WHEN IS IT COMMERCIAL?

COMMERCIAL BUILDING. For this code, all buildings that are not included in the definition of "Residential building."

RESIDENTIAL BUILDING. For this code, includes detached one- and two-family dwellings and multiple single family dwellings (townhouses) and Group R-2, R-3 and R-4 buildings three stories or less in height above grade plane.

MIXED USE?

C101.4.1 Mixed residential and commercial buildings.
Where a building includes both residential building and commercial building portions, each portion shall be separately considered and meet the applicable provisions of IECC—Commercial Provisions or IECC—Residential Provisions.
C103.2 Information on construction documents.

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.

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.

C401.2.2 ASHRAE 90.1.
Commercial buildings shall comply with the requirements of ANSI/ASHRAE/IESNA 90.1.
Prescriptive Path

COMMERCIAL

• Insulation component R-value-based method
• Assembly U-factor, C-factor, or F-factor method
• Component performance alternative

Insulation and Fenestration Criteria Option
The Concepts

• The project follows the book for requirements
• It’s the concept of tell me what to do
• Table C402.1.3 for Opaque Assembly Minimum R-Values
• Table C402.4 for Fenestration Maximum Values
• Table C402.5.4 for Fenestration Maximum Air Leakage Values
• Most straightforward approach for prescriptive

Commercial Prescriptive Path - Insulation component R-value-based method

No trade-off
By the book
Everything on the plans
No specific required reports, but
• Mechanical Compliance Certificate
• Interior Lighting Compliance Certificate
• Exterior Lighting Compliance Certificate

Comply with C402- C405
Comply with C406 additional efficiency requirements
Comply with C408 Commissioning

U-factor, C-factor and F-factor Alternative Option (2)
The Concepts

• This option uses the entire assembly to demonstrate compliance
• Table C402.1.4 provides the assembly components that must meet the values listed
• Table C402.4 for Fenestration Maximum Values
• Table C402.5.4 for Fenestration Maximum Air Leakage Values
• This approach is not often used
ASSEMBLY CONCEPT
U-FACTOR (THERMAL TRANSMITTANCE). The coefficient of heat transmission (air to air) through a building component or assembly, equal to the time rate of heat flow per unit area and unit temperature difference between the warm side and cold side air films (Btu/h • ft² • ºF) [W/(m² • K)].

C-FACTOR (THERMAL CONDUCTANCE). The coefficient of heat transmission (surface to surface) through a building component or assembly, equal to the time rate of heat flow per unit area and the unit temperature difference between the warm side and cold side surfaces (Btu/h • ft • ºF) [W/(m² • K)].

F-FACTOR. The perimeter heat loss factor for slab-on-grade floors (Btu/h • ft • ºF) [W/(m • K)].

Commercial Prescriptive Path – Assembly U-factor, C-factor, Or F-factor Method

• No trade-off
• By the book
• Everything on the plans
• Documentation of assembly values
• No specific required reports, but
  • Mechanical Compliance Certificate
  • Interior Lighting Compliance Certificate
  • Exterior Lighting Compliance Certificate

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COMPONENT PERFORMANCE ALTERNATIVE
Twin building concept based on assembly U-factor, C-factor, F-factor or U-factor

• Prescriptive U, C, and F factor or U-factor or U-factor values of thermal envelope assemblies
• Proposed building thermal envelope U, C, and F factor or U-factor

If the sum of the proposed U, C, and F factor or U-factor is equal to or less than the sum of the values found in the table(s) it is compliant

\[ U \leq U \]

Shgc must be met also

Commercial Prescriptive Path – Component performance alternative

By the book - except for............

Trade off allowed for the thermal envelope
Everything on the plans and should match the COMcheck Values

COMcheck-Envelope Compliance Certificate required

• Mechanical Compliance Certificate
• Interior Lighting Compliance Certificate
• Exterior Lighting Compliance Certificate

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C401.2 Application. Commercial buildings shall comply with Section C401.2.1 or C401.2.2. 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.

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Total Building Performance - Commercial

• Annual Energy Cost must be \( \leq 80\% \) of annual energy cost of reference design
• Utilizes Tables C407.4.1(1)
• Table C407.2 are required.
• Compliance report submitted for permit
• Reporting software comply with C407.5
• C408 Commissioning

ASHRAE 90.1

• All disciplines should show the use of 90.1
• All reports should show the code/standard used as 90.1
• 90.1 has other options for compliance paths
• Items may be required in ASHRAE 90.1 that may not be a requirement of IECC
What is missing, or is anything missing?

