**Code Amendment Proposal Form**

For public amendments proposed to the 2018 editions of the International Codes

**Instructions:** Upload this form and all accompanying documentation at [www.denvergov.org/BuildingCode](http://www.denvergov.org/BuildingCode). If you are submitting your proposal on a separate sheet, make sure it includes all information requested below.

All proposals must be received by **April 26, 2019**.

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**CONTACT INFORMATION**

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Organization: New Buildings Institute

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Signature: ____________________________

Co-proposed by: Jim Meyers, Southwest Energy Efficiency Project

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**AMENDMENT PROPOSAL**

Please use a separate form for each proposal.

1) Code(s) associated with this proposal. Please use acronym: **IECC**

   If you submitted a separate coordination change to another code, please indicate which code: ____________________________

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Code Name</th>
<th>Acronym</th>
<th>Code Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(e.g., DBC-IBC, DBC-IEBC)</td>
<td>IGCC</td>
<td>International Green Construction Code</td>
</tr>
<tr>
<td>IBC</td>
<td>International Building Code</td>
<td>IMC</td>
<td>International Mechanical Code</td>
</tr>
<tr>
<td>IEBC</td>
<td>International Existing Building Code</td>
<td>IPC</td>
<td>International Plumbing Code</td>
</tr>
</tbody>
</table>

2) Please check here if a separate graphic file is provided: □

   *Graphics may also be embedded within your proposal below.*

3) Use this template to submit your proposal or attach a separate file, but please include all items requested below in your proposal. The only formatting needed is **BOLDING, STRIKEOUT, AND UNDERLINING**. Please do not provide additional formatting such as tabs, columns, etc., as this will be done by CPD.

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**Code Sections/Tables/Figures Proposed for Revision:**

C401.2, C407

**Proposal:**

Modify Section C401.2 as follows:

C401.2 Application. Commercial buildings shall comply with one of the following:
1. The requirements of compliance option a. of Section 4.2.11 of ANSI/ASHRAE/IESNA 90.1.

2. The requirements of Sections C402 through C405 and C408. In addition, commercial buildings shall comply with Section C406 and tenant spaces shall comply with Section C406.1.1.

3. The requirements of Sections C402.5, C403.2, C403.3 through C403.4, C403.4 through C403.4.2.3, C403.5.5, C403.7, C403.8.1 through C403.8.4, C403.10.1 through C403.10.3, C403.11, C403.12, C404, C405, C407 and C408. The building energy cost shall be equal to or less than 85 percent of the standard reference design building.

4. The requirements of Sections C402.5.1.2, C408 and C409.

Modify Section C407.4.1 as follows:

C407.4.1 Compliance report. Permit submittals shall include a report documenting that the proposed design has annual energy costs less than or equal to the annual energy costs of the standard reference design. The compliance documentation shall include the following information:

1. Address of the building.
2. An inspection checklist documenting the building component characteristics of the proposed design as specified in Table C407.5.1(1). The inspection checklist shall show the estimated annual energy cost and site Energy Use Intensity in kBtu/sf/yr for both the standard reference design and the proposed design.

Add new Section C409 as follows:

C409.1 Scope. For purposes of complying with this section, buildings shall comply with Sections C402.5.1.2, C408, and the requirements of compliance option c. of Section 4.2.1.1 of ANSI/ASHRAE/IESNA 90.1 as modified by this section.

C409.2 Compliance. Section 4.2.1.1 shall be replaced with the following

4.2.1.1 New Buildings

New buildings shall comply with either the provisions of

a. Section 5, “Building Envelope”; Section 6, “Heating, Ventilating, and Air Conditioning”; Section 7, “Service Water Heating”; Section 8, “Power”; Section 9, “Lighting”; and Section 10, “Other Equipment,” or
b. Section 11, “Energy Cost Budget Method,” or

c. Appendix G, “Performance Rating Method,” using one of the following methods:

1. When using the Energy Cost approach for Appendix G, the Performance Cost Index (PCI) shall be less than or equal to the Performance Cost Index Target (PCIt) when calculated in accordance with the following:

   \[ \text{PCIt} = 0.82 \times \frac{\text{BBUEC} + (\text{BPF} \times \text{BBREC})}{\text{BBP}} \]

   Where
   
   PCI = Performance Cost Index calculated in accordance with Section G1.2.
   
   BBUEC = Baseline Building Unregulated Energy Cost, the portion of the annual energy cost of a Baseline building design that is due to unregulated energy use.
   
