.

For SI: 1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US) = 3.785 L, °C = (°F – 32)/1.8, 1 degree = 0.79 rad.

- a.

  Where required by the code official, testing shall be conducted by an approved party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals,* or the equivalent, shall be used to determine the energy loads resulting from infiltration.

- b.

  The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals*, page 26.24 and the “Whole-house Ventilation” provisions of 2001 ASHRAE *Handbook of Fundamentals,* page 26.19 for intermittent mechanical ventilation.

- c.

  Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.

- d.

  For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

- e.

  For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

- f.

  For a proposed design home without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

- g.

  For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater having the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For a proposed design without a proposed water heater, a 40-gallon storage-type water heater having the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.

- h.

  For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:

  - .

    $AF = A_s \times FA \times F$

  - .

    where:

  - .

    AF = Total glazing area.

  - .

    A_s = Standard reference design total glazing area.

  - .

    FA = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).

  - .

    F = (above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.

  - .

    and where:

  - .

    Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.

– .

Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.

– .

Below-grade boundary wall is any thermal boundary wall in soil contact.

– .

Common wall area is the area of walls shared with an adjoining dwelling unit.

• i.

The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the "hot water rectangle") divided by the floor area of the dwelling.

– 1.

Sources of hot water include water heaters, or in multifamily buildings with central water heating systems, circulation loops or electric heat traced pipes.

– 2.

The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping.

– 3.

The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.

– 4.

Where there is more than one water heater and each water heater serves different plumbing fixtures and appliances, it is permissible to establish a separate hot water rectangle for each hot water distribution system and add the area of these rectangles together to determine the compactness ratio.

– 5.

The basement or attic shall be counted as a story when it contains the water heater.

– 6.

Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and *HWDS* factor.

Reason:

The intent of this code change is to build optimal flexibility in achieving increased energy savings. Adding the ability to trade off mechanical equipment for envelope provisions that are not cost-effective is an energy neutral solution to preserving home affordability.

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposal allows for energy neutral trade-offs that will likely be more cost effective and could lead to the decrease in the cost of construction.

REPI-124-21

IECC®: TABLE R405.4.2(1)

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R405.4.2(1) (TABLE N1105.4.2(1)) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Air exchange rate	The air leakage rate at a pressure of 0.2 inch w.g. (50 Pa) shall be Climate Zones 0 through 2: 5.0 air changes per hour. Climate Zones 3 through 8: 3.0 air changes per hour.	The measured air exchange rate.[a]
	The mechanical ventilation rate shall be in addition to the air leakage rate and shall be the same as in the proposed design, but not greater than B x M~~0.01 × *CFA* + 7.5 × (N_{br} + 1)~~ where: B = 0.01 × *CFA* + 7.5 × (N_{br} + 1), cfm. *M = 1.0 where the measured air exchange rate is > = 3.0 air changes per hour at 50 Pascals, and otherwise, M = minimum (1.7, Q/B)* *Q = the proposed mechanical ventilation rate, cfm.* *CFA* = conditioned floor area, ft^2. N_{br} *= number of bedrooms.* *The mechanical ventilation system type shall be the same as in the proposed design. Energy recovery shall not be assumed for mechanical ventilation.*	The mechanical ventilation rate[b], Q, shall be in addition to the air leakage rate and shall be as proposed.
Mechanical ventilation	Where mechanical ventilation is not specified in the proposed design: None Where mechanical ventilation is specified in the proposed design, the annual vent fan energy use, in units of kWh/yr, shall equal ~~(1/e_f) × [0.0876 × *CFA* + 65.7 × (N_{br}+1)]~~ (8.76 × B × M)/e_f where: B and M are determined in accordance with the Air Exchange Rate row of this table. e_f = the minimum fan efficacy, as specified in Table 403.6.2, corresponding to the system type at a flow rate of B × M~~(0.01 × *CFA* + 7.5 × (N_{br}+1))~~. *CFA* = conditioned floor area, ft^2.	As proposed

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN

N_{br} = number of bedrooms.

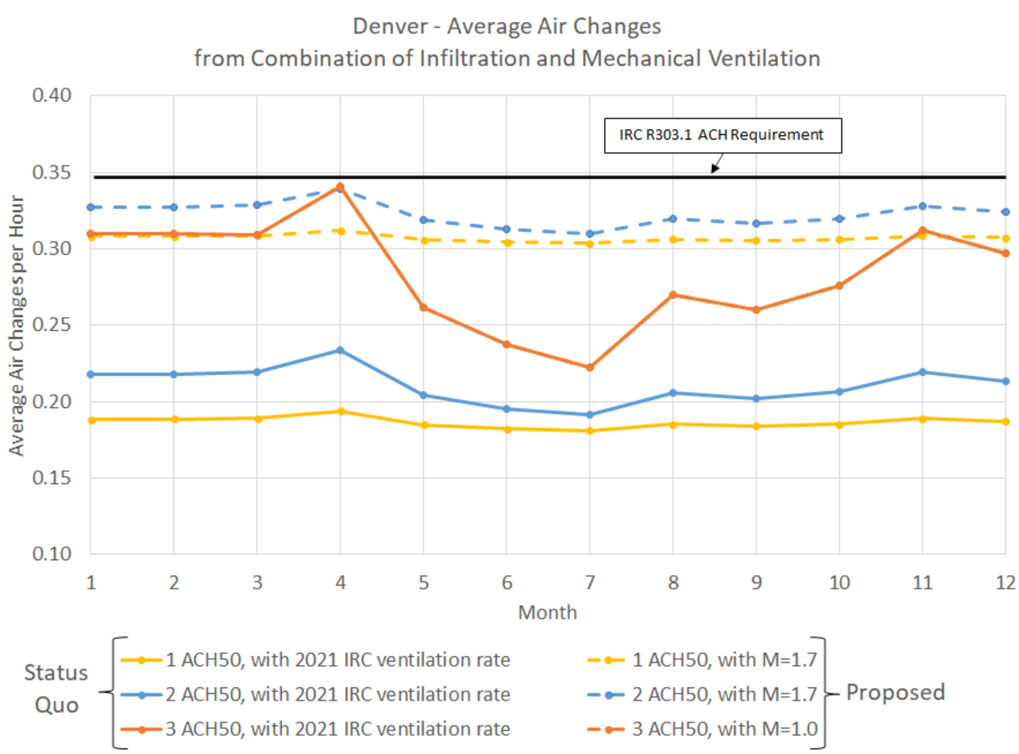
Attached Files

- **Denver Average Air Changes.png**
  http://localhost/proposal/272/912/files/download/201/
- **Mechanical Ventilation as Function of Envelope Tightness.png**
  http://localhost/proposal/272/912/files/download/200/

Reason Statement:

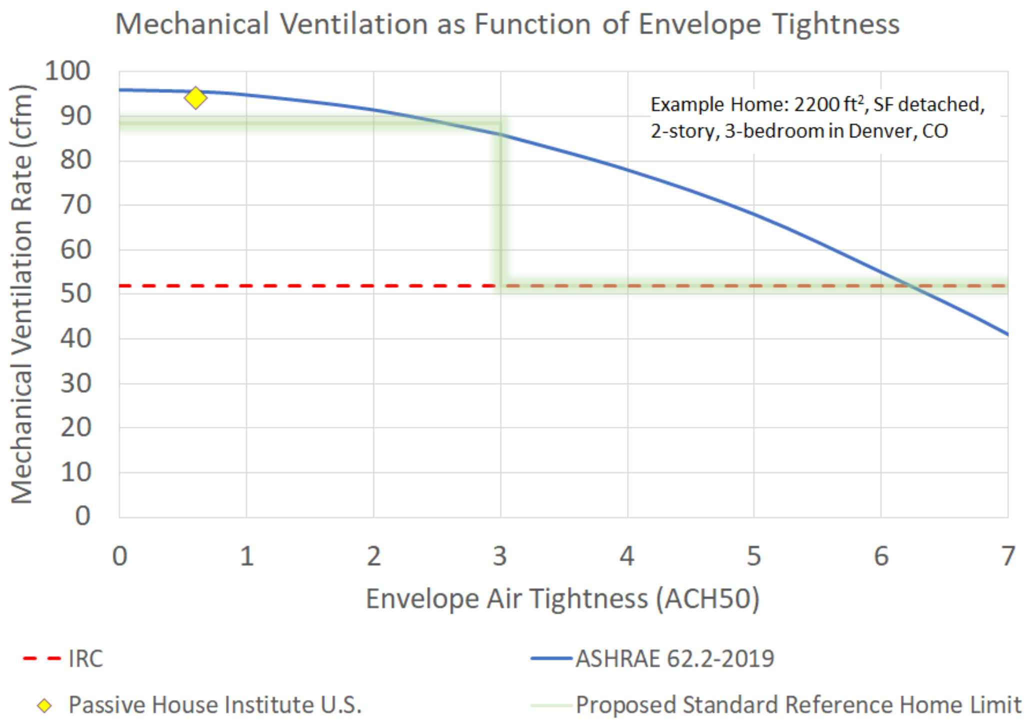
Within very tight homes, this proposal would permit builders and homeowners to increase mechanical ventilation rates to a more reasonable level without imposing an IECC performance path penalty. The IECC incentivizes builders to build as tightly as possible, which is good. However, the IECC penalizes builders for providing mechanical ventilation at rates that are minimally compliant with consensus standards (ASHRAE 62.2-2019), minimally compliant with IRC R303.1, and that are above the minimum required by IRC M1505.4.3; this is bad. Because the IRC M1505.4.3 mechanical ventilation rate is not calculated as a function of the building envelope air tightness, the combination of the IECC and IRC requirements encourages builders to build homes with air changes that can be ~50% lower than the 0.35 air changes per hour (ACH) that has traditionally been the target for minimum acceptable indoor air quality (see IRC Section R303.1).

The following graph shows monthly average air changes rates (i.e., total air changes resulting from mechanical ventilation combined with infiltration from building envelope leakage) in Denver, CO for a typical 2200 ft^2 single-family dwelling unit, calculated using the ASHRAE Handbook of Fundamentals.[1] The solid lines show the monthly average air changes resulting from a builder tightening a home without increasing the minimum IRC M1505.4.3 mechanical ventilation rate. At 3.0 ACH50, the home is expected to have an annual average air change rate of 0.28 ACH, which is 20% lower than the 0.35 ACH target. However, if the same home is tightened to 1.0 ACH50 without increasing the mechanical ventilation rate, the annual average air change rate decreases to 0.18 ACH, which is almost 50% lower than the 0.35 ACH target! To incentivize builders to build tight without penalizing them for providing reasonable number of air changes, the performance path's standard reference mechanical ventilation rate should permit higher ventilation rates for very tight construction (i.e., < 3.0 ACH50). In the example chart below, the dashed lines show the maximum air change rate (combined infiltration and mechanical ventilation rate) for the standard reference home that would be permitted by this proposal. These rates are still lower than the traditional 0.35 ACH target and strike a more reasonable balance between health and energy concerns than Table R405.4.2(1)'s current language.



Why did the ASHRAE Ventilation Rates and IRC Ventilation Rates Diverge?

The IRC M1505.4.3 ventilation rate was developed based on the ASHRAE 62.2-2010 ventilation rate equation, which was built around the assumption of the ventilation system being installed in a fairly leaky building that was typical practice at the time (i.e., ~6 - 7 ACH50). In 2012, the IECC required building air sealing to be verified by a blower door test for the first time. In 2013, ASHRAE 62.2 responded to the IECC building air sealing requirements by changing the ventilation rate equation to be a function of the building envelope air tightness level. This change by ASHRAE was intended to provide an occupant with the same amount of fresh air (on an annual basis), regardless of how tightly the occupant's home is constructed. Unfortunately, the IRC M1505.4.3 ventilation rates have not kept pace with improvements in building air sealing. The chart below illustrates how ASHRAE 62.2-2019 rates change as a function of envelope air tightness, which results in comparable fresh air regardless of building tightness. This proposal would permit tight homes (i.e., those with an air tightness below 3 ACH50) to step up their mechanical ventilation rate to a rate comparable to the ASHRAE 62.2-2019 and the IRC R303.1 minimum ventilation rate without penalty.



<u>Why is it Important to have the OPTION to Specify Higher, Reasonable Ventilation Rates without Penalty?</u>

The total ventilation rates promulgated by ASHRAE 62.2-2019 and IRC R303.1 have long been referenced as rates needed to provide minimum acceptable indoor air quality. It is expected that occupants seeking improved IAQ may elect to use these rates that are higher than the IRC M1505.4.3 minimum to reduce pollutant concentration and support better productivity and health outcomes, which have also been linked to increases in wages. Studies that have shown better health outcomes or improved performance for building occupants as a function of higher ventilation rates include:

- Sundell[2]: Sick building syndrome declines as ventilation rate increases.
- Milton[3]: Sick leave decreases as ventilation rate increases.
- Bornehag[4]: Risk of asthma for children increases with decreasing ventilation rate in homes.
- Seppänen[5] : Productivity decreases with decreasing ventilation rate.
- Tejsen[6]: Productivity increases with increasing residential ventilation rate.

While some of these studies were conducted in commercial buildings, LBNL's[7] analysis of residential studies concluded that, “Just over half of (residential) studies report one or more statistically significant health benefits of increased ventilation rates.” LBNL noted that, “The findings of research on how ventilation rates in homes affect health are mixed,” but that “overall… the number of reported statistically significant improvements in health with increased ventilation rates far exceeded the anticipated chance improvements in health.”

Additional Q&A

Q1: What happens if the proposed building envelope is 3 ACH50 or greater?

A1: There is no change to current requirements.

Q2: What happens if the builder doesn't increase the proposed design mechanical ventilation rate beyond the IRC Section M1505.4.3 minimum?

A2: In this case, Q/B = 1, M = 1 (i.e., minimum(1.7, Q/B) = 1), BxM = B, and there is no change to the current requirements.

Q3: What if the builder triples the proposed design mechanical ventilation rate beyond the IRC Section M1505.4.3 minimum?

A3: In this case, Q/B = 3, M = 1.7 (i.e., minimum(1.7, Q/B), and BxM = 1.7B, meaning the mechanical ventilation rate of the standard reference home increases to 1.7 times the IRC Section M1505.4.3 minimum. The builder would be penalized for the energy use associated with the difference between the proposed design mechanical ventilation rate of 3B and the standard reference home's ventilation rate of 1.7B.

Bibliography:

1. ASHRAE Handbook of Fundamentals. 2017. Chapter 17 Enhanced Model.
2. Sundell et al. 1994. Sick Building Syndrome (SBS) in Office Workers and Facial Skin Symptoms among VDT-Workers in Relation to Building and Room Characteristics: Two Case-Referent Studies. Indoor Air, 4: 83-94.
3. Milton et al. 2000. Risk of Sick Leave Associated with Outdoor Air Supply Rate, Humidification, and Occupant Complaints. Indoor Air, 10:212-221.
4. Bornehag, C & Sundell, Jan & Hägerhed, Linda. (2003). Asthma and allergy among children and the association to ventilation rate at home, a case control study. Epidemiology. 14. 10.1097/00001648-200309001-00224.
5. Seppänen, O. A., and W. Fisk. 2006. Some quantitative relations between indoor environmental quality and work performance or health. HVAC&R Research 12 (4):957–73. doi:10.1080/10789669.2006.10391446.
6. Tejsen et al. 2016. The effects of bedroom air quality on sleep and next-day performance. Indoor Air, 26:679-686.
7. LBNL. Indoor Air Quality Scientific Findings Resource Bank. Building Ventilation. Accessed May 6, 2021. https://iaqscience.lbl.gov/ventsummary#:~:text=Just%20over%20half%20of%20studies,improve%20with%20increased%20ventila

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

In some cases, this proposal could increase the estimated savings associated with mechanical ventilation systems in very tight construction. This could help to reduce construction costs.

REPI-124-21

REPI-125-21

IECC®: TABLE R405.4.2(1)

Proponents:

Maston Stafford, US-EcoLogic, representing US-EcoLogic (maston.stafford@texenergy.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE R405.4.2(1) (TABLE N1105.4.2(1)) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Foundations	Type: same as proposed.[i]	As proposed
	Foundation wall area above and below grade and soil characteristics: same as proposed.	As proposed

For SI: 1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US) = 3.785 L, °C = (°F – 32)/1.8, 1 degree = 0.79 rad.

a. Where required by the code official, testing shall be conducted by an approved party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals,* or the equivalent, shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals,* page 26.24 and the "Whole-house Ventilation" provisions of 2001 ASHRAE *Handbook of Fundamentals,* page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

f. For a proposed design home without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

g. For a proposed design with a nonstorage-type water heater, a 40-gallon storage-type water heater having the prevailing federal minimum energy factor for the same fuel as the predominant heating fuel type shall be assumed. For a proposed design without a proposed water heater, a 40-gallon storage-type water heater having the prevailing federal minimum efficiency for the same fuel as the predominant heating fuel type shall be assumed for both the proposed design and standard reference design.

For residences with conditioned basements, R-2 and R-4 residences, and for townhouses, the following formula shall be used to determine glazing area:

. $AF = A_s \times FA \times F$

. where:

. AF = Total glazing area.

. A_s = Standard reference design total glazing area.

h.

. FA = (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).

. F = (above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.

. and where:

. Thermal boundary wall is any wall that separates conditioned space from unconditioned space or ambient conditions.

. Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.

. Below-grade boundary wall is any thermal boundary wall in soil contact.

. Common wall area is the area of walls shared with an adjoining dwelling unit.

i.

The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the “hot water rectangle”) divided by the floor area of the dwelling.

1. Sources of hot water include water heaters, or in multifamily buildings with central water heating systems, circulation loops or electric heat traced pipes.
2. The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping.
3. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.
4. Where there is more than one water heater and each water heater serves different plumbing fixtures and appliances, it is permissible to establish a separate hot water rectangle for each hot water distribution system and add the area of these rectangles together to determine the compactness ratio.
5. The basement or attic shall be counted as a story when it contains the water heater.

6. Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and *HWDS* factor.

j. For a proposed design dwelling unit designated by the *code official* to be exempt from slab-edge insulation due to having a very heavy termite infestation probability, any standard reference design slab-on-grade floor will not have insulation.

Reason Statement:

This proposal is intended to clarify that the standard reference design home will not have insulation for slab-on-grade floors when the slab-edge insulation exemption is used for the Total Building Performance path.

Section R402.2.9 Slab-on-grade Floors has an exemption that slab-edge insulation is not required in jurisdictions designated by the *code official* as having a “very heavy” termite infestation. IRC Figure R318.4 indicates the areas of the country that have a "very heavy" termite infestation probability.

Prior to the 2021 version of the IECC, slab edge insulation was only required in climate zone 4 and above. The “very heavy” termite infestation probability map only included a tiny portion of climate zone 4. This exemption was never addressed for the Performance Path in prior versions of the IECC. When the slab-edge insulation requirement from 2021 IECC Table R402.1.3 was included in climate zone 3, how the slab-edge exemption is used in section R405 became an issue for the “very heavy” termite infestation probability jurisdictions. By overlaying the “very heavy” probability portion of IRC Figure R318.4 to the IECC Figure R301.1 Climate Zones map, roughly half of climate zone 3A has a “very heavy” termite infestation probability. The exemption was never addressed in Section 405 of the 2021 IECC leaving it unclear how slab-on-grade floors should be modeled when the exemption is used.

The impact this makes on the R405 Total Building Performance calculations is significant. As an example: A 1,442 square foot single-family single-story home with a slab-on-grade foundation was entered into RESCheck Online for 2021 IECC total building performance compliance. Two locations were selected: Atlanta, Georgia and McKinney, Texas both in Climate Zone 3A and a very heavy termite infestation probability. These two locations have not adopted 2021 IECC and are only used for example purposes. The insulation levels and orientation were input so that the home would just meet 2021 IECC performance path. This included slab edge insulation of R-10 at a 2 ft. depth equal to the minimum required by Table R402.1.3. The home in Atlanta calculated 0.4% better than code and in McKinney calculated 0.8% better than code. By only removing the slab insulation and making no other changes to the proposed design, the two homes calculated as failing 2021 total building performance by -50% and -25% respectfully. This is because the standard reference design home still has a slab-on-grade floor with R-10 insulation at 2 ft. depth meeting the insulation level of Table R402.1.3 for climate zone 3A. No other energy efficiency measures can cost effectively offset this slab-edge insulation exemption in the total building performance calculations. The standard reference design home needs to change if the slab-edge insulation cannot be used in the proposed design.

Bibliography:

2021 International Residential Code Figure R318.4 Termite Infestation Probability Map

Cost Impact:

The code change proposal will decrease the cost of construction.

The impact that the slab-edge insulation exemption makes on R405 Total Building Performance calculations without this added footnote is so significant, the price of the additional energy efficiency measures that would be required to offset the removal of slab-edge insulation on the proposed design would be too substantial if not impossible. Therefore, this code change proposal would decrease the cost of construction for a dwelling unit using the Total Building Performance path where the slab-edge insulation exemption is required.

REPI-125-21

REPI-126-21

IECC®: R406.2, TABLE R406.2, R406.3, R406.3.1, R406.3.2, R406.4, R406.5, TABLE R406.5, R406.6, R406.7, R406.7.1, R406.7.2, R406.7.2.1, R406.7.2.2, R406.7.3, R406.7.4, R406.7.5, R406.7.6

Proponents: Robby Schwarz, BUILDTank, Inc., representing BUILDTank, Inc. (robby@btankinc.com)

2021 International Energy Conservation Code

Revise as follows:

R406.2 (N1106.2) ERI compliance. Compliance based on the Energy Rating Index (ERI) requires that the rated design meets all of the following:

1. The requirements of the sections indicated within Table R406.2.
2. Maximum ERI values indicated in of Table R406. 4 ~~5~~.

TABLE R406.2 (TABLE N1106.2) REQUIREMENTS FOR ENERGY RATING INDEX

SECTION[a]	TITLE
General	
R401.2.5	Additional efficiency packages
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.8	Basement walls
R402.8.1	Basement wall insulation installation
R402.2.9.1	Slab-on-grade floor insulation installation
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.4.2	Fireplaces
R402.4.3	Fenetration air leakage
R402.4.4	Rooms Containing fuel burning appliances
R402.4.5	Recessed Lighting
R402.4.6	Electrical and Communication outlet boxes (air sealed boxes)
Mechanical	
R403.1	Controls
R403.2	Hot water boiler temperature reset
R403.3 ~~except Sections R403.3.2, R403.3.3 and R403.3.6~~	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent residential spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls
R406.3	Building thermal envelope

a. Reference to a code section includes all of the relative subsections except as indicated in the table.

Delete without substitution:

~~**R406.3 Building thermal envelope.** Building and portions thereof shall comply with Section R406.3.1 or R406.3.2.~~

~~**R406.3.1 On-site renewables are not included.** Where on-site renewable energy is not included for compliance using the ERI analysis of Section R406.4, the proposed total building thermal envelope UA, which is sum of *U*-factor times assembly area, shall be less than or equal to the building thermal envelope UA using the prescriptive *U*-factors from Table R402.1.2 multiplied by 1.15 in accordance with Equation 4-1. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.~~

$UA_{\text{Proposed design}} = 1.15 \times UA_{\text{Prescriptive reference design}}$ ~~**(Equation 4-1)**~~

~~**R406.3.2 On-site renewables are included.** Where on-site renewable energy is included for compliance using the ERI analysis of Section R406.4, the *building thermal envelope* shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2018 *International Energy Conservation Code.*~~

Revise as follows:

R406.3 ~~**R406.4 (N1106.4)**~~ **Energy Rating Index.** The Energy Rating Index (ERI) shall be determined in accordance with the most recent publication of the ANSI/RESNET/ICC 301 standard. ~~except for buildings covered by the *International Residential Code* , the ERI reference design ventilation rate shall be in accordance with Equation 4-2.~~

~~**(Equation 4-2)**~~

Delete equation that is an image

~~Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the building site shall not be included in the *ERI reference design* or the *rated design*. For compliance purposes, any reduction in energy use of the rated design associated with on-site renewable energy shall not exceed 5 percent of the total energy use.~~

R406.4 ~~**R406.5 (N1106.5)**~~ **ERI-based compliance.** Compliance based on an ERI analysis requires that the *rated proposed design* and confirmed built dwelling be shown to have an ERI score without and with on-site power production (OPP) less than or equal to the appropriate value indicated in Table R406. 4 ~~5~~ when compared to the *ERI reference design*.

TABLE R406.4 ~~R406.5 (TABLE N1106.5)~~ MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX without OPP	ENERGY RATING INDEX with OPP[a]
0- 1	52	52 or less
2	52	52 or less
3	51	51 or less
4	54	54 or less
5	55	55 or less
6	54	54 or less
7	53	53 or less
8	53	53 or less

a. Installation of Onsite Power production is not a requirement. If it is installed the ERI score with OPP must be equal to or lower than the ERI score without OPP.

R406.5 ~~R406.6 (N1106.6)~~ Verification by approved agency. Verification of compliance with Section R406 as outlined in Sections R406.3 ~~R406.4~~ and R406.5 ~~R406.6~~ shall be completed by an *approved* third party. Verification of compliance with Section R406.2 shall be completed by the authority having jurisdiction or an *approved* third-party inspection agency in accordance with Section R105.4.

R406.6 ~~R406.7 (N1106.7)~~ Documentation. Documentation of the software used to determine the ERI and the parameters for the *residential building* shall be in accordance with Sections R406.6.1 ~~R406.7.1~~ through ~~R406.7.4~~ R406.6.4.

R406.6.1 ~~R406.7.1 (N1106.7.1)~~ Compliance software tools. Software tools used for determining ERI shall be *Approved* Software Rating Tools in accordance with ANSI/RESNET/ICC 301.

R406.6.2 ~~R406.7.2 (N1106.7.2)~~ Compliance report. Compliance software tools shall generate a report that documents that the home and the ERI score of the *rated design* complies with Sections R406.2, R406.3 and R406.4 . Compliance documentation shall be created for the proposed design and shall be submitted with the application for the building permit. Confirmed compliance documents of the built *dwelling unit* shall be created and submitted to the code official for review before a certificate of occupancy is issued. Compliance reports shall include information in accordance with Sections R406.6 .2.1 ~~R406.7.2.1~~ and R406.6 .2.2 ~~R406.7.2.2~~.

R406.6.2.1 ~~R406.7.2.1 (N1106.7.2.1)~~ Proposed compliance report for permit application. Compliance reports submitted with the application for a building permit shall include the following:

1. Building street address, or other *building site* identification.
2. Declare ERI on title page and building plans.
3. The name of the individual performing the analysis and generating the compliance report.
4. The name and version of the compliance software tool.
5. Documentation of all inputs entered into the software used to produce the results for the reference design and/or the rated home.
6. A certificate indicating that the proposed design has an ERI less than or equal to the appropriate score indicated in Table R406.5 when compared to the ERI reference design. The certificate shall document the building component energy specifications that are included in the calculation, including: component level insulation *R*-values or *U*-factors; assumed duct system and building envelope air leakage testing results; and the type and rated efficiencies of proposed heating, cooling, mechanical ventilation, and service water-heating equipment to be installed. If on-site renewable energy systems will be installed, the certificate shall report the type and production size of the proposed system.
7. When a site-specific report is not generated, the proposed design shall be based on the worst-case orientation and configuration of the rated home.

R406.6.2.2 ~~R406.7.2.2 (N1106.7.2.2)~~ Confirmed compliance report for a certificate of occupancy. A confirmed compliance report submitted for obtaining the certificate of occupancy shall be made site and address specific and include the following:

1. Building street address or other *building site* identification.
2. Declaration of ERI on title page and on building plans.
3. The name of the individual performing the analysis and generating the report.
4. The name and version of the compliance software tool.
5. Documentation of all inputs entered into the software used to produce the results for the reference design and/or the rated home.

6. A final confirmed certificate indicating that the confirmed rated design of the built home complies with Sections R406.2 and R406.4. The certificate shall report the energy features that were confirmed to be in the home, including: component-level insulation *R*-values or *U*-factors; results from any required duct system and building envelope air leakage testing; and the type and rated efficiencies of the heating, cooling, mechanical ventilation, and service water-heating equipment installed. Where on-site renewable energy systems have been installed on or in the home, the certificate shall report the type and production size of the installed system.

R406.6.3 ~~R406.7.3 (N1106.7.3)~~ **Renewable energy certificate (REC) documentation.** Where on-site renewable energy is included in the calculation of an ERI, one of the following forms of documentation shall be provided to the code official:

1. Substantiation that the RECs associated with the on-site renewable energy are owned by, or retired on behalf of, the homeowner.
2. A contract that conveys to the homeowner the RECs associated with the on-site renewable energy, or conveys to the homeowner an equivalent quantity of RECs associated with other renewable energy.

R406.6.4 ~~R406.7.4 (N1106.7.4)~~ **Additional documentation.** The *code official* shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the *ERI reference design*.
2. A certification signed by the builder providing the building component characteristics of the *rated design.*
3. Documentation of the actual values used in the software calculations for the *rated design*.

R406.6.5 ~~R406.7.5 (N1106.7.5)~~ **Specific approval.** Performance analysis tools meeting the applicable subsections of Section R406 shall be *approved*. Documentation demonstrating the approval of performance analysis tools in accordance with Section R406.7.1 shall be provided.

R406.6.6 ~~R406.7.6 (N1106.7.6)~~ **Input values.** Where calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from RESNET/ICC 301.

Reason: The current ERI compliance alternative is overly complicated due to a lack of understanding of the energy modeling that produces an ERI index score. Because of this the Code ERI score is significantly different than other ERI system generated score which creates a lack of confidence in the compliance path, energy modeling in general, and ERI scores specifically.
Let's being with backstops. This proposal requires an ERI compliance score without onsite renewables/ onsite power production (OPP) and with OPP. It should be noted that ERI scores can only account for renewable energy that is generated on side. Offsite utility solar or wind energy, community solar gardens, and the like cannot be incorporated into the generation of an ERI score at this time.

Backstops in the current ERI compliance path complicate use of an ERI score, making the ERI compliance path the most restrictive path that is far from equal to the energy performance achieved by the other available compliance options. The objective of the current incorporated backstops is to ensure that one cannot build a poorly performing thermal envelope and then install either good mechanical systems or OPP to drive the ERI score down to a specific compliant level. This is a valid concern but one that can be handled in a much simpler way.

This proposal uses an energy modeled ERI score without OPP installed to be the backstop that protects the quality of the installed R-values and U-values of the building thermal envelope. In addition, it uses the requirement table to ensure installation of energy components in the home follow the IECC. Additions have been added to the requirement table ensuring parity of requirements across compliance paths.

An ERI score set in the 50's and calculated before OPP is installed requires that the builder install R-values and U-values in the envelope that are better than the current 2021 IECC requirements. In fact, the modeling shows that the builder is also required to install mechanical equipment that is better than federal minimums to obtain an ERI score without OPP to meet the ERI score requirements of the past and of this proposal. Therefore, it makes sense to simplify the compliance path, allow for flexibility in developing energy specifications for the house, while at the same time ensuring that the building thermal envelope cannot be less efficient than that required by the prescriptive compliance options. This is all done by setting an ERI compliance score in the 50's before OPP is installed on the home.

This proposal also requires that a score be developed with OPP. Currently the score has been set to be the same as the score without OPP meaning that the code is not mandating that renewables be installed on the home. However, a simple amendment by a progressive jurisdiction could change the two required scores to achieve climate action or other community goals they may have. For example, if the ERI score was set at 40 without OPP it would be at a about the tipping point where you can't get lower after maximizing the thermal envelope and mechanical system performance and before renewables would have to be added. So, a jurisdiction could also amend the ERI score with OPP to be zero and mandate zero energy homes. This mandate, however, allows the builder to determine what works best for them for how to achieve the ERI score of 40 without OPP.