Which option of the prescriptive path was this project designed to?
- Insulation component R-value-based method
- Assembly U-factor, C-factor, or F-factor method
- Component performance alternative

HELP ME, HELP YOU

HELP ME, HELP YOU

HELP ME, HELP YOU

HELP ME, HELP YOU

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.

C406 – Additional Efficiency Requirements
How it works for the 2021 IECC

- More options available
- Required to obtain 10 points for new building
- Required to obtain 5 points for tenant spaces
- Available points are weighted by occupancy and the efficiency provided for the occupancy
- Not all requirements are available for all occupancies
- Most will require multiple requirements to reach the required points
- Will require more planning in the design
C406.1 Additional Energy Efficiency Credit Requirements

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.

C406.2 More Efficient HVAC Equipment Performance

- Comply with C406.2.1- C406.2.5
- Heating efficiency 5% or 10%
- Cooling efficiency 5% or 10%
- Baseline of efficiency found in Tables C403.3.2(1) – C403.3.2(9)
- If equipment is not listed in the tables and variable refrigerant flow systems limited to 10% of the total building capacity.
- Use 90.1 for variable refrigerant flow systems

C406.3 Reduced Lighting Power

- Buildings shall comply with Section C406.3.1 or C406.3.2, and dwelling units and sleeping units within the building shall comply with Section C406.3.3.
- C406.3.1 Reduced lighting power by more than 10 percent.
- The total connected interior lighting power calculated in accordance with Section C405.3.1 shall be less than 90 percent of the total lighting power allowance calculated in accordance with Section C405.3.2.
- C406.3.2 Reduced lighting power by more than 15 percent.
- Where the total connected interior lighting power calculated in accordance with Section C405.3.1 is less than 85 percent of the total lighting power allowance calculated in accordance with Section C405.3.2, additional energy efficiency credits shall be determined based on Equation 4-13, rounded to the nearest whole number.
C406.4 Enhanced digital lighting controls.

Interior lighting in the building shall have the following enhanced lighting controls that shall be located, scheduled and operated in accordance with Section 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:
   1. Control reconfiguration based on digital addressability.
   2. Load shedding.
   3. Individual user control of overhead general illumination in open offices.
   4. 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.
C406.5 On-site Renewable Energy.
Buildings shall comply with Section C406.5.1 or C406.5.2

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/m²) or 0.25 watts per square foot (2.7 W/m²) 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.

C406.5.2 Enhanced renewable credit.
Where the total minimum ratings of on-site renewable energy systems exceeds the rating in Section C406.5.1, additional energy efficiency credits shall be determined based on Equation 4-14, rounded to the nearest whole number.

C406.6 Dedicated outdoor air system.
Buildings containing equipment or systems regulated by Section C403.3.4, C403.4.3, C403.4.4, C403.4.5, C403.6, C403.8.4, C403.8.5, C403.8.5.1, C403.9.1, C403.9.2, C403.9.3 or C403.9.4 shall be equipped with an independent ventilation system designed to provide not less than the minimum 100-percent outdoor air to each individual occupied space, as specified by the International Mechanical Code. The ventilation system shall be capable of total energy recovery. 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.

C406.7.1 Reduced Energy Use
In Service Water Heating.
Buildings shall be of the following types to use this compliance method:

- Group R-1: Boarding houses, hotels or motels.
- Group I-2: Hospitals, psychiatric hospitals and nursing homes.
- Group A-2: Restaurants and banquet halls or buildings containing food preparation areas.
- Group F: Laundries.
- Group R-2.
- Group A-3: Health clubs and spas.
- Group E: Schools with full-service kitchens or locker rooms with showers.
- Buildings showing a service hot water load of 10 percent or more of total building energy loads, as shown with an energy analysis as described in Section C407.
C406.7. Reduced Energy Use
In Service Water Heating.
Comply with one of these options
C406.7.2 Recovered or renewable water heating
C406.7.3 Efficient fossil fuel water heater
C406.7.4 Heat pump water heater

C406.8 Enhanced Envelope Performance.
• Total UA of building 15% better than code
• Component performance alternative

C406.9 Reduced Air Infiltration
• Building air leakage testing
• Maximum 0.25 cfm/ft² leakage rate
• Test report provided to code official and building owner
• Exception for buildings over 250,000 ft² – test represents above grade sections of building not whole building
• Must be at least 25% of conditioned floor area

C406.10 Energy monitoring.
Buildings shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C406.10.1 through C406.10.5.