   BBREC = Baseline Building Regulated Energy Cost, the portion of the annual energy cost of a Baseline building design that is due to regulated energy use.
   
   BPF = Building Performance Factor from the PCI column of Table 4.2.1.1. For building area types not listed in Table 4.2.1.1 use “All others.” Where a building has multiple building area types, the required BPF shall be equal to the area-weighted average of the building area types.
   
   BBP = Baseline Building Performance.

   Regulated energy cost shall be calculated by multiplying the total energy cost by the ratio of regulated energy use to total energy use for each fuel type. Unregulated energy cost shall be calculated by subtracting regulated energy cost from total energy cost.

2. When using the Energy Source approach for Appendix G, the Source Energy Index (SEI) shall be less than or equal to the Source Energy Index Target (SEIt) when calculated in accordance with the following:

   \[ \text{SEIt} = 0.82 \times \frac{\text{BBUSE} + (\text{BPF} \times \text{BBRSE})}{\text{BBP}} \]

   Where
   
   SEI = Source Energy Index calculated in accordance with Section G1.2.
   
   BBUSE = Baseline Building Unregulated Source Energy, the portion of the annual source energy of a Baseline building design that is due to unregulated energy use multiplied by the site to source conversion ratios.
in Table 4.2.1.2 for each fuel type.

\[ \text{BBRSE} = \text{Baseline Building Regulated Source Energy}, \]  
the portion of the annual source energy of a Baseline building design that is due to regulated energy use multiplied by the site to source conversion ratios in Table 4.2.1.2 for each fuel type.

\[ \text{BPF} = \text{Building Performance Factor from the SEI column of Table 4.2.1.1}. \]  
For building area types not listed in Table 4.2.1.1 use “All others.” Where a building has multiple building area types, the required BPF shall be equal to the area-weighted average of the building area types.

\[ \text{BBP} = \text{Baseline Building Performance}. \]

Regulated source energy shall be calculated by multiplying the total source energy by the ratio of regulated energy use to total energy use for each fuel type. Unregulated source energy shall be calculated by subtracting regulated source energy from total source energy.

### Table 4.2.1.1 Building Performance Factor (BPF)

<table>
<thead>
<tr>
<th>Building Area Type</th>
<th>Performance Rating Method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PCI</td>
</tr>
<tr>
<td>Multifamily</td>
<td>0.8</td>
</tr>
<tr>
<td>Healthcare/hospital</td>
<td>0.52</td>
</tr>
<tr>
<td>Hotel/motel</td>
<td>0.61</td>
</tr>
<tr>
<td>Office</td>
<td>0.61</td>
</tr>
<tr>
<td>Restaurant</td>
<td>0.58</td>
</tr>
<tr>
<td>Retail</td>
<td>0.59</td>
</tr>
<tr>
<td>School</td>
<td>0.5</td>
</tr>
<tr>
<td>Warehouse</td>
<td>0.61</td>
</tr>
<tr>
<td>All others</td>
<td>0.57</td>
</tr>
</tbody>
</table>

### Table 4.2.1.2 Source Energy Conversion Factors

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Conversion Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity (Grid Purchase)</td>
<td>2.80</td>
</tr>
<tr>
<td>Electricity (On-site Renewable Energy Installation)</td>
<td>1.00</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>1.05</td>
</tr>
<tr>
<td>Fuel Oil</td>
<td>1.01</td>
</tr>
<tr>
<td>Propane &amp; Liquid Propane</td>
<td>1.01</td>
</tr>
<tr>
<td>Steam</td>
<td>1.20</td>
</tr>
<tr>
<td>Hot Water</td>
<td>1.20</td>
</tr>
<tr>
<td>Chilled Water, Coal, Wood, Other</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### C409.3 Mandatory Provisions

Section G1.2.1 shall be replaced with the following:

**G1.2.1 Mandatory Provisions**

This performance rating method requires conformance with the following provisions:

a. All requirements of Sections 5.4, 6.4, 7.4, 8.4 except 8.4.2, 9.4, and 10.4, shall be met.

b. The interior lighting power shall not exceed the interior lighting power allowance determined using either Tables G3.7 or G3.8 and the methodology described in Sections 9.5.1 and 9.6.1.

