2012 IECC Commercial: Overview and Changes

April 2014
Presented by Dave Houser P.E.
Dale Horton, Architect
National Center for Appropriate Technology
- International Building Code
- International Mechanical Code
- International Fuel Gas Code
- International Property Maintenance Code
- International Fire Code
- International Zoning Code
- International Plumbing Code
- International Existing Building Code
- International Private Sewage Disposal Code
- International Performance Code
- International Residential Code
- **International Energy Conservation Code**
- International Wildlife-Urban Interface Code
“...shall regulate the design and construction of buildings for the effective use and conservation of energy over the life of each building.”
## Organization of 2012 IECC

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Commercial Section</th>
<th>Residential Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Scope and Administration</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Definitions</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>General Requirements</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td><strong>Commercial Energy Efficiency</strong></td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Referenced Standards</td>
<td>5</td>
</tr>
</tbody>
</table>
Does My Project Need to Comply with Commercial or Residential Provisions?
Residential Building Definition

- Detached one and two family dwellings and
- Multiple single family dwellings (townhouses) and
- Group R-2, R-3, R-4 \( \leq 3 \) stories in height

All other buildings must use the Commercial Provisions
IECC Residential Provisions Applicability

**R-1:** Transient uses. (hotels, motels, boarding houses)

**R-2:** Occupants primarily permanent. (apartments, dormitories, fraternities and sororities, convents, monasteries)

**R-3:** Catchall. (single detached houses and duplexes
Adult facilities and child care facilities that provide accommodation for <= 5 occupants

**R-4:** Residential care/assisted living facilities 6-15 occupants
Definitions

Commercial Building Definition

“Not Residential”

Source: Going Beyond Code USDOE Building Energy Codes Program
### 2012 IECC Commercial - Major Changes

<table>
<thead>
<tr>
<th>Envelope</th>
<th>Thermal Envelope Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Window Wall Ratio (40% to 30%)</td>
</tr>
<tr>
<td></td>
<td>Redefined Fenestration Categories</td>
</tr>
<tr>
<td></td>
<td>Air Barriers and Sealing</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Automatic Start Capabilities</td>
</tr>
<tr>
<td></td>
<td>Demand Controlled Ventilation</td>
</tr>
<tr>
<td></td>
<td>Energy Recovery Ventilation Systems</td>
</tr>
<tr>
<td></td>
<td>Economizers</td>
</tr>
<tr>
<td>Lighting</td>
<td>Space by Space LPD</td>
</tr>
<tr>
<td></td>
<td>Modified Controls Requirements</td>
</tr>
<tr>
<td></td>
<td>(Daylight Zones, Specific Applications)</td>
</tr>
<tr>
<td></td>
<td>Additional Efficiency Package Options</td>
</tr>
<tr>
<td></td>
<td>Commissioning</td>
</tr>
</tbody>
</table>
2012 IECC Compliance: Choose a Path

IECC

Mandatory Provisions

- Prescriptive
  - Building Envelope
  - Mechanical
  - Lighting
  - Service Hot Water
  - Additional Efficiency Packages
  - Total Building Performance <= 85% of standard reference building

ASHRAE 90.1

Mandatory Provisions

- Envelope Prescriptive Path
- Envelope Tradeoff Option
- Energy Cost Budget

- Mechanical
- Lighting
- Service Hot Water
- Power
- Other Equipment

Source: NCAT
Proposed building must have an annual cost less than the standard reference design. \textit{C407}

The building energy cost must be \( \leq 85\% \) of the standard reference design. \textit{C401.2}

- \textit{C402.4} – Air Leakage
- \textit{C403.2} - Mandatory General Mech Provisions
- \textit{C404} - All Service Water Heating Provisions
- \textit{C405.2} – Lighting Controls
- \textit{C405.3} – Tandem Wiring
- \textit{C405.4} – Exit Signs
- \textit{C405.6} - Exterior Building Lighting Controls
- \textit{C405.7} – Residential Separate Electric Metering
This code applies to **commercial buildings** and the buildings sites and associated systems and equipment.

**BUILDING SITE.** A contiguous area of land that is under the ownership or control of one entity.
Compliance through Prescriptive Path or ASHRAE90.1

C101.4.1  Not Retroactive

C101.4.2  Historic Buildings Exempt

C101.4.3  Additions, alterations & repairs to existing buildings
     “Whatever is new has to comply.”

C101.4.4  Change in occupancy
     Triggers full code compliance in Space.

C101.4.5  Change in Space Conditioning.
     Nonconditioned to conditioned - full compliance.

C101.4.6  Mixed occupancy.
     Both *residential* and *commercial* occupancies, each separately considered
C101.4.6 Mixed occupancy.
Both residential and commercial occupancies, each separately considered.
C101.4.3 Additions, alterations & repairs to existing buildings
“Whatever is new has to comply.”

Exceptions:
1. Storm window installation.
2. Glass only replacements.
3. If exposed cavities are filled with insulation.
4. If roof, wall or floor cavity is not exposed.
5. If reroofing (typically insulated adjacent to roof deck) can be required to install insulation to code.
6. Replacement of existing doors, new vestibule not required.
7. If < 50% luminaires in space replaced, no greater LPD.
8. Bulb/ballast replacement, no greater LPD.
Determining Your Climate Zone is the First Step in the Process
### TABLE C402.2 OPAQUE THERMAL ENVELOPE REQUIREMENTS

<table>
<thead>
<tr>
<th></th>
<th>2012 IECC</th>
<th></th>
<th>2009 IECC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Climate Zone 6</td>
<td></td>
<td>Climate Zone 6</td>
</tr>
<tr>
<td></td>
<td>All Other</td>
<td>Group R</td>
<td>All Other</td>
</tr>
<tr>
<td><strong>Roofs</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Insulation entirely above deck</td>
<td>R-30ci</td>
<td>R-30ci</td>
<td>R-20ci</td>
</tr>
<tr>
<td>Metal buildings (with R-5 thermal blocks)a, b</td>
<td>R-25 + R-11 LS</td>
<td>R-25 + R-11 LS</td>
<td>R-13 + R-19</td>
</tr>
<tr>
<td>Attic and other</td>
<td>R-49</td>
<td>R-49</td>
<td>R-49</td>
</tr>
<tr>
<td><strong>Walls, Above Grade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metal building</td>
<td>R-13 + R-13ci</td>
<td>R-13 + R-13ci</td>
<td>R-13 + R-5.6ci</td>
</tr>
<tr>
<td>Metal framed</td>
<td>R-13 + R-7.5ci</td>
<td>R-13 + R-7.5ci</td>
<td>R-13 + R-7.5ci</td>
</tr>
<tr>
<td>Wood framed and other</td>
<td>R-13 + R-7.5ci, or R-20 + R-3.8ci</td>
<td>R-13 + R-7.5ci, or R-20 + R-3.8ci</td>
<td>R-13 + R-7.5ci, or R-21</td>
</tr>
<tr>
<td><strong>Walls, Below Grade</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below-grade walld</td>
<td>R-7.5ci</td>
<td>R-7.5ci</td>
<td>R-7.5ci</td>
</tr>
<tr>
<td><strong>Floors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass</td>
<td>R-12.5ci</td>
<td>R-12.5ci</td>
<td>R-12.5ci</td>
</tr>
<tr>
<td>Joist/framing</td>
<td>R-30</td>
<td>R-30</td>
<td>R-30</td>
</tr>
<tr>
<td><strong>Slab-on-Grade Floors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unheated slabs</td>
<td>R-10 for 24 below</td>
<td>R-15 for 24 below</td>
<td>R-10 for 24 below</td>
</tr>
<tr>
<td>Heated slabsd</td>
<td>R-15 for 36 below</td>
<td>R-20 for 48 below</td>
<td>R-15 for 24 below</td>
</tr>
<tr>
<td><strong>Opaque Doors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swinging</td>
<td>U-0.37</td>
<td>U-0.37</td>
<td>U-0.7</td>
</tr>
<tr>
<td>Roll-up or sliding</td>
<td>R-4.75</td>
<td>R-4.75</td>
<td>U-0.5</td>
</tr>
</tbody>
</table>