As the Building thermal envelope is protected in this proposal by having an ERI score before OPP requirement, I am proposing that the ERI score remain the same per climate zone because they are all in the 50's. There is not a requirement to install OPP but a requirement if it is installed that the score with OPP be equal to or better than the score requirement without OPP.

Next Ventilation: The ventilation debate has been politicized in the current R406 ERI compliance option. I am not here to say that a few more or less cubic feet of air to ventilate a house is good or bad. All I know is that the primary reason for the diversion of the IECC ERI score and the true ANSI/RESNET/ICC standard 301 ERI score is the amended ventilation rate that has been implemented in the IECC adoption of the ERI compliance path. Although the average difference in ERI score is around 10 points, I have seen them differ by as much as 16. This divergence impacts not only the credibility of the ERI compliance process but of Energy Modeling as well. Since the IECC has accepted the ANSI/RESNET/ICC 301 standard as the standard by which to develop an ERI score I propose that the standard be used rather than be significantly amended. The biggest issue we need to keep at the forefront is that all IECC compliant homes are built tight to a specific IECC requirement and are ventilated. This proposal does not change that. All homes will be mechanically ventilated. The upside is more use of a compliance path.

Continuous maintenance standards vs. IECC code development. I know that it is not the norm, but this proposal seeks to use the most recent version of the ANSI/RESNET/ICC 301 standard starting with the 2024 IECC and moving forward. The reason is that the ANSI standards are under continual maintenance and significant changes for the better are made and adopted on a regular basis. The ANSI standards are phased in with compliance dates set based on the permit date of the house, usually six months into the future. So, for example, if an updated version of ANSI 301 is release on January 1st, 2022, the implementation date for that standard would be for houses permitted on June 1st, 2022. This gives time for energy modelers and builders to coordinate any changes in construction practices that may be needed to maintain compliance while allowing homes that permitted prior to June 1st, 2022, to complete using the standard that was in place at the time of the original building permit.

This change will make the ERI compliance path dynamic based on the effective dates of the ANSI 301 standard which will also allows all ERI scores based on the ANSI 301 standard to progress in unison rather than continually being out of sync. As the public, builders, jurisdictions, and the ICC do not truly understand all these nuances and do not realize that currently Section R406 ERI is a snapshot in time where the sole audience should be local code officials only, this break from the norm makes sense in this case.

As an example of this issue is put forth in a RESNET paper that states, “homes with permits in the fall of 2020 and seeking a HERS Rating will be using ANSI/RESNET/ICC Standard 301-2019. If their state has adopted 2018 IECC, their code-compliance ERI will still be based on the much older 2014 version of Standard 301 with Addendum A and B. The result is different index scores, since the older version of Standard 301 with only Addendum A and B was before amendments like the Index Adjustment Factor or the allowance of credit for LED lighting.” Link provided in Bibliography

Bibliography: https://www.resnet.us/articles/the-iecc-energy-rating-index-and-hers-index-whats-the-difference/

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not change cost implications of using the ERI compliance option. Because the ERI score without OPP have not changed the path is still not as flexible as other compliance options. However, it is easier to use and is more likely to be used without significant amendments.

REPI-127-21

IECC®: R406.2, R406.4, R406.5, R406.7.1, R406.7.2.1, R406.7.6

Proponents:

Gayathri Vijayakumar, representing Steven Winter Associates, Inc. (gayathri@swinter.com)

2021 International Energy Conservation Code

Revise as follows:
R406.2 (N1106.2) ERI compliance.
Compliance based on the Energy Rating Index (ERI) requires that the rated design meets all of the following:

1. The requirements of the sections indicated within Table R406.2.
2. Maximum ERI of Table R406.5 or less than or equal to the ERI of the *standard reference design as* defined in in R405.

R406.4 (N1106.4) Energy Rating Index.

The Energy Rating Index (ERI) shall be determined in accordance with ANSI/RESNET/ICC 301 except for buildings covered by the *International Residential Code* , the ERI reference design ventilation rate shall be in accordance with Equation 4-2.

$$\text{Ventilation rate, CFM} = (0.01 \times \text{total square foot area of house}) + [7.5 \times (\text{number of bedrooms} + 1)]$$

(Equation 4-2)

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the building site shall not be included in the *ERI reference design* or the *rated design*. For compliance purposes, any reduction in energy use of the rated design associated with on-site renewable energy shall not exceed 5 percent of the total energy use.

R406.5 (N1106.5) ERI-based compliance.
Compliance based on an ERI analysis requires that the *rated proposed design* and confirmed built dwelling be shown to have an ERI less than or equal to the appropriate value indicated in Table R406.5 or less than or equal to the ERI of the *standard reference design* when compared to the *ERI reference design*.
R406.7.1 (N1106.7.1) Compliance software tools.
Software tools used for determining ERI shall be *Approved* Software Rating Tools in accordance with ANSI/RESNET/ICC 301.
R406.7.2.1 (N1106.7.2.1) Proposed compliance report for permit application.
Compliance reports submitted with the application for a building permit shall include the following:

1. Building street address, or other *building site* identification.
2. Declare ERI on title page and building plans.
3. The name of the individual performing the analysis and generating the compliance report.
4. The name and version of the compliance software tool.
5. Documentation of all inputs entered into the software used to produce the results for the reference design and/or the rated home.
6. A certificate indicating that the proposed design has an ERI less than or equal to the appropriate score indicated in Table R406.5 or less than or equal to the ERI of the *standard reference design* when compared to the ERI reference design. The certificate shall document the building component energy specifications that are included in the calculation, including: component level insulation *R*-values or *U*-factors; assumed duct system and building envelope air leakage testing results; and the type and rated efficiencies of proposed heating, cooling, mechanical ventilation, and service water-heating equipment to be installed. If on-site renewable energy

systems will be installed, the certificate shall report the type and production size of the proposed system.

7. When a site-specific report is not generated, the proposed design shall be based on the worst-case orientation and configuration of the rated home.

R406.7.6 (N1106.7.6) Input values.

Where calculations require input values not specified by Sections R402, R403, R404 and R405, those input values shall be taken from ANSI/RESNET/ICC 301.

Reason Statement:

Two changes are contained in this one proposal.

1 - adding "ANSI" in front of "RESNET/ICC" to properly reference this Standard.

2 - to avoid inconsistencies between R405 and R406, allow the option to calculate the ERI for the Standard Reference Design and then require the Rated Design to be less than or equal to that ERI value.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This has no impact on cost.

This is simply to acknowledge that R405 and R406 evaluate energy performance in slightly different ways and by calculating the ERI of the Standard Reference Design we can ensure that one path is not more stringent than another.

This also acknowledges that updates to modeling protocols between published versions of ANSI/RESNET/ICC 301 can change the ERI, resulting in higher or lower ERI's for a given Rated Design, that are not indicators of improvements or failures in performance.

In essence, with this code change proposal, any future change to the modeling protocols of ANSI/RESNET/ICC 301 will affect both the ERI of the Standard Reference Design and the Rated Design in a similar way, whereas fixed ERI values are not able to account for those changes. For example, if a change in the modeling protocols resulted in ERI values that dropped by 10 points without a change in the Rated Design, it would be easier to meet the fixed ERI table currently, without any actual improvement to energy efficiency. In contrast, ERI scores that increase can cause a built home to no longer be compliant, again with no change to their actual design. By having the ERI be calculated for both the standard reference design and the rated design, those changes in modeling impact both equally.

REPI-127-21

REPI-128-21

IECC®: R406.3, R406.3.1, R406.3.2

Proponents:

Joseph Cain, representing Solar Energy Industries Association (SEIA) (JoeCainPE@gmail.com)

2021 International Energy Conservation Code

Delete without substitution:

~~R406.3 Building thermal envelope~~.

~~Building and portions thereof shall comply with Section R406.3.1 or R406.3.2.~~

Revise as follows:

~~R406.3.1 (N1106.3.1)~~ R406.3 ~~On-site renewables are not included~~Building thermal envelope.

~~Where on-site renewable energy is not included for compliance using the ERI analysis of Section R406.4, the~~ The proposed total building thermal envelope UA, which is ~~sum~~ the summation of *U*-factor times assembly area, shall be less than or equal to the total building thermal envelope UA using the prescriptive *U*-factors from Table R402.1.2 multiplied by 1.15 in accordance with Equation 4-1. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

$$UA_{\text{Proposed design}} = 1.15 \times UA_{\text{Prescriptive reference design}}$$

(Equation 4-1)

Delete without substitution:

~~R406.3.2 On-site renewables are included~~.

~~Where on-site renewable energy is included for compliance using the ERI analysis of Section R406.4, the *building thermal envelope* shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2018 *International Energy Conservation Code*.~~

Reason Statement:

This proposal is intended to establish a uniform and consistent building thermal envelope backstop -- and method of determining building thermal envelope backstop -- whether or not renewable energy systems are used in the ERI method. There should be no discriminatory practice against renewable energy. Greater building envelope measures should not be required when a renewable energy system is installed and used in the ERI method to further reduce a building's net energy use.

The first sentence of Section R406.3 is struck out entirely, as the UA method in R406.3 and Equation 4-1 is based on "The proposed total building thermal envelope UA," and does not require further analysis for any "portions thereof." This sentence will cause confusion about the total building thermal envelope versus "portions thereof." The sentence is incorrect, and it is no longer needed if there is a single method for thermal envelope backstop.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will not necessarily increase nor decrease the cost of construction, but could result in some savings in cost of construction. The proposal is intended to provide a uniform method for thermal envelope backstop.

REPI-128-21

REPI-129-21

IECC®: R406.3.2

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:
R406.3.2 (N1106.3.2) On-site renewables are included.
Where on-site renewable energy is included for compliance using the ERI analysis of Section R406.4, the proposed total *building thermal envelope* UA, which is the sum of *U*-factor times assembly area, shall be ~~greater~~ less than or equal to the ~~levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2018 *International Energy Conservation Code*~~ building thermal envelope UA using the prescriptive *U*-factors from Table R402.1.2. The area-weighted maximum fenestration SHGC permitted shall be 0.25 in Climate Zones 0 through 3 and 0.40 in Climate Zones 4 through 5.

Attached Files

- **R5 table pix.PNG**
  http://localhost/proposal/313/932/files/download/180/

Reason Statement:

The purpose of this code change proposal is to improve the Energy Rating Index ('ERI") compliance path in the *IECC* by updating and adding flexibility to the mandatory thermal envelope backstop for projects with on-site generation by incorporating a UA trade-off and basing the requirements on the current *IECC*. This proposal will serve to make the two ERI backstops more consistent in approach.

These backstops are crucial to ensure that the home retains reasonable thermal envelope performance (U-factor and SHGC) under alternative compliance paths (in this case, the ERI) and that the prescriptive envelope is not unduly traded-off for other measures. Trading off envelope and associated occupant comfort can have direct impacts on energy usage. For example, if the occupant responds to discomfort from a "cold" or "hot" room due to an inadequate building envelope by adjusting the thermostat, the additional energy use from the adjusted thermostat can be substantial. Below is a summary of estimated energy use increases associated with adjusting a thermostat 1 degree higher or lower, broken out by climate zone.

[R5 table pix,png]

Increased Energy Use Resulting from Thermostat Adjustment

Measure	Nat'l Avg	1	2	3	4	5	6	7	
+1 Degree Heating	4.1%	0.5%	3.0%	4.2%	4.4%	4.7%	4.5%	4.0%	2
-1 Degree Cooling	3.2%	7.8%	5.3%	3.9%	2.6%	1.8%	1.4%	0.7%	0

An effective envelope trade-off backstop can help improve occupant comfort and can save significant energy and energy cost.

In the development of the 2021 *IECC*, the EECC supported Proposal No. RE150-19 (as modified), which was submitted by the National Association of Homebuilders. RE150-19 improved the ERI thermal envelope backstop for projects without on-site generation by changing it from being based on the 2009 *IECC* prescriptive tables to a calculation based on a percentage of the Total UA of the envelope, using the current code requirements. This solution provided several benefits:

- A Total UA-based calculation provides more flexibility by allowing reasonable trade-offs among the efficiency (U-factors) of thermal envelope components to achieve an overall efficiency target;
- Basing the calculation on the current code helps ensure that improvements to the code baseline over time will be reflected in the

ERI backstop without a need for additional code change proposals in the future; and
- Referencing the current code will simplify compliance by avoiding references to older versions of the code.

However, unlike the ERI envelope backstop for projects without onsite generation, similar improvements were not adopted last cycle for projects complying under ERI using on-site generation. As a result, the backstop for projects with on-site generation currently references the prescriptive values of the 2018 *IECC* (reflecting the need for a more rigorous backstop for ERI compliance using on-site generation) and does not include a UA trade-off approach. A similar backstop could also be applied to ERI calculations that incorporate on-site renewable energy, so long as the backstop is more rigorous, protecting against direct trade-offs between energy generation and the thermal envelope. The changes in this proposal provide the best solution for the two ERI thermal envelope backstops:

- It uses a Total UA-based calculation both for ERI projects with and without on-site power, improving consistency, code compliance and enforcement;
- It provides more flexibility for code users, allowing reasonable trade-offs among the efficiency (U-factor) of thermal envelope components;
- It sets the UA calculation baseline for projects with on-site renewable generation based on the level of the prescriptive envelope requirements of the current IECC to avoid rolling back the efficiency of the code and to help ensure that envelope efficiency is not traded away for additional on-site generation; and
- It removes a reference to a previous code edition, allowing the backstop to automatically update in future editions of the code without the need for additional code change proposals.

We agree with the ICC's recent call for each new edition of the *IECC* to provide "increased energy savings over the prior edition." (*See* proposed Section R101.3 Intent.) Implicit in this call is protection of current energy savings and other *IECC* benefits, such as provided by the backstops applicable to alternative code compliance paths. Code proposals should not only seek improvement for top-performing homes on the leading edge of energy efficiency, but also for homes simply built to the code minimums. Effective thermal envelope trade-off backstops will help to maintain a reasonable level of efficiency for all homes built to the 2024 *IECC*.

Bibliography:

Pacific Northwest National Laboratory, *National Cost Effectiveness of the Residential Provisions of the 2021 IECC* (June 2021)

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal does not increase the baseline stringency of the 2021 *IECC*, and whether the proposal results in increased or decreased costs ultimately depends on compliance choices made by the code user in each case. The added flexibility of moving to a UA-based backstop will allow builders to use what they conclude is the optimal combination of envelope measures to meet the building thermal envelope UA under the code, which may reduce construction costs as compared with the current backstop in some cases.

COST-EFFECTIVENESS

This proposal does not increase or otherwise affect the stringency of the prescriptive code values or result in increased costs. Instead, the ERI thermal envelope backstop only places limits on choices under an alternative compliance path (which is optional), so a cost-effectiveness analysis does not apply.

The ICC Board of Directors set the 2021 *IECC* as the baseline for future *IECC* development – and by extension made the 2021 *IECC* the basis for cost-effectiveness analyses. This means for purposes of analyzing code proposals, the existing provisions of the 2021 *IECC* are considered cost-effective and reasonable (since they are the starting point for analyses of code changes and no rollbacks are permitted). It should also be noted that US DOE found the entire 2021 *IECC* cost effective, including section R406. *See* Pacific Northwest National Laboratory, *National Cost Effectiveness of the Residential Provisions of the 2021 IECC* (June 2021). Changes to trade-off backstops like this code change proposal (which utilizes U-factors and SHGCs no more stringent than the prescriptive measures of the 2021 *IECC*) do not increase the stringency of that baseline or impose any additional costs to meet specific measures. In addition, if the prescriptive values are cost-effective, then the backstop values would be cost-effective. These backstops serve only as a consumer protection against excessive trade-offs, but do not require anything more than what would be required for base code prescriptive compliance. Thus, a cost-effectiveness analysis would be difficult or impossible to apply and would not be informative.

REPI-129-21

REPI-130-21

IECC®: R406.3, R406.3.1, R406.3.2, R406.4

Proponents:

Vladimir Kochkin, NAHB, representing NAHB (vkochkin@nahb.org)

2021 International Energy Conservation Code

Revise as follows:
~~R406.3 Building thermal envelope~~.

~~Building and portions thereof shall comply with Section R406.3.1 or R406.3.2.~~

~~R406.3.1(N1106.3.1)~~R406.3 (N1106.3) ~~On-site renewables are not included~~ Building thermal envelope.
~~Where on-site renewable energy is not included for compliance using the ERI analysis of Section R406.4, t~~The proposed total building thermal envelope UA, which is sum of *U*-factor times assembly area, shall be less than or equal to the building thermal envelope UA using the prescriptive *U*-factors from Table R402.1.2 multiplied by 1.15 in accordance with Equation 4-1. The area-weighted maximum fenestration SHGC permitted in Climate Zones 0 through 3 shall be 0.30.

$$UA_{Proposed\ design} = 1.15 \times UA_{Prescriptive\ reference\ design}$$

(Equation 4-1)

Delete without substitution:
~~R406.3.2 On-site renewables are included~~.
~~Where on-site renewable energy is included for compliance using the ERI analysis of Section R406.4, the *building thermal envelope* shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or Table R402.1.4 of the 2018 *International Energy Conservation Code*.~~

Revise as follows:
R406.4 (N1106.4) Energy Rating Index.

The Energy Rating Index (ERI) shall be determined in accordance with RESNET/ICC 301 except for buildings covered by the *International Residential Code* , the ERI reference design ventilation rate shall be in accordance with Equation 4-2.

$$\text{Ventilation rate, CFM} = (0.01 \times \text{total square foot area of house}) + [7.5 \times (\text{number of bedrooms} + 1)]$$

(Equation 4-2)

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the building site shall not be included in the *ERI reference design* or the *rated design*. For compliance purposes, any reduction in energy use of the rated design associated with on-site renewable energy shall not exceed ~~5~~ 15 percent of the total energy use.

Reason Statement:

This proposal restores the flexibility in design options for achieving ERI thresholds. The proposed modification will provide a consistent set of envelope requirements for the building independent of on-site generation. It also increases the allowance for the fraction of the overall energy use that can be met by on-site renewables from 5 to 15 percent. The 5% limit is a new requirement that did not exist in the previous energy code and is overly restrictive.

Cost Impact:

The code change proposal will decrease the cost of construction.

This change may help decrease cost of construction in some cases by providing more options for compliance.

REPI-130-21

REPI-131-21

IECC®: R406.4

Proponents:

Vladimir Kochkin, NAHB, representing NAHB (vkochkin@nahb.org)

2021 International Energy Conservation Code

Revise as follows:
R406.4 (N1106.4) Energy Rating Index.

The Energy Rating Index (ERI) shall be determined in accordance with RESNET/ICC 301 except the air exchange rate in RESNET/ICC 301 shall be in accordance with items (1) and (2) as follows:

1. Air exchange rate for the Energy Rating Reference Home in RESNET/ICC 301 Table 4.2.2(1) shall be replaced by the air exchange rate for the Standard Reference Design as defined in Table R405.4.2(1) of this code.
2. Air exchange rate for the Rated House in RESNET/ICC 301 Table 4.2.2(1) and Table 4.3.1(1) shall be replaced by the air exchange rate for the Proposed Design as defined in Table R405.4.2(1) of this code.

Buildings designed in accordance with this code shall not be required to meet the RESNET/ICC 301 air exchange rates or mechanical ventilation rates used for the purpose of determining the ERI.

~~for buildings covered by the *International Residential Code* , the ERI reference design ventilation rate shall be in accordance with Equation 4-2.~~

~~Ventilation rate, CFM = (0.01 × total square foot area of house) + [7.5 × (number of bedrooms + 1)]~~
~~(Equation 4-2)~~

Reason Statement:

The purpose of this proposal is to fix an inadvertent error that was introduced in the 2018 IECC during an effort to coordinate the ERI calculation procedure with the residential ventilation rates. The change in 2018 IECC resulted in a significant increase in the ERI scores. That was never the intent of the change as was confirmed by the original proponent, and it was the result of using terms that were not fully coordinated with the specific terms in Standard 301. Proposals and public comments attempted to fix this issue in 2021 IECC, but in the end none of them were approved. The proposed amendment resolves the issues in accordance with the original intent by requiring the calculation of air exchange rate in Standard 301 be aligned with IECC Table R405.4.2(1) used in the performance path calculations. This amendment will coordinate the ERI procedure with the residential mechanical code provisions on this subject. The proposed amendment also makes it clear that IECC buildings rated using the ERI are not required to meet the Standard 301 air exchange and ventilation rates -- this is added because Standard 301 uses the terms "**required** dwelling unit total exchange rate" and "total **required** ventilation rate." It's noted that the coordination between Standard 301 and this code should be done such that there is a single ERI index for buildings complying with the IECC.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal fixes an error. There is no impact on construction practices. The change will allow designers to calculate correct ERI scores.

REPI-131-21

REPI-132-21

IECC®: R406.4

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:
R406.4 (N1106.4) Energy Rating Index.

The Energy Rating Index (ERI) shall be determined in accordance with RESNET/ICC 301~~ except for buildings covered by the *International Residential Code* , the ERI reference design ventilation rate shall be in accordance with Equation 4-2~~.

~~(Equation 4-2)~~

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the building site shall not be included in the *ERI reference design* or the *rated design*. For compliance purposes, any reduction in energy use of the rated design associated with on-site renewable energy shall not exceed 5 percent of the total energy use.

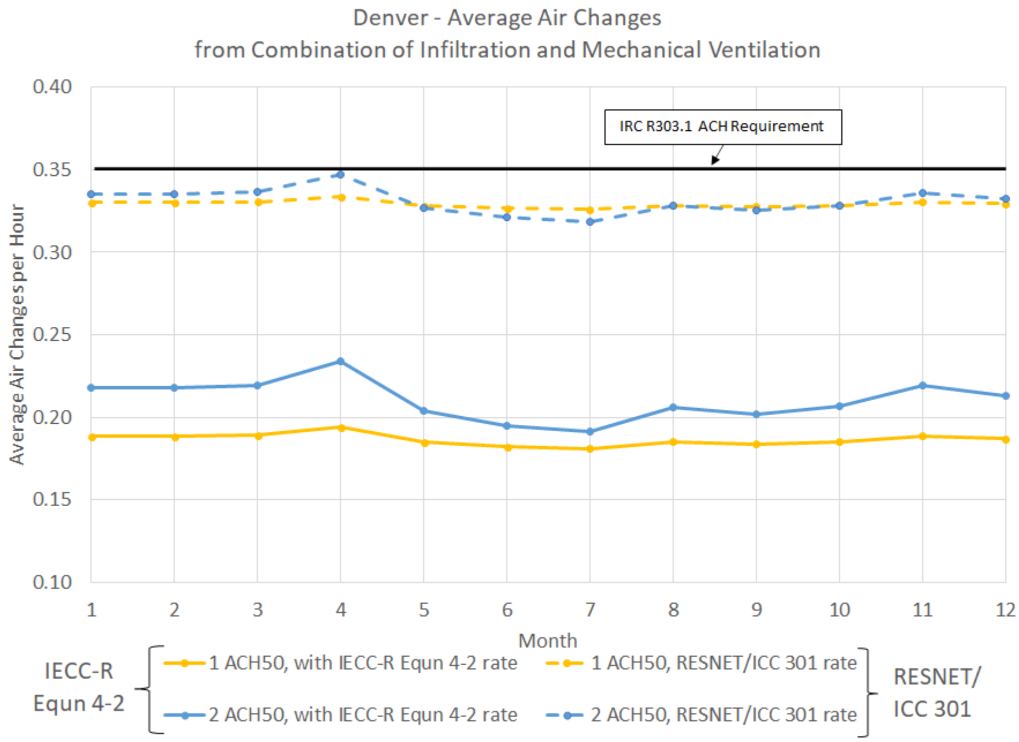
Attached Files

- **Mechanical Ventilation as Function of Envelope Tightness - ERI.png**
  http://localhost/proposal/296/921/files/download/205/

Reason Statement:

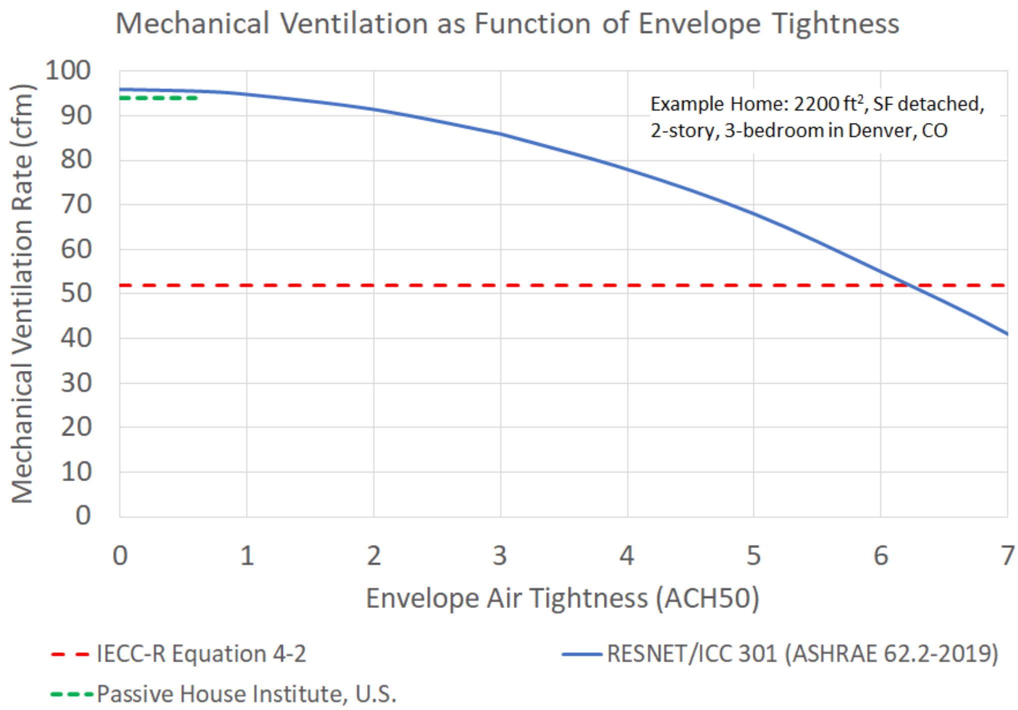
This proposal would permit builders and homeowners to increase mechanical ventilation rates to a more reasonable level without imposing an ERI penalty. The IECC incentivizes builders to build as tightly as possible, which is good. However, the IECC has modified RESNET/ICC 301 to penalize builders for providing mechanical ventilation at rates that are minimally compliant with a national consensus standard (ASHRAE 62.2-2019) and that is comparable to what is considered minimally compliant by IRC R303.1; this is bad. Because the ventilation rate calculated by Equation 4-2 (i.e., the IRC M1505.4.3 mechanical ventilation rate equation) is not calculated as a function of the building envelope air tightness, the combination of the IECC and IRC requirements encourages builders to build homes with air changes that can be ~50% lower than the 0.35 air changes per hour (ACH) that has traditionally been the target for minimum acceptable indoor air quality (see IRC Section R303.1).

The following graph shows monthly average air changes rates (i.e., total air changes resulting from mechanical ventilation combined with infiltration from building envelope leakage) in Denver, CO for a typical 2200 ft single-family dwelling unit, calculated using the ASHRAE Handbook of Fundamentals.[1] The solid lines show the monthly average air changes resulting from a builder tightening a home without increasing the minimum R406.4 Equation 4-2 mechanical ventilation rate. At 3.0 ACH50, the home is expected to have an annual average air change rate of 0.28 ACH, which is 20% lower than the IRC R303.1 target of 0.35 ACH. However, if the same home is tightened to 1.0 ACH50 without increasing the mechanical ventilation rate, the annual average air change rate decreases to 0.18 ACH, which is almost 50% lower than the IRC R303.1 target of 0.35 ACH! To incentivize builders to build tight without penalizing them for providing reasonable number of air changes, the ERI path's reference design mechanical ventilation rate should be kept intact, without modification. In the example chart below, the dashed lines show the maximum air change rate (combined infiltration and mechanical ventilation rate) for the reference design home that would be permitted by compliance with RESNET/ICC 301. These rates are still lower than the traditional IRC R303.1 target of 0.35 ACH and strike a more reasonable balance between health and energy concerns than IECC R406.4 Equation 4-2.



Why did the RESNET/ICC 301 Ventilation Rates and the IECC-R Equation 4-2 Ventilation Rates Diverge?

The IECC-R Equation 4-2 ventilation rate (i.e., same as IRC M1505.4.3) was developed based on the ASHRAE 62.2-2010 ventilation rate equation, which was built around the assumption of the ventilation system being installed in a fairly leaky building that was typical practice at the time (i.e., ~6 - 7 ACH50). In 2012, the IECC required building air sealing to be verified by a blower door test for the first time. In 2013, ASHRAE 62.2 responded to the IECC building air sealing requirements by changing the ventilation rate equation to be a function of the building envelope air tightness level. This change by ASHRAE was intended to provide an occupant with the same amount of fresh air (on an annual basis), regardless of how tightly the occupant's home is constructed. Unfortunately, the IECC-R Equation 4-2 ventilation rate has not kept pace with improvements in building air sealing. The chart below illustrates how ASHRAE 62.2-2019 rates (same as the ASHRAE 62.2-2016 rates that are referenced by RESNET/ICC 301) change as a function of envelope air tightness, which results in comparable fresh air regardless of envelope air tightness. By reverting to the RESNET/ICC 301 requirements for mechanical ventilation, this proposal would ensure that homes following the ERI path are provided with mechanical ventilation that scales with building air tightness and is comparable to the IRC R303.1 minimum ventilation rate, without penalty.



Why is it Important to be able to Specify Higher, Reasonable Ventilation Rates without Penalty?

The total ventilation rates promulgated by RESNET/ICC 301 (i.e., ASHRAE 62.2-2016/2019) and IRC R303.1 have long been referenced as rates needed to provide minimum acceptable indoor air quality. It is expected that occupants seeking improved IAQ may elect to use these rates that are higher than the IECC-R Equation 4-2 (i.e., IRC M1505.4.3) minimum to reduce pollutant concentration and support better productivity and health outcomes, which have also been linked to increases in wages. Studies that have shown better health outcomes or improved performance for building occupants as a function of higher ventilation rates include:

- Sundell[2]: Sick building syndrome declines as ventilation rate increases.
- Milton[3]: Sick leave decreases as ventilation rate increases.
- Bornehag[4]: Risk of asthma for children increases with decreasing ventilation rate in homes.
- Seppänen[5]: Productivity decreases with decreasing ventilation rate.
- Tejsen[6]: Productivity increases with increasing residential ventilation rate.

While some of these studies were conducted in commercial buildings, LBNL's[7] analysis of residential studies concluded that, "Just over half of (residential) studies report one or more statistically significant health benefits of increased ventilation rates." LBNL noted that, "The findings of research on how ventilation rates in homes affect health are mixed," but that "overall… the number of reported statistically significant improvements in health with increased ventilation rates far exceeded the anticipated chance improvements in health."