<table>
<thead>
<tr>
<th>LOAD CATEGORY</th>
<th>DESCRIPTION OF ENERGY USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total HVAC system</td>
<td>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.</td>
</tr>
<tr>
<td>Interior lighting</td>
<td>Lighting systems located within the building.</td>
</tr>
<tr>
<td>Exterior lighting</td>
<td>Lighting systems located on the building site but not within the building.</td>
</tr>
<tr>
<td>Plug loads</td>
<td>Services, appliances and equipment connected to convenience receptacle outlets.</td>
</tr>
<tr>
<td>Process loads</td>
<td>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.</td>
</tr>
<tr>
<td>Building operations and other miscellaneous loads</td>
<td>The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems and automatic doors.</td>
</tr>
</tbody>
</table>
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.

C406.12 Efficient kitchen equipment.
For buildings and spaces designated as Group A-2, facilities that include 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 prior to the issuance of the Certificate of Occupancy.
3. Have associated performance levels listed on the construction documents submitted for permitting.

Energy efficiency credits for efficient kitchen equipment shall be independent of climate zone and determined based on Equation 4-15, rounded to the nearest whole number.

### Table C406.12(1)
<table>
<thead>
<tr>
<th>SECTION</th>
<th>ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP A OCCUPANCIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA &amp; IA</td>
<td>IB</td>
</tr>
<tr>
<td>C406.2.1 5% heating efficiency improvement</td>
<td>NA</td>
</tr>
<tr>
<td>C406.2.2 5% cooling efficiency improvement</td>
<td>6</td>
</tr>
<tr>
<td>C406.2.3 10% heating efficiency improvement</td>
<td>NA</td>
</tr>
<tr>
<td>C406.2.4 10% cooling efficiency improvement</td>
<td>11</td>
</tr>
</tbody>
</table>

### Table C406.12(2)
<table>
<thead>
<tr>
<th>SECTION</th>
<th>ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP B &amp; I OCCUPANCIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>NA &amp; IA</td>
<td>IB</td>
</tr>
<tr>
<td>C406.2.1 5% heating efficiency improvement</td>
<td>NA</td>
</tr>
<tr>
<td>C406.2.2 5% cooling efficiency improvement</td>
<td>3</td>
</tr>
<tr>
<td>C406.2.3 10% heating efficiency improvement</td>
<td>NA</td>
</tr>
<tr>
<td>C406.2.4 10% cooling efficiency improvement</td>
<td>5</td>
</tr>
</tbody>
</table>

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### TABLE 4C.1-(3)
**ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP I OCCUPANCIES**

<table>
<thead>
<tr>
<th>SECTION</th>
<th>CLIMATE ZONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0A &amp; 1A</td>
<td>0B &amp; 1B</td>
</tr>
<tr>
<td>CA02.1 5% heating efficiency improvement</td>
<td>NA</td>
</tr>
<tr>
<td>CA02.2 5% cooling efficiency improvement</td>
<td>4</td>
</tr>
<tr>
<td>CA02.3 10% heating efficiency improvement</td>
<td>NA</td>
</tr>
<tr>
<td>CA02.4 10% cooling efficiency improvement</td>
<td>7</td>
</tr>
<tr>
<td>CA03 Reduced lighting power</td>
<td>8</td>
</tr>
<tr>
<td>CA04 Enhanced digital lighting controls</td>
<td>2</td>
</tr>
<tr>
<td>CA05 On-site renewable energy</td>
<td>6</td>
</tr>
<tr>
<td>CA06 Dedicated outdoor air system</td>
<td>NA</td>
</tr>
<tr>
<td>CA07.2 Recovered or renewable water heating*</td>
<td>1</td>
</tr>
<tr>
<td>CA07.3 Efficient fossil fuel water heater*</td>
<td>NA</td>
</tr>
<tr>
<td>CA07.5 Heat pump water heater*</td>
<td>NA</td>
</tr>
<tr>
<td>CA08 Enhanced envelope performance</td>
<td>7</td>
</tr>
<tr>
<td>CA09 Reduced air infiltration</td>
<td>1</td>
</tr>
<tr>
<td>CA10 Energy monitoring</td>
<td>3</td>
</tr>
<tr>
<td>CA11 Fault detection and diagnostics system</td>
<td>1</td>
</tr>
</tbody>
</table>