*Source: NCAT*
C202 Definition: > 50% above grade.

C402.2.2.1: > 15% above grade.

*The more stringent definition of 85/15 would apply.*
Radiant Panels to be insulated with R-3.5

<table>
<thead>
<tr>
<th>Radiant Panel for Sensible Heating of Indoor Space</th>
<th>Must Comply with U and R-Value Tables</th>
<th>Must Comply with R-3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slab in contact with ground $\leq 24''$ Below Grade</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Slab in contact with ground $&gt;24''$ Below Grade</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Slab not in contact with ground</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Not a slab</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Source: NCAT
### TABLE C402.3 BUILDING ENVELOPE REQUIREMENTS: FENESTRATION

<table>
<thead>
<tr>
<th>2012 Categories</th>
<th>Climate Zone 6</th>
<th>2009 Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vertical fenestration</strong></td>
<td>2012 IECC</td>
<td>2009 IECC</td>
</tr>
<tr>
<td>Fixed fenestration</td>
<td>0.36</td>
<td></td>
</tr>
<tr>
<td>Operable fenestration</td>
<td>0.43</td>
<td></td>
</tr>
</tbody>
</table>

**U factor**

<table>
<thead>
<tr>
<th></th>
<th>2012 IECC</th>
<th>2009 IECC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed fenestration</td>
<td>0.35</td>
<td>Non-Metal Frame</td>
</tr>
<tr>
<td>Operable fenestration</td>
<td>0.45</td>
<td>Metal Frame Curtain</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wall/Storefront</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Metal Frame - All Other</td>
</tr>
</tbody>
</table>

**Entrance doors**

<table>
<thead>
<tr>
<th></th>
<th>2012 IECC</th>
<th>2009 IECC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skylights</td>
<td>0.40</td>
<td>0.40</td>
</tr>
</tbody>
</table>

**SHGC**

<table>
<thead>
<tr>
<th></th>
<th>2012 IECC</th>
<th>2009 IECC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.40</td>
<td>0.40</td>
</tr>
</tbody>
</table>

Source: NCAT
Maximum Vertical Fenestration Area C402.3.1

Percentage of Vertical Fenestration Area to Gross Wall Area

Allows up to 30% maximum of above grade wall

In Climate Zones 1-6, up to 40% maximum of above grade wall with automatic daylighting controls
Vertical Fenestration Requirement \textit{C402.3.1}

Based on above-grade wall area (\textit{gross})

- Includes walls between conditioned space and unconditioned space or outdoors.
- Includes walls that are $> 15\%$ above grade.

Total fenestration area (\textit{includes frame and glazing}) but not opaque door area
Skylight Minimum Fenestration Area \textit{C402.3.1}

Limited to $\leq 3\%$ of Roof Area

Up to 5\% allowed if automatic daylighting controls installed in daylight zones under skylights
Up to 40% vertical fenestration area allowed in Climate Zones 1-6, provided

No less than 50% of the conditioned floor area is within a daylight zone

Automatic daylighting controls are installed in daylight zones; and

VT of vertical fenestration is $\geq 1.1$ times SHGC

**Exception:**

Fenestration that is outside the scope of NFRC 200 isn’t required to comply with VT
Haze Factor C402.3.2.2

- Skylights in certain space types to have a glazing material or diffuser with a measured haze factor > 90% per ASTM D 1003
  - Office, storage, automotive service, manufacturing, nonrefrigerated warehouse, retail store, and distribution/sorting area

- **Exception**
  - Skylights designed to exclude direct sunlight entering the occupied space by use of fixed or automated baffles, or the geometry of skylight and light well
Fenestration U-Factor 303.1.3

How Do You Meet the Requirement?

Fenestration product rating in accordance to NFRC 100

Labeled and certified by the manufacturer

Non-NFRC 100 rated fenestration

Default Glazed Fenestration U-factor Table C303.1.3(1)
# Default Glazed Fenestration U-Factor

## Table 102.1.3(1)
### Default Glazed Fenestration U-Factor

<table>
<thead>
<tr>
<th>Frame Type</th>
<th>Single Pane</th>
<th>Double Pane</th>
<th>Skylight Single</th>
<th>Skylight Double</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td>1.20</td>
<td>0.80</td>
<td>2.00</td>
<td>1.30</td>
</tr>
<tr>
<td>Metal with Thermal Break</td>
<td>1.10</td>
<td>0.65</td>
<td>1.90</td>
<td>1.10</td>
</tr>
<tr>
<td>Nonmetal or Metal Clad</td>
<td>0.95</td>
<td>0.55</td>
<td>1.75</td>
<td>1.05</td>
</tr>
<tr>
<td>Glazed Block</td>
<td></td>
<td>0.60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Table 102.1.3(2)
### Default Door U-Factors

<table>
<thead>
<tr>
<th>Door Type</th>
<th>U-Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninsulated Metal</td>
<td>1.20</td>
</tr>
<tr>
<td>Insulated Metal</td>
<td>0.60</td>
</tr>
<tr>
<td>Wood</td>
<td>0.50</td>
</tr>
<tr>
<td>Insulated, nonmetal edge, max 45% glazing, any glazing double pane</td>
<td>0.35</td>
</tr>
</tbody>
</table>
Two Options for Meeting the SHGC and VT Requirements

Fenestration product rated and labeled to NFRC 200, or

<table>
<thead>
<tr>
<th></th>
<th>Single Glazed</th>
<th>Double Glazed</th>
<th>Glazed Block</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Clear</td>
<td>Tinted</td>
<td>Clear</td>
</tr>
<tr>
<td>SHGC</td>
<td>0.8</td>
<td>0.7</td>
<td>0.7</td>
</tr>
<tr>
<td>VT</td>
<td>0.6</td>
<td>0.3</td>
<td>0.6</td>
</tr>
</tbody>
</table>
The Effect of Overhangs on Fenestration SHGC

Overhangs allow a higher SHGC product to be installed

Projection factor must be calculated

When different windows or glass doors have different PFs Evaluate separately
When PF ≥ 0.2, the required maximum SHGC in must be adjusted by multiplying the required maximum SHGC by the multiplier in Table C402.3.3.1.