Bibliography:

1. ASHRAE Handbook of Fundamentals. 2017. Chapter 17 Enhanced Model.
2. Sundell et al. 1994. Sick Building Syndrome (SBS) in Office Workers and Facial Skin Symptoms among VDT-Workers in Relation to Building and Room Characteristics: Two Case-Referent Studies. Indoor Air, 4: 83-94.
3. Milton et al. 2000. Risk of Sick Leave Associated with Outdoor Air Supply Rate, Humidification, and Occupant Complaints. Indoor Air, 10:212- 221.
4. Bornehag, C & Sundell, Jan & Hägerhed, Linda. (2003). Asthma and allergy among children and the association to ventilation rate at home, a case control study. Epidemiology. 14.10.1097/00001648-200309001-00224.
5. Seppänen, O. A., and W. Fisk. 2006. Some quantitative relations between indoor environmental quality and work performance or health. HVAC&R Research 12 (4):957–73. doi:10.1080/10789669.2006.10391446.
6. Tejsen et al. 2016. The effects of bedroom air quality on sleep and next-day performance. Indoor Air, 26:679-686.
7. LBNL. Indoor Air Quality Scientific Findings Resource Bank. Building Ventilation. Accessed May 6, 2021. https://iaqscience.lbl.gov/ventsummary#:~:text=Just%20over%20half%20of%20studies,improve%20with%20increased%20ventila

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

In some cases, this proposal could increase the estimated savings associated with mechanical ventilation systems. This could help to reduce construction costs.

REPI-132-21

REPI-133-21 Part I

IECC®: R406.4

Proponents:

Craig Conner, representing self (craig.conner@mac.com)

THIS IS A 2 PART PROPOSAL. PART I & II WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Energy Conservation Code

Revise as follows:
R406.4 Energy Rating Index.

The Energy Rating Index (ERI) shall be determined in accordance with RESNET/ICC 301 except for buildings covered by the *International Residential Code* , the ERI reference design ventilation rate shall be in accordance with Equation 4-2.

Ventilation rate, CFM = (0.01 × total square foot area of house) + [7.5 × (number of bedrooms + 1)]

(Equation 4-2)

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the building site shall not be included in the *ERI reference design* or the *rated design*.~~ For compliance purposes, any reduction in energy use of the rated design associated with on-site renewable energy shall not exceed 5 percent of the total energy use.~~

REPI-133-21 Part I

REPI-133-21 Part II

IRC: N1106.4

Proponents:

Craig Conner, representing self (craig.conner@mac.com)

2021 International Residential Code

Revise as follows:
N1106.4 Energy Rating Index.

The Energy Rating Index (ERI) shall be determined in accordance with RESNET/ICC 301 except that the *ERI reference design* ventilation rate shall be in accordance with Equation 11-5.

Ventilation rate, CFM = (0.01 × total square foot area of house) + [7.5 × (number of bedrooms + 1)]

(Equation 11-5)

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the *building site* shall not be included in the *ERI reference design* or the *rated design*. ~~For compliance purposes, any reduction in energy use of the rated design associated with on-site renewable energy shall not exceed 5 percent of the total energy use.~~

Reason Statement:

The energy saved by renewables is real and can be substantial. Many homes with low energy have much more than 5% renewable energy. Very low or no energy homes often have 30% or more renewable contribution. "Zero Energy" or "Net Zero Energy" homes are not practical or plausible without renewables.

Home design should not be constrained. Homes could use no renewables. Homes could use lots of renewable. Why would the code limit renewable use? The key consideration is how much energy a home uses.

Cost Impact:

The code change proposal will decrease the cost of construction.

Sometimes renewables are part of the least cost home, sometimes not. For homes where renewables are part of a least-cost design, limiting renewables would tend to increase cost of the home.

REPI-133-21 Part II

REPI-134-21

IECC®: R406.4

Proponents:

Joseph Cain, representing Solar Energy Industries Association (SEIA) (JoeCainPE@gmail.com)

2021 International Energy Conservation Code

Revise as follows:
R406.4 (N1106.4) Energy Rating Index.

The Energy Rating Index (ERI) shall be determined in accordance with RESNET/ICC 301 except for buildings covered by the *International Residential Code* , the ERI reference design ventilation rate shall be in accordance with Equation 4-2.

$$\text{Ventilation rate, CFM} = (0.01 \times \text{total square foot area of house}) + [7.5 \times (\text{number of bedrooms} + 1)]$$

(Equation 4-2)

Energy used to recharge or refuel a vehicle used for transportation on roads that are not on the building site shall not be included in the *ERI reference design* or the *rated design*. ~~For compliance purposes, any reduction in energy use of the rated design associated with on-site renewable energy shall not exceed 5 percent of the total energy use.~~

Reason Statement:

This proposal is intended to strike out the language created by Proposal RE184-19, which was Disapproved at the Committee Action Hearings, and again Disapproved at the Public Comment Hearing. The ICC Long-Term Code Development Process Committee has recommended to the ICC Board of Directors that double-disapproved proposals not move forward to the Online Governmental Consensus Vote. Under CP28 Section 8.1, the OGCV vote for double-disapproved proposals can be voted on only As Submitted or Disapprove. That means these proposals do not benefit from public testimony or Committee discussion at the Committee Action Hearing, and do not have the benefit of being revised or improved during the public comment process, in response to identification of flaws or opportunities for improvement.

The statement in Section R406.4 that constrains renewable energy to no more than 5% of the ERI score is overly restrictive. This might be in conflict with Appendix Chapter RC where adopted. An artificial constraint on renewable energy certainly is not within the scope and intent of any effort to achieve net zero energy of zero carbon, or a "glide path to zero." We cannot achieve zero net energy or zero carbon without renewable energy.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proponent has selected "neither increase nor decrease the cost of construction" as there are multiple variables in play. The cost of construction might increase if renewable energy is considered as a first-cost cash purchase. The cost of construction might decrease if third-party financing tools are used for renewable energy and a more cost-effective path to ERI compliance is utilized.

REPI-134-21

REPI-135-21

IECC®: TABLE R406.5

Proponents:

seth wiley, representing architect, self

2021 International Energy Conservation Code

Revise as follows:

TABLE R406.5 MAXIMUM ENERGY RATING INDEX

CLIMATE ZONE	ENERGY RATING INDEX
0-1	~~52~~43
2	~~52~~45
3	~~51~~47
4	~~54~~47
5	~~55~~47
6	~~54~~46
7	~~53~~46
8	~~53~~46

Attached Files

- **IECC-2024_Proposal_Energy-Rating-Index_2021-09-18.pdf**
  http://localhost/proposal/333/593/files/download/74/

Reason Statement:

To improve occupant health and safety, improve energy efficiency, and decrease greenhouse gas emissions

Bibliography:

Based on professional knowledge and experience, feedback from other professionals, established research, and established local and national construction quality frameworks

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code chance proposal is understood to neither increase nor decrease the cost of construction

REPI-135-21

REPI-136-21

IECC®: R408.2, R408.2.2

Proponents:

Ryohei Hinokuma, Daikin U.S. Corporation, representing Daikin U.S. Corporation (ryohei.hinokuma@daikinus.com)

2021 International Energy Conservation Code

Revise as follows:
R408.2 (N1108.2) Additional efficiency package options.

Buildings meeting the requirements ~~Additional efficiency package options~~ for compliance with Section R401.2.1 are set forth in Sections R408.2.1 through R408.2.5.

R408.2.2 (N1108.2.2) More efficient HVAC equipment performance option.

Heating and cooling *equipment* shall meet one of the following efficiencies:

Centrally Ducted Systems

1. Greater than or equal to 95 AFUE natural gas furnace and ~~16 SEER~~ 16.9 SEER2 air conditioner.

2. Greater than or equal to 95 AFUE natural gas furnace and 8.5 HSPF2/16.9 SEER2 air source heat pump.

~~2.~~3. Greater than or equal to ~~10 HSPF/16 SEER~~ 8.5 HSPF2/16.9 SEER2 air source heat pump.

~~3.~~4. Greater than or equal to 3.5 COP ground source heat pump.

Ductless Systems

1. Single Zone: 8.5 HSPF2/16.9 SEER2 variable speed air source heat pump
2. Multi Zone: 8.5 HSPF2/16.9 SEER2 variable speed air source heat pump (Non-Ducted Indoor Units)
3. Multi Zone: 8.5 HSPF2/15.2 SEER2 variable speed air source heat pump (Ducted or Mixed Indoor Units)

For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

Attached Files

- **2021.10.12_Daikin Comments - 2024 IECC_Final.pdf**
  http://localhost/proposal/538/1005/files/download/207/

Reason Statement:

The 2021 IECC has implemented a new section, R408 Additional Efficiency Package Options, which defines requirements to achieve additional energy efficiency to be selected from one of the following five options: 1. Enhanced envelope performance option., 2. More efficient HVAC equipment performance option., 3. Reduced energy use in servicing water-heating option., 4. More efficient duct thermal distribution system option., and 5. Improved air sealing and efficient ventilation system option. Daikin requests that the 2024 version of IECC retains the section to continue effectively driving builders and users to optimize the energy performance of their homes.

As mentioned in our Introduction (see attached letter), variable speed heat pumps provide superior energy performance over single and two-stage equipment due to their higher efficiency attained during partial load operation. Also, ductless systems with variable speed compressors provide~~s~~ homeowners opportunities to further save energy consumption by turning off individual indoor units in unoccupied zones. For the 2024 IECC, Daikin proposes changes to R408.2 and R408.2.2 to accurately capture the energy performance superiority of variable speed air source heat pumps in both centrally ducted and ductless systems.

The metrics of HSPF and SEER are being updated to the new metrics of HSPF2 and SEER2 that will be in effect when the 2024 IECC is adopted by jurisdictions (see 10 CFR 430.32).

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PHONE: (202) 383-8740

October 12, 2021

The International Code Council
500 New Jersey Ave NW 6th Floor
Washington, DC 20001
Re: 2024 International Energy Conservation Code (IECC) Code Change Proposal

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Daikin U.S. Corporation ("Daikin") hereby submits the following code change proposal in response to the development process of 2024 International Energy Conservation Code (IECC). Daikin U.S. Corporation is a subsidiary of Daikin Industries, Ltd., the world's largest air conditioning equipment manufacturer. The Daikin Group includes Daikin Applied, Daikin North America LLC, and Goodman Manufacturing Company, L.P.

I. Introduction

Buildings account for 40 percent of all US energy consumption and 24 percent of its greenhouse gas (GHG) emissions[1]. Out of those, 22 percent of the consumption and 12 percent of the emissions come from residential buildings[2]. Under the Biden Administration, the United States targets to reduce its GHG emission by 50-52 percent by 2030. To achieve the decarbonization goal, energy efficiency as well as building electrification will need to play a critical role.

Replacement of lower efficiency or carbon intensive HVAC equipment with heat pumps are an effective solution to drive energy efficiency and building electrification and thus building decarbonization. Within heat pumps, variable speed heat pumps have demonstrated superior energy performance over single and two-stage equipment. For instance, the United States Environmental Protection Agency (U.S. EPA) notes that variable speed equipment and modulating systems specifically provide additional customer comfort advantages by following load, provide

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[1] Use of energy in explained - U.S. Energy Information Administration, https://www.eia.gov/energyexplained/use-of-energy/

[2] Fast Facts on Transportation Greenhouse Gas Emissions | US EPA, https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

capacities (i.e., less than 100% capacity). When operating at part-load, it can be significantly more efficient. As shown in Figure 1, variable speed equipment's efficiency increases significantly as its load reduces below 100%. This exceeds the performance of both single and two-stage equipment as load reduces. According to computer simulations, validated by the Electric Power Research Institute (EPRI), when variable speed HVAC equipment reduces its cooling capacity by 25% it results in a 43% reduction in power consumption while for single-speed equipment it would yield only a 25% reduction in power consumption[4]. However, according to National Resource Defense Council (NRDC), "current test procedures do not adequately capture the impact of a variable [speed] unit's control logic, which can have a large impact on efficiency[5]." Lastly, Daikin would like to point out that ductless systems can further improve energy performance of HVAC systems by allowing homeowners to turn off indoor units in unoccupied zones.

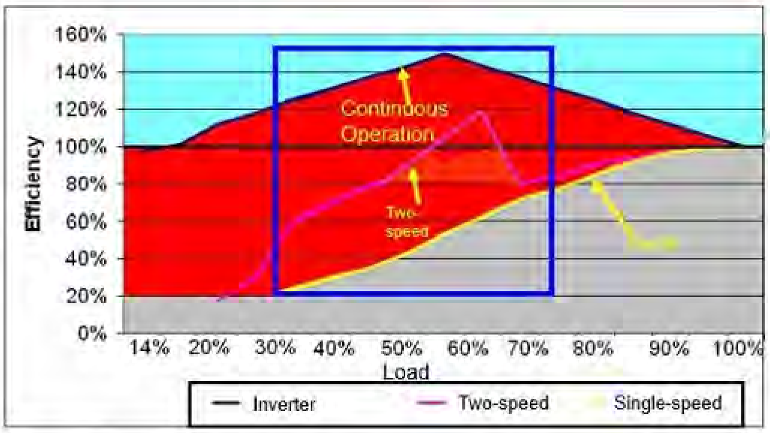

Figure 1: HVAC Equipment Efficiency at Various Part-Loads

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[3] U.S. EPA, ENERGY STAR Residential Air Source Heat Pump and Central Air Conditioning Equipment Version 6.0 Discussion Guide dated August 3, 2018, https://www.energystar.gov/sites/default/files/

[4] HRAI and AHRI, Letter to U.S. EPA Regarding ENERGY STAR Residential Air Source Heat Pump and Central Air Conditioning Equipment Version 6.0 Discussion Guide dated September 21, 2018, https://www.energystar.gov/sites/default/files/AHRI_HRAI_Comments_CAC_ASHP_Discussion%20Guide_09%2021%202018.pdf

[5] NRDC, NRDC Comments on ENERGY STAR Program Requirements for Air Source Heat Pump and Central Air Conditioner Equipment Version 6.0, Draft 1 dated May 23, 2019, https://www.energystar.gov/sites/default/files/NRDC%20Comments%20on%20CACASHP%20Draft%201%20V6.0.pdf

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However, heat pumps currently account for only 12 percent of the space heating install base in the United States, whilst a significant portion of space heating installed consists of combustion equipment such as furnaces and boilers (76 percent of total)[6]. To significantly boost the proportion of heat pumps, especially variable speed heat pumps including the ones in ductless configuration, effective and aggressive market transformation will be required. Daikin believes that building codes should play a critical role in accelerating the adoption of such technologies in the United States.

Hereby, to execute the forementioned market transformation, Daikin would like to make the following code change proposals for the development process of 2024 IECC:

II. Code Change Proposal to R403.1.2 Heat Pump Supplementary Heat

The use of electric resistance heaters as backup heating devices can significantly increase winter energy consumption, and air source heat pumps can effectively provide heating without such devices including the cold climate regions in the United States. Also, Daikin has observed that it's common for heat pumps to be installed with electric resistance heaters configured to operate in conditions where sufficient heating capacity is available from the heat pump alone. This results in reducing the operation hours of heat pumps and increasing the operation hours of electric heaters. Such setting of heat pump systems will fail to yield expected reduction of GHG emissions and result in higher energy consumption and longer peak demand events. Therefore, Daikin proposes to revise R403.1.2, which defines the use of electric resistance heaters as supplementary heat for heat pumps, to prevent such practice as following:

> **R403.1.2 Heat pump supplementary heat (Mandatory).**
> Heat pumps having supplementary electric-resistance heat shall have controls that, ~~except during defrost,~~ prevent supplemental heat operation when the capacity of the heat pump ~~compressor~~ can meet the heating load. The controls shall permit supplemental heat operation only during heat pump capacity shortage, defrost operation, or for emergency use when heat pump is not operational. To ensure the use

[6] Statistics Office

of electric-resistance heat for supplementary use only, the space heating design ambient temperature shall be used to switch operation from heat pumps to the resistance heat.

III. Code Change Proposal to R408.2 Additional Efficiency Package Options

The 2021 IECC has implemented a new section, R408 Additional Efficiency Package Options, which defines requirements to achieve additional energy efficiency to be selected from one of the following five options: 1. Enhanced envelope performance option., 2. More efficient HVAC equipment performance option., 3. Reduced energy use in servicing water-heating option., 4. More efficient duct thermal distribution system option., and 5. Improved air sealing and efficient ventilation system option. Daikin requests that the 2024 version of IECC retains the section to continue effectively driving builders and users to optimize the energy performance of their homes.

As mentioned in our Introduction, variable speed heat pumps provide superior energy performance over single and two-stage equipment due to their higher efficiency attained during partial load operation. Also, ductless systems with variable speed compressors provide~~s~~ homeowners opportunities to further save energy consumption by turning off individual indoor units in unoccupied zones. For the 2024 IECC, Daikin proposes the following changes to R408.2 to accurately capture the energy performance superiority of variable speed air source heat pumps in both centrally ducted and ductless systems.

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R408.2 Additional efficiency package options.

Buildings meeting the requirements Additional efficiency package options for compliance with Section 401.2.1 are set forth in Sections R408.2.1 through R408.2.

R408.2.2 More efficient HVAC equipment performance option.

Heating and cooling equipment shall meet one of the following efficiencies:

Centrally Ducted Systems

1. Greater than or equal to 95 AFUE natural gas furnace and ~~16 SEER~~ 16.9 SEER2[7] air conditioners.
2. Greater than or equal to 95 AFUE natural gas furnace and 8.5 HSPF2/16.9 SEER2 air source heat pump.
3. ~~2.~~ 3. Greater than or equal to ~~10 HSPF/16 SEER~~ 8.5 HSPF2[8]/16.9 SEER2 air source heat pump.
4. ~~3.~~ 4. Greater than or equal to 3.5 COP ground source heat pump.

Ductless Systems

1. Single Zone: 8.5 HSPF2/16.9 SEER2 variable speed air source heat pump.
2. Multi Zone: 8.5 HSPF2/16.9 SEER2 variable speed air source heat pump (Non-Ducted Indoor Units).
3. Multi Zone: 8.5 HSPF2/15.2 SEER2 variable speed air source heat pump (Ducted or Mixed Indoor Units)

For multiple cooling system, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

[7] SEER2 per 10CFR 430.32 (effective 1/1/2023)

[8] HSPF2 per 10CFR 430.32 (effective 1/1/2023)

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal may increase the cost of construction when utilizing variable speed air source heat pumps, but it will result in energy savings and lower utility costs for the end-user.

REPI-136-21

REPI-137-21

IECC®: R408.2, R408.2.6 (N1108.2.6) (New)

Proponents:

William Fay, representing Energy Efficient Codes Coalition; Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org); Amber Wood, representing Energy Efficient Codes Coalition (awood@aceee.org); Jason Reott, representing Energy Efficient Codes Coalition

2021 International Energy Conservation Code

Revise as follows:
R408.2 (N1108.2) Additional efficiency package options.

Additional efficiency package options for compliance with Section R401.2.1 are set forth in Sections R408.2.1 through R408.2.6~~R408.2.5~~.

Add new text as follows:
R408.2.6 (N1108.2.6) On-Site Renewable Energy.

Renewable energy resources shall be permanently installed that have the capacity to produce a minimum of 1.0 watt of *on-site renewable energy* per square foot of conditioned floor area. To qualify for this option, one of the following forms of documentation shall be provided to the code official:

1. Substantiation that the *REC*s associated with the *on-site renewable energy* are owned by, or retired on behalf of, the homeowner.
2. A contract that conveys to the homeowner the *REC*s associated with the *on-site renewable energy*, or conveys to the homeowner an equivalent quantity of *REC*s associated with other renewable energy.

Reason Statement:

The purpose of this code change proposal is to add a new option to Section R408 that will give credit for homes with on-site renewable energy resources. This will not only expand the number of options available to code users to improve the home from an energy perspective but will also promote the installation of such resources without introducing unnecessary trade-offs of prescriptive energy conservation measures.

One of the purposes of creating the Additional Efficiency Options was to create a space in the IECC for measures that may not be appropriate to require in every situation, but which can contribute to a substantial reduction in the consumption of energy. The Additional Efficiency Options leave it to the code user to determine which options are feasible and best for the particular project. This code change proposal is intended to stretch the Additional Efficiency Options concept to allow a renewable energy resource to be selected as an option to offset energy use. Although we strongly believe that renewable energy should not be used as a direct trade-off against energy conservation measures in the residential prescriptive and performance paths, we believe it can be successfully added as an option in Section R408. While renewable energy already has a place both in the Energy Rating Index under section R406 and under the Zero Energy Appendix RC, allowing it as an option under Section R408 accomplishes a similar purpose, by allowing renewable energy as a potential option to further reduce use of off-site energy after reasonable energy conservation has been maximized.

This proposal bases the required amount of on-site renewable energy capacity on the total conditioned square footage of the building multiplied by 1 watt per square foot. Selection of the appropriate amount of renewable energy to require is a judgment call based on a number of considerations. A smaller system has a lower initial cost, but a larger system may exhibit economies of scale or avoid duplicative costs when installing additional renewable capacity at some point in the future. For an average-sized single-family home of 2,400 square feet, this proposal would require a 2.4 kW system. According to the U.S. Energy Information Administration, a “typical” solar PV system is 5 kW. *See* https://www.eia.gov/todayinenergy/detail.php?id=23972 . While we would normally support a higher level of on-site renewable energy as an option, this proposal sets the requirement at a conservative level that allows the code user to scale up the system if desirable or if it improves payback – without potentially requiring a system too large for the particular project or location. In general, we believe a 2.4 kW system (depending on location, federal and state tax incentives, and other factors) is likely large enough to offset enough purchased energy to have a reasonable payback, and the code user can decide whether a larger system is more appropriate. Of course, in those situations where this option does not make sense, the builder may simply select another additional efficiency option.

This proposal also requires the same level of Renewable Energy Credit (REC) documentation that is required under the Energy Rating Index, Section R406.7.3. Specifically, the builder must substantiate that the renewable aspects of the on-site generation are owned or retired by the homeowner, or that a contract conveys the RECs (or equivalent) to the homeowner. This will help ensure that the renewable energy generation installed is actually displacing fossil fuel generation and reduces the likelihood of the environmental benefits being double counted.

Bibliography:

(1) https://www.eia.gov/todayinenergy/detail.php?id=23972; (2) https://www.seia.org/research-resources/solar-market-insight-report-2020-year-review; (3) https://www.energycodes.gov/sites/default/files/2021-07/2021IECC_CostEffectiveness_Final_Residential.pdf

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal will only increase the cost of construction in cases where this option is selected by the builder; since this proposal would simply offer the user another option to voluntarily select in addition to the current five options (as well as the performance path and ERI options), this proposal should not be viewed as increasing the cost of construction. According to the Solar Energy Industry Association, the cost of residential solar PV has fallen substantially in recent years, to an average installed cost of $2.83/watt in 2020. *See* https://www.seia.org/research-resources/solar-market-insight-report-2020-year-review. Obviously, the installed cost will vary significantly based on location, state and federal tax incentives, and other factors, but based on that national average estimate, a 2.4kW system would cost roughly $6,800.

COST-EFFECTIVENESS

Because this proposal simply adds another option to the five options already available under the current code under Section R406, no cost-effectiveness test should apply. In other words, if a user deems this option not reasonable and cost-effective for a specific project, they need not choose it. Instead, they can choose whatever option in section R406 that works for them. We note that since the 2021 IECC is the baseline for the development of the new IECC standard and no rollbacks are permitted, the current code provision, with five other options can be considered cost-effective. It should also be noted that US DOE found the 2021 IECC cost effective, including section R406. *See* https://www.energycodes.gov/sites/default/files/2021-07/2021IECC_CostEffectiveness_Final_Residential.pdf.

REPI-137-21

REPI-138-21

IECC®: R408.2.3

Proponents:

Patricia Chawla, representing Austin Energy (patricia.chawla@austinenergy.com)

2021 International Energy Conservation Code

Revise as follows:
R408.2.3 (N1108.2.3) Reduced energy use in service water-heating option.
The hot water system shall meet one of the following efficiencies:

1. Greater than or equal to 0.82 UEF ~~EF~~ fossil fuel service water-heating system.

2. Greater than or equal to 2.0 UEF ~~EF~~ electric service water-heating system.

3. Greater than or equal to 0.4 solar fraction solar water-heating system.

Reason Statement:

This proposal updates the water heating efficiency units from EF to UEF as they are now the common units for water heating efficiency.

Bibliography:

10 CFR 430.32 Energy and water conservation standards and their compliance dates. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-C/section-430.32

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The existing code refers to outdated water efficiency units. Federal energy conservation standards for water heating equipment uses the UEF unit. Updating R408.2.3 to use the UEF will not affect the cost of construction since water heating equipment on the market do not use the older EF unit.

REPI-138-21

REPI-139-21

IECC®: R408.2.5

Proponents:

David Baylon, representing Northwest Energy Efficiency Alliance (david@davidbaylon.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Revise as follows:

R408.2.5 (N1108.2.5) Improved air sealing and efficient ventilation system option.

The measured air leakage rate shall be less than or equal to ~~3.0~~ 2.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed. Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent Sensible Recovery Efficiency (SRE), less than or equal to 1.1 cubic feet per minute per watt (0.03 m^3/min/watt) and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent Latent Recovery/Moisture Transfer (LRMT).

Reason Statement:

The goal of this proposal is to reduce the incidental infiltration in the home but not to change the effectiveness of the HRV/ERV required in the "Option" The infiltration introduces outside air into the building and has the effect of increasing the overall heat loss (or gain) impacts on the heating and cooling requirement. In by reducing the infiltration rate by 30% the impact on the overall heat loss rate (UA) would be about 5%. This would reduce the heating requirement by about that amount and have no effect on the perfromance of the HRV/ERV.

Cost Impact:

The code change proposal will increase the cost of construction.

The cost analysis that accompanied the Washington Code proposals in the 2018 code change process estimated the cost of increased envelope tightness at about $0.25/SF of building. This cost depends on the need to change some of the construction practice. Builders would probably learn over time what approach to added tightness would require and they would integrated it into their building practice. That would have the effect of reducing or eliminating this incremental cost for builders that used this option.

REPI-139-21

REPI-140-21

IECC®: R408.2.5

Proponents:

Mike Moore, Stator LLC, representing Broan-NuTone (mmoore@statorllc.com)

2021 International Energy Conservation Code

Revise as follows:
R408.2.5 (N1108.2.5) Improved air sealing and efficient ventilation system option.
The measured air leakage rate shall be less than or equal to 3.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed. ~~Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent~~ HRV and ERV Sensible Recovery Efficiency (SRE)~~,~~ shall be no less than 75 percent at 32°F (0°C), at the lowest listed net supply airflow~~less than or equal to 1.1 cubic feet per minute per watt (0.03 m~~^{3}~~/min/watt) and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent~~ ERV Latent Recovery/Moisture Transfer (LRMT) shall be no less than 50 percent, at the lowest listed net supply airflow. In Climate Zone 8, recirculation shall not be used as a defrost strategy.

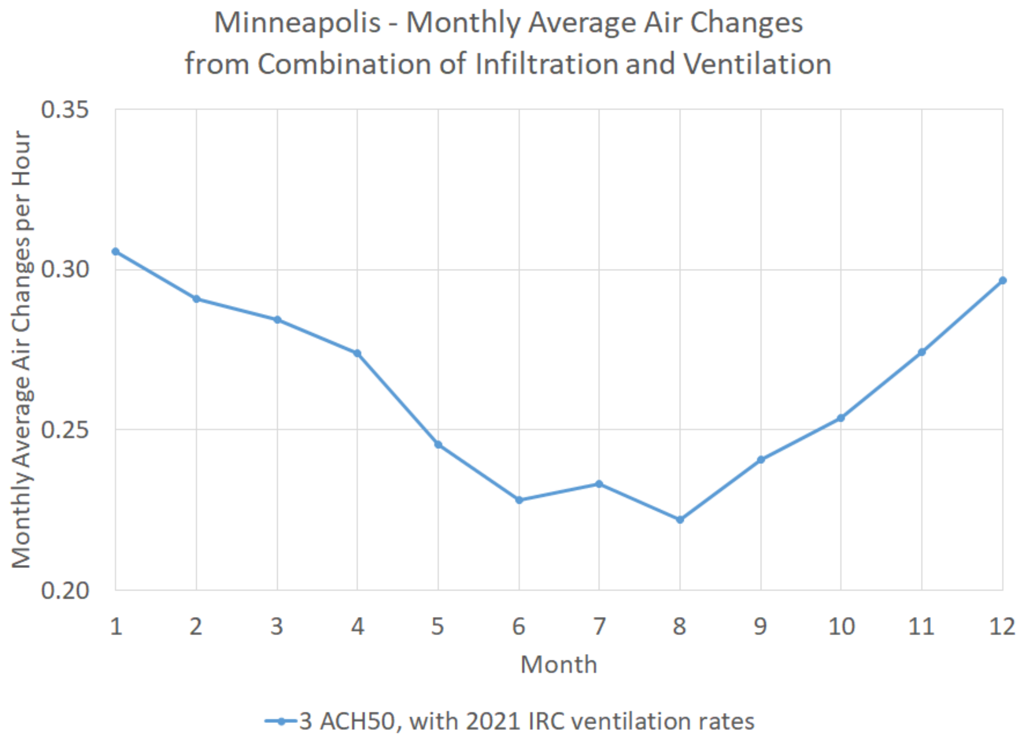
Reason Statement:

This proposal removes a conflict between the H/ERV fan efficacy of this section and that of Table R403.6.2 (removing the requirement here to ensure that the higher fan efficacy of R403.6.2 takes precedent), clarifies that performance values should be *listed* values (and for SRE, uses the same reference temperature as is required in Section R403.6.1), permits recirculation defrost to be used in all climate zones but Climate Zone 8, and improves readability of the section.

Recirculation defrost draws a fraction of the electrical load of an H/ERV that uses electric resistance defrost, which is a strategy that designers may specify to meet the current Section R408.2.5 requirements. In fact, electric resistance defrost can draw over 900 Watts in a typical unit. A common criticism of recirculation defrost is that it reduces air exchange when installed in cold climates that require frequent operation of the defrost cycle – leaving occupants without access to fresh air. However, by overlaying a typical recirculation defrost control strategy on a TMY3 weather data for each climate zone, we can see that recirculation defrost cycles are very limited on an annual basis, even in cold climates:

Climate Zone	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Annual Recirc Defrost Run Time (%)	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	1%	0%	3%	2%	4%	7%

In all but climate zone 8, a typical reduction in annual run time is less than 5%. Also, that reduction happens during the coldest time of the year, when infiltration of outdoor air through leaks within the building envelope is at its peak and is offsetting the reduction in mechanical ventilation (see the chart below for an illustration of total ventilation rates for a typical code compliant home). For these reasons, permitting recirculation defrost in all but climate zone 8 strikes a good balance between IAQ and energy demand.



Cost Impact:

The code change proposal will decrease the cost of construction.

The proposal can help reduce costs by providing additional, energy efficient compliance options.

REPI-140-21

REPI-141-21

IECC®: R408.2.6 (N1108.2.6) (New), ASTM Chapter 06 (New)

Proponents:

Amanda Hickman, representing Reflective Insulation Manufacturers Association (RIMA) (amanda@thehickmangroup.com)

2021 International Energy Conservation Code

Add new text as follows:
R408.2.6 (N1108.2.6) Radiant barriers installed in vented attics.

In Climate Zones 1, 2, and 3, vented attics shall be installed with radiant barriers. Radiant barriers shall be tested in accordance with ASTM C1313/1313M and installed in accordance with ASTM C1743.

Add new standard(s) as follows:

ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

C1313/C1313M-13(2019) Standard Specifications for Sheet Radiant Barriers Construction Applications

ASTM ASTM International 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken PA 19428-2959

C1743-19 Standard Practice for Installation and Use of Radiant Barrier Systems (RBS) in Residential Building Construction

Reason Statement:

This language is being proposed to add an additional option to this section to increase flexibility and energy savings. According to the DOE[1], some studies show that radiant barriers can reduce cooling costs 5% to 10% when used in a warm, sunny climate. The reduced heat gain may even allow for a smaller air conditioning system. https://www.energy.gov/energysaver/weatherize/insulation/radiant-barriers

In cooling climates, attic radiant barriers (ARBs) have been shown to conserve substantial amounts of energy by reducing temperatures in vented attics. Lower attic temperatures slow the rate of temperature differential – driven heat transfer from ceiling envelope elements and HVAC equipment and ducting.