### C409.4 Performance Rating Calculation

Section G1.2.2 shall be replaced with the following:

**G1.2.2 Performance Rating Calculation**

The performance of the proposed design is calculated in accordance with provisions of this appendix using either of the following formula:

\[ \text{Performance Cost Index} = \text{Proposed building performance/Baseline building performance} \]

\[ \text{Source Energy Index} = \text{Proposed building performance/Baseline building performance} \]

Both the proposed building performance and the baseline building performance shall include all end-use load components within and associated with the building when calculating the Performance Cost Index or Source Energy Index.

### C409.5 Documentation Requirements

Documentation requirements f, m, o and q of Section G1.3 shall be replaced with the following:

f. A table with a summary by end use of the energy cost or source energy savings in the proposed building performance.

m. Purchased energy rates or Source Energy Conversion Rates used in the simulations.
o. For any exceptional calculation methods employed, document the predicted energy savings by energy type, the energy cost of source energy savings, a narrative explaining the exceptional calculation method performed, and theoretical or empirical information supporting the accuracy of the method.

q. The site energy, in kbtu/sf/yr, of the proposed design and baseline building design.
**Supporting Information:**

**Purpose:**

The purpose of this proposal is to support the City of Denver’s goals for the Denver Energy Code by:

1. improving the consistency of energy outcomes among modeling compliance paths
2. adding flexibility to the Appendix G modeling path foster electrification
3. calibrating the modeling compliance paths to each other, the prescriptive compliance paths, and Denver’s energy code goals

**Reason:**

This proposal combines all of the modeling elements from P82 and P83 so that modeling can be considered together. The resulting proposal is based on extensive stakeholder engagement with local modelers and building department staff. In addition to general stakeholder meetings in Feb. and Mar. that covered modeled compliance issues, there were also specific stakeholder meetings in July and August dedicated to the issue of modeled compliance as well as additional interim discussions. These stakeholders expressed a series of priorities:

- A desire to limit how much the energy cost basis of Appendix G disincentivizes all-electric buildings.
- A desire to place some limits on the number of compliance paths available as having multiple paths increased the amount of work that they had to do as they evaluated multiple options and even effectively turned them into code consultants on jobs as project owners turned to them to figure out which compliance path to take.
- A desire to retain C407 as a modeling-based compliance path as the modeling community acclimates to major changes made to ASHRAE 90.1 Appendix G and to the implications of longer-term city goals to broaden the use of modeling and to make modeling submittals more consistent.
- A desire to reduce non-modeling differences in requirements that can act as a driver for choosing one modeling path over another, such as the metering and receptacle-switching requirements in ASHRAE 90.1 and the air barrier testing and commissioning requirements from Denver’s amended IECC.

In response to this stakeholder input and the City of Denver’s higher-level goals for the Denver Energy Code, this code makes the following changes:

**ASHRAE 90.1 Chapter 11.** The proposal eliminates Chapter 11 as a modeling option in the Denver code, focusing compliance on Appendix G and C407. It does this by limiting the ASHRAE reference in item 1 to just the prescriptive path and adding a new item for a new Section C409 that is dedicated to Appendix G and its modifications.

**Section C407.** The proposal makes a handful of changes to C407:

- It calibrates the C407 to Denver’s Energy Code goals (see calibration discussion below).
- It adds reporting of the site EUI of the proposed and reference designs to the required submittals. This is meant to inform the City of Denver about the levels of performance being achieved by code compliant building designs and inform future efforts to set performant targets for the energy code. It will also facilitate a greater awareness among design teams for the performance implications of design choices.

**ASHRAE 90.1 Appendix G.** The proposal makes the following changes to Appendix G.

- It calibrates Appendix G to Denver’s Energy Code goals (see calibration discussion below).
- It eliminates the requirement for switched receptacles from the mandatory minimums for Appendix G, and adds the air barrier testing requirements (C402.5.1.2) and commissioning requirements (C408).
- It adds a requirement for reporting site energy to the documentation requirements for the same reasons.
- It adds an additional Building Performance Rating method based on source energy. This method uses the Building Performance Factors developed by PNNL for source energy and includes a table of source energy conversion factors (these are national averages since the source energy conversion factors for XCEL were not available, however these numbers can be updated if better source conversion numbers become available). This method will reduce the disadvantage faced by all-electric designs since source energy does not favor gas as much as the energy cost method does in light of Denver's especially low natural gas prices. Adding this additional method requires minor changes throughout Appendix G to ensure that source energy is referenced appropriately. The approach was developed for the New York State Stretch Energy Code by NBI and PNNL. The places were the modified Appendix G differ from the model standard are highlighted in yellow in this proposal for greater ease of reading.