<table>
<thead>
<tr>
<th>PROJECTION FACTOR</th>
<th>ORIENTED WITHIN 45 DEGREES OF TRUE NORTH</th>
<th>ALL OTHER ORIENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 ≤ PF &lt; 0.5</td>
<td>1.1</td>
<td>1.2</td>
</tr>
<tr>
<td>PF ≤ 0.5</td>
<td>1.2</td>
<td>1.6</td>
</tr>
</tbody>
</table>
Increased Skylight SHGC C402.3.3.3

In Climate Zones 1-6, skylights above daylight zones with automated daylight controls are permitted a maximum SHGC of 0.60.
Skylights above daylight zones with automated daylight controls are permitted a maximum U-factor of

- 0.9 in Climate Zones 1-3
- 0.75 in Climate Zones 4-8
Dynamic Glazing C402.3.3.5

SHGC determined using manufacturer’s lowest-rated SHGC

VT/SHGC ratio determined using maximum VT and maximum SHGC

Considered separately from other fenestration

Area-weighted averaging isn’t allowed
Area-Weighted U-Factor C402.3.4

Allowed to meet requirements in Table C402.3

Can’t combine products from different categories when calculating the area-weighted average U-factor
Mandatory Requirements

- Air barriers
- Fenestration air leakage
- Air intakes, exhaust openings, stairways and shafts
- Loading dock weatherseals
- Vestibules
- Recessed lighting
Continuous air barrier required except in Climate Zones 1-3

Air barrier requirements:

• Placement allowed
  – Inside of building envelope
  – Outside of building envelope
  – Located within assemblies composing envelope OR
  – Any combination thereof

• Continuous for all assemblies part of the thermal envelope and across joints and assemblies

• Joints and seams to be sealed per C402.4.2

• Recessed lighting to comply with C404.2.8

• Where similar objects are installed that penetrate the air barrier, make provisions to maintain the air barrier’s integrity
Air Barrier Compliance

Paths

Materials

Assemblies

Building Testing
Air Barrier Materials \( C402.4.1.2.1 \)

Materials with air permeance \( \leq 0.004 \text{ cfm/ft}^2 \) under pressure differential of 0.3 in. w.g. tested in accordance with ASTM E 2178

**C402.4.1.2.1 Materials Deemed to Comply as Air Barrier**

<table>
<thead>
<tr>
<th></th>
<th>Material Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3/8 inch plywood</td>
</tr>
<tr>
<td>2</td>
<td>3/8 inch oriented strand board</td>
</tr>
<tr>
<td>3</td>
<td>1/2 inch extruded polystyrene insulation board</td>
</tr>
<tr>
<td>4</td>
<td>1/2 inch foil-back polyisocyanurate insulation board</td>
</tr>
<tr>
<td>5</td>
<td>1 1/2 inch 1.5 pcf closed cell spray foam</td>
</tr>
<tr>
<td>6</td>
<td>4.5 inch (0.4 and 1.5 pcf) open cell spray foam</td>
</tr>
<tr>
<td>7</td>
<td>1/2 inch exterior or interior gypsum board</td>
</tr>
<tr>
<td>8</td>
<td>1/2 inch cement board</td>
</tr>
<tr>
<td>9</td>
<td>Built up roofing membrane</td>
</tr>
<tr>
<td>10</td>
<td>Modified bituminous roof membrane</td>
</tr>
<tr>
<td>11</td>
<td>Fully adhered single-ply roof membrane</td>
</tr>
<tr>
<td>12</td>
<td>5/8 inch Portland cement/sand parge, or gypsum plaster</td>
</tr>
<tr>
<td>13</td>
<td>Cast-in-place and precast concrete.</td>
</tr>
<tr>
<td>14</td>
<td>Fully grouted concrete block masonry.</td>
</tr>
<tr>
<td>15</td>
<td>Sheet steel or aluminum.</td>
</tr>
</tbody>
</table>
Assemblies of materials and components (sealants, tapes, etc.) with average air leakage ≤ 0.04 cfm/ft² at 0.3 in. w.g.

These assemblies meet this requirement:

• Concrete masonry walls coated with one application either of block filler and two applications of a paint or sealer coating OR
• Portland cement/sand parging, stucco or plaster minimum ½ thick
Air leakage rate of completed building tested and confirmed to not exceed 0.40 cfm/ft\(^2\) at a pressure differential of 0.3 inches water (75 Pa).
Air Barrier Penetrations C402.4.2

- **Penetrations of air barrier and air leakage paths to be caulked, gasketed, or otherwise sealed**

- **Joints and seals**
  - Sealed in same manner or taped or covered with a moisture vapor-permeable wrapping material
  - Securely installed in or on the joint for the entire length
    - To resist positive and negative pressure from wind, stack effect and mechanical ventilation
  - Sealing materials appropriate to construction materials
## Air Leakage of Fenestration  C402.4.3

<table>
<thead>
<tr>
<th>Fenestration Assembly</th>
<th>cfm/ft²</th>
<th>Test Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows, sliding glass doors, and swinging doors</td>
<td>0.20</td>
<td>AAMA/WDMA/CSA 101/I.S.2/A440 or NFRC 400</td>
</tr>
<tr>
<td>Skylights - with condensation weepage openings</td>
<td>0.30</td>
<td></td>
</tr>
<tr>
<td>Skylights – all other</td>
<td>0.20</td>
<td></td>
</tr>
<tr>
<td>Curtain walls and storefront glazing</td>
<td>0.06</td>
<td>NFRC 400 or ASTM E283 at 1.57 psf</td>
</tr>
<tr>
<td>Commercial glazed swinging entrance doors</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Revolving doors</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Garage doors</td>
<td>0.4</td>
<td>ANSI/DASMA 105, NFRC 400, or ASTM E283 at 1.57 psf</td>
</tr>
<tr>
<td>Rolling doors</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

### Exceptions
- Field-fabricated fenestration assemblies
- Fenestration in buildings that meet the building test for air barrier compliance option
Mandatory Requirements C402.4.5.1
Stairway and Shaft Vents

• To have Class I motorized dampers with maximum leakage rate of 4 cfm/ft$^2$ at 1.0 inch water gauge

• Dampers to be installed with controls to be able to open automatically upon
  – Activation of any fire alarm initiating device of building’s fire alarm system or
  – Interruption of power to the damper
Mandatory Requirements C402.4.5.2
Outdoor Air Intakes and Excerts

Buildings ≥ 3 stories in height above grade

Class IA motorized leakage-rated damper

- Maximum leakage rate ≤ 4 cfm/ft² @ 1.0 inch w.g.