Attic radiant barriers are extensively used across Climate Zones 1, 2 and 3, i.e. in the sunbelt areas, and numerous demonstration projects and studies have confirmed the energy savings and cost-effectiveness of these installations. Such radiant barrier products have been on the market for over 24 years and are used by 87 of the top 100 US Builders. They have an established history and have been accepted into several regional code requirements and are included in the Energy Star Reference Home Guidelines. Over one billion square feet of radiant barriers are installed annually.
The codes that include radiant barrier are:

IBC 2021

- Section 1510, Radiant Barriers Installed Above Deck

Hawaii Title 3, Chapter 181.1 2015

- Section 407.2 Requirements
- Table 407.1 Points Option

Texas

- City of Austin Ordinance No. 20210603-055, City Code Chapter 12-25, Article 12, R402.6

2020 Florida Building Code, Energy Conservation, 7th Edition

- R405.7.1 Installation criteria for homes claiming the radiant barrier option
- Figure R405.7.1 Acceptable attic radiant barrier configurations
- Table 303.2.1 Insulation Installation Standards

2019 California Title 24, Part 6

- Section 100.1 Definitions
- Section 110.8 Mandatory requirements for insulation, roofing products and radiant barriers

This product has two ASTM Standards that are applicable – ASTM C1313, “Standard Specification for Sheet Radiant Barriers for Building Construction Applications,” and ASTM C1743, “Standard Practice for Installation and Use of Radiant Barrier Systems (RBS) in Residential Building Construction”. This proposal requires the use of radiant barriers in a manner consistent with the existing language in the Energy Star for Homes – “Version 3, Exhibit 1” and, additionally, requires that the radiant barriers comply with the two ASTM standards just referenced.

A comprehensive review of radiant barrier studies was performed by Mario Medina, Ph.D. P.E. “This paper provides a general description of RBs, including installation configurations, the physical principles that make them work, and the laboratory and field experiments used to evaluate their thermal performance. An extensive review of the literature is summarized, highlighting fundamental issues, such as reduced ceiling heat flows, reduced space cooling and heating loads, and changes in attic temperatures produced by the installation of RBs in residential attics.”

[2] The document has been mentioned here as an additional reference related to radiant barrier product information and to highlight the scope of “benefit” studies that have been completed.

Another study, performed in 2008 by the Energy Center of Appalachian State University[3], compared a pair of adjacent four-bedroom Centex model homes in Charlotte using a total of 61 senors installed in and outside of the houses. It found:

* A 23-degree drop in the peak attic temperature in the home outfitted with radiant heat barrier versus the similar home without the barrier;

* A 20% reduction in the run-time of the air conditioning unit during the seven hours of peak attic temperatures;

* A 57% improvement in the efficiency of cooled air delivered through the air ducts during the same period.

Bibliography:

[1]Department of Energy - Energy Saver website https://www.energy.gov/energysaver/weatherize/insulation/radiant-barriers

[2] Medina, Mario, “A Comprehensive Review of Radiant Barrier Research Including Laboratory and Field Experiments”, report prepared for the Reflective Insulation Manufacturers Association.

[3] Davis, Bruce Eugene & Tiller, Jeffrey, “Radiant Barrier Impact on Selected Building Performance Measurements, Model Home Case Study, Centex Homes“.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal only adds an additional cost-effective option to R408, which will promote more flexibility in the code.

REPI-141-21

REPI-142-21

IECC®: 408.2.6 (N1108.2.6) (New), 403.5.4 (N1103.5.4) (New), 403.5.4.1 (N1103.5.4.1) (New)

Proponents:

Dan Wildenhaus, representing Northwest Energy Efficiency Alliance (dwildenhaus@trccompanies.com); Kevin Rose, representing Northwest Energy Efficiency Alliance (NEEA) (krose@neea.org)

2021 International Energy Conservation Code

Add new text as follows:
408.2.6 (N1108.2.6) Improved Domestic Hot Water Distribution.

The hot water distribution system shall meet Section R403.5.4 and shall be paired with a drain water heat recover system per Section R403.5.3. The storage limit specified by R403.5.4 shall be measured from the water heating source to the fixture itself. In addition, no more than 0.6 gallons (2.3 liters) of water shall be collected from the hot water fixture before hot water is delivered. The fixture with the greatest stored volume between the fixture and the hot water source (or recirculation loop) will need to be tested.To field verify that the system meets the 0.6 gallon (2.3 liter) limit, verifiers shall first initiate operation of on-demand recirculation systems, if present, and let such systems run for at least 40 seconds. In accordance with Department of Energy's Zero Energy Ready Home National Specification (Rev. 07). Next, a bucket or flow measuring bag (pre-marked for 0.6 gallons) shall be placed under the hot water fixture. The hot water shall be turned on completely and a digital temperature sensor used to record the initial temperature of the water flow. Once the water reaches the pre-marked line at 0.6 gallons (approximately 24 seconds for a lavatory faucet), the water shall be turned off and the ending temperature of the water flow (not the collection bucket) shall be recorded. The temperature of the water flow must increase by not less than 10 °F (5.6ºC).

403.5.4 (N1103.5.4) Compact Hot Water Distribution systems (CHWD).

Where installed, CHWD systems shall comply with the provisions of section R403.5.4.1.

403.5.4.1 (N1103.5.4.1) Water Volume in Pipe Method.

The hot water distribution system shall store not more than 0.5 gallons (1.9 liters) of water in any piping/manifold between the hot water source and any hot water fixture when calculated using approved engineering calculations. These calculations will use the nominal diameter and length of the piping or tubing, and the longest pipe run from water heater, including both horizontal and vertical run of pipe, shall not be more than 20 feet (6.1m).

Reason Statement:

Inefficient hot water distribution systems have been recognized as a problem for many years as they result in energy and water waste, and result in long hot water delay times that are the cause of a significant number of complaints by new home buyers. Recirculation systems are a solution to two of the three problems (water and wait time), but the thermal energy impact of different recirculation system options has already been addressed in section **R403.5.1.1 Circulation system**.[1]

In all non-recirculation distribution options, water heater energy consumption and hot water waste are correlated. A decrease in water heater energy consumption follows a reduction in wasted water; therefore, improving insulation and reducing the piping length and/or pipe diameter have equal benefits for energy and water waste. In recirculation systems, water heater energy consumption and wasted hot water are independent, and often have an inverse effect (when recirculation is not demand based).[2]

This distribution system problem exists for a variety of factors including:

- An outdated pipe sizing methodology in the plumbing code that results in oversized hot water distribution systems since the assumed fixture flow rates are much higher than current requirements.
- Municipalities with design recommendations that force plumbers and designers to assume low supply water pressure, resulting in larger distribution piping, which waste more water and energy.
- Increasing efforts to conserve water has resulted in the realization of water savings due to improvements in showerhead and lavatory maximum flow rates; however, reduced flow rates often result in increased wait times if the hot water distribution system is not designed to accommodate lower flows.
- Increasing popularity of gas instantaneous water heaters, which offer improved operating efficiency, but can result in increased

water waste when starting from a “cold start up” situation.
- Inefficient plumbing installations that are not focused on minimizing pipe length or pipe diameters.

The IECC has already addressed pipe insulation and Circulation systems in the 2021 IECC Residential provisions.

[1] *Residential Compact Domestic Hot Water Distribution Design: Balancing Energy Savings, Water Savings, and Architectural Flexibility*

Farhad Farahmand, TRC Companies and Yanda Zhang, ZYD Energy

[2] *Evaluating Domestic Hot Water Distribution System Options With Validated Analysis Models* E. Weitzel and M. Hoeschele Alliance for Residential Building Innovation

Savings:

The following savings have been calculated for compact domestic hot water distribution only, as Drain Water Heat Recovery has already been included in the 2021 IECC. The California Energy Codes & Standards Case Report for *Compact Hot Water Distribution*; Measure Number: 2019-RES-DHW1-F, Residential Plumbing[3] performed savings analysis using 16 California climate zones. This analysis focused on Therm and Water Savings as it’s estimated that over 75% of Residential New Construction Water Heaters installed are gas tankless systems. Nationally, ~68% of Residential New Construction Domestic Hot Water systems are gas fueled, according to the *Home Innovation Research Lab’s Annual Builder Practices Survey, 2021*[4]. California’s climate zones correlate approximately to IECC Climate Zones 2, 3b, 3c, 4c, 5b, and 6. Savings estimated should be conservative for climate zones 4c and higher as ground temperatures and therefore incoming water temperatures in California homes may be 1 to 3^{o}F higher than in these cooler climates.

Energy Savings Compact Hot Water Distribution Design:In climate zones 3b and lower, first year weighted average residential energy savings (translated from Therms/yr to Mmbtu/yr) are estimated to be per Single Family Home: Climate ZoneSavings in ThermsSavings in Mmbtu2 and 3b4.480.4483c and higher5.570.557 These estimates come from assumption of a 2,430 sq ft home with 3.5 bedrooms.

3

California Energy Codes & Standards Case Report for *Compact Hot Water Distribution*; Measure Number: 2019-RES-DHW1-F, Residential Plumbing

[4] Home Innovation Research Labs Annual Builder Practices Survey, 2021

Water Savings

:

Estimated impacts on water use are presented in the table below. Water use savings estimates are challenging given that hot water usage behaviors among individuals and households are highly variable and can depend strongly on the demographics of the household (Parker, D.; Fairey, P.; and Lutz, J.; 2015). In addition, the proposed compliance option approach ensures that compliant hot water distribution systems will be smaller than a conventional non-compact system but cannot precisely specify the design and configuration and hence the impacts on water waste. To provide a best approximation of water savings impacts, the Statewide CASE Team relied on detailed distribution simulation study completed under the U.S. Department of Energy’s Building America program (Weitzel, E.; Hoeschele, M. 2014). In these estimates, it was assumed that all water savings occur indoors.

Impacts on Water Use Table On-Site Indoor Water Savings (gal/yr) Per Dwelling Unit Impacts (single family) 962

Per Dwelling Unit Impacts (multifamily) 321

Drain Water Heat Recovery Savings:

Using the most conservative Department of Energy savings estimates of 800kWh per year, with an U.S. Energy Information Agency hybrid electricity rate for the nation of 13.5 cents per kWh show an annual savings estimate for electric water heating at: $108/yr

https://energy.cdpaccess.com/proposal/446/975/files/download/139/
https://energy.cdpaccess.com/proposal/446/975/files/download/138/
https://energy.cdpaccess.com/proposal/446/975/files/download/137/
https://energy.cdpaccess.com/proposal/446/975/files/download/136/
https://energy.cdpaccess.com/proposal/446/975/files/download/135/

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- *Residential Compact Domestic Hot Water Distribution Design: Balancing Energy Savings, Water Savings, and Architectural Flexibility* Farhad Farahmand, TRC Companie;Yanda Zhang, ZYD Energy
- *Evaluating Domestic Hot Water Distribution System Options With Validated Analysis Models* E. Weitzel and M. Hoeschele Alliance for Residential Building Innovation
- California Energy Codes & Standards Case Report for *Compact Hot Water Distribution*; Measure Number: 2019-RES-DHW1-F, Residential Plumbing
- Home Innovation Research Labs Annual Builder Practices Survey, 2021
- Department of Energy Zero Energy Ready Home National Program Requirements (Rev. 07) [footnote 15]
- Efficient hot water distribution system – USBGC LEED BD+C: Homes v4 – LEED v4
- Residential Hot Water Distribution Systems: Roundtable Session; JD Lutz, Lawrence Berkely National Laboratory; G Klein, California Energy Commission; D Springer, Davis Energy Group; BD Howard, Building Environmental Science & Technology

Cost Impact:

The code change proposal will increase the cost of construction.

Incremental first costs to builders, designers, and plumbers are design based and each builder will need to determine potential cost impacts based on existing designs and measures in use. Depending on current practices and paths taken for IECC compliance this measure may result in small incremental cost increases or decreases. These potential cost differences relative to standard practices are likely to be:

- Reduced cost of PEX or copper tubing due to less material installed.
- Reduced cost to pipe insulation due to smaller plumbing layout.
- Reduced or neutral cost in labor hours for plumber.
- Increased water heating venting costs, if a gas water heater or electric heat pump water heater is centrally located.
- Increased venting labor costs, if a gas water heater or electric heat pump water heater is located is centrally located and not on a garage wall.

This measure should not have maintenance costs associated with it compared to standard practices.

Energy Savings and Cost Impact for Drain Water Heat Recovery: Using the most conservative Department of Energy savings estimates of 800kWh per year savings, with an U.S. Energy Information Agency hybrid electricity rate for the nation of 13.5 cents per kWh, and an increased cost of $1,000 per unit due to increase copper prices; these systems provide an 11 year simple payback.

REPI-142-21

REPI-143-21

IECC®: R501.7 (N1109.7) (New), R502.1, R502.2, R502.3, R502.2.2 (N1110.2.2) (New), R502.2.3 (N1110.2.3) (New), R502.3.1, R502.3.2, R502.3.3, R502.3.4, R502.2.1.1 (N1110.2.1.1) (New), R502.2.2.1 (N1110.2.2.1) (New), R502.2.3.1 (N1110.2.3.1) (New)

Proponents:

Robby Schwarz, BUILDTank, Inc., representing Colorado Chapter of the ICC (robby@btankinc.com)

2021 International Energy Conservation Code

Add new text as follows:
R501.7 (N1109.7) **Change in space conditioning**.

Any unconditioned or low-energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with this code.

Exceptions:

1. Where the simulated performance option in Section R405 is used to comply with this section, the annual energy cost of the *proposed design* is permitted to be 110 percent of the annual energy cost otherwise allowed by Section R405.2.

2. Where the Total UA, as determined in Section R402.1.5, of the existing *building* and the *addition*, and any *alterations* that are part of the project, is less than or equal to the Total UA generated for the existing *building*.

3. Where complying in accordance with Section R405 and the annual energy cost or energy use of the *addition* and the existing *building*, and any *alterations* that are part of the project, is less than or equal to the annual energy cost of the existing *building*. The *addition* and any *alterations* that are part of the project shall comply with Section R405 in its entirety.

Revise as follows:
R502.1 (N1110.1) General.
Additions to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction. ~~without requiring the unaltered portion of the existing *building* or *building* system to comply with this code.~~ *Additions* shall not create an unsafe or hazardous condition or overload existing *building* systems. ~~An *addition* shall be deemed to comply with this code where the *addition* alone complies, where the existing *building* and *addition* comply with this code as a single building, or where the *building* with the *addition* does not use more energy than the existing *building*. *Additions* shall be in accordance with Section R502.2 or R502.3.~~
R502.2 (N1110.2) Compliance ~~Change in space conditioning~~.

An *addition* shall be deemed to comply with this code where the existing building with the addition complies prescriptively (using Total UA) or does not use more energy than the existing building and demonstrates compliance using either Building Performance energy cost, or Energy Rating Index compliance option listed below.

Existing building envelope and energy features shall be evaluated per ANSI/RESNET/ICC 301-2019 or ANSI/BPI 1200-S-2017 standards.

Exceptions: Unaltered portions of the existing *building* or *building* system are not required to comply with this code section if

1. **The existing building was constructed to the 2009 International Energy Conservation Code or later or**

2. **The addition is less than 30% of the total conditioned floor area of the existing building or**

3. **The building has undergone a documented energy efficiency upgrades to the envelope within the last 10 years.**

~~**Any unconditioned or low-energy space that is altered to become *conditioned space* shall be required to be brought into full compliance with this code.**~~
~~**Exceptions:**~~
~~**1. Where the simulated performance option in Section R405 is used to comply with this section, the annual energy cost of the**~~

~~*proposed design* is permitted to be 110 percent of the annual energy cost otherwise allowed by Section R405.2.~~

~~2.~~ ~~**Where the Total UA, as determined in Section R402.1.5, of the existing building and the *addition*, and any *alterations* that are part of the project, is less than or equal to the Total UA generated for the existing *building*.**~~

~~3.~~ ~~**Where complying in accordance with Section R405 and the annual energy cost or energy use of the *addition* and the existing *building*, and any *alterations* that are part of the project, is less than or equal to the annual energy cost of the existing *building*. The *addition* and any *alterations* that are part of the project shall comply with Section R405 in its entirety.**~~

R502.2.1 ~~R502.3~~ (N1110.2.1) **Existing plus addition** (Prescriptive compliance).

Total UA compliance verification in Section R402.1.5 shall demonstrate that the existing building plus the addition, has a total UA that is less than or equal to the Total UA of the existing *building* prior to the addition. This method requires the project to create two Total UA compliance verification reports as outlined in Section R502.2.1.1.
~~*Additions* shall comply with Sections R502.3.1 through R502.3.4.~~

Add new text as follows:
R502.2.2 (N1110.2.2) **Existing plus addition compliance (Total Building Performance).** .

Total building performance Section R405 compliance verification shall demonstrate that the existing building plus the addition uses no more energy than the existing *building* did prior to the addition. This method requires the project to create cost compliance verification at three stages as outlined in Section R502.2.2.1.

R502.2.3 (N1110.2.3) **Existing plus addition compliance (Energy Rating Index Alternative).**.

An Energy Rating Index score shall demonstrate that the existing building plus the addition uses no more energy than the existing *building* did prior to the addition. This method requires the project to obtain an Energy Rating Index score at three stages as outlined in Section R502.2.3.1

Revise as follows:
R502.3~~.1~~(N1110.3) Building envelope.

New *building* envelope assemblies that are part of the *addition* shall comply with Sections R402.1, R402.2, R402.3.1 through R402.3.5, and R402.4.

~~**Exception:** New envelope assemblies are exempt from the requirements of Section R402.4.1.2.~~

R502.4 ~~3.2~~ (N1110.4) Heating and cooling systems.

HVAC ducts newly installed as part of an *addition* shall comply with Section R403.

Exception:
1. Where ducts from an existing heating and cooling system are extended to an *addition* that is less than 30% of the total conditioned floor area of the existing building.

2. **HVAC Design**: Manual J, S, and D are not required for additions that increase the existing floor area less than 30% of the total conditioned floor area of the existing building

R502.5 ~~3.3~~ (N1110.5) Service hot water systems.
New service hot water systems that are part of the *addition* shall comply with Section R403.5.
R502.6 ~~3.4~~ (N1110.6) Lighting.
New lighting systems that are part of the *addition* shall comply with Section R404.1.
Add new text as follows:
R502.2.1.1 (N1110.2.1.1) Reporting.

1. For permitting: A Total UA compliance benchmark report of the existing structure prior to construction.

2. For permitting: Total UA compliance report of the existing building plus the addition based on the proposed design.

R502.2.2.1 (N1110.2.2.1) Reporting.

1. For permitting: A baseline total building performance cost compliance report of the existing structure prior to construction.

2. For permitting: Projected total building performance cost compliance report of the existing building plus the addition based on the

proposed design for the building in its entirety.

3. For Certificate of Occupancy: A final confirmed total building performance cost compliance report shall be submitted prior to final inspection.

R502.2.3.1 (N1110.2.3.1) Reporting.

1. For permitting: A baseline ERI of the existing structure prior to construction.

2. For Permitting: A projected ERI of the existing building plus the addition based on the proposed design for the building in its entirety.

3. For Certificate of Occupancy: A confirmed ERI report shall be submitted prior to final inspection.

Reason Statement:

The existing Section **R502.2 Change in space conditioning** in the additions chapter 5 Existing homes has not reference to additions. Is speaks to a general condition of changing a low energy space during an alteration to become a conditioned space. This is not an addition, so it was moved to a new section in R501 General as an overarching general requirement rather than one specific to additions.

The additions section R502 struggle with how to determine compliance with the requirements of the IECC as they relate to existing home additions. The existing section R502.1 general spoke loosely to demonstrating compliance but it is not specific enough to guide enforcement well. We therefore stuck language from this section and created a true compliance section for additions on Section R502.2. This new section leverages an existing compliance option and states that the *addition* shall be deemed to comply with this code where the existing building with the addition complies prescriptively (using Total UA) or does not use more energy than the existing building and demonstrates compliance using either Building Performance energy cost, or Energy Rating Index compliance option listed below. In this way a prescriptive nonenergy compliance base compliance path can be used, and two energy-based compliance paths are options. All of the compliance paths require that the building plus the addition be compared to the building before the addition to quantify that the building plus the addition is equal to or better than the building before the addition was added.

This approach requires benchmarking the existing structure before construction begins so a comparison can be made using one of the three compliance approaches. ANSI/RESNET/ICC 301-2019 or ANSI/BPI 1200-S-2017 standards have been referenced as guidelines for how to evaluate insulation levels and other energy features needed to benchmark an existing building through computer modeling.

All compliance approaches compare the building plus addition to itself without the addition, so parity is achieved. The two performance approaches should be more flexible as they are whole house approaches meaning, for example, that a leaky house before an addition, is compared with a leaky house plus a tighter addition with more volume which can offset (trade) to be equal to or better than. In addition, the existing house could add LED lighting or do other low hanging, low cost, energy upgrades to ensure compliance.

This approach is new and forces us to consider and offer opportunity to upgrade existing homes at the time that an addition is added to the structure. New Homes become existing homes and they last a really long time. Jurisdictions around the country are struggling with how to encourage energy upgrades to help meet climate action and other goals they may have for their housing stock. This proposal offers a starting point by which a community grow from. It requires a look at the existing structure to consider if some level of upgrade must happen when an addition is added. Communities could go further and require that the existing structure plus the addition be x percentage better than the existing structure was before. This is the direction that communities are looking to go. If we want jurisdictions to continue to use the IECC this proposal needs to be considered. Otherwise community goals will outpace the what the IECC can offer to meet their climate goals.

Cost Impact:

The code change proposal will increase the cost of construction.

Cost of construction will increase with this proposal primarily due to the cost of demonstrating compliance. However, there was no true means developed in the past existing home additions section to demonstrate compliance other than a vague visual inspection. This approach truly quantifies compliance while offering an opportunity to address issues with the existing structure.

REPI-143-21

REPI-144-21

IECC®: R502.3, R502.3.5 (N1110.3.5) (New), R503.1, R503.1.5 (N1111.1.5) (New), SECTION R506 (N1114) (New), R506.1 (N1114.1) (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:
R502.3 (N1110.3) Prescriptive compliance.
Additions shall comply with Sections R502.3.1 through ~~R502.3.4~~ R502.3.5.
Add new text as follows:
R502.3.5 (N1110.3.5) Additional Efficiency Packages.

Additions shall comply with Section R506. *Alterations* to the existing building that are not part of the *addition*, but permitted with the *addition*, may be used to achieve this requirement.

Exceptions:

1. *Additions* that increase the *building*'s total *conditioned floor area* by less than 25 percent.
2. *Additions* that do not include the addition or replacement of equipment covered in Sections R403.5 or R403.7.
3. *Additions* that do not contain *conditioned space*.
4. Where the *addition* alone or the existing building and *addition* together comply with Section R405 or R406.

Revise as follows:
R503.1 (N1111.1) General.

Alterations to any building or structure shall comply with the requirements of the code for new construction, without requiring the unaltered portions of the existing building or building system to comply with this code. *Alterations* shall be such that the existing building or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration.Alterations* shall not create an unsafe or hazardous condition or overload *existing* building systems. *Alterations* shall be such that the existing *building* or structure does not use more energy than the existing building or structure prior to the *alteration. Alterations* to existing *buildings* shall comply with Sections R503.1.1 through ~~R503.1.4~~ R503.1.5.

Add new text as follows:
R503.1.5 (N1111.1.5) Additional Efficiency Packages.

Alterations shall comply with Section R506.

Exceptions:

1. *Alterations* only requiring compliance with one of Sections R402.1, R403.5, or R403.7.
2. *Alterations* that are part of an addition complying with section R502.3.5.
3. *Alterations* that comply with Section R405 or R406.

SECTION R506 (N1114) ADDITIONAL EFFICIENCY PACKAGE OPTIONS
R506.1 (N1114.1) General.

Where required in Section R502 or R503, the *building* shall comply with one or more additional efficiency package options in accordance with the following:

1. Enhanced envelope performance in accordance with Section R408.2.1.
2. More efficient HVAC equipment performance in accordance with R408.2.2
3. Reduced energy use in service water-heating in accordance with R408.2.3
4. More efficient duct thermal distribution system in accordance with R408.2.4

5 Improved air sealing and efficient ventilation system in accordance with R408.2.5

Reason Statement:

Section R408 was added to the IECC in 2021. R408 requires homes to include an additional efficiency option to achieve greater efficiency. R408 was a residential version of section C406 that had been in the commercial code since 2012. This allowed the IECC to achieve additional efficiency in a highly flexible way. However, there is one significant gap in R408, it does not apply to additions or alterations. R502 and R503 do not reference R408 in the sections with which additions and alterations must comply. The exclusion from R408 is a significant loophole. Additions and substantial alterations are prime opportunities for achieving greater energy efficiency utilizing R408.This proposal creates a framework to apply R408 to additions and substantial alterations. It creates a new Section R506 that provides guidance for how to utilize R408 for existing buildings. R506.1 takes the place of the charging language in R401.2.5, R408.1 and R408.2 for existing buildings. This section R506 is referenced by new sections in R502 and R503 that set which additions and alterations need to meet the additional efficiency option requirement in R506.The new Section R502.3.5 establishes which additions must comply with C506. It also allows alterations and additions that are part of the same permit to meet C506 together. The section includes certain exemptions in order to ensure that C506 is only getting triggered by larger additions that have enough new systems included to enable flexible application of the package options:

1. Smaller additions that add less than 25% conditioned area
2. Additions that don't include new water heating or space conditioning systems
3. Additions that don't include conditioned space
4. Additions that will comply with R405 or R406.

The new section C503.3.5 requires that large alterations comply with the new R506. The section includes important exceptions:

1. The first exception ensures that the requirements only apply to substantial additions with significant scope. The exemption is worded to address small alterations that only impact one of the main buildings systems: envelope (R402), HVAC (R403.5) and water heating (C403.7). Alterations that impact two or more of these systems – and must therefore comply with two or more of these sections – will have a larger scope with more opportunities to choose from among the available package options.
2. An exception that reflects the allowance for alterations and additions to comply together under C502.
3. An exception for buildings that comply with R405 or R406.By limiting requirement to substantial alterations, the proposal ensures that projects will likely have sufficient package options within the existing scope of the project. The project team will be able to pick a package option that applies to building elements that are already within the project scope.

The savings for this proposal will vary based on which project is chosen. However, the savings should be higher for alterations in particular since the baselines for alterations include many below-code existing building features. Depending on how inefficient the rest of the building is, the impact of this proposal could be substantially higher without any greater cost than new construction R408 measures.

Cost Impact:

The code change proposal will increase the cost of construction.

This proposal is crafted so that it will only impact major renovations / large-scope alterations that are already impacting the major systems that serve as the basis for packages under R408. This means that these projects are already undertaking the cost of bringing two or more of these major systems up to current code requirements, and the incremental cost is therefore only the cost from code rather than the cost of a standalone retrofit. Therefore, the costs for this proposal are the same as the costs for R408 requirements for new construction. However, savings for each package will generally be much higher since the rest of the building will nearly always have specifications that fall short of the latest energy code and each package will deliver greater savings. As a result, any package that is cost effective for new construction will be even more cost effective for major alterations.

REPI-144-21

REPI-145-21

IECC®: R502.3.2, R502.3.2.1 (N1110.3.2.1) (New), R503.1.2, R503.1.2.1 (N1111.1.2.1) (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:
R502.3.2 (N1110.3.2) Heating and cooling systems.

HVAC ducts newly installed as part of an *addition* shall comply with Section R403 and R502.3.2.1

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Exception: Where the extension of ducts from an existing heating and cooling system ~~are extended to~~ into an addition results in an increase of total duct volume in the *building* of less than 20 percent.

Add new text as follows:
R502.3.2.1 (N1110.3.2.1) Duct Testing.

Ducts that serve the *addition* shall be tested in accordance with Section R403.3.5.The report required by Section R403.3.5 shall be provided to the owner in addition to the *code official.*

Revise as follows:
R503.1.2 (N1111.1.2) Heating and cooling systems.
New heating and cooling and duct systems that are part of the alteration ~~HVAC ducts newly installed as part of an alteration~~ shall comply with Section R403.

Exception: Where ducts from an existing heating and cooling system are extended to an *addition*.

Add new text as follows:
R503.1.2.1 (N1111.1.2.1) Duct testing.

Ducts and plenums that serve new heating or cooling equipment in an alteration shall be tested in accordance with Section R403.3.5.The reportrequired by Section R403.3.5 shall be provided to the owner in addition to the *code official.*

Reason Statement:

This proposal requires that existing ductwork serving new equipment in additions and alterations is tested. In an alteration, all ductwork serving new equipment will need to be tested. In additions, the ductwork serving the addition, both existing and new ductwork, will need to be tested if it increases the total volume of the ductwork serving the addition by more than 20%. The proposal does not include a performance criterion for the testing; the testing is informational.

The requirements for duct construction and sealing in the IECC have developed substantially over recent code cycles. Fiberboard materials, cloth tape, un-sealed duct joints, cavity plenum returns and other materials and approaches that can lead to very leaky ducts were once commonplace but are not now allowed by the IECC. The result is that the ductwork in many existing buildings fall far below modern standards.

Duct tightening can be a very cost-effective energy retrofit. The replacement of equipment or substantial expansion of existing ductwork present prime opportunities to undertake this testing and will provide project teams and building owners important information about the relative need and savings opportunity that could come from duct tightening projects. It will also give project teams important information for configuring new equipment and ductwork to ensure the whole system performs effectively.

Cost Impact:

The code change proposal will increase the cost of construction.

The cost will depend on the size of the duct system serving the alteration or addition.

REPI-145-21

REPI-146-21

IECC®: SECTION 202, R503.1.1

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:
IECC2021P1E_RE_Ch02_SecR202_DefROOF_REPLACEMENT ROOF REPLACEMENT. The process of removing ~~the~~ all existing layers of the roof ~~covering~~ system down to the roof deck, repairing any damaged substrate and installing a new roof ~~covering~~ system.
R503.1.1 (N1111.1.1) Building envelope.

Building envelope assemblies that are part of the *alteration* shall comply with Section R402.1.2 or R402.1.4, Sections R402.2.1 through R402.2.12, R402.3.1, R402.3.2, R402.4.3 and R402.4.5.

Exception: The following alterations shall not be required to comply with the requirements for new construction provided that the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.
2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.
3. Construction where the existing roof, wall or floor cavity is not exposed.
4. Roof recover.
5. ~~Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.~~ *Roof replacement*:
   - 5.1. Where the existing roof insulation is integral to or is located below the roof deck.
   - 5.2. Where the new *roof assembly* above deck *R-value* or *roof assembly U-factor*, is installed in accordance with the following:
     - 5.2.1. In compliance with the provisions of either R402.1.2 or R402.1.3 or R402.1.4 or R402.1.5 or R405 or R406; and
     - 5.2.2. In maximum practicable compliance with Table R402.1.2 or Table R402.1.3 or R402.1.5 or R405, or R406, including any partial compliance in areas subject to limiting conditions identified in a survey of existing conditions conducted prior to the *alteration* and provided to the *code official*; and
     - 5.2.3. In no case shall the *R-value* of the roof insulation be reduced or the *U-factor* of the *roof assembly* be increased as part of the *roof replacement*.
6. Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided that the code does not require the glazing or fenestration assembly to be replaced.