Because Appendix G cannot be modified directly, a new section C409 was created to locate the changes to Appendix G that would be necessary to accomplish these changes. This keeps the charging language in C401.2 clean and uncluttered.

**Calibrating the Modeling Paths:**

ASHRAE 90.1-2016 and IECC-2018 represent different levels of performance. The graph below compares the relative stringency of these two model codes and trajectory of the City of Denver’s goals for the Denver Energy Code. In order for the next version of the energy code to stay “on the line” to make Denver’s 2035 goal, the IECC and C407 will need to be 22% more efficient than the IECC-2018. ASHRAE Standard 90.1 is more stringent than the IECC, therefore it will require an 18% improvement over Standard 90.1 to meet Denver’s energy...
code goals. The proposal builds these factors into the requirements in order to achieve this level of performance. If the committee decides on a different performance target for the code – such as the performance level of the prescriptive path once all prescriptive proposals have been heard, these factors can be easily adjusted to that modified performance level.

Appendix G: The proposal builds a 0.82 multiplier into the equation in Appendix G that sets the performance target for the proposed design in order to achieve this 18% performance improvement.

IECC Section C407. Section C407 is slightly more complex. C407 already has a multiplier of 0.85 built into the requirements. Therefore an improvement of 22% means adjusting that multiplier to 0.66.

It is important to note that the existing factor is not intended to require additional efficiency from modeled buildings, but to bring more parity to the modeled performance task. The factor was added in 2012 when the additional efficiency options of C406 was added and the code generally made significant improvements in efficiency. The modeling protocol in C407 had not been updated to account for many of these code changes and so would have fallen substantially behind the prescriptive compliance path. This situation has gotten worse in the code cycles since as only the changes to the envelope tables, LPD tables and HVAC tables have made it into Section C407. According to Mike Rosenberg at PNNL, the factor in C407 should be closer to or 0.75 or 0.70. Some of the substantial code improvements in the prescriptive path that are not represented in C407 include:

- Air leakage and continuous air barrier
- Lighting controls including daylighting, occupancy sensors, etc.
- HVAC controls
- There are several constant volume systems in the baseline, but many of those are no longer allowed prescriptively.
- Variable speed drives are not required in the baseline unless except with a fan motor of 25 hp or larger. The prescriptive limit is ¼ hp for hydronic systems and no minimum for dx systems >65,000 Btuh
- Minimum boiler turndown is not specified in the baseline design but is required prescriptively
- Hydronic system controls
- Airside heat recovery.
- Heat recovery for service water heating is required under some circumstances prescriptively
- Base prescriptive window wall ratio is at 30%. C407 sets the base line at 40% WWR

Some of these are mandatory requirements and so are required in the proposed case, but none of them are required in the reference case. We understand that many modelers in Denver include all of the prescriptive requirements in their reference models but the reality is that the code simply does not require this. Unfortunately, there is no easy fix to this problem. C407 would need more than just a reference to these mandatory and prescriptive requirements in the baseline, it would also need requirements for how to model them. This is especially critical for requirements like equipment controls and turndown performance as there could be substantial variability between approaches taken by different modelers and just as substantial differences in outcomes. This has been the subject of much debate at the national level with multiple attempts to simply delete C407 as a lost cause.
**Referenced Standards:**

NA

**Note:** List any new referenced standards that are proposed to be referenced in the code.

**Impact:**

The effect of the proposal on the cost of construction: ☒ Increase ☐ Reduce ☐ No Effect
- The proposal would require improved performance from the rest of the wall thermal envelope which would increase cost of wall construction.

The effect of the proposal on the cost of design: ☒ Increase ☐ Reduce ☐ No Effect
- There may be a minor increase in the cost of design for projects that are not already doing the UA approach.

Is the proposal more or less restrictive than the I-codes: ☒ More ☐ Less ☐ Same
- This is a loophole in the IECC that this proposal closes.

**Departmental Impact:** (To be filled out by CPD staff)

**Note:** CITY STAFF ONLY. Discuss the impact of this proposal in this section AND indicate the impact of this amendment proposal for each of the following:

- The effect of the proposal on the cost of review: ☐ Increase ☐ Reduce ☐ No Effect
- The effect of the proposal on the cost of enforcement/inspection: ☐ Increase ☐ Reduce ☐ No Effect