Buildings < 3 stories in height

- Gravity (nonmotorized) with maximum leakage rate of 20 cfm/ft² at 1.0 inch water gauge allowed
- For exhaust and relief dampers
- For ventilation air intakes and exhaust and relief dampers in buildings of any height in CZ 1-3
- Where design outdoor air intake or exhaust capacity is < 300 cfm
- Dampers < 24 inches in either dimension may have a leakage of 40 cfm/ft² at 1.0 inch water gauge
Mandatory Requirements C402.4.6
Loading Dock Weatherseals

Equip cargo doors and loading dock doors with weatherseals

Goal is to restrict infiltration
Mandatory Requirements C402.4.7
Vestibules

Required to reduce infiltration into spaces

Required on entrance doors leading into spaces ≥ 3,000 ft²

Doors must have self-closing devices

Exceptions

- Buildings in Climate Zones 1 and 2
- Doors from a sleeping unit or dwelling unit
- Revolving doors
- Doors not intended for public use or intended solely for employee use
Mandatory Requirements  C402.4.8
Recessed Lighting

All recessed luminaires installed in the building envelope

Type IC rated and sealed with gasket or caulk between housing and interior wall or ceiling covering

Type IC rated and labeled in accordance with ASTM E 283 to allow ≤ 2.0 cfm of air movement between conditioned and unconditioned spaces
Commercial Mechanical
Mandatory Provisions C403.2

Provisions Applicable to ALL Mechanical Systems

- HVAC Load Calculations
- Equipment and System Sizing
- HVAC Equipment Performance
- HVAC System Controls
- Ventilation
- Energy Recovery Ventilation Systems
- Duct and Plenum Insulation and Sealing
- Piping Insulation
- HVAC System Commissioning and Completion
- Air System Design and Control
- Heating Outside a Building
Heating and cooling load sizing calculations required

ASHRAE/ACCA Standard 183

Other approved computation procedures – defined in Chapter 3

Interior design conditions

Specified by Section C302 of the IECC

≤ 72°F for heating load

≥ 75°F for cooling load
Output capacity SHALL NOT exceed sizing
Select the system which serves the greater load, heating or cooling

Exceptions
- Standby Equipment with Required Controls
- Multiple Units with Combined Capacities Exceeding Loads
  Sequencing Controls Required
Applies to all equipment used in heating and cooling of buildings

Where components from different manufacturers are used

calculations & supporting data demonstrating combined efficiency meets requirements

Must comply with all listed efficiencies
Table C403.2.3(1) Significant Changes

- New Cooling Rating for Small-Duct High-Velocity Heat Pumps (air-cooled) – 10.0 SEER
- Added New Ratings for IEER Values

**Integrated Energy Efficiency Ratio (IEER)**

\[ \text{IEER} = (0.020 \cdot A) + (0.617 \cdot B) + (0.238 \cdot C) + (0.125 \cdot D) \]

Where:
- \( A \) = EER at 100% net capacity at AHRI Standard Rating Conditions
- \( B \) = EER at 75% net capacity and reduced air entering outdoor unit conditions
- \( C \) = EER at 50% net capacity and reduced air entering outdoor unit conditions
- \( D \) = EER at 25% net capacity and reduced air entering outdoor unit conditions

- New Ratings for Water-Cooled Air Conditioners Larger than 240,000 BTUH
- New Ratings for Evaporatively-Cooled Air Conditioners Larger than 240,000 BTUH and Higher Ratings for Smaller Units
- New Categories and Ratings for Condensing Units

**INTEGRATED PART LOAD VALUE (IPLV).** A single-number figure of merit based on part-load EER, COP, or kW/ton expressing part-load efficiency for air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for equipment.
Table C403.2.3(2) & (3) Significant Changes

Table C403.2.3(2) Significant Changes

- Added IEER Values
- Higher SEER Ratings for Through-the-Wall Units
- New Heating Rating for Small-Duct High-Velocity Heat Pumps (air-cooled) – 6.8 HSPF
- Replaced HSPF Factor for Heat Pumps in Heating Mode with COP Values
- Added New Categories for Water Source (water to water) and Ground Source (brine to water) Heat Pumps

Table C403.2.3(3) Significant Changes

- Higher EER Values for PTAC and PTHP Units
- Added New Categories and Ratings for SPVAC and SPVHP Units
- Added Categories and Ratings for Room Air Conditioners
###TABLE C403.2.3(2)  MINIMUM EFFICIENCY REQUIREMENTS: ELECTRICALLY OPERATED UNITARY AND APPLIED HEAT PUMPS (Partial)

<table>
<thead>
<tr>
<th>EQUIPMENT TYPE</th>
<th>SIZE CATEGORY</th>
<th>HEATING SECTION TYPE</th>
<th>SUBCATEGORY OR RATING CONDITION</th>
<th>MINIMUM EFFICIENCY</th>
<th>TEST PROCEDURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air cooled (cooling mode)</td>
<td>&lt; 65,000 Btu/h</td>
<td>All</td>
<td>Split system</td>
<td>13.0 SEER</td>
<td>AHRI 210/240</td>
</tr>
<tr>
<td></td>
<td>≤ 30,000 Btu/h</td>
<td>All</td>
<td>Single packaged</td>
<td>13.0 SEER</td>
<td></td>
</tr>
<tr>
<td>Single-duct high-velocity air cooled</td>
<td>&lt; 65,000 Btu/h</td>
<td>All</td>
<td>Split system</td>
<td>10.0 SEER</td>
<td></td>
</tr>
</tbody>
</table>

Source: NCAT
Modifications to Efficiency Tables

- New Equations for Adjusting Ratings of Water Cooled Chillers at Non-Standard Conditions Modified
- New Column Added to Identify Heating Section Type
- Some New Equipment Types have been Added
- Several Efficiency Requirements have Increased
- Two new Tables have been Added to Address Heat Rejection and Heat Transfer Equipment
- New set of Tables with Higher Efficiency Requirements in Section 406.2, Optional Compliance Path
Modifications to HVAC Controls

- Optimal Start Controls Required on all HVAC Systems
- Occupancy Density Threshold for Mandatory Demand Controlled Ventilation Requirements Lowered Significantly
- Threshold for Mandatory Energy Recovery Ventilation Lowered Significantly
- Threshold Requirements for Mandatory Economizers has been Significantly Reduced
- Variable Speed Controlled on Fans Greater Than or Equal to 7.5 hp
Automatic Start Capabilities C403.2.4.3.3 Mandatory

Automatic start controls for each HVAC system

Capable of automatically adjusting daily start time to bring each space to desired occupied temperature immediately prior to scheduled occupancy
DCV must be provided for each zone with spaces > 500 ft² and the average occupant load > 25 people/1000 ft² of floor area where the HVAC system has:

- An air-side economizer, or
- Automatic modulating control of the outdoor air damper, or
- A design outdoor airflow > 3,000 cfm

**Demand control ventilation (DCV):** A ventilation system capability that provides for the automatic reduction of outdoor air intake below design rates when the actual occupancy of spaces served by the system is less than design occupancy.
Exceptions:

- Systems with energy recovery per C403.2.6
- Multiple zone systems without direct digital control of single zones communicating with central control panel
- Systems with design outdoor airflow < 1,200 cfm
- Spaces where supply airflow rate minus any makeup or outgoing transfer air requirement < 1,200 cfm
- Ventilation provided for process loads only
Energy Recovery Ventilation Systems C403.2.6

- Applies to fan systems with supply airflow rates > values in Table C403.2.6
- Exhaust air recovery efficiency must be ≥ 50%
- When an air economizer is required
  include a bypass or controls that permit operation of economizer per C403.4