Attached Files

- **Analyzing R-value requirements--November 2014.pdf**
  http://localhost/proposal/356/605/files/download/82/
- **CodeMemorandum_Roofing Requirements_2016-06-20.pdf**
  http://localhost/proposal/356/605/files/download/81/
- **7_2018 IECC_Illinois Specific Amendments (w SO-UL) - Effective 2019-07-01.pdf**
  http://localhost/proposal/356/605/files/download/80/

Reason Statement:

The proposal addresses envelope requirements applicable to *roof replacements* to existing buildings by:

- Defining *roof replacement* consistently with the *International Building Code* (IBC) with improvements consistent with NRCA's assessment of contemporary roofing industry practice and code enforcement terminology;
- Confirming *roof replacement* as an *alteration* having its unique set of provisions by exception, and
  - Consistent with the intent of the framers of existing building provisions of the IECC prior to the 2015 Edition.
  - Consistent with the intent of the framers of existing building provisions of the 2018 Illinois Energy Conservation Code (2018 IECC) for alterations to existing buildings;
  - Consistent with the Chicago Department of Buildings Memorandum (attached) negotiated by the CRCA and the former IL DCEO, Office of Energy & Recycling in support of the 2012, 2015, 2018 and 2021 Editions of the Chicago Energy Conservation Code (CECC);
  - Derived during "Envelope Subcommittee" work to develop similar provisions for ASHRAE 90.1-2023, which had remained silent on *roof replacement* since its inception.
- Adding a provision for an "survey" of existing conditions conducted prior to the alteration and requiring its submission to those who inspect to and enforce the Code; and
- Assuring advocates of efficiency measures that in no case shall the *R-value* of the roof insulation be reduced or the *U-factor* of the roof assembly be increased as part of *roof replacement* operations.

To further articulate the "clear intent" of the references identified in b. (ii.) and b. (iii.) of this proposal:

1. **R402.1.2.** This reference is "limited" solely to the selected path for U-factors using Table R402.1.2 only (it ends there); or
2. **R402.1.3.** This reference is "limited" solely to the selected path for R-values & fenestration U-factors using Table R402.1.3 only (it ends there); or
3. **R402.1.4.** This reference is "limited" solely to the selected path for alternative R-value computations using Table R402.1.3 only (it ends there); or
4. **R402.1.5.** This reference is "limited" solely to the Total UA-alternative path for UA compliance using Section R402.1.5, the REScheck tool, or a "pencil and paper" UA calc only (it ends there); or
5. **R405.** This reference is "limited" solely to the "Total Building Performance" path for compliance using Section 405 or tools such as REMrate or Ekotrope RATER only (it ends there); or
6. **R406.** This reference is "limited" solely to the "ERI" path for compliance using Section 406, or tools such as REMrate or Ekotrope RATER only (it ends there).

These references are cited to establish clear linkage to any one (1) of the six (6) potential paths for RESIDENTIAL R-value, U-factor, UA, REScheck, REMrate, Ekotrope RATER, or ERI as the methodology by which "thermal performance" is declared. There is no intent or hint that the provisions of R402.2, "Specific insulation requirements," are subject to retroactive compliance.

Bibliography:

[1] Graham M., "Analyzing R-value Requirements – Cost paybacks to increases in R-values may not be practical," NRCA Industry Issue Update, National Roofing Contractors Association, 2014.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Increases in model energy codes' building energy performance requirements have resulted in increased R-values being specific for many of the thermal envelope components of the building, including and particularly, roof systems. Where is the equivalency among a four-story brownstone in Chicago required to provide a low-slope, above-deck R-value of R-60, while a four-story multi-family building in Oak Park is permitted to provide a low-slope, above-deck R-value of R-30? Comparatively, where is the equivalency among a three-story, three-flat in Rockford is required to provide a low-slope, above-deck R-value of R-60, while a two-story Bass Pro Shop in Belleville is allowed to provide a low-slope, above-deck R-value of R-30?

Such R-value increases have been implemented into the code with little to no consideration of the added initial (construction) costs and long-term payback to building owners and local property managers who (primarily) initiate their maintenance, repair and replacement by initiating such inquiries, not with an Architect or code enforcement but a roofing contractor.

Accordingly, NRCA conducted a 2014 energy-savings and payback analysis for roof assembly R-value increases[1] in sixteen (16) of Americas largest cities and representative of the Standard's (then) eight (8) U.S. climate zones. We believe that using contemporary pricing for materials and the relatively flat-costs of energy across the commercial building sector, will only increase the paybacks forecast.

[1] Graham M., “Analyzing R-value Requirements – Cost paybacks to increases in R-values may not be practical,” NRCA Industry Issue Update, National Roofing Contractors Association, 2014.

REPI-146-21

REPI-147-21

IECC®: R503.1.1

Proponents:

Bill McHugh, representing Chicago Roofing Contractors Association (bill@mc-hugh.us)

2021 International Energy Conservation Code

Revise as follows:
R503.1.1 (N1111.1.1) Building envelope.

Building envelope assemblies that are part of the *alteration* shall comply with Section R402.1.2 or R402.1.4, Sections R402.2.1 through R402.2.12, R402.3.1, R402.3.2, R402.4.3 and R402.4.5.

Exception: The following alterations shall not be required to comply with the requirements for new construction provided that the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.
2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.
3. Construction where the existing roof, wall or floor cavity is not exposed.
4. Roof recover.
5. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.
<u>6.</u> <u>*Roof replacements* for roof systems 2:12 slope or less where installation of insulation above the structural roof deck necessary to achieve the code-required R-value is deemed infeasible by the code official. Conditions of infeasibility presented by existing rooftop conditions include, but are not limited to flashing heights at HVAC or skylight curbs, low door or glazing, parapet, or weep holes in walls.</u>

~~6.~~<u>7.</u> Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided that the code does not require the glazing or fenestration assembly to be replaced.

Reason Statement:

The purpose of this proposal is to provide the code official clear guidance when roof replacements on existing residential buildings have conditions that make it technically infeasible to meet new construction insulation thickness requirements.

This concept has been adopted by the State of Illinois in the 2018 version of the Illinois Energy Conservation Code. Prior to being added to the IL Energy Conservation Code, the 'relief' for flashing height infeasibility was on the State of Illinois' FAQ website, #14 C503, Roof Alterations.

The exception is also part of the City of Chicago's new 2019 Chicago Building Rehabilitation Code, based on the IEBC. Prior to codification, it was allowed based on a 2016 Roofing Memorandum, published by the City of Chicago, without code official approval required.

Both the City of Chicago and State of Illinois provide this solution as a reasonable way to manage the limits presented by existing building conditions, when new construction insulation thicknesses just are not technically feasible. The City of Chicago's Paradigm is that the scope of work for *roof replacement* is to replace the roof, not rebuild the top of the building to accommodate insulation. The City of Chicago only requires a letter stating that the flashing heights will not accommodate the additional thickness of insulation to gain permission to install less than the new construction requirement insulation thicknesses. The building official does not need to verify, grant permission nor review the question.

By adding approval for this type of operation by the code official before technical infeasibility takes place, it provides a 'check and balance' that those involved in this process will try first to add insulation, reducing energy costs, and that it is not just because a few 'easy to raise' pieces of equipment are on the roof.

Cost Impact:

The code change proposal will decrease the cost of construction.

This is a tough question to answer. Does this allowance than less than the code required insulation increase cost? No, it won't. If it is technically infeasible to install the insulation, is there really a decrease in construction costs? It seems it is a way to provide cost of construction that makes sense for the building.

REPI-147-21

REPI-148-21

IECC®: R503.1.1

Proponents:

Darren Meyers, P.E., representing International Energy Conservation Consultants LLC (dmeyers@ieccode.com); Mark Graham, representing National Roofing Contractors Association (mgraham@nrca.net)

2021 International Energy Conservation Code

Revise as follows:
R503.1.1 (N1111.1.1) Building envelope.

Building envelope assemblies that are part of the *alteration* shall comply with Section R402.1.2 or R402.1.4, Sections R402.2.1 through R402.2.12, R402.3.1, R402.3.2, R402.4.3 and R402.4.5.

Exception: The following alterations shall not be required to comply with the requirements for new construction provided that the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.
2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.
3. Construction where the existing roof, wall or floor cavity is not exposed.
4. Roof recover.
5. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.
6. Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided that the code does not require the glazing or fenestration assembly to be replaced.
7. *Air barriers* shall not be required for *roof recover* and *roof replacement* where the *alterations* or renovations to the *building* do not include *alterations*, renovations or *repairs* to the remainder of the *building thermal envelope*.

Reason Statement:

The National Roofing Contractors Association offers that such provisions are just as applicable to multi-family buildings three stories or less in height (R503.1.1), as they are to multi-family buildings four or more stories in height (C503.1, Exception 7) and commercial buildings of any height (C503.1, Exception 7). Note how the provision is similarly limited provided the *alterations* or renovations to the *building* do not include *alterations*, renovations or *repairs* to the remainder of the *building thermal envelope*.

Worth contemplating is the relative ineffectiveness of systemic air-sealing or -leakage testing resulting solely from a reroofing permit (i.e., *alteration*). For instance, consider the analogy where the existing shell of a building (built 10-, 20- or 50-years ago) and under *roof recover* or *roof replacement* is viewed as if it were a food colander:

- Holes in the food colander constitute existing leakage pathways through existing doors, windows, chimneys, walls and floors over outdoor air or crawlspaces not within the scope of the permit;
- Consider a piece of cellophane wrapped over the top of the colander the existing low-sloped, roof system or roof covering;
- When conducting a roof recover, a new piece of cellophane is wrapped over the existing low-sloped, roof covering/membrane. Should such operation require retroactive air sealing of the roof, much more the building?

- When conducting a roof replacement, the existing cellophane is removed and a new piece of cellophane is wrapped over the colander. Should such operation require retroactive air sealing of the roof, much more the building?

Cost Impact:

The code change proposal will decrease the cost of construction.

The code change proposal will decrease the cost of construction.

REPI-148-21

REPI-149-21

IECC®: R503.1.1, SECTION 202 (New)

Proponents:

Bill McHugh, representing Chicago Roofing Contractors Association (bill@mc-hugh.us)

2021 International Energy Conservation Code

Revise as follows:
R503.1.1 (N1111.1.1) Building envelope.

Building envelope assemblies that are part of the *alteration* shall comply with Section R402.1.2 or R402.1.4, Sections R402.2.1 through R402.2.12, R402.3.1, R402.3.2, R402.4.3 and R402.4.5.

Exception: The following alterations shall not be required to comply with the requirements for new construction provided that the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.

2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.

3. Construction where the existing roof, wall or floor cavity is not exposed.

4. Roof recover.

5. <u>*Roof Membrane Peel and Replacement.*</u>

~~5.~~ <u>6.</u> Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.

~~6.~~ <u>7.</u> Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided that the code does not require the glazing or fenestration assembly to be replaced.

Add new definition as follows:
<u>R202</u> <u>ROOF MEMBRANE PEEL AND REPLACEMENT</u>. <u>Condition where an existing weather resisting roof membrane is removed, exposing insulation, an existing roof membrane or sheathing, and a new weather resisting roof membrane is installed.</u>

Reason Statement:

As listed in Section 503, ROOF ALTERATIONS, neither the definitions of *Roof Replacement* nor *Roof Recover* handle the situation that is described in the newly proposed definition. Both definitions invoke the addition of material not scoped in a *roof covering peel and replacement*. The proposed definition provides a clear direction to the code user for this circumstance. This allows the building owner and manager to remove (or "peel") only the existing roof covering, reuse the roof membrane or existing insulation that has much life left in it, and replace the roof covering / membrane alone. There are several applications where this is not only practical, but preferred. The proposal, if approved, will be consistent with the positions of the IL Energy Office (Now IL EPA) FAQ No. 14, effective 2016-1-1 and of the Chicago Department of Buildings in their 2016 Roofing Code Memorandum effective 2016-7-20 and also the 2019 Chicago Energy Code, based on the 2018 International Energy Conservation Code. The proposal also covers where two roofs exist, and where the underlying roof assembly is dry, or 'recover' board was used to prepare the surface for a roof membrane, removing the top layer, leaving the underlying layer, also considered a *roof covering peel and replacement*.

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposal will provide the building owner and manager with a very viable option not covered in the current code.

REPI-149-21

REPI-150-21

IECC®: R503.1.1, R503.1.1.1, R503.1.1.2 (N1111.1.1.2) (New), 503.1.1.3 (N1111.1.1.3) (New), R503.1.1.4 (N1111.1.1.4) (New), R503.1.1.5 (N1111.1.1.5) (New), R503.1.1.6 (N1111.1.1.6) (New)

Proponents:

Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2021 International Energy Conservation Code

Revise as follows:

R503.1.1 (N1111.1.1) Building thermal envelope.

Alterations of existing *building thermal envelope* assemblies shall comply with this section. New ~~B~~*building thermal envelope* assemblies that are part of the *alteration* shall comply with Section R402 ~~R402.1.2 or R402.1.4, Sections R402.2.1 through R402.2.12, R402.3.1, R402.3.2, R402.4.3 and R402.4.5~~. In no case shall the *R*-value of insulation be reduced or the *U*-factor of a *building thermal envelope* assembly be increased as part of a *building thermal envelope* alteration.

Exception: The following alterations shall not be required to comply with the requirements for new construction provided that the energy use of the building is not increased:

1. Storm windows installed over existing fenestration.

~~2. Existing ceiling, wall or floor cavities exposed during construction provided that these cavities are filled with insulation.~~

~~3. Construction where the existing roof, wall or floor cavity is not exposed.~~

2.~~4.~~ Roof recover.

~~5. Roofs without insulation in the cavity and where the sheathing or insulation is exposed during reroofing shall be insulated either above or below the sheathing.~~

3.~~6.~~ Surface-applied window film installed on existing single pane fenestration assemblies to reduce solar heat gain provided that the code does not require the glazing or fenestration assembly to be replaced.

4. An existing building undergoing alterations that is demonstrated to be in compliance with Section R405 or Section R406.

R503.1.1.1 (N1111.1.1.1) ~~Replacement f~~Fenestration alterations.

Where new fenestration area is added to an existing building, the new fenestration shall comply with Section R402.3. Where some or all of an existing fenestration unit is replaced with a new fenestration product, including sash and glazing, the replacement fenestration unit shall meet the applicable requirements for *U*-factor and SHGC as specified in Table R402.1.3. Where more than one replacement fenestration unit is to be installed, an area-weighted average of the *U*-factor, SHGC or both of all replacement fenestration units shall be an alternative that can be used to show compliance.

Add new text as follows:

R503.1.1.2 (N1111.1.1.2) Roof alterations.

Roof insulation complying with Section R402.1 or an *approved* design shall be provided for the following roof alteration conditions as applicable:

1. sheathing or insulation is exposed during *reroofing* and the roof assembly has no insulation and is above *conditioned space*,
2. *roof replacements* for roofs with insulation entirely above deck,
3. conversion of an unconditioned attic space into *conditioned space*, and
4. replacement of ceiling finishes exposing cavities or surfaces of the roof assembly to which insulation can be applied.

503.1.1.3 (N1111.1.1.3) Above-grade wall alterations.

Above-grade wall alterations shall comply with the following requirements as applicable:

1. Where interior finishes are removed exposing wall cavities, the cavity shall be filled with existing or new insulation complying with Section R303.1.4;
2. Where exterior wall coverings are removed and replaced for the full extent of any exterior wall assembly, *continuous insulation* shall be provided where required in accordance with Section R402.1 or an *approved* design;
3. Where Items 1 and 2 apply, the entire wall assembly shall be insulated in accordance with Section R402.1; and,
4. Where new interior finishes or exterior wall coverings are applied to the full extent of any exterior wall assembly of mass construction, insulation shall be provided where required in accordance with Section R402.1 or an *approved* design.

Where any of the above requirements are applicable, the a*bove-grade wall* alteration shall comply with the insulation and water vapor retarder requirements of Section R702.7 of the *International Residential Code.* Where the exterior wall coverings are removed and replaced, the *above-grade wall* alteration shall comply with the water and wind resistance requirements of Section R703.1.1 of the *International Residential Code*.

R503.1.1.4 (N1111.1.1.4) Floor alterations.

Where an alteration to a floor or floor overhang exposes cavities or surfaces to which insulation can be applied and the floor or floor overhang is part of the building thermal envelope, the floor or floor overhang shall be brought into compliance with Section R402.1 or an *approved* design. This requirement shall apply to floor alterations where the floor cavities or surfaces are exposed and accessible prior to construction.

R503.1.1.5 (N1111.1.1.5) Below-grade wall alterations.

Where a blow-grade space is changed to *conditioned space*, the *below-grade walls* shall be insulated where required in accordance with Section R402.1. Where the below-grade space is *conditioned space* and a *below-grade wall* is altered by removing or adding interior finishes, it shall be insulated where required in accordance with Section R402.1.

R503.1.1.6 (N1111.1.1.6) Air barrier.

Building thermal envelope assemblies altered in accordance with Section R503.1.1 shall be provided with an *air barrier* in accordance with Section R402.4. The *air barrier* shall not be required to be made continuous with unaltered portions of the *building thermal envelope*. Testing requirements of Section R402.4.1.2 shall not be required.

Reason Statement:

Existing building alterations are perhaps one of the primary opportunities to reduce national energy consumption, yet Chapter 5 does little to address this need. There are many opportunities to cost-effectively improve energy efficiency of the existing building stock by use of reasonable criteria to trigger (or avoid) requirements with flexibility in the manner or extent of compliance where needed. This proposal attempts to strike that balance in a practical and cost-effective manner for building envelope assemblies of existing buildings that are undergoing specific types of alterations. Consequently, this proposal will help to address the 40% of national energy use that is attributed to the existing building stock and will only apply where alterations are proposed that provide opportunity to improve the performance of the existing building stock. A similar coordinated proposal was also submitted for the IECC-C committee.

Key changes made in this proposal are summarized as follows:

1. The revisions to charging language in Section R503.1.1 are made to be consistent with commercial building provisions in C503.2.

2. A clause is added to Section R503.1.1 to prevent reduction in existing building thermal envelope insulation levels as is included in the IECC provisions.

3. Exceptions 2 and 3 of Section R503.1.1 are deleted as they are now addressed and preserved within requirements in new subsections for above-grade walls, floors, and roofs.

4. Existing exception 5 of Section R503.1.1 is deleted because it is a requirement (not an exception) that is now moved to new Section R503.1.1.2 for roof alterations.

5. New exception 4 is added to Section R503.1.1 to provide the flexibility of a “whole” existing building compliance path using the

existing total building performance and ERI paths in Sections R405 and R406. This would be most applicable to extensive or multiple alterations as may occur in a building renovation.

6. Section 503.1.1.1 for fenestration replacements is modified to address fenestration alterations including both added fenestration and fenestration replacements as both are also addressed in the IECC-C provisions for existing buildings and are relevant to existing residential building alterations.

7. A new Section R503.1.1.2 is provided to address multiple types of roof alterations to identify conditions where it is appropriate to provide insulation (if not already present).

8. A new Section R503.1.1.3 is provided for above-grade wall alterations which identifies conditions where it is appropriate and practical to provide insulation (if not already present). Language is also provided to ensure coordination with building code moisture control requirements which require integration with and can influence the method of complying with the insulation requirements.

9. A new Section R503.1.1.4 is provided for floor alterations and takes an approach similar to that done for above-grade walls (although with fewer conditional requirements).

10. A new Section R503.1.1.5 is provided for below-grade wall alterations. This captures the cases where a below-grade space (e.g., basement) is being converted to conditioned space and where basement walls are altered and the basement is already conditioned.

11. Finally, new Section R503.1.1.6 is provided to address air barrier installations in altered building thermal envelope assemblies. However, it is made clear that continuity of the air barrier is not required with unaltered portions of the building thermal envelope as that would cause the alteration to extend beyond its intended scope. It also is made clear that whole building air leakage testing is not required.

Cost Impact:

The code change proposal will increase the cost of construction.

Where requirements are triggered and where upgrades in energy efficiency were not already planned for an alteration, this proposal will increase cost for a limited set of envelope alteration activities for existing buildings. Some existing requirements such as roof replacements and filling of exposed stud cavities remain unchanged. For those existing buildings with deficient insulation levels (or no insulation) and where planned alterations allow that deficiency to be addressed efficiently, the cost-benefits are expected to closely align with that for new buildings. However, it is not possible to conduct a simple cost-benefit analysis for existing buildings because of the multitude of variables involved and the flexibility provided in this proposal that make it nearly impossible to quantify with any reasonable level of certainty. Thus, we consider these proposed provisions to be cost-effective by judgment as these types of existing building thermal envelope upgrades are currently being used in the existing building/remodeling/renovation market, although not consistently or in an enforceable manner. In addition, the current charging language in Section R503.1.1 requires compliance with insulation requirements for new buildings for all alterations, barring only those few excepted. Now, this proposal provides requirements that also provide flexibility in means of compliance for the many alterations that are currently not included in exceptions to Section 503.1.1. For these cases, this proposal could be considered to reduce cost.

REPI-150-21

REPI-151-21

IECC®: R503.1.2, R503.1.2.2 (N1111.1.2.2) (New), R503.1.2.1 (N1111.1.2.1) (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:
R503.1.2 (N1111.1.2) Heating and cooling systems.

~~HVAC ducts newly installed as part of an alteration shall comply with section R403~~ New heating and cooling and duct systems that are part of the alteration shall comply with Section R403 and this section.

Add new text as follows:
R503.1.2.2 (N1111.1.2.2) System Sizing.

New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with Section R403.7 based on the existing *building* features as modified by the *alteration.*

Exception: Where it has been demonstrated to the *code official* that compliance with this section would result in heating or cooling equipment that is incompatible with the remaining portions of the existing heating or cooling system.
R503.1.2.1 (N1111.1.2.1) Ducts.
HVAC ducts newly installed as part of an *alteration* shall comply with Section R403.

Exception: Where ducts from an existing heating and cooling system are extended to an *addition*.

Reason Statement:

Historically, HVAC equipment has been routinely oversized. Studies have found very high rates of equipment oversizing; for example, 60% of RTU units in CA were found to be oversized.[1] Oversized equipment results in increased energy use, decreased occupant comfort and increased wear-and-tear on equipment.[2] Oversized equipment is also less effective at dehumidification. Like-for-like equipment replacement are particularly vulnerable to oversizing. The original equipment may have been installed when code requirements for “right-sizing” equipment did not exist or was not enforced. The materials markups that are common practice among contractors disincentivize them to install smaller, right-sized equipment. Changes to building use could have occurred since the original equipment was installed, creating a mismatch between current design loads and the original equipment. The building may have modified, particularly by energy efficiency programs, altering the design loads of the building. Lighting especially stands out here. Fluorescent and LED lighting is ubiquitous, but many HVAC systems were designed to account for incandescent lamps that convert over 75% of the energy they consume into heat.

With all of these considerations, it is reasonable to assume that the existing equipment sizing is more likely to be wrong than right, yet many equipment replacements use existing system sizing to size new equipment. This proposal explicitly requires that new equipment installed as part of an alteration be sized based on current building characteristics and loads, using current sizing standards. The resulting installations will be more efficient and more effective and many will be less costly to install as owners stop paying for more equipment than they need.

Savings will vary based on the amount that existing equipment is oversized. “Right-sizing” has been found to result in about 0.2% energy savings for every 1% reduction in oversizing.[3]

[1] D.R. Felts, P. Bailey, The State of Affairs – Packaged Cooling Equipment in California, 2000.

[2] Ery Djunaedy, Kevin van den Wymelenberg, Brad Acker, Harshana Thimmana, *Oversizing of HVAC system: Signatures and penalties.* “Energy and Buildings,” Volume 43, Issues 2–3, 2011,

[3] H.McLain,D.Goldberg. “Benefits of Replacing Residential Central Air Conditioning Systems.” American Council for an Energy-Efficient Economy, WashingtonDC, USA, 1984.

Cost Impact:

The code change proposal will decrease the cost of construction.

As “wrong-sized” equipment is generally oversized, this proposal will generally decrease the cost of installation. Smaller, right-sized equipment will generally be less costly to install.

REPI-151-21

REPI-152-21

IECC®: R503.1.2.1(N1111.1.2.1) (New)

Proponents:

Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2021 International Energy Conservation Code

Add new text as follows:
R503.1.2.1(N1111.1.2.1) Controls.

New heating and cooling equipment that are part of the *alteration* shall be provided with controls that comply with Section R403.1.

Reason Statement:

The IECC only requires that new portions of HVAC systems comply with the requirements for new construction. This leaves unaltered portions of the HVAC system unaffected, including controls. Controls are a vital component of effective and efficient operation of heating and cooling systems and older controls that do not meet current code requirements significantly hamper efficiency in buildings. Obsolete controls also increase the operational costs for building owners and tenants. The IECC has relied on HVAC controls as a cost-effective means of delivering energy efficiency in buildings, so this is a significant missed opportunity. Equipment replacement is an ideal time to also upgrade controls. Contractors are onsite, operation of the HVAC system is already disrupted, and the cost of controls would generally be a small line-item cost in the project.

This proposal requires that thermostats be brought into compliance with current control requirements when equipment is replaced. The proposal does not require the installation of new controls, so if the existing controls already meet current code requirements, they would already be in compliance with this new section.

Cost Impact:

The code change proposal will increase the cost of construction.

Cost will vary depending on the type of control and how obsolete existing controls are. In most systems subject to this requirement, compliance would require replacing one thermostat with another. Modern, wireless thermostats can be used to control costs when existing control wiring is insufficient to support modern controls. Utilities have consistently found thermostat retrofits to be cost effective efficiency incentive measures.

REPI-152-21

REPI-153-21

IECC®: SECTION RC101, RC101.1

Proponents:

Patricia Chawla, representing Austin Energy (patricia.chawla@austinenergy.com)

2021 International Energy Conservation Code

Revise as follows:
SECTION RC101(AX101) ~~COMPLIANCE~~GENERAL
RC101.1(AX101.1) ~~Compliance~~ Scope.

~~Existing residential buildings shall comply with Chapter 5. New residential buildings shall comply with Section RC102.~~ This appendix applies to new *residential buildings.*

Reason Statement:

This proposal seeks to simplify the scope statement of this appendix.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed code change deletes redundant text from the existing code language and will not affect the cost of construction.

REPI-153-21

REPI-154-21

IECC®: APPENDIX RC, SECTION RC102, RC102.2

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:

APPENDIX RC (APPENDIX AX) ZERO <u>NET</u> ENERGY RESIDENTIAL BUILDING PROVISIONS

SECTION RC102 (AX102) ZERO <u>NET</u> ENERGY RESIDENTIAL BUILDINGS
RC102.2 (AX102.2) Energy Rating Index zero <u>net</u> energy score.
Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in Table RC102.2 when compared to the Energy Rating Index (ERI) reference design determined in accordance with RESNET/ICC 301 for both of the following:

1. ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.
2. ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation RC-1.

$$\text{Adjusted OPP} = \text{OPP} + \text{CREF} + \text{REPC}$$

(Equation RC-1)
where:
CREF = Community Renewable Energy Facility power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.
REPC = Renewable Energy Purchase Contract power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from an energy facility that generates energy with photovoltaic, solar thermal, geothermal energy or wind systems, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.

Reason Statement:

The term "zero energy" is more suited for a marketing brochure, rather than an IECC Appendix or an ICC code. All buildings use energy, and the use of a term like "zero energy", while appealing, is not accurate and will mislead and misinform consumers and businesses and policy makers.

The term that should be used is "zero net energy", which is the technically correct way to describe such buildings.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Using the more accurate term will have no impact on the cost of construction.

REPI-154-21

REPI-155-21

IECC®: RC102 (AX102) (New), SECTION 202 (New), SECTION RC102, RC102.1, RC102.2, TABLE RC102.2

Proponents: Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Ben Rabe, representing Fresh Energy (rabe@fresh-energy.org); Bryan Bomer, representing Department of Permitting Services (bryan.bomer@montgomerycountymd.gov); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org); Howard Wiig, representing Hawaii State Energy Office (howard.c.wiig@hawaii.gov); Kim Burke, representing Colorado Energy Office (kim.burke@state.co.us); Chris Castro, representing City of Orlando (chris.castro@orlando.gov); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com)

2021 International Energy Conservation Code

Add new text as follows:

RC102 (AX102)
GENERAL DEFINITIONS

Add new definition as follows:

ALL-ELECTRIC BUILDING. A *building* that contains no combustion equipment, or plumbing for combustion equipment, installed within the *building*, or *building site.*

Revise as follows:

SECTION ~~RC102~~ RC103 (AX103)
ZERO ENERGY RESIDENTIAL BUILDINGS

RC103.1 ~~RC102.1~~ **(AX103.1) General.** New *residential buildings* shall be *all-electric buildings* and comply with Section RC103.2 ~~RC102.2~~.

RC103.2 ~~RC102.2~~ **(AX103.2) Energy Rating Index zero energy score.** Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in Table RC103.2 ~~RC102.2~~ when compared to the Energy Rating Index (ERI) reference design determined in accordance with RESNET/ICC 301 for both of the following:

1. ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.
2. ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation RC-1.

$$\text{Adjusted OPP} = \text{OPP} + \text{CREF} + \text{REPC} \quad \textbf{(Equation RC-1)}$$

where:

CREF = Community Renewable Energy Facility power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.

REPC = Renewable Energy Purchase Contract power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from an energy facility that generates energy with photovoltaic, solar thermal, geothermal energy or wind systems, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.

TABLE RC103.2 ~~RC102.2~~ (TABLE AX103.2) MAXIMUM ENERGY RATING INDEX[a]

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING OPP	ENERGY RATING INDEX INCLUDING ADJUSTED OPP (as proposed)
1	43	0
2	45	0
3	47	0
4	47	0
5	47	0
6	46	0
7	46	0
8	46	0

a. The building shall meet the requirements of Table R406.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or R402.1.3 of the *2015 International Energy Conservation Code*.

Reason: The adoption of the Zero Home Appendix into the 2021 IECC has garnered a lot of attention and questions from cities and states looking to understand its energy impact and alignment with energy reduction and climate goals. The 2021 IECC version of the appendix does not address onsite carbon emissions, a request that has been made by jurisdictions seeking to set carbon targets in addition to energy reductions via energy code and stretch codes. This amendment would place the Appendix in line with the ICC's stated goals on carbon and energy reductions by requiring buildings be all-electric in addition to energy efficient. Since the Appendix is structured to be used as an optional stretch code, it presents opportunities for jurisdictions to begin to move residential construction toward full decarbonization in line with climate goals.
In order to meet President Biden's 2050 goal of reducing greenhouse gas emissions in half by 2030 and achieving net zero carbon emissions by 2050, the United States must not only reduce energy use through energy efficiency and move to utility scale and on-site renewable energy, but also transition away from using combustion equipment in buildings that runs on fossil fuels to electric equipment. In 2020, combustion equipment in commercial and residential buildings accounted for 36% of the United States energy-related greenhouse gas emissions. To meet President Biden's goal, it is crucial that new homes built today are all-electric so that emissions from these buildings are not "locked-in" by gas-dependent building infrastructure. Reduced carbon emissions was also recently cited as a priority of energy code development by the ICC in their Leading the Way to Energy Efficiency: A Path Forward on Energy and Sustainability to Confront a Changing Climate in 2021.

Fortunately, heat pump technology has dramatically improved over the last few decades, giving contractors and building owners access to highly efficient electric heating and cooling, and water heating technologies. An Ecotope study of the 2017 Oregon Residential code found that homes heated by electric heat pumps use 40 percent less energy than homes heated with gas (including water heating). Even accounting for reduced efficiency in extreme cold weather, according to a study by RMI, modern air source heat pumps are more than twice as efficient as gas furnaces and can save families up to 9 percent on their utility bills in Climate Zone 6. This is one reason why the U.S. EPA just announced that standards for the most efficient appliances in 2022 certified under the ENERGY STAR program will be all-electric.