Energy recovery ventilation (ERV) systems: employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of preheating, precooling, humidifying or dehumidifying outdoor ventilation air prior to supplying the air to a space, either directly or as part of an HVAC system.
## Table C403.2.6 For Climate Zone Six - Energy Recovery Requirement

<table>
<thead>
<tr>
<th>% Outside Air at Full Design Airflow Rate</th>
<th>Design Supply Fan Airflow Rate (cfm) Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>30% - 39%</td>
<td>Climate Zone Six (B)</td>
</tr>
<tr>
<td>40% - 49%</td>
<td>11,000</td>
</tr>
<tr>
<td>50% - 59%</td>
<td>5,500</td>
</tr>
<tr>
<td>60% - 69%</td>
<td>4,500</td>
</tr>
<tr>
<td>70% - 79%</td>
<td>3,500</td>
</tr>
<tr>
<td>80% - 100%</td>
<td>2,500</td>
</tr>
<tr>
<td>80% - 100%</td>
<td>1,500</td>
</tr>
</tbody>
</table>
Energy Recovery Ventilation Systems C403.2.6

Mandatory

Exceptions:

- Where prohibited by the IMC
- Lab fume hood system with at least one of the following:
  - VAV hood exhaust and room supply systems capable of reducing exhaust and makeup air volume to $\leq 50\%$ of design values
  - Direct makeup (auxiliary) air supply equal to at least $75\%$ of exhaust rate, plus a number of other specific conditions
- Systems serving uncooled spaces & heated to $< 60^\circ$F
- Where $> 60\%$ of outdoor heating energy is from site-recovered or site solar energy
- Cooling energy recovery
- Systems requiring dehumidification that employ energy recovery in series with the cooling coil
- Where largest source of air exhausted at a single location at building exterior is $< 75\%$ of design outside air flow rate
# Energy Recovery Ventilation Systems C403.2.6

Mandatory

## TABLE C403.2.6 ENERGY RECOVERY REQUIREMENT

<table>
<thead>
<tr>
<th>PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE</th>
<th>DESIGN SUPPLY FAN AIRFLOW RATE (cfm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 30% and &lt; 40%</td>
<td>≥ 11000</td>
</tr>
<tr>
<td>≥ 40% and &lt; 50%</td>
<td>≥ 5500</td>
</tr>
<tr>
<td>≥ 50% and &lt; 60%</td>
<td>≥ 4500</td>
</tr>
<tr>
<td>≥ 60% and &lt; 70%</td>
<td>≥ 3500</td>
</tr>
<tr>
<td>≥ 70% and &lt; 80%</td>
<td>≥ 2500</td>
</tr>
<tr>
<td>≥ 80%</td>
<td>≥ 1500</td>
</tr>
</tbody>
</table>

Source: NCAT
Compliance for Simple HVAC Systems and Equipment

Use Section C403.3?

Newly Purchased Equipment?

Yes

Single-zone, Unitary HVAC System?

Yes

Yes, Use Section C403.3

No

Must Use C403.4

Source: NCAT
The total capacity of all systems without economizers shall not exceed 300,000 Btu/h per building, or 20 percent of its air economizer capacity, whichever is greater.

### Table C403.3.1(1)

<table>
<thead>
<tr>
<th>Claimate Zone 6</th>
<th>Economizers on all cooling systems ≥ 33,000 Btu/h&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
</table>

<sup>a</sup> The total capacity of all systems without economizers shall not exceed 300,000 Btu/h per building, or 20 percent of its air economizer capacity, whichever is greater.

Source: NCAT
Economizers

C403.3.1 Exceptions

Exceptions (economizers not required)

- Individual fan-cooling units with supply capacity < Table C403.3.1(1)
- Where > 25% of air designed to be supplied by the system is to spaces that are designed to be humidified > 35°F dew-point temperature to satisfy process needs
- Systems that serve residential spaces where system capacity is < 5 times requirement in Table C403.3.1(1)
- Systems expected to operate < 20 hours/week
- Where use of outdoor air for cooling will affect supermarket open refrigerated casework systems
- Where cooling efficiency meets or exceeds efficiency requirements in Table C403.3.1(2)
Capable of modulating outdoor air and return air dampers to provide up to 100% of design supply air quantity as outdoor air for cooling.
Economizer dampers to be capable of being sequenced with mechanical cooling equipment and not be controlled by only mixed air temperature

**Exception:**
Can use mixed air temperature limit control for systems controlled from space temperature

Example: single-zone systems
Air Economizers

- Air economizers to be capable of automatically reducing outdoor air intake to design minimum outdoor air quantity when outdoor air intake will no longer reduce cooling energy usage.

- High-limit shutoff control types to be chosen from Table C403.3.1.1.3(1) for specific climates.

<table>
<thead>
<tr>
<th>CLIMATE ZONES</th>
<th>ALLOWED CONTROL TYPES</th>
<th>PROHIBITED CONTROL TYPES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate Zone 6B</td>
<td>Fixed dry bulb</td>
<td>Fixed enthalpy</td>
</tr>
<tr>
<td></td>
<td>Differential dry bulb</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electronic enthalpy(^a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Differential enthalpy</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dew-point and dry-bulb temperatures</td>
<td></td>
</tr>
</tbody>
</table>

- Specifications for high-limit shutoff control type settings per Table C403.3.1.1.3(2)
Air Economizers C403.3.1.1.4 Relief of Excess Outdoor Air

- Systems to be capable of relieving excess outdoor air during air economizer operation to prevent over-pressurizing the building
- Relief air outlet to be located to avoid recirculation into the building
Hydronic System Controls C403.3.2

Hydronic systems ≥ 300,000 Btu/h design output capacity supplying heated and chilled water for comfort conditioning to have controls meeting C403.4.3

- Avoid Reheating and Recooling
- Three pipe Systems with Common Return Line Prohibited
- Two Pipe Changeover Systems 15 Degree Deadband
- Cooling Tower Bypass
- Part Load Controls
Water economizer systems
Capable of providing 100% of the cooling system load at 50°F dry bulb/45°F wet bulb and below

Exception:
Water economizer systems where dehumidification requirements can’t be met at 50°F dry bulb/45°F wet bulb
Satisfy 100% of expected cooling load at 45°F dry bulb/40°F wet bulb
Precooling coils and water-to-water heat exchangers in water economizer systems to have either a

- Waterside pressure drop of < 15 ft of water OR
- Secondary loop created so coil or heat exchanger drop isn’t seen by circulating pumps when system is in normal cooling mode
Economizers

- Integrated with mechanical cooling system
- Capable of providing partial cooling even when additional mechanical cooling is required to meet remainder of cooling load

Exceptions:
Direct expansion systems with controls that reduce quantity of outdoor air

- required to prevent coil frosting at lowest step of compressor unloading
- provided this lowest step is ≤ 25% of total system capacity

Individual direct expansion units with rated cooling capacity < 54,000 Btu/h and using nonintegrated economizer controls that preclude simultaneous operation of the economizer and mechanical cooling
Economizer operation to not increase building heating energy use during normal operation