All-electric homes are also healthier homes. Gas appliances release harmful pollutants like nitrogen dioxide (NO2) and carbon monoxide (CO) either indoors because of gas stoves or outdoors because of space-heating and water heating equipment. A recent study from the Harvard Chang School of Public Health and RMI shows that in 2017, air pollution from burning fuels in buildings led to an estimated 48,000 to 64,000 early deaths and $615 billion in health impact costs. These emissions can particularly affect children. In a meta-analysis analyzing the connections between gas stoves and childhood asthma, children in homes with gas stoves were 42% more likely to experience asthma symptoms, and 32% more likely to being diagnosed with asthma.

All-electric new construction is also less expensive to build than a home with gas appliances and in the long term will result in fewer retrofit costs for homeowners to meet future policy goals to eliminate all carbon emissions in the U.S. by 2050.

Therefore, building all-electric buildings is critical to reducing air pollution, protecting public health, reducing utility and construction costs, and meeting climate goals. NBI is submitting this amendment along with amendments that address on-site renewables, electric vehicles, and grid integration techniques. These proposed changes to the 2021 IECC, working together, will put the U.S. on the path to a decarbonized, resilient, and healthier future.

Bibliography: Fact Sheet: President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies, The White House, 22 Apr. 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-president-biden-sets-2030-greenhouse-gas-pollution-reduction-target-aimed-at-creating-good-paying-union-jobs-and-securing-u-s-leadership-on-clean-energy-technologies/.
"U.S. Energy Information Administration." What are U.S. energy-related carbon dioxide emissions by source and sector?, https://www.eia.gov/tools/faqs/faq.php?id=75&t=11

Leading the Way to Energy Efficiency: A Path Forward on Energy and Sustainability to Confront a Changing Climate, ICC, https://www.iccsafe.org/wp-content/uploads/ICC_Leading_Way_to_Energy_Efficiency.pdf.

Oregon Residential Specialty Code: 2005 Baseline and Code Roadmap to Achieve the 2030 Goal; Ecotope (2020) https://neea.org/resources/oregon-residential-specialty-code-2005-baseline-and-code-roadmap-to-achieve-the-2030-goal

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Uncovering the Deadly Toll of Air Pollution from Buildings. RMI, 5 May 2021, https://rmi.org/uncovering-the-deadly-toll-of-air-pollution-from-buildings/

Gas Stoves: Health and Air Quality Impacts and Solutions. RMI, 1 Feb. 2021, rmi.org/insight/gas-stoves-pollution-health/.

ENERGY STAR Most Efficient 2022 Criteria Development, U.S. EPA, https://www.energystar.gov/products/spec/energy_star_most_efficient_2022_criteria_development_pd.

Dinulescu, Cristina, Cost to Replace Electrical Panel: Factors & Prices. Penna Electric, 27, July 2020, https://pennaelectric.com/electrician-blog/cost-to-replace-electrical-panel-factors-prices/

Cost Impact: The code change proposal will decrease the cost of construction.
Electric appliances and equipment cost less than gas appliances. Installing all-electric appliances also reduces natural gas infrastructure costs such as gas mains, services and meters. Using data from RSMeans, Grainger, Home Depot, NBI estimates that an all-electric home costs $8,735 less than a home built with natural gas appliances and equipment. A recent analysis by RMI which examined the cost effectiveness of all-electric homes in seven cities across the country from Climate Zone 2A to 6A, found that installing efficient heat pumps in water heating and space-heating compared to standard equipment installed in a mixed-fuel home resulted in life cycle cost savings in every city. Including the cost of more efficient electric equipment, the all-electric home cost on average $2,700 less than a code compliant mixed-fuel home. All-electric homes with efficient heat pumps exhibited on average $107 in lower annual utility costs. The analysis concluded that a homeowner with an all-electric home would save $3,700 over a 15-year analysis period. In addition, all electric homes with efficient heat pumps resulted in carbon emissions savings of between fifty to ninety-three percent in all climate zones. Accounting for the societal benefit carbon emissions would result in increased life cycle cost savings across all climate zones.

NBI also analyzed the cost effectiveness of an all-electric home in New York City (Climate Zone 4A) that met the requirements in NBI's Decarbonization code compared to a code compliant mixed-fuel home that met the requirements of the 2021 IECC. NBI's decarbonization code all-electric home analyzed was solar-ready, EV-ready, utilized a heat pump water heater, demand responsive controls and minimum code compliant HVAC system. These features resulted in reduced cost of $8,357 for a single-family home. Utilizing local time-of-use rates, the all-electric home resulted in equivalent utility costs as the baseline mixed fuel home and positive life cycle cost savings of $14,828 for the consumer over a 30-year analysis period. Life cycle cost savings doubled to $23,934 if the social cost of carbon is included in the analysis.

Finally, neither analysis cited includes the cost of electrical retrofits that will be required of homes that are not all-electric to meet future policy goals of achieving net zero carbon emissions by 2050. Simply upgrading the electrical panel itself to add electrical capacity for new electric appliances can cost a homeowner between $2,650 to $4,500. Adding electrical outlets that can service major appliances so that homeowners can replace a natural gas appliance with an all-electric appliance will also add significant additional costs especially if those appliances are in areas where dry wall must be removed and repaired.

REPI-156-21

IECC®: SECTION RC102, SECTION 202 (New), SECTION RC103 (AX103) (New), RC102.1, RC102.2, TABLE RC102.2

Proponents: Patricia Chawla, representing Austin Energy (patricia.chawla@austinenergy.com)

2021 International Energy Conservation Code

Revise as follows:

SECTION RC102 (AX102)
~~ZERO ENERGY RESIDENTIAL BUILDINGS~~
GENERAL DEFINITIONS

Add new definition as follows:

COMMUNITY RENEWABLE ENERGY FACILITY (CREF)POWER PRODUCTION. The yearly energy, in kilowatt hour equivalent (kWheq), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.

RENEWABLE ENERGY PURCHASE CONTRACT (REPC)POWER PRODUCTION. The yearly energy, in kilowatt hour equivalent (kWheq), contracted from an energy facility that generates energy with photovoltaic, solar thermal, geothermal energy or wind systems, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.

Add new text as follows:

SECTION RC103 (AX103)
ZERO ENERGY RESIDENTIAL BUILDINGS

Revise as follows:

~~RC102.1~~ RC103.1 (AX103.1) General. New *residential buildings* shall comply with Section ~~RC102.2~~ RC103.2.

~~RC102.2~~ RC103.2 (AX103.2) Energy Rating Index zero energy score. Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in Table ~~RC102.2~~ RC103.2 when compared to the Energy Rating Index (ERI) reference design determined in accordance with RESNET/ICC 301 for both of the following:

1. ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.
2. ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation RC-1.

$$\text{Adjusted OPP} = \text{OPP} + \text{CREF} + \text{REPC} \qquad \textbf{(Equation RC-1)}$$

~~where:~~

~~CREF = Community Renewable Energy Facility power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.~~

~~REPC = Renewable Energy Purchase Contract power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from an energy facility that generates energy with photovoltaic, solar thermal, geothermal energy or wind systems, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.~~

TABLE ~~RC102.2~~ RC103.2 (TABLE AX103.2) MAXIMUM ENERGY RATING INDEX[a]

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING OPP	ENERGY RATING INDEX INCLUDING ADJUSTED OPP (as proposed)
1	43	0
2	45	0
3	47	0
4	47	0
5	47	0
6	46	0
7	46	0
8	46	0

a. The building shall meet the requirements of Table R406.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or R402.1.3 of the *2015 International Energy Conservation Code*.

Reason: This proposal seeks to improve readability and structure of the language by moving defined words to a definitions portion of the Appendix. No changes were made to the content of the definitions. All other changes are renumbering changes.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed code reorganizes and restructures the existing code only and will not affect the cost of construction. No changes were made to the content of the definitions. The reorganization and restructuring increase the flexibility of the code for future code proposals.

REPI-157-21

IECC®: APPENDIX RC, SECTION RC102, RC102.2 (AX102.2) (New), RC102.2, TABLE RC102.2, ASHRAE Chapter 06 (New)

Proponents:

Emily Toto, representing ASHRAE (etoto@ashrae.org)

2021 International Energy Conservation Code

Revise as follows:

APPENDIX RC (APPENDIX AX) NET ZERO ENERGY RESIDENTIAL BUILDING PROVISIONS

SECTION RC102 (AX102) NET ZERO ENERGY RESIDENTIAL BUILDINGS

Add new text as follows:

RC102.2 (AX102.2) Requirements.

New residential buildings shall comply with all of the following:

- 1.

  Table R406.2,

- 2.

  ASHRAE/IES Standard 90.2,

- 3.

  the ERI requirements of ASHRAE/IES 90.2 Table 6-1 without the use of on-site power production (OPP), and

- 4.

  achieve an ERI of less than or equal to zero through additional efficiency measures, the use of OPP, or a combination of the two.

Revise as follows:

~~RC102.2~~RC102.2.1 (AX102.2.1) ~~Energy Rating Index zero energy score~~Adjusted On-site Power Production Calculation.

~~Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in Table RC102.2 when compared to the Energy Rating Index (ERI) reference design determined in accordance with RESNET/ICC 301 for both of the following:~~

- 1.

  ~~ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.~~

- 2.

  ~~ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation RC-1.~~

Where Energy Rating Index (ERI) values for on-site power production (OPP) include Community Renewable Energy Facility (CREF), Renewable Energy Purchase Contract (REPC), or both, an adjusted OPP shall be calculated in accordance with Equation RC-1.

$$\text{Adjusted OPP} = \text{OPP} + \text{CREF} + \text{REPC}$$

(Equation RC-1)

where:

CREF = Community Renewable Energy Facility power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.

REPC = Renewable Energy Purchase Contract power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from an energy facility that generates energy with photovoltaic, solar thermal, geothermal energy or wind systems, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.

Delete without substitution:

~~TABLE RC102.2 MAXIMUM ENERGY RATING INDEX~~[a]

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING OPP	ENERGY RATING INDEX INCLUDING ADJUSTED OPP (as proposed)
~~1~~	~~43~~	~~0~~
~~2~~	~~45~~	~~0~~
~~3~~	~~47~~	~~0~~
~~4~~	~~47~~	~~0~~
~~5~~	~~47~~	~~0~~
~~6~~	~~46~~	~~0~~
~~7~~	~~46~~	~~0~~
~~8~~	~~46~~	~~0~~

- ~~a.~~

  ~~The building shall meet the requirements of Table R406.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or R402.1.3 of the *2015 International Energy Conservation Code*.~~

Add new standard(s) as follows:

ASHRAE	ASHRAE 180 Technology Parkway NW Peachtree Corners GA 30092
ASHRAE/IES 90.2-2018:	Energy-Efficient Design of Low-Rise Residential Buildings

Reason:

The modifications in this proposal aim to standardize the method of achieving Net Zero for residential buildings. The modifications do not change the ERI values or the fact that you must meet the requirements of Table R406.2. By adding a reference to ASHRAE 90.2 users, software developers, and code officials will have the added guidance of a well vetted ASHRAE standard. The previously referenced standard RESNET 301 does not set ERI targets like that of ASHRAE 90.2. The targets in the existing appendix were taken from ASHRAE 90.2. At the time 90.2 was just being finalized and therefore was not referenced in the existing appendix. Modifications include:

- Adding the word “Net” Zero. Although there is some debate over the inclusion of the word “Net” in the industry to describe buildings achieving this degree of efficiency and reliance on renewable energy sources it is widely accepted and adequately describes the intent of this section.
- Replacing then text of RC102.2 with a new “Requirements” section that clearly outlines the requirements of this section:
- #1 points users to the “mandatory requirements” of the code. This is consistent with the current appendix.
- #2 points users to the newly referenced ASHRAE 90.2 standard vs. RESNET 301.
- #3 lets users know they must comply with Table 6-1 of 90.1 without using renewable energy in the calculation. This is consistent with the existing appendix language.
- #4 makes it clear that users must also achieve and ERI of 0 and that they can use renewable energy to achieve this calculation. This is also consistent with the current appendix.
- Section RC102.2.1 is added to address the existing allowance to use Community Renewable Energy Facility power production and Renewable Energy Purchase Contract power production in OPP calculations in a way that is more meaningful in light of the reference to ASHRAE 90.2.
- Table RC102.2 is deleted as it is no longer needed because these exact ERI values are contained in the ASHRAE 90.2 standard.
- Added ASHRAE/IES 90.2 to Chapter 6 Referenced Standards.

Bibliography:

ASHRAE/IES 90.2-2018: Energy-Efficient Design of Low-Rise Residential Buildings

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This code change does not impact the cost of construction. Modifications do not change the stringency of this voluntary appendix.

REPI-158-21

IECC®: SECTION 202, SECTION R404, R404.4 (N1104.4) (New), R406.7.3, RC102.3 (AX102.3) (New)

Proponents:

Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Revise as follows:
IECC2021P1E_RE_Ch02_SecR202_DefRENEWABLE_ENERGY_CERTIFICATE_REC_ RENEWABLE ENERGY CERTIFICATE (REC). A~~n~~ market-based instrument that represents and conveys the environmental,social and other non-power attributes of one megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with renewable energy resources ~~energy~~; also known as anenergy attribute and energy attribute certificate (EAC).
SECTION R404 (N1104) ELECTRICAL POWER, ~~AND~~ LIGHTING,AND RENEWABLE ENERGY SYSTEMS
Add new text as follows:
R404.4 (N1104.4) Renewable energy certificate (REC) documentation.

Where on-site renewable energy generation is required by this codethe property owner or owner's authorized agent shall demonstrate that any RECs or EACs associated with on-site renewable energy are retained, or retired, on behalf of the property owner.

Revise as follows:
R406.7.3 (N1106.7.3) Renewable energy certificate (REC) documentation.
Where on-site renewable energy is included in the calculation of an ERI, documentation shall comply with Section R404.4. ~~one of the following forms of documentation shall be provided to the code official:~~

1. ~~Substantiation that the RECs associated with the on-site renewable energy are owned by, or retired on behalf of, the homeowner.~~
2. ~~A contract that conveys to the homeowner the RECs associated with the on-site renewable energy, or conveys to the homeowner an equivalent quantity of RECs associated with other renewable energy.~~

Add new text as follows:
RC102.3 (AX102.3) Renewable energy certificate (REC) documentation.

Documentation shall comply with Section R404.4

Reason Statement:

During the 2021 IECC process the original proposal was revised during the public comment period. Because of the rules of the public comment hearings, the original proposal and not the public comment was put up for the online vote. This proposal brings back the public comment language for consideration into the 2024 IECC.

The revised language clarifies and simplifies the original proposal. The Solar Energy Industry Association (SEIA) assisted NBI in drafting these revisions. The Comment clarifies that the owner or the owner's agent shall show that the ownership or retirement of RECs have been properly tracked to the owner. This information about the treatment of RECs is found in typical leases, contracts and incentive agreements for installed solar energy systems. A reference to the contractual provision is all that is needed to satisfy the requirements of this proposal – and this reference to the RECs provision in the plans set is all that the code official would need to examine.

As an example, the following language from Austin Energy's solar program states (emphasis added): "*Customers receiving service under either Non-Demand or Demand Value-Of-Solar Riders cannot combine services with the Load Shifting Voltage Discount Rider. Renewable Energy Credits (RECs) and all other renewable energy attributes for generation receiving Value-of-Solar credits are aggregated by Austin Energy. All RECs for energy consumed onsite* ***will be retired on behalf of the solar customer****.* "

This is a sample bilateral contract involving the Solano (CA) Community College District: "***Environmental Attributes and Energy Credits.*** *District shall own all right, title, and interest associated with or resulting from the development, construction, installation and ownership of any facilities installed on the Project ("Generating Facilities")"*

This proposal also seeks to clarify the term renewable energy certificate. The proposal more closely aligns the definition with language under consideration both in ASHRAE Standard 228P, The Standard Method of Evaluating Zero Energy Building Performance, and in ASHRAE Standard 189.1, which will be the basis of the IgCC.

Finally, the proposal adds the term “renewable energy” in the title of Section R404 and documentation for REC requirements in this section to ensure REC documentation requirements apply if renewable energy requirements are added to this section.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal simply clarifies requirements and thus will result in no additional cost for compliance with the standard.

REPI-158-21

REPI-159-21

IECC®: RC102.1.1 (AX102.1.1) (New)

Proponents:

Patricia Chawla, representing Austin Energy (patricia.chawla@austinenergy.com)

2021 International Energy Conservation Code

Add new text as follows:
RC102.1.1 (AX102.1.1) Above code programs.
The *code official* or other authority having jurisdiction shall be permitted to deem a national, state or local above code program to meet the energy efficiency required by this appendix. *Buildings approved* in writing by such an above code program shall be considered to be in compliance with this appendix.

Reason Statement:

"There are multiple "green" programs and standards that can be used to determine if a residential building will achieve zero net energy. This proposal will allow users more choices and flexibility."-perfectly stated from Mr. Rosenstock. Since this appendix is only applicable when adopted by the local jurisdiction, building in flexibility allows jurisdictions a pathway to include local solutions to local problems and goals.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed new code allows for alternative paths of compliance for Appendix RC. Allowing for additional options will not affect the cost of construction.

REPI-159-21

REPI-160-21

IECC®: RC102.2

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Revise as follows:
RC102.2 (AX102.2) Energy Rating Index zero energy score.
Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in Table RC102.2 when compared to the Energy Rating Index (ERI) reference design determined in accordance with RESNET/ICC 301 for both of the following:

1. ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.
2. ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation RC-1.

$$\text{Adjusted OPP} = \text{OPP} + \text{CREF} + \text{REPC}$$

(Equation RC-1)
where:
CREF = Community Renewable Energy Facility power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.
REPC = Renewable Energy Purchase Contract power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from an energy facility that generates energy with *renewable energy resources* ~~photovoltaic, solar thermal, geothermal energy or wind systems~~, and that is demonstrated by an energy purchase contract or lease with a duration of not less than ~~15~~ 10 years.

Reason Statement:

This proposal aligns the text of RC102.2 with the definition of renewable energy resources located on page R2-3. By taking out the list and using the definition, it will prevent conflicts with state or local laws that have a longer list of eligible renewable energy resources.

In addition, it modifies the contract period to be more consistent with the typical length of time that people are in a residence.

https://ipropertymanagement.com/research/average-length-of-homeownership (data shows that the average length of home ownership is 8.17 years, and only 37% of Americans have lived in their homes for 10+ years)

https://www.nar.realtor/blogs/economists-outlook/how-long-do-homeowners-stay-in-their-homes (median length of home ownership is 13 years, with significant regional variations).

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

These proposed changes will not affect the cost of construction.

REPI-160-21

REPI-161-21

IECC®: SECTION 202 (New), RC102.2

Proponents:

Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2021 International Energy Conservation Code

Add new definition as follows:
R202 COMMUNITY RENEWABLE ENERGY FACILITY.

A facility that produces energy harvested from *renewable energy resources* and is qualified as a community energy facility under applicable jurisdictional statutes and rules.

R202 FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (FPPA) .

A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

R202 PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (PPPA).

A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

Revise as follows:
RC102.2 (AX102.2) Energy Rating Index zero energy score.
Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in Table RC102.2 when compared to the Energy Rating Index (ERI) reference design determined in accordance with RESNET/ICC 301 for both of the following:

1. ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.
2. ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation RC-1.

Adjusted OPP = OPP+CREF+~~REPC~~PPPA+FPPA
(Equation RC-1)

where:
CREF = Community Renewable Energy Facility power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from a *community renewable energy facility*.~~community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.~~

~~REPC~~ PPPA= Physical Renewable Energy Power Purchase Agreement ~~Contract~~ power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from a *physical renewable energy power purchase agreement* ~~an energy facility that generates energy with photovoltaic, solar thermal, geothermal energy or wind systems~~, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.

FPPA = Financial Renewable Energy Power Purchase Agreement power production – the yearly energy, in kilowatt hour equivalent (kWheq) contracted from a *financial renewable energy power purchase agreement* with a duration of not less than 15 years.

Reason Statement:

This amendment clarifies and aligns off-site renewable energy definitions with other codes. The amendment changes the name of a "renewable energy purchase contract" to the more common name "physical renewable energy power purchase agreement." The amendment clarifies the definition of a community renewable energy facility and allows financial renewable energy power purchase agreements to be counted towards a buildings ERI zero energy score. Finally, this amendment aligns the nomenclature and definitions in this Appendix with language under consideration both in ASHRAE Standard 228P, The Standard Method of Evaluating Zero Energy Building Performance, and in ASHRAE Standard 189.1, which will be the basis of the IgCC.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal simply clarifies requirements and thus will result in no additional cost for compliance with the standard.

REPI-161-21

REPI-162-21

IECC®: TABLE RC102.2

Proponents: David Collins, representing SEHPCAC (sehpcac@iccsafe.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE RC102.2 (TABLE AX102.2) MAXIMUM ENERGY RATING INDEX[a]

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING OPP	ENERGY RATING INDEX INCLUDING ADJUSTED OPP (as proposed)
0	43	0
1	43	0
2	45	0
3	47	0
4	47	0
5	47	0
6	46	0
7	46	0
8	46	0

a. The building shall meet the requirements of Table R406.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or R402.1.3 of the *2015 International Energy Conservation Code*.

Reason: Values need to be added for Climate Zone 0. CE-36-19 Part II reason statement indicates Climate Zone 0 is a subset of the previous Climate Zone 1, therefore the values for Climate Zone 1 have been duplicated for Climate Zone 0.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Clarification of criteria for Climate Zone 0 matching inferred criteria from Climate Zone 1. Thus no change in requirement or cost of construction.

REPI-163-21

IECC®: TABLE RC102.2

Proponents: Kim Cheslak, NBI, representing NBI (kim@newbuildings.org); Lauren Urbanek, representing Natural Resources Defense Council (lurbanek@nrdc.org)

2021 International Energy Conservation Code

Revise as follows:

TABLE RC102.2 (TABLE AX102.2) MAXIMUM ENERGY RATING INDEX[a]

CLIMATE ZONE	ENERGY RATING INDEX NOT INCLUDING OPP	ENERGY RATING INDEX INCLUDING ADJUSTED OPP (as proposed)
0	34	0
1	~~43~~ 34	0
2	~~45~~ 34	0
3	~~47~~ 38	0
4	~~47~~ 38	0
5	~~47~~ 34	0
6	~~46~~ 34	0
7	~~46~~ 34	0
8	~~46~~ 34	0

a. The building shall meet the requirements of Table R406.2, and the building thermal envelope shall be greater than or equal to the levels of efficiency and SHGC in Table R402.1.2 or R402.1.3 of the *2015 International Energy Conservation Code*.

Reason: The adoption of the Zero Home Appendix into the 2021 IECC has garnered a lot of attention and questions from cities and states looking to understand its energy impact and alignment with energy reduction and climate goals. The 2021 IECC provided scores that are in line with ASHRAE Standard 90.2 – which is more efficient than the base 2021, but less efficient than we know can be built.
To truly embody the goal of a zero energy home, a building cannot just offset its energy, it also needs to use less energy. Targets presented for consideration here are based on a scan of PHIUS certified projects in the US.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Because the proposal is based on a performance path, the strategies to achieve the targets are able to be optimized by the design teams to incur the smallest upfront incremental costs and the largest month over month energy, cost, and carbon savings for the life of the building.

REPI-164-21

IECC®: RC103 (AX 103) (New)

Proponents:

Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2021 International Energy Conservation Code

Add new text as follows:
<u>RC103 (AX 103)</u> <u>Alternative Scoring Programs and Standards</u>.
<u>Alternative programs or standards, such as but not limited to the US EPA Energy Star Homes, USGBC LEED for Homes, and the ICC-700 National Green Building Standard shall be allowed to be used to comply with this section when *approved* by *code officials*.</u>

Reason Statement:

There are multiple "green" programs and standards that can be used to determine if a residential building will achieve zero net energy. This proposal will allow users more choices and flexibility.

Bibliography:

International Code Council, *ICC 700-2020 National Green Building Standard*, Washington, DC.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This will have no impact on construction costs.

REPI-164-21

REPI-165-21

IECC®: TABLE R402.1.2, R402.1.3, APPENDIX RD (New), RD101 (New), RD101.1 (New), TABLE RD101.1 (New), RD101.2 (New), RD101.3 (New), RD102 (New), RD103 (New), RD104 (New), RD105 (New), RD106 (New)

Proponents: Jay Crandell, P.E., ABTG/ARES Consulting, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz); Joel Martell, representing North American Insulation Manufacturers Association (NAIMA) (joel.e.martell@gmail.com)

2021 International Energy Conservation Code

Revise as follows:

TABLE R402.1.2 MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS
Portions of table not shown remain unchanged.

For SI: 1 foot = 304.8 mm.

a. Nonfenestration *U*-factors shall be obtained from Appendix RD or by *approved* test data ~~measurement~~, *approved* calculation, or an *approved* source.

R402.1.3 R-value alternative. Assemblies with *R*-value of insulation materials equal to or greater than that specified in Table R402.1.3 shall be an alternative to the *U*-factor in Table R402.1.2. *R*-values of insulation materials for the assemblies specified in Appendix RD that have a *U*-factor less than or equal to the *U*-factor required by Table R402.1.2 shall be permitted.

Add new text as follows:

APPENDIX RD
ALTERNATIVE BUILDING THERMAL ENVELOPE INSULATION R-VALUE OPTIONS

RD101
ABOVE-GRADE WALL ASSEMBLIES

RD101.1 Wood frame walls. Wood frame *above-grade wall* assemblies shall comply with both the *cavity insulation* and *continuous insulation R*-values and framing conditions specified by Table RD101.1 where the tabulated *U*-factors are less than or equal to those needed for compliance with Section R402.1.2. For assemblies not addressed by the conditions of Table RD101.1, *U*-factors shall be determined by using accepted engineering practice or by testing in accordance with ASTM C1363 and shall be subject to approval by the *code official* in accordance with Section R102.1. Use of a lesser framing fraction than the indicated maximums in Table RD101.1 shall require wall framing layout details for each *above-grade wall* elevation to be included on *approved* construction documents and shall be inspected for compliance

TABLE RD101.1 ASSEMBLY U-FACTORS FOR WOOD FRAME WALLS[a,b,c,d,e,]

Wood Stud Size & Spacing	Cavity Insulation Installed R-value	Continuous Insulation R-value																		
		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	20	25	30
2x4 (12" oc)	0	0.324	0.239	0.190	0.158	0.136	0.119	0.106	0.096	0.087	0.080	0.074	0.069	0.064	0.060	0.057	0.054	0.042	0.035	0.030
	11	0.094	0.085	0.078	0.072	0.067	0.062	0.059	0.055	0.052	0.050	0.047	0.045	0.043	0.041	0.040	0.038	0.032	0.027	0.024
	12	0.090	0.082	0.075	0.069	0.064	0.060	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.039	0.037	0.031	0.027	0.024
	13	0.087	0.079	0.072	0.067	0.063	0.059	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.031	0.027	0.023
	14	0.084	0.076	0.070	0.065	0.061	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.030	0.026	0.023
	15	0.082	0.074	0.068	0.063	0.059	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.030	0.026	0.023
	16	0.079	0.072	0.066	0.062	0.058	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.034	0.029	0.025	0.022
	17	0.077	0.070	0.065	0.060	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.029	0.025	0.022
	18	0.076	0.069	0.063	0.059	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.034	0.033	0.028	0.025	0.022
	19	0.074	0.067	0.062	0.058	0.054	0.051	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.032	0.028	0.024	0.022
	20	0.072	0.066	0.061	0.056	0.053	0.050	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.027	0.024	0.021
2x6 (12" oc)	0	0.313	0.230	0.183	0.153	0.131	0.115	0.102	0.093	0.084	0.078	0.072	0.067	0.063	0.059	0.055	0.053	0.041	0.034	0.029
	18	0.065	0.060	0.056	0.053	0.050	0.048	0.045	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.027	0.024	0.021
	19	0.063	0.059	0.055	0.052	0.049	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.027	0.024	0.021
	20	0.062	0.057	0.054	0.051	0.048	0.046	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.026	0.023	0.021
	21	0.060	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.026	0.023	0.021
	22	0.059	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020
	23	0.058	0.054	0.051	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020

	24	0.057	0.053	0.050	0.047	0.044	0.042	0.040	0.039	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	25	0.056	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.036	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	30	0.052	0.048	0.045	0.043	0.041	0.039	0.037	0.035	0.034	0.033	0.031	0.030	0.029	0.028	0.027	0.027	0.023	0.021	0.019
	35	0.049	0.046	0.043	0.040	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.022	0.020	0.018
2x8	0	0.308	0.226	0.179	0.149	0.128	0.112	0.100	0.091	0.083	0.076	0.070	0.066	0.061	0.058	0.054	0.052	0.041	0.034	0.029
(12" oc)	20	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020
	21	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	22	0.053	0.050	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	23	0.052	0.049	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	24	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.019
	25	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019
	30	0.046	0.044	0.041	0.039	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.026	0.023	0.020	0.018
	35	0.043	0.041	0.039	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.026	0.025	0.024	0.021	0.019	0.017
	40	0.041	0.039	0.037	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.024	0.024	0.023	0.020	0.018	0.017
	0	0.331	0.243	0.193	0.161	0.138	0.120	0.107	0.097	0.088	0.081	0.075	0.069	0.065	0.061	0.057	0.054	0.043	0.035	0.030
2x4	11	0.092	0.083	0.076	0.071	0.066	0.061	0.058	0.054	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.032	0.027	0.024
(16" oc)	12	0.088	0.080	0.073	0.068	0.063	0.059	0.056	0.053	0.050	0.048	0.045	0.043	0.041	0.040	0.038	0.037	0.031	0.027	0.024
	13	0.084	0.077	0.071	0.066	0.061	0.057	0.054	0.051	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.030	0.026	0.023
	14	0.081	0.074	0.068	0.064	0.059	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.037	0.035	0.030	0.026	0.023
	15	0.079	0.072	0.066	0.062	0.058	0.054	0.051	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.029	0.025	0.023
	16	0.077	0.070	0.065	0.060	0.056	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.029	0.025	0.022

	17	0.075	0.068	0.063	0.058	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.028	0.025	0.022
	18	0.073	0.066	0.061	0.057	0.053	0.050	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.028	0.024	0.022
	19	0.071	0.065	0.060	0.056	0.052	0.049	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.027	0.024	0.021
	20	0.069	0.063	0.059	0.055	0.051	0.048	0.046	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.032	0.031	0.027	0.024	0.021
2x6	0	0.322	0.236	0.187	0.156	0.133	0.117	0.104	0.094	0.086	0.079	0.073	0.068	0.063	0.059	0.056	0.053	0.042	0.034	0.029
(16" oc)	18	0.063	0.059	0.055	0.052	0.049	0.047	0.044	0.042	0.041	0.039	0.037	0.036	0.035	0.034	0.032	0.031	0.027	0.024	0.021
	19	0.061	0.057	0.054	0.051	0.048	0.046	0.043	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.027	0.023	0.021
	20	0.060	0.056	0.052	0.050	0.047	0.045	0.042	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.026	0.023	0.021
	21	0.058	0.055	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020
	22	0.057	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	23	0.056	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	24	0.055	0.051	0.048	0.046	0.043	0.041	0.039	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	25	0.054	0.050	0.047	0.045	0.042	0.040	0.039	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.019
	30	0.050	0.046	0.044	0.041	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.029	0.029	0.028	0.027	0.026	0.023	0.020	0.018
	35	0.047	0.043	0.041	0.039	0.037	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.025	0.022	0.019	0.017
2x8	0	0.317	0.232	0.184	0.152	0.131	0.115	0.102	0.092	0.084	0.077	0.071	0.066	0.062	0.058	0.055	0.052	0.041	0.034	0.029
(16" oc)	20	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.026	0.023	0.020
	21	0.053	0.050	0.048	0.045	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	22	0.052	0.049	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	23	0.051	0.048	0.046	0.043	0.041	0.040	0.038	0.036	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.020
	24	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019

	25	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019
	30	0.045	0.042	0.040	0.038	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.027	0.026	0.025	0.022	0.020	0.018
	35	0.042	0.039	0.037	0.036	0.034	0.033	0.031	0.030	0.029	0.028	0.027	0.027	0.026	0.025	0.024	0.024	0.021	0.019	0.017
	40	0.039	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.024	0.024	0.023	0.022	0.020	0.018	0.016
2x4 (24" oc)	0	0.339	0.248	0.196	0.163	0.139	0.122	0.108	0.098	0.089	0.081	0.075	0.070	0.065	0.061	0.058	0.055	0.043	0.035	0.030
	11	0.089	0.081	0.075	0.069	0.065	0.061	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.039	0.037	0.031	0.027	0.024
	12	0.085	0.078	0.072	0.067	0.062	0.058	0.055	0.052	0.049	0.047	0.045	0.043	0.041	0.039	0.038	0.036	0.031	0.027	0.023
	13	0.082	0.075	0.069	0.064	0.060	0.056	0.053	0.050	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.030	0.026	0.023
	14	0.079	0.072	0.067	0.062	0.058	0.055	0.052	0.049	0.047	0.044	0.042	0.041	0.039	0.037	0.036	0.035	0.030	0.026	0.023
	15	0.076	0.070	0.065	0.060	0.056	0.053	0.050	0.048	0.045	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.029	0.025	0.022
	16	0.074	0.068	0.063	0.058	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.028	0.025	0.022
	17	0.072	0.066	0.061	0.057	0.053	0.050	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.033	0.028	0.024	0.022
	18	0.070	0.064	0.059	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.027	0.024	0.021
	19	0.068	0.062	0.058	0.054	0.051	0.048	0.045	0.043	0.041	0.039	0.038	0.036	0.035	0.034	0.032	0.031	0.027	0.024	0.021
	20	0.066	0.061	0.056	0.053	0.050	0.047	0.044	0.042	0.040	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.027	0.023	0.021
2x6 (24" oc)	0	0.330	0.241	0.191	0.159	0.136	0.119	0.106	0.095	0.087	0.080	0.074	0.068	0.064	0.060	0.057	0.053	0.042	0.035	0.030
	18	0.061	0.057	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.036	0.034	0.033	0.032	0.031	0.027	0.024	0.021
	19	0.060	0.056	0.052	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.034	0.032	0.031	0.030	0.026	0.023	0.021
	20	0.058	0.054	0.051	0.048	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.026	0.023	0.020
	21	0.057	0.053	0.050	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	22	0.055	0.052	0.049	0.046	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020

	23	0.054	0.051	0.048	0.045	0.043	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.025	0.022	0.020
	24	0.053	0.049	0.047	0.044	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.019
	25	0.052	0.048	0.046	0.043	0.041	0.039	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019
	30	0.047	0.044	0.042	0.040	0.038	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.022	0.020	0.018
	35	0.044	0.041	0.039	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.025	0.024	0.021	0.019	0.017
2x8 (24" oc)	0	0.326	0.238	0.188	0.156	0.133	0.117	0.104	0.094	0.085	0.078	0.072	0.067	0.063	0.059	0.056	0.053	0.042	0.034	0.029
	20	0.054	0.051	0.048	0.046	0.043	0.042	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.025	0.022	0.020
	21	0.052	0.049	0.047	0.044	0.042	0.041	0.039	0.037	0.036	0.035	0.033	0.032	0.031	0.030	0.029	0.029	0.025	0.022	0.020
	22	0.051	0.048	0.046	0.043	0.041	0.040	0.038	0.037	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.024	0.022	0.020
	23	0.050	0.047	0.044	0.042	0.041	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.028	0.024	0.021	0.019
	24	0.048	0.046	0.044	0.041	0.040	0.038	0.036	0.035	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.024	0.021	0.019
	25	0.047	0.045	0.043	0.041	0.039	0.037	0.036	0.034	0.033	0.032	0.031	0.030	0.029	0.028	0.027	0.027	0.023	0.021	0.019
	30	0.043	0.041	0.039	0.037	0.035	0.034	0.033	0.032	0.030	0.029	0.029	0.028	0.027	0.026	0.025	0.025	0.022	0.020	0.018
	35	0.040	0.038	0.036	0.034	0.033	0.032	0.030	0.029	0.028	0.027	0.027	0.026	0.025	0.024	0.024	0.023	0.021	0.018	0.017
	40	0.037	0.035	0.034	0.032	0.031	0.030	0.029	0.028	0.027	0.026	0.025	0.024	0.024	0.023	0.022	0.022	0.019	0.018	0.016

For SI: 1 W/m2-K = 0.176 Btu/hr-ft2-F

a. Linear interpolation of U-factors shall be permitted between continuous insulation and cavity insulation R-values. For non-standard stud spacing, use the next lesser stud spacing shown in the table.

b. Table values are based on the parallel path calculation procedure as applicable to wood-frame assemblies and requires compliance with the following assembly conditions:

   1. Maximum framing fractions of 28% (assumed for 12"oc studs), 25% (assumed for 16"oc studs), and 22% (assumed for 24"oc studs) with 4% attributed to headers in all cases. The framing fraction is the percentage of overall opaque wall area occupied by framing members.
   2. Wood framing materials or species with a minimum thermal resistivity of R-1.25 per inch.
   3. Exterior sheathing with a minimum R-value of R-0.62 as based on wood structural panel. For walls having no exterior sheathing or sheathing of lesser R-value, footnote d shall be used to adjust the tabulated U-factor.
   4. Siding of a minimum R-0.62 as based on the assumption of vinyl siding. For walls with siding having a lower R-value, footnote d shall be used to adjust the tabulated U-factor.
   5. Interior finish of a minimum R-0.45 based on 1/2" gypsum. For walls having no interior finish or a finish of lesser R-value, footnote d shall be used to adjust the tabulated U-factor.
   6. Cavity insulation with a rated R-value installed as required by the manufacturer's installation instructions to satisfy the indicated installed R-value, considering a reduced R-value for compression in an enclosed cavity where applicable.
   7. Continuous insulation specified in accordance with the indicated rated R-value and installed continuously over all exterior wood framing, including studs, plates, headers, and rim joists.
   8. Indoor air film R-value of 0.68 and outdoor air-film R-value of 0.17.

c. Where any of the building materials that are continuous over the interior or exterior wall surface vary from those stated in footnote b, it is permissible to adjust the U-factor as follows: $U_{adj} = 1/ [1/U + R_d]$ where U is the U-factor from the table and Rd is the increase (positive) or decrease (negative) in the cumulative R-value of building material layers on the outside and inside faces of the wall, excluding the continuous insulation R-value if present.

d. For a specific continuous insulation R-value not addressed in this table, the U-factor of the assembly shall be permitted to be determined as follows: Uadj = 1/[1/Unci + Rci] where Unci is the U-factor from the table for no continuous insulation (0 R-value column) and Rci is the specific rated R-value of continuous insulation added to the assembly.

e. For double wall framing, the U-factor shall be permitted to be determined by combining the U-factors for single wall framing from the table as follows: Ucombined = 1/[1/U1 + 1/U2] where U1 and U2 are the U-factors from the table for each of the adjacent parallel walls in the double wall assembly.

f. The use of insulation in accordance with this table does not supersede requirements in Section R702.7 of the International Residential Code for use of insulation and water vapor retarders to control water vapor.

RD101.2 Mass walls. *Reserved.*

RD101.3 Cold-formed steel frame walls. *Reserved.*

RD102 Roof and Ceiling Assemblies. *Reserved.*

RD103 Floor Assemblies. Reserved.

RD104 Basement Walls. *Reserved.*

RD105 Crawlspace Walls. *Reserved.*

RD106 Slabs-on-Grade. *Reserved.*

Reason: The purpose of this proposal is to provide expanded R-value options for determining compliance with the U-factor criteria prescribed in Section R402.1.2 of the IECC residential provisions. It also supplements the limited selection of common insulation conditions addressed in the R-value approach of Table R402.1.3 of the IECC. This proposal is intended to cover common wood-framed assemblies and not intended to address all assemblies at this time, but rather provides a framework for that to occur over time and address many different assembly types and options. Therefore, assembly types that are not addressed are labeled as “reserved” and those with interest in those “reserved” portions can bring forth future improvements or additions consistent with that done for Section RD101.1 for wood frame walls.
The proposal is focused on U-factor compliance options for wood frame above-grade walls (Section RD101.1) at this time because that is considered the most immediate need in the 2021 IECC residential prescriptive provisions due to the many market-available insulation methods and materials as well as different techniques to frame walls that can provide useful means to comply with the U-factors (and as supplemental alternatives to prescribed R-values). This proposal will also help to ensure that a wide-range of possible solutions are achieved in an equivalent and transparent manner. Thus, it will give support to the use of Section R102.1 by code officials often tasked with reviewing and approving alternative assemblies.

The calculations for proposed Table RD101.1 follow the same basis as used to justify the existing R-value options in Table R402.1.3. Calculations supporting this proposal can be made available to the committee upon request. However, the complete basis of the calculations are documented in footnotes to proposed Table RD101.1. Having calculations and assumptions documented in this manner will serve to make the code more transparent and compliance more consistent.

PLEASE SEE ATTACHED WORD FILE FOR PROPER FORMAT AND TABLES FOR THIS PROPOSAL.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal provides additional pre-calculated options for flexibility in prescriptive compliance. In that regard, it may actually reduce cost.

Attached Files

- **211012 IECC-R, U-factor appendix for Alternative R-values (448).docx**
  https://energy.cdpaccess.com/proposal/448/973/files/download/172/

REPI-166-21

IECC®: APPENDIX X (New), X101 (New), X101.1 (New), X102 (New), X103 (New), X104 (New)

Proponents:

Hope Medina, representing Myself (hmedina@coloradocode.net)

2021 International Energy Conservation Code

Add new text as follows:

APPENDIX X CONSTRUCTION AND SITE WASTE DECARBONIZATION

X101 General.

The provisions of this appendix are to improve efforts for decarbonization.

X101.1 Scope.

The provisions of this appendix shall apply to new construction and construction performed on existing buildings.

X102 Building site waste management Plan.

A building site waste management plan shall be developed and implemented for excavated soil, rock, and land-clearing debris. Land-clearing debris is limited to stumps and vegetation. Diverted land-clearing debris and removed rock and soil shall not be sent to sites where development activity is prohibited or to greenfield sites other than those being used for agricultural purposes or being developed as part of a building project.

Not less than 90% of the land-clearing debris, excluding invasive plant materials, shall be diverted from disposal in landfills and incinerators other than waste-to-energy systems with an energy-recovery efficiency rate higher than 60%. Land-clearing debris calculations shall be based on either weight or volume but not both. Receipts or other documentation related to diversion shall be maintained through the course of construction, and provide to the code official for certificate of occupancy.

The plan shall address all of the following:

1. Land-clearing debris, rock, and soil to be diverted from disposal by composting, recycling, or reuse.
2. Waste materials that will be diverted on-site.
3. The locations to which waste materials will be diverted off-site.
4. Soils to be stockpiled for future use at any location.
5. Woody waste to be used as fuel.
6. The destruction and disposal of invasive plant materials.
7. The methods of removal of any contaminated soils.
8. The treatment of vegetation to comply with the rules of government-designated quarantine zones for invasive insect species.

X103 Construction and demolition waste management plan..

Prior to the start of any construction, demolition, or deconstruction, a construction and demolition waste management plan shall be prepared and made available to the owner and AHJ. The plan shall do the following:

1. Identify the construction and demolition waste materials expected to be diverted.
2. Identify materials or building elements to be deconstructed.
3. Indicate whether construction and demolition waste materials are to be source-separated or comingled.
4. Identify service providers and designate destination facilities for construction and demolition waste materials generated at the job site.
5. Identify the average diversion rate for facilities that accept or process comingled construction and demolition materials. Separate average percentages shall be included for those materials collected by construction and demolition materials processing facilities that end up as alternative daily cover and incineration.
6. Specify a method for tracking.

7. Specify a reporting mechanism for disposition of waste using items (1) through (6).

X104 Diversion..

A minimum of 50% of nonhazardous construction, demolition, or deconstruction waste material shall be diverted from disposal in landfills and incinerators through reuse, recycling, repurposing, and/or composting. Excavated soil and land-clearing debris shall not be included in the calculation. Alternative daily cover and waste-to-energy incineration shall not be included as diverted material. All diversion calculations shall be based on weight throughout the construction process.

Reason Statement:

Currently we are really all over the board as far as to the degree of compliance or even direction the jurisdictions are looking for when it comes to the IECC. We really are at a great precipice for a one size fits all energy code. I think if we continue on the current path of the IECC concept we are going to lose jurisdictions for various reasons including the current body of the code is not efficient enough or it moves to too much efficiency for what a jurisdiction is capable of doing. By utilizing the approach of a "dedicated appendix" to introduce more advanced concepts you allow the "minimum" code provisions to address many entities starting off with energy compliance or do not have support from elected officials and their community for more advance energy to still be able to use the IECC. You leave the body of the IECC alone to progress naturally without introducing advanced concepts, and work through the appendices to move the IECC along some of those more advanced or intense energy efficiency provisions.

Many cities are looking at ways to achieve their goals including reducing green house gases and decarbonization. People are looking at the design of the building, mechanical equipment sizing and efficiency, electrification, and one of the areas that is overlooked is site and construction waste. Construction practices in the United States is often wasteful. The amount of waste found in the construction dumpsters as one visits a development is astounding. Diverting materials through various means is a practice often found in other locations of the world, and it is something we need to consider as our landfills fill up and our options start to dwindle.

Some of these requirements are good practices, and are provisions found in the IgCC, or found in the NGBS. They are provisions that are already being utilized, and this places them in one location for jurisdictions wanting to work towards their carbon reduction goals.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

I believe this will neither increase nor decrease cost, but shift the costs. The cost of throwing in a landfill may be spent for recycling instead.

REPI-166-21

REPI-167-21

IECC®: R401.2.5, TABLE R402.1.2, TABLE R402.1.3, SECTION R408, R408.1, R408.2, R408.3 (New), R408.2.1, R408.2.2, TABLE R408.3.2 (New), R408.2.3, R408.2.4, 408.3.5 (New), 408.4 (New), 408.4.1 (New), 408.4.2 (New), TABLE R408.4.2 (New), 408.4.3 (New), 408.4.4 (New), R408.2.5, 408.4.6 (New), TABLE R408.4.6 (New), R408.4.7 (New)

Proponents: Aaron Vander Meulen, representing Vander Meulen Builders/President; Thomas Marston, representing Self (thmarstonmd@gmail.com)

2021 International Energy Conservation Code

Revise as follows:

R401.2.5 Additional ~~energy~~ requirements ~~efficiency~~. This section establishes additional requirements for buildings complying with Section 401.2.1 or Section 401.2.2~~applicable to all compliance approaches to achieve additional energy efficiency~~.

1. For buildings complying with Section R401.2.1, additional requirements of Section 408 shall also be met ~~one of the additional efficiency package options shall be installed according to Section R408.2~~.
2. For buildings complying under with Section R401.2.2, the building shall meet one of the following:

   2.1. ~~One of the additional efficiency packages Options in Section R408.2 shall be~~ The building shall meet Section 408 ~~installed~~ without including ~~such~~ the additional measures selected to comply with Section 408 in the proposed design under Section R405; or

   2.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to ~~95~~ XX (TBD) percent of the annual energy cost of the standard reference design.

~~3. For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.~~

The option selected for compliance shall be identified in the certificate required by Section R401.3.

TABLE R402.1.2 MAXIMUM ASSEMBLY U-FACTORS[a] AND FENESTRATION REQUIREMENTS

Portions of table not shown remain unchanged.

CLIMATE ZONE	FENESTRATION *U*-FACTOR[f]	SKYLIGHT *U*-FACTOR	GLAZED FENESTRATION SHGC[d, e]	CEILING *U*-FACTOR	WOOD FRAME WALL *U*-FACTOR	MASS WALL *U*-FACTOR[b]	FLOOR *U*-FACTOR	BASEMENT WALL *U*-FACTOR	CRAWL SPACE WALL *U*-FACTOR
0	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
1	0.50	0.75	0.25	0.035	0.084	0.197	0.064	0.360	0.477
2	0.40	0.65	0.25	0.030 ~~0.026~~	0.084	0.165	0.064	0.360	0.477
3	0.30	0.55	0.25	0.030 ~~0.026~~	0.060	0.098	0.047	0.091[c]	0.136
4 except Marine	0.30	0.55	0.40	0.026 ~~0.024~~	0.060 ~~0.045~~	0.098	0.047	0.059	0.065
5 and Marine 4	0.30	0.55	0.40	0.026 ~~0.024~~	0.060 ~~0.045~~	0.082	0.033	0.050	0.055
6	0.30	0.55	NR	0.026 ~~0.024~~	0.045	0.060	0.033	0.050	0.055
7 and 8	0.30	0.55	NR	0.026 ~~0.024~~	0.045	0.057	0.028	0.050	0.055

TABLE R402.1.3 INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT[a]

Portions of table not shown remain unchanged.

CLIMATE ZONE	FENESTRATION *U*-FACTOR[b, i]	SKYLIGHT[b] *U*-FACTOR	GLAZED FENESTRATION SHGC[b, e]	CEILING *R*-VALUE	WOOD FRAME WALL *R*-VALUE[g]	MASS WALL *R*-VALUE[h]	FLOOR *R*-VALUE	BASEMENT[c,g] WALL *R*-VALUE	SLAB[d] *R*-VALUE & DEPTH	CRAWL SPACE[c,g] WALL *R*-VALUE
0	NR	0.75	0.25	30	13 or 0 & 10ci	3/4	13	0	0	0
1	NR	0.75	0.25	30	13 or 0 & 10ci	3/4	13	0	0	0
2	0.40	0.65	0.25	38 ~~49~~	13 or 0 & 10ci	4/6	13	0	0	0
3	.30	0.55	0.25	38 ~~49~~	20 or 13 & 10ci[h] or 0 & 15ci[h]	8/13	19	5ci or 13[f]	10ci, 2 ft	5ci or 13[f]
4 except Marine	.30	0.55	0.40	49 ~~60~~	~~30 or~~ 20 ~~& 5ci~~[h] or 13 & 5 ~~10~~ci[h] or 0 & 15~~20~~ci[h]	8/13	19	10ci or 13	10ci, 4 ft	10ci or 13
5 and Marine 4	0.30[i]	0.55	0.40	49 ~~60~~	~~30 or~~ 20 ~~& 5ci~~[h] or 13 & 5 ~~10~~ci[h] or 0 & 15 ~~20~~ci[h]	13/17	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
6	0.30[i]	0.55	NR	49 ~~60~~	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	15/20	30	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci
7 and 8	0.30[i]	0.55	NR	49 ~~60~~	30 or 20 & 5ci[h] or 13 & 10ci[h] or 0 & 20ci[h]	19/21	38	15ci or 19 or 13 & 5ci	10ci, 4 ft	15ci or 19 or 13 & 5ci

SECTION R408
ADDITIONAL REQUIREMENTS ~~EFFICIENCY PACKAGE OPTIONS~~

R408.1 Scope. This section establishes additional requirements ~~efficiency packages options~~ to achieve ~~additional energy efficiency~~ compliance in accordance with Section R401.2.5 R401.2.1

R408.2 Additional energy measures ~~efficiency package options~~. A minimum of one energy measure from Section R408.3 or a minimum of two energy measures from Section R408.4 shall be implemented. ~~Additional efficiency package options for compliance with Section R401.2.1 are set forth in Sections R408.2.1 through R408.2.5.~~

R408.3 Single Energy Measure. Where selected for compliance with Section R408.2, one energy measure shall be implemented from this section

R408.3.1 ~~R408.2.1~~ Enhanced envelope performance measure ~~option~~. The total *building thermal envelope* UA, the sum of *U*-factor times assembly area, shall be less than or equal to ~~95~~ 90 percent of the total UA resulting from multiplying the *U*-factors in Table R402.1.2 by the same assembly area as in the proposed building. The UA calculation shall be performed in accordance with Section R402.1.5. The area-weighted average SHGC of all glazed fenestration shall be less than or equal to 95 percent of the maximum glazed fenestration SHGC in Table R402.1.2. The air leakage rate shall be not more than 90 percent of the air leakage rate required in Section R402.4.

R408.3.2 ~~R408.2.2~~ More efficient HVAC equipment performance measure ~~option~~. Heating and cooling *equipment* shall meet ~~one of the following~~ the minimum efficiencies in accordance with Table R408.2.2.COP

1. ~~Greater than or equal to 95 AFUE natural gas furnace and 16 SEER air conditioner.~~
2. ~~Greater than or equal to 10 HSPF/16 SEER air source heat pump.~~
3. ~~Greater than or equal to 3.5 COP ground source heat pump.~~

For multiple cooling systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the cooling design load. For multiple heating systems, all systems shall meet or exceed the minimum efficiency requirements in this section and shall be sized to serve 100 percent of the heating design load.

Add new text as follows:

TABLE R408.3.2 MINIMUM EFFICIENCIES FOR HEATING AND COOLING EQUIPMENT

	Climate Zones							
Equipment	**0**	**1**	**2**	**3**	**4 except Marine**	**5 and Marine 4**	**6**	**7 and 8**
Gas and Propane Heaters	80% AFUE	80% AFUE	92% AFUE	92% AFUE	95% AFUE	95% AFUE	95% AFUE	95% AFUE
Oil Furnace	83% AFUE	83% AFUE	85% AFUE	85% AFUE	90% AFUE	90% AFUE	90% AFUE	90% AFUE
Gas-fired Hot Water Boiler	84% AFUE	84% AFUE	85% AFUE	85% AFUE	90% AFUE	90% AFUE	94% AFUE	94% AFUE
Oil Boiler	86% AFUE	86% AFUE	88% AFUE	88% AFUE	90% AFUE	90% AFUE	92% AFUE	92% AFUE
Heat Pump	8.8 HSPF	8.8 HSPF	9.0 HSPF	9.0 HSPF	9.5 HSPF	10.0 HSPF	11 HSPF	11 HSPF
Cooling	18 SEER	18 SEER	18 SEER	17 SEER	16 SEER	16 SEER	15 SEER	15 SEER
Ground Source Heat Pump	3.5 COP	3.5 COP	3.5 COP	3.5 COP	3.5 COP	3.5 COP	3.5 COP	3.5 COP

Revise as follows:

R408.3.3 ~~R408.2.3~~ ~~Reduced energy use in~~ More energy efficient electric service water-heating measure ~~option~~. An electric ~~The~~ hot water system with the Uniform Energy Factor of 2.5 or higher shall be installed. ~~meet one of the following efficiencies:~~

1. ~~Greater than or equal to 82 EF fossil fuel service water-heating system.~~
2. ~~Greater than or equal to 2.0 EF electric service water-heating system.~~
3. ~~Greater than or equal to 0.4 solar fraction solar water-heating system.~~

R408.3.4 ~~R408.2.4~~ More efficient duct thermal distribution system measure ~~option~~. The thermal distribution system shall meet one of the following efficiencies:

1. 100 percent of ducts and air handlers located entirely within the *building thermal envelope*.
2. 100 percent of ductless thermal distribution system or hydronic thermal distribution system located completely inside the *building thermal envelope*.
3. 100 percent of duct thermal distribution system located in *conditioned space* as defined by Section R403.3.2.

408.3.5 Renewable Energy Measure. The building shall include the use of energy from a *renewable energy resource* from one of the following:

1. On-site power production.
2. Community renewable energy facility power production allocated to the building.
3. Renewable energy purchase contract power production allocated to the building.

The renewable energy production allocated to the building shall be not less than 10 percent of the estimated whole-building energy use on an annual basis.

408.4 Two Energy Measures. Where selected for compliance with Section R408.2, a minimum of two energy measures shall be implemented from this section.

408.4.1 More energy efficient gas service water-heating measure. A gas water heater with an UEF of 0.82 or higher is installed.

408.4.2 More efficient fenestration measure. Fenestration shall have a U-factor and glazed fenestration SHGC equal to or less than that specified in Table R408.4.2.

Add new text as follows:

TABLE R408.4.2 MINIMUM FENESTRATION REQUIREMENTS

Climate Zone	Fenestration U-factor	Glazed Fenestration SHGC
0	0.40	0.23
1	0.40	0.23
2	0.30	0.23
3	0.27	0.25
4 except Marine	0.27	0.25
5 and Marine 4	0.27	0.25
6	0.27	0.25
7 and 8	0.27	0.25

Revise as follows:

408.4.3 More efficient duct thermal distribution system measure. Where ducts are located outside of conditioned space, the total leakage of the ducts, measured in accordance with Section R403.3.5, shall be in accordance with one of the following:

1. Where air handler is installed at the time of testing, 2.0 cubic feet per minute per 100 square feet of *conditioned floor area.*
2. Where air handler is not installed at the time of testing, 1.75 cubic feet per minute per 100 square feet of *conditioned floor area.*

408.4.4 Reduced air leakage rate measure. In Climate Zones 4, 5, 6, 7, or 8, the building or dwelling unit shall have an air leakage rate not exceeding 2.0 ACH 50. Air leakage testing shall be in accordance with Section R402.4.1.2.

R408.4.5 ~~R408.2.5~~ Improved air sealing and efficient ventilation system measure ~~option~~. The measured air leakage rate shall be less than or equal to 3.0 ACH50, with either an Energy Recovery Ventilator (ERV) or Heat Recovery Ventilator (HRV) installed. Minimum HRV and ERV requirements, measured at the lowest tested net supply airflow, shall be greater than or equal to 75 percent Sensible Recovery Efficiency (SRE), less than or equal to 1.1 cubic feet per minute per watt (0.03 m^3/min/watt) and shall not use recirculation as a defrost strategy. In addition, the ERV shall be greater than or equal to 50 percent Latent Recovery/Moisture Transfer (LRMT).

408.4.6 More energy efficient appliances. Appliances installed in a dwelling unit shall meet the product energy efficiency specifications listed in the referenced documents in accordance with Table R408.4.6 or equivalent energy efficiency specifications. A minimum of three types of appliances from Table R408.4.6 shall be installed for compliance with this section.

Add new text as follows:

TABLE R408.4.6
APPLIANCE SPECIFICATION REFERENCE DOCUMENT

Refrigerator	ENERGY STAR Program Requirements Product Specification for Consumer Refrigeration Products, Version 5.1 (08/05/2021)
Dishwasher	ENERGY STAR Program Requirements for Residential Dishwashers, Version 6.0 (01/29/2016)
Clothes Dryer	ENERGY STAR Program Requirements, Product Specification for Clothes Dryers, Version 1.1 (05/05/2017)
Clothes Washer	ENERGY STAR Program Requirements, Product Specification for Clothes Washers, Version 8.1, (02/05/2018)

Revise as follows:

R408.4.7 Solar thermal water heater. A solar hot water system with the solar fraction of 0.4 or greater shall be installed.

Reason: This is a comprehensive proposal that sets out to achieve the following:

- Energy efficiency measures are realigned to prioritize more cost-effective strategies for achieving improved performance.
- The overall energy performance is incrementally higher than the 2021 IECC (with the 95% UA option selected in Section R408 of 2021 IECC).
- The attic and wall insulation levels that were added in 2021 IECC are realigned to 2018 IECC levels. The 2021 IECC insulation levels result in egregiously unfavorable cost effectiveness metrics, in terms of both net present value and simple payback. A cost-effectiveness analysis report is attached with this submission. The analysis shows that the energy savings from 2021 IECC attic insulation are less than $1 (one) per month on average in most cases for a 2,600 sq. ft. house, which corresponds to simple paybacks well over 100 years. The savings from the wall insulation are $4-$5 per month on average, which corresponds to simple payback ranging between 78 and 103 years.
- To offset the small reduction in energy saving from attic and wall insulation and to further increase the energy performance of buildings, Section R408 is substantially revised as follows:
  - The additional energy measures are grouped into two categories based on the level of energy savings.
  - Where climate zones have significant impact on the level of energy savings, the measure requirements are organized by climate zone.
  - Several measures are added for increased flexibility of compliance.
- The additional requirement of Section R408 are removed from the ERI compliance path. The ERI thresholds already account for the use of high efficiency equipment. Requiring compliance with the additional requirements of Section R408 that includes high efficiency equipment is inconsistent and incorrect.

This proposal is offered as a potential blueprint for a path forward. It is recognized that the consensus committee will use a cost-effectiveness analysis to evaluate the proposed measures that may lead to more stringent or less stringent requirements. Similarly, the organizational format of the requirements can change. However, it is important that the key principles of the proposal are maintained: a relief from the unjustified mandatory insulation levels is included and all associated offsets and increases in stringency are based on a cost-effectiveness analysis of a broad range of measures without arbitrary restrictions.

https://energy.cdpaccess.com/proposal/154/607/files/download/88/
https://energy.cdpaccess.com/proposal/154/607/files/download/87/
https://energy.cdpaccess.com/proposal/154/607/files/download/87/
https://energy.cdpaccess.com/proposal/154/607/files/download/85/
https://energy.cdpaccess.com/proposal/154/607/files/download/84/

Bibliography: 2021 IECC Residential Cost Effectiveness Analysis. June 2021. Home Innovation Research Labs, Upper Marlboro, MD.

ENERGY STAR Program Requirements Product Specification for Consumer Refrigeration Products, Version 5.1 (08/05/2021)

ENERGY STAR Program Requirements for Residential Dishwashers, Version, Version 6.0 (01/29/2016)

ENERGY STAR Program Requirements, Product Specification for Clothes Dryers, Version 1.1 (05/05/2017)

ENERGY STAR Program Requirements, Product Specification for Clothes Washers, Version 8.1, (02/05/2018)

(Files are attached to the submission.)

Cost Impact: The code change proposal will increase the cost of construction.
The proposal includes changes that realign requirements with the net effect of an incremental increase in stringency. The proposal is offered with an understanding that the committee will conduct a cost-effectiveness analysis in accordance with the 2024 IECC framework.

REPI-168-21

IECC®: APPENDIX RX (New), (New), RX 101. (New), RX 101.1 (New), RX 101.2 (New), RX 101.3 (New), RX 101.4 (New), RX 101.5 (New), RX101.5.1 (New), RX101.5.2 (New), RX102 (New), RX102.1 (New), RX103 (New), RX104 (New), RX105 (New), RX105.1 (New), RX 106 (New), RX107 (New), RX108 (New), RX108.1 (New), RX108.2 (New), RX108.3 (New), RX108.4 (New), RX108.5 (New), RX109 (New), RX109.1 (New), RX110 (New), RX110.1 (New), RX110.2 (New), RX110.3 (New), RX110.4 (New), RX110.5 (New), RX110.6 (New), RX110.7 (New), RX110.7.1 (New), RX111 (New), RX112 (New), RX113 (New), RX114 (New), RX115 (New), RX116 (New)

Proponents:

Craig Conner, representing self (craig.conner@mac.com)

2021 International Energy Conservation Code

Add new text as follows:

APPENDIX RX ENERGY EFFICIENT OPTION

.

This appendix provides a simpler energy code with that conserves more energy.