**Exception:**
Economizers on VAV systems that cause zone level heating to increase due to a reduction in supply air temperature
Individual VAV fans with motors $\geq 7.5$hp must be:

- Driven by a mechanical or electrical variable speed drive OR
- Driven by a vane-axial fan with variable-pitch blades OR
- Have controls or devices to result in fan motor demand $\leq 30\%$ of their design wattage at $50\%$ of design airflow
Sensors used to control VAV fans
Placed so that the controller setpoint is \( \leq \frac{1}{3} \) the total design fan static pressure

Exception: systems with zone reset control complying with C403.4.2.2

Sensors installed downstream of major duct splits
At least one sensor to be located on each major branch so that static pressure can be maintained in each branch
Systems with direct digital control of individual zone boxes reporting to the central control panel

Static pressure reset point to be reset based on the zone requiring the most pressure (i.e., the set point is reset lower until one zone damper is nearly wide open)
Mechanical Commissioning
Prior to passing final mechanical inspection
Registered design profession to provide evidence of commissioning and completion

Construction document notes to clearly indicate provisions for commissioning and completion requirements
Permitted to refer to specifications

Copies of all documents to be provided to the owner and made available to code official upon request
These systems are exempt from commissioning requirements

- In buildings where total mechanical equipment capacity is < 480,000 Btu/h cooling capacity and 600,000 Btu/h heating capacity
- Included in Section C403.3 (Simple Systems) that serve dwelling units and sleeping units in hotels, motels, boarding houses or similar units
Developed by registered design professional or agency and include:

- Narrative description of activities to be accomplished during each phase of commissioning
  - Including personnel who will do each activity
- Listing of specific equipment, appliances or systems to be tested and description of tests to be performed
- Functions to be tested, including, but not limited to calibrations and economizer controls
- Conditions under which test will be performed
  - At a minimum, testing will affirm winter and summer design conditions and full outside air conditions
- Measurable criteria for performance
HVAC systems balanced per generally accepted engineering standards

Air and water flow rates measured and adjusted to deliver final flow rates within tolerances in product specifications

Test and balance activities to include air system and hydronic system balancing
- Each supply air outlet and zone terminal device equipped with means for air balancing per Chapter 6 of the IMC
- No discharge dampers on constant volume fans with motors $\geq 10$ hp
- Air systems balanced in a manner to first minimize throttling losses, then, for fans with system power $> 1$hp, fan speed adjusted to meet design flow conditions

**Exception** – fans with motors $\leq 1$hp
Hydronic Systems Balancing

- Individual hydronic heating and cooling coils equipped with means for balancing and measuring flow
- Hydronic systems proportionately balanced in a manner to first minimize throttling losses, then pump impeller to be trimmed or pump speed to be adjusted to meet design flow conditions
- Each hydronic system to have either capability to measure pressure across the pump, or test ports at each side of each pump

Exceptions
- Pumps with pump motors ≤ 5hp
- Where throttling results in ≤ 5% of nameplate hp draw above that required if the impeller were trimmed
To demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications, such that operation, function, and maintenance serviceability for each of the commissioned systems is confirmed.

Testing to include all modes and sequence of operation, including under full-load, part-load and the following emergency conditions:

- All modes as described in the sequence of operation
- Redundant or automatic back-up mode
- Performance of alarms, and
- Mode of operation upon a lost off power and restoration of power

**Exception** – Unitary or packaged HVAC equipment listed in Tables C403.2.3(1) through C403.2.3(3) that don’t require supply air economizers
Functional Performance Testing C408.2.3.2
Controls

- HVAC control systems to be tested to document that control devices, components, equipment, and systems are calibrated, adjusted and operate in accordance with approved plans and specifications
- Sequences of operation to be functionally tested to document they operate in accordance with approved plans and specifications
Air economizers to undergo a functional test to determine they operate in accordance with manufacturer’s specifications.
Registered design professional or approved agency to complete, certify, and submit to the building owner and will identify:

- Itemization of deficiencies found during testing that haven’t been corrected at the time of report preparation
- Deferred tests that can’t be performed at the time of report preparation due to climatic conditions
- Climatic conditions required for performance of deferred tests
Buildings or portions of buildings can’t pass final mechanical inspection until code official has received a letter of transmittal from the building owner acknowledging the building owner has received the Preliminary Commissioning Report.
Code official is permitted to require a copy of the report be made available for review
Construction documents to specify that documents described in C408.2.5 be provided to building owner within 90 days of receipt of certificate of occupancy

- Drawings
- Manuals
- System balancing report
- Final commissioning report
Include location and performance data on each piece of equipment
O&M manual to be provided to include all of the following:

- Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance
- Manufacturer’s operation and maintenance manuals for each piece of equipment requiring maintenance (except equipment not furnished as part of the project). Required routine maintenance actions to be clearly identified.
- Name and address of at least one service agency
- HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints to be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions
- Narrative of how each system is intended to operate, including recommended setpoints
To include descriptions of the activities and measurements completed per Section C408.2.2 (systems adjusting and balancing)
Delivered to building owner and include:

- Results of functional performance tests
- Disposition of deficiencies found during testing, including corrective measure details – used or proposed
- Functional performance test procedures used during commissioning process including measurable criteria for test acceptance

Exception – Deferred tests which can’t be performed at time of report preparation due to climatic conditions
What’s Covered Under Electrical Power & Lighting Systems Requirements?

- Mandatory Interior Lighting requirements
  - Required Controls
  - Wattage/Efficiency Limits

Interior Lighting Power Allowances (watts/ft\(^2\))

- Exterior Lighting Controls
  - Required Controls
  - Lamp Efficiency

Exterior Lighting Power Allowances (watts/ft\(^2\))
When do the Lighting and Power Requirements Apply?

- Original Installed Lighting System in a New Building, Addition, or Tenant Build-out
- Existing Lighting System that is Altered
- Change in Occupancy that Increases Energy
- Change in Occupancy that requires less LPD as shown in the LPD tables

Exceptions:

- Historic buildings
  - State or National listing
  - Eligible to be listed
- Alterations where less than 50% of the luminaires in a space are replaced and installed interior power lighting is not increased
- Lighting within dwelling units
  - Where ≥ 75% of permanently installed fixtures (except low-voltage) are fitted for and include high-efficacy lamps
Two methods to determine allowance:

- **Building Area Method**
  - Floor area for each building area type x value for the area
  - “area” defined as all contiguous spaces that accommodate or are associated with a single building area type as per the table
  - When used for an entire building, each building area type to be treated as a separate area

- **Space-by-Space Method**
  - Floor area of each space x value for the area
  - Then sum the allowances for all the spaces
  - Tradeoffs among spaces are allowed
# Interior Lighting Power Density Comparison

<table>
<thead>
<tr>
<th>Building Area Method</th>
<th>Reduced INT LTG Power</th>
<th>Spaceby-Space Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 LPD w/ft^2</td>
<td>2012 LPD w/ft^2</td>
<td></td>
</tr>
<tr>
<td><strong>Building Area Type</strong></td>
<td><strong>Building Area Type</strong></td>
<td><strong>Space Type</strong></td>
</tr>
<tr>
<td>1.00 Hotel</td>
<td>1.00 Hotel/Motel</td>
<td>Dining area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Guest rooms</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hotel lobby</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Highway lodging dining</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Highway lodging guest rooms</td>
</tr>
<tr>
<td>1.00 Office</td>
<td>0.90 Office</td>
<td>Office – enclosed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Office – open plan</td>
</tr>
</tbody>
</table>

* - First LPD value applies if at least 30% of conditioned floor area is in daylight zones with automatic controls. In all other cases, second LPD value applies.
## Interior Lighting Power Density Comparison

<table>
<thead>
<tr>
<th>Building Area Method</th>
<th>Reduced INT LTG Power</th>
<th>Spaceby-Space Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>2009 LPD w/ft²</td>
<td>2012 LPD w/ft²</td>
<td>LPD w/ft²</td>
</tr>
<tr>
<td><strong>School/University</strong></td>
<td><strong>0.99</strong></td>
<td><strong>Auditorium</strong></td>
</tr>
<tr>
<td>1.20</td>
<td>1.20</td>
<td>0.9</td>
</tr>
<tr>
<td></td>
<td><strong>Corridor/transition</strong></td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td><strong>Laboratory for classrooms</strong></td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td><strong>Lobby</strong></td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td><strong>Locker room</strong></td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td><strong>Lounge recreation</strong></td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td><strong>Office – enclosed</strong></td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td><strong>Restroom</strong></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td><strong>Stairway</strong></td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td><strong>Storage</strong></td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td><strong>Warehouse</strong></td>
<td></td>
</tr>
<tr>
<td>0.80</td>
<td>0.60</td>
<td><strong>Fine material storage</strong></td>
</tr>
<tr>
<td></td>
<td>0.60</td>
<td><strong>Medium/bulky material</strong></td>
</tr>
</tbody>
</table>

**Source:** NCAT

---

SUSDOE BUILDING TECHNOLOGIES PROGRAM
Building Energy Codes Resource Guide:
COMMERCIAL BUILDINGS for Architects
# Building Area Method vs. Space-by-Space Method

## TABLE C405.5.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD

<table>
<thead>
<tr>
<th>BUILDING AREA TYPE</th>
<th>LPD (w/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive facility</td>
<td>0.9</td>
</tr>
<tr>
<td>Convention center</td>
<td>1.2</td>
</tr>
<tr>
<td>Courthouse</td>
<td>1.2</td>
</tr>
<tr>
<td>Dining: bar lounge/leisure</td>
<td>1.3</td>
</tr>
<tr>
<td>Dining: cafeteria/fast food</td>
<td>1.4</td>
</tr>
<tr>
<td>Dining: family</td>
<td>1.6</td>
</tr>
<tr>
<td>Dormitory</td>
<td>1</td>
</tr>
<tr>
<td>Exercise center</td>
<td>1</td>
</tr>
<tr>
<td>Fire station</td>
<td>0.8</td>
</tr>
<tr>
<td>Gymnasium</td>
<td>1.1</td>
</tr>
<tr>
<td>Health care clinic</td>
<td>1</td>
</tr>
<tr>
<td>Hospital</td>
<td>1.2</td>
</tr>
<tr>
<td>Hotel</td>
<td>1</td>
</tr>
<tr>
<td>Library</td>
<td>1.3</td>
</tr>
</tbody>
</table>

## TABLE C405.5.2(2) —continued INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

<table>
<thead>
<tr>
<th>COMMON SPACE-BY-SPACE TYPES</th>
<th>LPD (w/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrium – First 40 feet in height</td>
<td>0.03 per</td>
</tr>
<tr>
<td>Atrium – Above 40 feet in height</td>
<td>0.02 per</td>
</tr>
<tr>
<td>Audience/seating area – permanent</td>
<td></td>
</tr>
<tr>
<td>For auditorium</td>
<td>0.9</td>
</tr>
<tr>
<td>For performing arts theater</td>
<td>2.6</td>
</tr>
<tr>
<td>For motion picture theater</td>
<td>1.2</td>
</tr>
<tr>
<td>Classroom/lecture/training</td>
<td>1.3</td>
</tr>
<tr>
<td>Conference/meeting/multipurpose</td>
<td>1.2</td>
</tr>
<tr>
<td>Corridor/transition</td>
<td>0.7</td>
</tr>
<tr>
<td>Dining area</td>
<td></td>
</tr>
<tr>
<td>Bar/lounge/leisure dining</td>
<td>1.4</td>
</tr>
<tr>
<td>Family dining area</td>
<td>1.4</td>
</tr>
<tr>
<td>Dressing/fitting room performing arts</td>
<td>1.1</td>
</tr>
<tr>
<td>Electrical/mechanical</td>
<td>1.1</td>
</tr>
</tbody>
</table>
Light Reduction Control **Not** required for the following:

- Areas with only one luminaire with rated power < 100 W
- Areas controlled by occupancy sensor
- Corridors, equipment rooms, storerooms, restrooms, public lobbies, electrical or mechanical rooms
- Sleeping units
- Spaces with <0.6 w/ft²
- Daylight spaces complying with Section C405.2.2.3.2
Each area required to have a manual control to also have controls meeting:

C405.2.2.1 – Automatic time switch control devices
C405.2.2.2 – Occupancy sensors
C405.2.2.3 – Daylight zone control

Exempted spaces

- Sleeping units
- Lighting for patient care
- When an automatic shutoff would endanger occupant safety or security
- Lighting intended for continuous operation
Occupancy sensors are required in:

- Classrooms
- Conference/meeting rooms
- Employee lunch and break rooms
- Private offices
- Storage rooms and janitorial closets
- Other spaces < 300 ft² enclosed by floor-to-ceiling height partitions

Features:

- Automatically turn lights off within 30 minutes of occupants leaving space
- Either manual or controlled to automatically turn lighting on to not more than 50% power
Exemptions

Full auto-on controls allowed in

- Public corridors
- Stairways
- Restrooms
- Primary building entrance areas and lobbies
- Areas with safety or security concern
Manual Daylighting Controls C405.2.2.3.1

Manual controls in daylight zones

Exemption:

Unless automatic controls are installed per C405.2.2.3.2 Automatic Daylighting Controls
Automatic Daylighting Controls C405.2.2.3.2

Set-point and other controls for calibrating the lighting control device to be readily accessible.