RX 101. Thermal Envelope.

The thermal envelope shall comply with RX101.1 through RX101.4.

RX 101.1 Insulation and fenestration criteria.

The building thermal envelope shall meet the requirements of Table R402.1.2, based on climate zone. Assemblies shall have a U-factor equal to or less than that specified in Table R402.1.2. Fenestration shall have a U-factor and glazed fenestration SHGC equal to or less than that specified in Table R402.1.2.

RX 101.2 R-value alternative.

Assemblies with an R-value of insulation materials equal to or greater than that specified in Table R402.1.3 shall be an alternative to the U-factor in Table R402.1.2.

RX 101.3 Specific insulation requirements.

The building shall comply with Section R402.2 “Specific Insulation Requirements”.

RX 101.4 Fenestration U-factor.

An area-weighted average of fenestration shall be permitted to satisfy the fenestration U-factor requirements.

RX 101.5

Glazed fenestration SHGC

.

An area-weighted average of fenestration products more than 50-percent glazed shall be permitted to satisfy the SHGC requirements.

Dynamic glazing shall be permitted to satisfy the SHGC requirements provided that the ratio of the higher to lower labeled SHGC is greater than or equal to 2.4, and the dynamic glazing is automatically controls the amount of solar gain into the space in multiple steps. Dynamic glazing shall be considered separately from other fenestration, and area-weighted averaging with other fenestration that is not dynamic glazing shall be prohibited.

Exception: Dynamic glazing shall not be required to comply with this section where both the lower and higher labeled SHGC comply with the SHGC requirements.
RX101.5.1 Glazed fenestration exemption.

Not greater than 15 square feet (1.4 m) of glazed fenestration per dwelling unit shall be exempt from the U-factor and SHGC requirements in this section. This exemption shall not apply to the Total building UA alternative.

RX101.5.2 **Opaque door exemption**.

One side-hinged opaque door assembly not greater than 24 square feet (2.22m) in area shall be exempt from the U-factor requirement. This exemption shall not apply to the total building UA alternative.

RX102 **HVAC efficiency**.

HVAC shall meet the following criteria as applicable:

1. In zones 3 through 8 gas furnaces shall be at least 90 AFUE. Where installed in an existing house without venting for condensing furnaces, gas furnaces shall be at least 83 AFUE. In both cases an alternative that conserves at least the same energy shall be permitted.
2. In zones 3 through 8 air source heat pump efficiency shall be at least 16 SEER and 8.2 HSPF; or an alternative that conserves at least the same energy,
3. Ground source heat pumps shall have at least a 3.5 COP.
4. Cooling shall have at least an 18 SEER in zones 0 to 2. Cooling shall have at least an 16 SEER in zones 3 to 7. In all zones an alternative that conserves at least the same energy shall be permitted

RX102.1 **Electric resistance heating**.

Electric resistance heating shall not be used as a primary heating system in zones 3 to 8.

RX103 **Equipment sizing**.

Heating and cooling equipment shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies.

RX104 **Air leakage**.

The building or dwelling unit shall be tested and verified as having an air leakage rate not exceeding 5 ACH50 in zones 0 to 3 and 3 ACH50 in zones 4 to 8. Testing shall be conducted in accordance with RESNET/ICC 380, ASTM E779 or ASTM E1827 and reported at a pressure of 0.2 inch w.g. (50 Pascals). Where required by the code official, testing shall be conducted by an approved third party. A written report of the test results shall be provided to the code official by the party conducting the test.

Testing shall be performed after creation of all penetrations of the building thermal envelope.

During testing:

1. Exterior windows and doors, fireplace and stove doors shall be closed, but not sealed, beyond weatherstripping or other infiltration control measures.
2. Dampers including exhaust, intake, makeup air, backdraft and flue dampers shall be closed, but not sealed beyond the infiltration control measures.
3. Exterior or interior terminations for continuous ventilation systems shall be sealed.
4. Where installed at time of test:
   - 4.1. Interior doors shall be open
   - 4.2. Heating and cooling systems shall be turned off
   - 4.3. Supply and return registers shall be fully open

RX105 **Mechanical ventilation**.

Buildings and dwelling units shall be provided with mechanical ventilation that complies with the requirements of the *International Residential Code* or *International Mechanical Code*, as applicable, or with other approved means of ventilation. Outdoor air intakes and exhausts shall have automatic or gravity dampers that close when the ventilation system is not operating.

RX105.1 **Heat or energy recovery ventilation**.

RX105.1 Heat or energy recovery ventilation. Dwelling units shall be provided with a heat recovery or energy recovery ventilation system in Climate Zones 7 and 8. The system shall be balanced with a minimum sensible heat recovery efficiency of 65 percent at 32°F (0°C) at a flow greater than or equal to the design airflow.

RX 106 **Whole-dwelling mechanical ventilation system fan efficacy**.

Fans providing whole-dwelling mechanical ventilation shall meet the following efficacy requirements at one or more rating points. Fans

Fans providing whole-dwelling mechanical ventilation shall meet the following efficacy requirements at one or more rating points. Fans shall be tested in accordance with HVI 916 and listed. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ERC, balanced, and in-line fans shall be determined at a static pressure of not less than 0.2 inch w.c. (49.85 Pa). Fan efficacy for ducted range hoods, bathroom and utility room fans shall be determined at a static pressure of not less than 0.1 inch w.c. (24.91 Pa).

Minimum efficacy shall be as follows. Design outdoor airflow rate/watts of fan shall be used.

1. HRV, ERV - 1.2 cfm/watt
2. In-line supply or exhaust fan - 3.8 cfm/watt
3. Other exhaust fan < 90 cfm - 2.8 cfm/watt
4. Other exhaust fan ≥ 90 cfm - 3.5 cfm/watt
5. Fan in air-handler in HVAC equipment - 1.2 cfm/watt

RX107 Mechanical system piping insulation.

Mechanical system piping capable of carrying fluids greater than 105°F (41°C) or less than 55°F (13°C) shall be insulated to an R-value of not less than R-3.

RX108 Service hot water systems.

Service hot water systems shall be in compliance with Section R403.5 or this section.

RX108.1 Service water heaters.

Service water heaters shall comply with 1, 2 3, or 4. It is permissible to have multiple water heaters service each dwelling. Each service water heater shall meet at least one of the criteria below:

1. water heater is within 10 horizontal feet of hot water use. Distance shall be as measured from the center of the water heater to the plumbing fixture or appliance on construction documents or as in actual construction
2. efficiency is at least 1.5 UEF if electric; or an alternative that conserves at least the same energy,
3. efficiency is at least 0.85 UEF if gas; or an alternative that conserves at least the same energy,
4. solar energy is projected to supply at least 70% of the service hot water energy.

RX108.2 Heated water circulation and temperature maintenance systems.

Heated water circulation systems heat trace temperature maintenance systems shall be in accordance with xxx and xxx. Automatic controls, temperature sensors and pumps shall be in a location with access. Manual controls shall be in a location with ready access.

RX108.3 Circulation systems.

Heated water circulation systems shall be provided with a circulation pump. The system return pipe shall be a dedicated return pipe or a cold water supply pipe. Gravity and thermosyphon circulation systems shall be prohibited. Controls for circulating hot water system pumps shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is no demand for hot water. The controls shall limit the temperature of the water entering the cold water piping to not greater than 104ºF (40ºC).

RX108.4 Demand recirculation water systems.

Where installed, demand recirculation water systems shall have controls that start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.

RX108.5 Heat trace systems.

Electric heat trace systems shall comply with IEEE 515.1 or UL 515. Controls shall automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with heated water use.

RX109 Hot water pipe insulation.

Insulation for service hot water piping with a thermal resistance, R-value, of not less than R-3 shall be applied to the following:

1. Piping 3/4 inch (19.1 mm) and larger in nominal diameter located inside the conditioned space.

2. Piping serving more than one dwelling unit.
3. Piping located outside the conditioned space.
4. Piping from the water heater to a distribution manifold.
5. Piping located under a floor slab.
6. Buried piping.
7. Supply and return piping in *circulating hot or cold water systems*.
   Exceptions:
   1. Cold water pipe returns in demand recirculation water systems.
   2. Where the source of service hot water is within 6 horizontal feet (1828 mm) of the plumbing fixture or appliance.

RX109.1 Short hot water pipes.

Where the source of service hot water is within 6 feet of the use of service hot water or recirculation loop, pipe insulation is not required

RX110 Ducts.
RX110 Ducts. Ducts and air handlers shall be installed in accordance with Sections RX110.1 through RX110.7.
RX110.1 Ducts outside conditioned space.

Supply and return ducts located outside conditioned space shall be insulated to an R-value of not less than R-8 for ducts 3 inches (76 mm) in diameter and larger; and not less than R-6 for ducts smaller than 3 inches (76 mm) in diameter. Ducts buried beneath a building shall be insulated as required per this section or have an equivalent thermal distribution efficiency. Underground ducts utilizing the thermal distribution efficiency method shall be listed and labeled to indicate the R-value equivalency.

RX110.2 Ducts in conditioned space.

For ductwork to be considered inside a conditioned space, it shall comply with at least one of the following:

1. The duct system shall be located completely within the continuous air barrier and within the building thermal envelope.
2. Ductwork in ventilated attic spaces shall be buried within ceiling insulation in accordance with Section R403.3.3 and all of the following conditions shall exist:
   2.1. The air handler is located completely within the continuous air barrier and within the building thermal envelope.
   2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the building thermal envelope in accordance with Section R403.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m) of conditioned floor area served by the duct system.
   2.3. The ceiling insulation R-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation R-value, less the R-value of the insulation on the duct.
3. Ductwork in floor cavities located over unconditioned space shall comply with all of the following:
   3.1. A continuous air barrier shall be installed between unconditioned space and the duct.
   3.2. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.
4. Ductwork located within exterior walls of the building thermal envelope shall comply with the following:
   4.1. A continuous air barrier installed between unconditioned space and the duct.
   4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.
   4.3. The remainder of the cavity insulation shall be fully insulated to the drywall side.

RX110.3 Ducts buried within ceiling insulation.

Where supply and return air ducts are partially or completely buried in ceiling insulation, such ducts shall comply with all of the following:

1. The supply and return ducts shall have an insulation R-value not less than R-8
2. At all points the sum of the ceiling insulation R-value against and above the top of the duct, and against and below the bottom of the duct, shall be not less than R-19, excluding the R-value of the duct insulation.
3. In Climate Zones 0A, 1A, 2A and 3A, the supply ducts shall be completely buried within ceiling insulation and insulated to an R-value of not less than R-13.

Exception: Sections of the supply duct that are less than 2 feet (914 mm) from the supply outlet shall not be required to comply with these requirements.

RX110.4 Effective R-value of deeply buried ducts.

Ducts located directly on or within 5.5 inches (140 mm) of the ceiling, surrounded with blown-in attic insulation having an R-value of R-30 or greater and located such that the top of the duct is not less than 3.5 inches (89 mm) below the top of the insulation, shall be considered as having an effective duct insulation R-value of R-25.

RX110.5 Duct sealing.

Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with either the *International Mechanical Code* or *International Residential Code*, as applicable.

RX110.6 Sealed air handler.

Air handlers shall have a manufacturer's designation for an air leakage of not greater than 2 percent of the design airflow rate when tested in accordance with ASHRAE 193.

RX110.7 Duct testing.

Ducts shall be pressure tested in accordance with ANSI/RESNET/ICC 380 or ASTM E1554 to determine air leakage by one of the following methods:

1. Rough-in test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the system, including the manufacturer's air handler enclosure if installed at the time of the test. Registers shall be taped or otherwise sealed during the test.
2. Postconstruction test: Total leakage shall be measured with a pressure differential of 0.1 inch w.g. (25 Pa) across the entire system, including the manufacturer's air handler enclosure. Registers shall be taped or otherwise sealed during the test.

Exception:

The duct air-leakage test in Section RX110.7 shall not be required for ducts serving heating, cooling or ventilation systems that are not integrated with ducts serving heating or cooling systems.

RX110.7.1 Duct leakage.

The total leakage of the ducts, where measured in accordance with Section R403.3.5, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m) of conditioned floor area where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 m) of conditioned floor area.
2. Postconstruction test: Total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m) of conditioned floor area.
3. Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the building thermal envelope, total leakage shall be less than or equal to 8.0 cubic feet per minute (226.6 L/min) per 100 square feet (9.29 m) of conditioned floor area.

RX111 Building cavities.

Building cavities shall not be used as ducts or plenums.

RX112 Rooms containing fuel-burning appliances.

In Climate Zones 3 through 8, where open combustion air ducts provide combustion air to open combustion fuel-burning appliances the following shall apply:

1. appliances and combustion air opening shall be located outside the building thermal envelope or enclosed in a room that is isolated from inside the thermal envelope
2. rooms shall be sealed and insulated in accordance with the envelope requirements of Table R402.1.3
3. walls, floors and ceilings shall meet a minimum of the basement wall R-value requirement

4. door(s) into the room shall be gasketed
5. water lines and ducts in the room shall be insulated in accordance with Section R403
6. combustion air duct shall be insulated where it passes through conditioned space to an R-value of not less than R-8

Exceptions:

1. Direct vent appliances with both intake and exhaust pipes installed continuous to the outside; and
2. Fireplaces and stoves complying with Section R402.4.2 and Section R1006 of the *International Residential Code*.

RX113 Fireplace doors.

Fireplaces shall have tight-fitting doors.

RX114 Renewables offset.

Renewables shall be permitted to be treated as a reduction in energy use of the dwelling. Such renewables shall be on-site or off-site renewables. Off-site renewables treated as a reduction in energy use shall be as specified by Section CC103.3.1

RX115 Pool covers.

Outdoor heated pools and outdoor permanent spas shall be provided with a vapor-retardant cover or other approved vapor-retardant means. Outdoor heated pools shall be provided with an automated pool cover.

Exception: Where more than 75 percent of the energy for heating, computed over an operation season of not fewer than 3 calendar months, is from a heat pump or an on-site renewable energy system, the covers or other vapor-retardant means shall not be required.

RX116 Fuel Gas Lighting Equipment.

Fuel gas lighting systems shall not have continuously burning pilot lights.

Reason Statement:

This proposal provides a simpler to understand energy code option. This energy code option also saves significantly more energy.

Simpler and clearer means used. Code users, code staff and product makers all need to understand the code. The price of complexity in the code is a lack of compliance.

This places the text for an energy code option in a few pages. There are a few specific references to other sections or tables. The code user needs only to understand the few pages in this option.

The additional energy savings come from requirements for service hot water and requirements for equipment efficiency. Per the NAECA federal law (National Appliance Energy Conservation Act), equipment efficiency requirements also come with a choice that does not require exceeding federal requirements.

Where there is already code language for a specific item, this usually uses the exact same language, phrase or section heading. Where a reference standard is required, this energy code option uses the same reference standard.

Again, understandable will mean use and compliance.

Cost Impact:

The code change proposal will increase the cost of construction.

Parts of this energy code option are clearly "above code" and would cost more; for example, the new requirements for equipment efficiency would usually cost more. Some parts would costs less. Overall, increased energy efficiency does not necessarily need to cost more.

IRCEPI-1-21

IRC: N1102.2.6, TABLE N1102.2.6, Chapter 44 (New)

Proponents:

Jonathan Humble, representing American Iron and Steel Institute (Jhumble@steel.org)

THIS PROPOSAL WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Residential Code

Revise as follows:

N1102.2.6 Steel-frame ceilings~~,~~ and walls~~, and floors~~.

Steel-frame ceilings~~,~~ and walls~~, and floors~~ shall comply with the ~~insulation requirements of Table N1102.2.6 or the~~ *U*-factor requirements of Table N1102.1.2. The ~~calculation of the~~ *U*-factor for a steel-frame envelope assembly shall ~~use a series-parallel path calculation method~~ be determined in accordance with AISI S250.

~~TABLE N1102.2.6 STEEL-FRAME CEILING, WALL AND FLOOR INSULATION R-VALUES~~

~~WOOD FRAME *R*-VALUE REQUIREMENT~~	~~COLD-FORMED STEEL-FRAME EQUIVALENT *R*-VALUE[a]~~
~~Steel Truss Ceilings[b]~~	
~~R-30~~	~~R-38 or R-30 + 3 or R-26 + 5~~
~~R-38~~	~~R-49 or R-38 + 3~~
~~R-49~~	~~R-38 + 5~~
~~Steel Joist Ceilings[b]~~	
~~R-30~~	~~R-38 in 2 × 4 or 2 × 6 or 2 × 8 R-49 in any framing~~
~~R-38~~	~~R-49 in 2 × 4 or 2 × 6 or 2 × 8 or 2 × 10~~
~~Steel-frame Wall, 16 inches on center~~	
~~R-13~~	~~R-13 + 4.2 or R-21 + 2.8 or R-0 + 9.3 or R-15 + 3.8 or R-21 + 3.1~~
~~R-13 + 5~~	~~R-0 + 15 or R-13 + 9 or R-15 + 8.5 or R-19 + 8 or R-21 + 7~~
~~R-13 + 10~~	~~R-0 + 20 or R-13 + 15 or R-15 + 14 or R-19 + 13 or R-21 + 13~~
~~R-20~~	~~R-0 + 14.0 or R-13 + 8.9 or R-15 + 8.5 or R-19 + 7.8 or R-21 + 7.5~~
~~R-20 + 5~~	~~R-13 + 12.7 or R-15 + 12.3 or R-19 + 11.6 or R-21 + 11.3 or R-25 + 10.9~~
~~R-21~~	~~R-0 + 14.6 or R-13 + 9.5 or R-15 + 9.1 or R-19 + 8.4 or R-21 + 8.1 or R-25 + 7.7~~
~~Steel-frame Wall, 24 inches on center~~	
~~R-13~~	~~R-0 + 9.3 or R-13 + 3.0 or R-15 + 2.4~~
~~R-13 + 5~~	~~R-0 + 15 or R-13 + 7.5 or R-15 + 7 or R-19 + 6 or R-21 + 6~~
~~R-13 + 10~~	~~R-0 + 20 or R-13 + 13 or R-15 + 12 or R-19 + 11 or R-21 + 11~~
~~R-20~~	~~R-0 + 14.0 or R-13 + 7.7 or R-15 + 7.1 or R-19 + 6.3 or R-21 + 5.9~~
~~R-20 + 5~~	~~R-13 + 11.5 or R-15 + 10.9 or R-19 + 10.1 or R-21 + 9.7 or R-25 + 9.1~~
~~R-21~~	~~R-0 + 14.6 or R-13 + 8.3 or R-15 + 7.7 or R-19 + 6.9 or R-21 + 6.5 or R-25 + 5.9~~
~~Steel Joist Floor~~	
~~R-13~~	~~R-19 in 2 × 6, or R-19 + 6 in 2 × 8 or 2 × 10~~
~~R-19~~	~~R-19 + 6 in 2 × 6, or R-19 + 12 in 2 × 8 or 2 × 10~~

For SI: 1 inch = 25.4 mm.

~~a. The first value is cavity insulation *R*-value; the second value is continuous insulation *R*-value. Therefore, for example, "R-30 + 3" means R-30 cavity insulation plus R-3 continuous insulation.~~

~~b. Insulation exceeding the height of the framing shall cover the framing.~~

Add new text as follows:
Chapter 44 Referenced Standards.

AISI

American Iron and Steel Institute

25 Massachusetts Avenue, NW, Suite 800

Washington, DC 20001

AISI S250-21

North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing

Section N1102.2.6

Attached Files

- **AISI_CFSD-Report-RP20-2-Final.pdf**
  http://localhost/proposal/157/863/files/download/31/
- **AISI S250-21&S250-21-C_s.pdf**
  http://localhost/proposal/157/863/files/download/30/

Reason Statement:

The purpose of this proposal is to address the issue of having to submit to the code official a request to use the alternative means and methods provisions for cold-formed steel framing designs that are not shown in the IECC. For example, Section C402.1.4.2 addresses only wall framing spacing for 16 and 24 inch on center spacing and is limited to cavity plus continuous insulation options only, whereas, in the market there are many more framing spacing and insulation options used.

This proposal recommends that the Section be modified to recognize the ANSI/AISI/COFS S250 standard. This standard covers cold-formed steel wall framing spacings from 6 inches to 24 inches on center, covers member sizes from 3.5 inches to 12 inches wide, and covers member thicknesses from 0.033 inches thick to 0.064 inches thick. This standard will provide greater latitude for the user of the IECC by mitigating the necessity of having to submit for approval under alternate means and methods provisions. Further, this standard also includes provisions for evaluation of wall assemblies where all the insulation is located outside the wall cavity, which is an option the IECC does not cover.

This standard also contains provisions for calculating ceiling assemblies constructed of cold-formed steel framing with either conventional c-shape framing members, or truss construction with insulation in the attic and with additional continuous insulation below the truss framing. Previous to this proposal we found users applying the 2003 IECC provisions, which contained the calculation procedures, as part of the alternative means and methods submission process to demonstrate compliance. This proposal is intended to mitigate that additional step.

The ANSI/AISI/COFS S250 was approved and published in September 2021.

As part of AISI’s effort to make this document user friendly, an excel spread sheet containing all the necessary equations and back-ground data was generated so that users would merely input the basic assembly materials data (e.g. R-values of insulations, sheathings, etc.) and allow the spread sheet to calculate within seconds the result. This excel spread sheet is available at no cost to any potential user (e.g. code official, design professional, building owner, etc.)

The proponent wishes to schedule time to present to the IECC Residential Committee this proposal, discuss, and to take questions from the Committee.

Bibliography:

AISI, "Development of a U-factor Calculation Procedure for Cold-Formed Steel C-Shaped Clear Wall Assemblies," American Iron and Steel Institute, Washington, DC, Research Report RP20-2, April 2020.

AISI, "North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing," American Iron and Steel Institute, Washington, DC, AISI S250-21.

Cost Impact:

The code change proposal will decrease the cost of construction.

This proposed change we expect will decease the cost of construction by eliminating the need to prepare an application to the alternative means and methods process. This is because of the standards wider range of envelope assembly options that the user is permitted to calculate in order to demonstrate compliance

IRCEPI-1-21

IRCEPI-2-21

IRC: N1103.6.4 (New)

Proponents:

Glory O'Brien, representing Western Mechanical Solutions (glory.obrien@westernmechanicalsolutions.com)

THIS PROPOSAL WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Residential Code

Add new text as follows:
N1103.6.4 Bathroom Intermittent Exhaust Control.

When a bathroom exhaust system is designed for intermittent operation, the power shall be provided through an automatic shutoff timer switch with a maximum time limit of 30 minutes.

Reason Statement:

Substantiation: Bin analysis was run on a 50 cfm bath exhaust fan. It was assumed the fan would run 2 hours a day with a manual switch vs. 5 minutes with a timer. Only heating energy and fan energy was reviewed, savings was $ 27 per year based on Denver rates with Xcel Energy. Assuming $ 100 installed cost, the payback is 4 years.

Added benefit is that occupants no longer need to remember to go back and shutoff the bathroom exhaust fan.

Cost Impact:

The code change proposal will increase the cost of construction.

A small increase in cost can significantly reduce the time a bathroom fan is on, and cause energy savings in the long term.

IRCEPI-2-21

IRCEPI-3-21

IRC: SECTION 202 (New)

Proponents:

David Bixby, representing ACCA (david.bixby@acca.org)

THIS PROPOSAL WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Residential Code

Add new definition as follows:
N1101.6 DUCT AIRFLOW BALANCING.
The measurement and adjustment of the airflow and temperature evenly throughout the home to provide correct delivered airflow into the rooms or spaces to improve occupant comfort and increase HVAC system efficiency.

Reason Statement:

A definition for "Duct Airflow Balancing" is proposed to support terminology used in ACCA's proposed exception to **N1103.3.6 (R403.3.6) Duct leakage., 3. Test for ducts within thermal envelope.** Airflow balance procedures document the volume of air returned through the duct system and supplied to the dwelling. This information can be used to ascertain the duct system leakage, thereby accomplishing the same intended purpose. Additionally, airflow balancing directly impacts the delivery of the correct volume of air to a given space. This is drastically better than leak testing ducts as it can only measure the duct’s leakage rate. Based on substantiation for the requirement to test ducts within the thermal envelope, airflow balancing will reduce energy costs by increasing the HVAC system’s efficiency. A reference to ANSI/ACCA Standard 5 QI is added as it contains an airflow balancing procedure.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The proposed definition does not increase or decrease the cost of construction as it merely supports a term used in another proposal.

IRCEPI-3-21

IRCEPI-4-21

IRC: N1103.3.6

Proponents:

David Bixby, representing ACCA (david.bixby@acca.org)

THIS PROPOSAL WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Residential Code

Revise as follows:
N1103.3.6 (R403.3.6) Duct leakage.

The total leakage of the ducts, where measured in accordance with Section N1103.3.5, shall be as follows:

1. Rough-in test: The total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* where the air handler is installed at the time of the test. Where the air handler is not installed at the time of the test, the total leakage shall be less than or equal to 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area*.

2. Postconstruction test: Total leakage shall be less than or equal to 4.0 cubic feet per minute (113.3 L/min) per 100 square feet (9.29 m^2) of conditioned floor area.

3. Test for ducts within thermal envelope: Where all ducts and air handlers are located entirely within the *building thermal envelope*, total leakage shall be less than or equal to 8.0 cubic feet per minute (226.6 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area*.

   Exception: Duct systems designed so the individual room airflow shall be within the greater of ± 20%, or 25 CFM of the design/application requirements for the supply and return ducts. This shall be demonstrated by using a *duct airflow balancing* procedure as specified by ANSI/ACCA 5 QI or by other approved methods.

Staff Note: ANSI/ACCA 5 QI -2010 HVAC Quality Installation Specification is included as part of the code change proposal. The code change proposal will be updated by staff with the changes in the reference standard chapter of the IECC-R and IRC when the applicable cdpACCESS update is provided.

Reason Statement:

An exception is proposed for leak testing ducts located within the thermal envelope. Airflow balance procedures document the volume of air returned through the duct system and supplied to the dwelling. This information can be used to ascertain the duct system leakage, thereby accomplishing the same intended purpose. Additionally, airflow balancing directly impacts the delivery of the correct volume of air to a given space. This is drastically better than leak testing ducts as it can only measure the duct's leakage rate. Based on substantiation for the requirement to test ducts within the thermal envelope, airflow balancing will reduce energy costs by increasing the HVAC system's efficiency. A reference to ANSI/ACCA Standard 5 QI is added as it contains an airflow balancing procedure. In addition, a definition is proposed for "duct airflow balancing."

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This proposal will not affect cost of construction as the current code requirement involves the cost to leak test ducts. The cost to perform a duct airflow balance test would amount to about the same cost for leak testing ducts, it would just utilize different types of equipment.

IRCEPI-4-21

IRCEPI-5-21

IRC: N1105.2

Proponents:

James Ranfone, representing American Gas Association (jranfone@aga.org)

THIS PROPOSAL WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Residential Code

Revise as follows:
N1105.2 (R405.2) Performance-based compliance.

Compliance based on total building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table N1105.2.
2. The building thermal envelope shall be greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 *International Energy Conservation Code*.
3. An annual energy cost that is less than or equal to the annual energy cost of the *standard reference design*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's State Energy Data System Prices and Expenditures reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations.

   Exception: The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be ~~3.16~~ 2.80. The source energy multiplier for fuels other than electricity shall be 1.1.

Reason Statement:

The 2.80 reflects the revised conversion factor for source energy multiplier for electricity based on federal estimates of improvements due to the inclusion of renewable energy sources.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

EPA now uses 2.80 instead of 3.10 in its Portfolio Manager program convert to source energy. EPA sates that "We use national average ratios for the conversion to source energy to ensure that no specific building will be credited (or penalized) for the relative efficiency of its energy provider(s).

IRCEPI-5-21

IRCEPI-6-21

IRC: N1103.3

Proponents:

David Bixby, representing ACCA (david.bixby@acca.org)

THIS PROPOSAL WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Residential Code

Revise as follows:
N1103.3 (R403.3) Ducts.
Duct Supply and Duct Return shall be designed and sized in accordance with M1601.1 of the International Residential Code or Section 603.2 of the International Mechanical Code, as applicable. Ducts and air handlers shall be installed in accordance with Sections N1103.3.1 through N1103.3.7.

Reason Statement:

Section N1103.7 (R403.7) in Chapter 11 specifies that heating and cooling equipment must be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J. However, Chapter 11 does not reference ACCA Manual D procedures for sizing residential duct systems. Manual D uses ACCA Manual J heating and cooling loads to determine space air delivery requirements, and matches duct system resistance (pressure drop) to blower performance (as defined by manufacture's blower performance tables). This assures that appropriate airflow is delivered to all rooms and spaces; and that system airflow is compatible with the operating range of primary equipment. It is widely understood that duct leakage and return path restrictions affect the efficiency of the duct system, the performance of the building envelope, the efficiency and effectiveness of the HVAC equipment, the capacity of the exhaust equipment, and the power of the vents for fuel burning components. In most cases these effects are interactive. For this reason, Manual D belongs in Chapter 11. The proposal references M1601.1 which is reproduced below.

[M1601.1 Duct design. *Duct systems* serving heating, cooling and *ventilation equipment* shall be installed in accordance with the provisions of this section and ACCA *Manual D*, the *appliance* manufacturer's installation instructions or other *approved* methods.**]**

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

The reference to Manual D is already a mandatory requirement in the mechanical section of the IRC. Therefore, the addition of this reference to Chapter 11 will not affect the cost of construction.

IRCEPI-6-21

IRCEPI-7-21

IRC: N1103.3.2

Proponents:

Craig Conner, representing self (craig.conner@mac.com); Joseph Lstiburek, representing Building Science Corporation (joe@buildingscience.com)

THIS PROPOSAL WILL BE HEARD BY THE IECC-RESIDENTIAL COMMITTEE.

2021 International Residential Code

Revise as follows:
N1103.3.2 Ducts located in conditioned space.

For ductwork to be considered inside a *conditioned space*, it shall comply with one of the following:

1. The duct system is located completely within the *continuous air barrier* and within the *building thermal envelope.*
2. Ductwork in ventilated attic spaces <u>or sealed attic with vapor diffusion port</u> is buried within ceiling insulation in accordance with Section N1103.3.3 and all of the following conditions exist:
   - 2.1. The air handler is located completely within the *continuous air barrier* and within the *building thermal envelope*.
   - 2.2. The duct leakage, as measured either by a rough-in test of the ducts or a post-construction total system leakage test to outside the *building thermal envelope* in accordance with Section N1103.3.6, is less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* served by the duct system.
   - 2.3. The ceiling insulation *R*-value installed against and above the insulated duct is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the duct.
3. Ductwork in floor cavities located over unconditioned space shall have the following:
   - 3.1. A *continuous air barrier* installed between unconditioned space and the duct.
   - 3.2. Insulation installed in accordance with Section N1102.2.7.
   - 3.3. A minimum R-19 insulation installed in the cavity width separating the duct from unconditioned space.
4. Ductwork located within *exterior walls* of the *building thermal envelope* shall have the following:
   - 4.1. A *continuous air barrier* installed between unconditioned space and the duct.
   - 4.2. Minimum R-10 insulation installed in the cavity width separating the duct from the outside sheathing.
   - 4.3. The remainder of the cavity insulation fully insulated to the drywall side.

Reason Statement:

Research done by the Department of Energy through the Building America Program shows that sealed attics with vapor diffusion ports significantly reduce the risk of condensation on ductwork. The existing IRC language allows sealed attics with vapor diffusion ports. This language makes it clear that the buried duct language for vented attics also applies to sealed attics with vapor diffusion ports.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

This adds an option but not necessarily a cost.

IRCEPI-7-21