Daylighting controls device to be capable of automatically reducing the lighting power in response to available daylight either by:

- Continuous dimming using dimming ballasts and daylight-sensing automatic controls
  - capable of reducing general lighting power in daylit zone continuously to < 35% of rated power at maximum light output

OR

- Stepped dimming using multi-level switching and daylight-sensing controls capable of reducing lighting power automatically. System to:
  - provide at least two control channels per zone
  - be installed so that at least one control step is between 50-70% of design lighting power and another control step is no greater than 35% of design power
Where multi-level lighting controls are required:

- General lighting in daylight zone to be separately controlled by at least one multi-level lighting control that reduces lighting power in response to daylight available in the space

Where daylight illuminance in the space is > rated illuminance of the general lighting:

- General lighting to be automatically controlled so its power draw is no greater than 35% of its rated power

Multi-level lighting control to be located so that: calibration and set point adjustment controls are readily accessible and separate from light sensor
Specific Application Controls C405.2.3

These types be controlled by dedicated, independent control
- Display and accent lighting
- Display case lighting
- Nonvisual applications (i.e., plant growth and food warming)
- Lighting equipment for sale or demonstration in lighting education

Hotel and motel sleeping units and guest suites
- Master control device at main room entry
  - Controls all permanently installed luminaires and switched receptacles

Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting
- Have control device integral to luminaires OR
- Be controlled by readily accessibly, wall-mounted control device
Exterior grounds lighting over 100 W provides >60 lm/W unless on motion sensor or fixture is exempt from scope of code or from external LPD.
Exemptions from Exterior Calculation C405.6.2

The following lighting does not need to be included in the proposed lighting calculation:

- Specialized signal, directional, and marker lighting associated with transportation
- Advertising signage or directional signage
- Lighting integral to *equipment* or instrumentation and installed by its manufacturer
- Lighting for theatrical purposes, including performance, stage, film production, and video production
- Lighting for athletic playing areas
- Temporary lighting
- Lighting for industrial production, material handling, transportation sites, and associated storage areas
- Theme elements in theme/amusement parks
- Lighting used to highlight features of public monuments and registered *historic* landmark structures or *buildings*
Lighting System Functional Testing  C408.3.1

- Testing to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working order per construction documents and manufacturer’s installation instructions

- Construction documents to state who will conduct the testing

- Where required by the code official

  an approved independent party shall be responsible for the testing and documentation certifying the installed controls meet the provisions
Where the following are installed:

- Occupant sensors
- Time switches
- Programmable schedule controls
- Photosensors
- Daylighting controls

It is required that the following be confirmed:

- Placement, sensitivity and time-out adjustments for occupant sensors yield acceptable performance
- Time switches and programmable schedule controls are programmed to turn the lights off
- Placement and sensitivity adjustments for photosensor controls reduce electric light based on the amount of usable daylight in the space as specified
Additional Efficiency Package Options
One additional efficiency feature must be selected to comply with the IECC

More efficient HVAC system

OR

More efficient lighting system (consistent with 90.1-2010)

OR

Installation of onsite renewables; 3% of the regulated energy
Efficient HVAC performance per C406.2 OR
- Per Tables C406.2(1) thru C406.2(7)
- Only used when efficiencies in the above tables are greater than those in the efficiency tables in C403

Efficient lighting system per C406.3 OR
- Whole building LPD complies with C406.3.1
- Determine total LPD of building using reduced whole building interior lighting power in Table 406.3 x floor area for the building types

On-site supply of renewable energy per C406.4
- Total minimum ratings to comply with
  - Provide \( \geq 1.75 \text{ Btu} \) or \( \geq 0.50 \text{ watts per ft}^2 \) of conditioned floor area OR
  - Provide \( \geq 3\% \) of energy used for mechanical and SWH equipment and lighting

Individual tenant spaces to comply with either C406.2 or C406.3 unless documentation is provided that demonstrates compliance with C406.4 for the entire building
# Additional Efficiency Package Options C406.3

## Table C405.5.2(1) Interior Lighting Power Allowances: Building Area Method

<table>
<thead>
<tr>
<th>Building Area Type</th>
<th>LPD (w/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive facility</td>
<td>0.9</td>
</tr>
<tr>
<td>Convention center</td>
<td>1.2</td>
</tr>
<tr>
<td>Courthouse</td>
<td>1.2</td>
</tr>
<tr>
<td>Dining: bar lounge/leisure</td>
<td>1.3</td>
</tr>
<tr>
<td>Dining: cafeteria/fast food</td>
<td>1.4</td>
</tr>
<tr>
<td>Dining: family</td>
<td>1.6</td>
</tr>
<tr>
<td>Dormitory</td>
<td>1.0</td>
</tr>
<tr>
<td>Exercise center</td>
<td>1.0</td>
</tr>
<tr>
<td>Fire station</td>
<td>0.8</td>
</tr>
<tr>
<td>Gymnasium</td>
<td>1.1</td>
</tr>
<tr>
<td>Health care clinic</td>
<td>1.0</td>
</tr>
<tr>
<td>Hospital</td>
<td>1.2</td>
</tr>
<tr>
<td>Hotel</td>
<td>1.0</td>
</tr>
<tr>
<td>Library</td>
<td>1.3</td>
</tr>
<tr>
<td>Manufacturing facility</td>
<td>1.3</td>
</tr>
</tbody>
</table>

## Table C406.3 Reduced Interior Lighting Power

<table>
<thead>
<tr>
<th>Building Area Type</th>
<th>LPD (w/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automotive facility</td>
<td>0.82</td>
</tr>
<tr>
<td>Convention center</td>
<td>1.08</td>
</tr>
<tr>
<td>Courthouse</td>
<td>1.05</td>
</tr>
<tr>
<td>Dining: bar lounge/leisure</td>
<td>0.99</td>
</tr>
<tr>
<td>Dining: cafeteria/fast food</td>
<td>0.90</td>
</tr>
<tr>
<td>Dining: family</td>
<td>0.89</td>
</tr>
<tr>
<td>Dormitory</td>
<td>0.61</td>
</tr>
<tr>
<td>Exercise center</td>
<td>0.88</td>
</tr>
<tr>
<td>Fire station</td>
<td>0.71</td>
</tr>
<tr>
<td>Gymnasium</td>
<td>1.0</td>
</tr>
<tr>
<td>Health care clinic</td>
<td>0.87</td>
</tr>
<tr>
<td>Hospital</td>
<td>1.1</td>
</tr>
<tr>
<td>Library</td>
<td>1.18</td>
</tr>
<tr>
<td>Manufacturing facility</td>
<td>1.11</td>
</tr>
<tr>
<td>Hotel/motel</td>
<td>0.88</td>
</tr>
</tbody>
</table>
## Additional Efficiency Package Options \( C406.3 \)

<table>
<thead>
<tr>
<th>Watts/sq. ft.</th>
<th>( C405.5.2(1) )</th>
<th>( C406.3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office</td>
<td>0.9</td>
<td>0.90/0.85</td>
</tr>
<tr>
<td>Retail</td>
<td>1.4</td>
<td>1.4/1.3</td>
</tr>
<tr>
<td>Hospital</td>
<td>1.2</td>
<td>1.10</td>
</tr>
<tr>
<td>School</td>
<td>1.2</td>
<td>0.99</td>
</tr>
<tr>
<td>Warehouse</td>
<td>0.6</td>
<td>0.60</td>
</tr>
<tr>
<td>Gymnasium</td>
<td>1.1</td>
<td>1.00</td>
</tr>
<tr>
<td>Town Hall</td>
<td>1.1</td>
<td>0.92</td>
</tr>
</tbody>
</table>
Many of the slides and images in this presentation were provided by the USDOE Building Energy Codes Program Energy Codes University and Ken Baker of K Energy

energycodes.gov

Building Energy Codes Program