### TABLE 4C.1-(4)
**ADDITIONAL ENERGY EFFICIENCY CREDITS FOR GROUP II OCCUPANCIES**

<table>
<thead>
<tr>
<th>SECTION</th>
<th>CLIMATE ZONE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0A &amp; 1A</td>
<td>0B &amp; 1B</td>
</tr>
<tr>
<td>CA02.1 5% heating efficiency improvement</td>
<td>NA</td>
</tr>
<tr>
<td>CA02.2 5% cooling efficiency improvement</td>
<td>6</td>
</tr>
<tr>
<td>CA02.3 10% heating efficiency improvement</td>
<td>NA</td>
</tr>
<tr>
<td>CA02.4 10% cooling efficiency improvement</td>
<td>8</td>
</tr>
<tr>
<td>CA03 Reduced lighting power</td>
<td>13</td>
</tr>
<tr>
<td>CA04 Enhanced digital lighting controls</td>
<td>3</td>
</tr>
<tr>
<td>CA05 On-site renewable energy</td>
<td>8</td>
</tr>
<tr>
<td>CA06 Dedicated outdoor air system</td>
<td>3</td>
</tr>
<tr>
<td>CA07.2 Recovered or renewable water heating</td>
<td>NA</td>
</tr>
<tr>
<td>CA07.3 Efficient fossil fuel water heater</td>
<td>NA</td>
</tr>
<tr>
<td>CA07.5 Heat pump water heater</td>
<td>NA</td>
</tr>
<tr>
<td>CA08 Enhanced envelope performance</td>
<td>4</td>
</tr>
<tr>
<td>CA09 Reduced air infiltration</td>
<td>1</td>
</tr>
<tr>
<td>CA10 Energy monitoring</td>
<td>4</td>
</tr>
<tr>
<td>CA11 Fault detection and diagnostics system</td>
<td>2</td>
</tr>
</tbody>
</table>

---

**DO THEY ALL MATCH?**

**RESOURCES AVAILABLE**
HELP ME, HELP YOU

- Code analysis
- List Compliance Path
- Additional Efficiency Requirements

WHAT IS MISSING?

WHAT DO WE KNOW AND SHOULD BE LOOKING FOR WITH THE THERMAL ENVELOPE?

- Roof insulation – Attic
- Above grade walls (is it metal or wood studs?)
- Below grade walls?
- Floors - Mass?
- Slab on grade - Unheated

Is it continuous?

C103.2 Information on construction documents.
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.

Thermal Envelope Depiction (C103.2.1)

NOT PART OF THE THERMAL ENVELOPE. THIS IS THE FIRE RATED ASSEMBLY AND SOUND.
INSULATION ISN'T JUST FOR THERMAL RESISTANCE

- Thermal envelope - thermal resistance
- Fire resistance rated construction
- Sound attenuation
- Vapor retarder assembly

C402.1.1.1 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.

FIBERGLASS BATTS
R-3.0 - 3.8

FIBERGLASS BLOWN IN
R-2.2 - 3.5

EXPANDED POLYSTYRENE INSULATION (EPS)
R-3.4 - 3.9

OPEN-CELL SPRAY FOAM
R-3.5 - 4.2

POLYISOCYANURATE
R-6.2 - 7.2

EXTRUDED POLYSTYRENE (XPS)
R-4.7

CELLULOSE BLOWN IN
R-3.2 - 3.8

CLOSED-CELL SPRAY FOAM
R-6.0 - 7.0

High Average of R-Values for Various Insulation Types
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.

C402.2.1 Roof assembly.  
The minimum thermal resistance (R-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table C402.1.3, based on construction materials used in the roof assembly.
Should list the R-value of insulation

Missing the minimum 2 layers

Table C402.1.3

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>WALL</th>
<th>All other</th>
<th>Group R</th>
<th>All other</th>
<th>Group R</th>
<th>All other</th>
<th>Group R</th>
<th>All other</th>
<th>Group R</th>
<th>All other</th>
<th>Group R</th>
<th>All other</th>
<th>Group R</th>
<th>All other</th>
<th>Group R</th>
</tr>
</thead>
</table>

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.

WHAT IS SO DIFFERENT WITH METAL BUILDINGS?

- Girders
- Purlins
- Metal Skin

- This is not a metal framed building
**TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD**

<table>
<thead>
<tr>
<th>CLIMATE ZONE</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>All other</td>
<td>R-19 + R-11 L3</td>
<td>R-19 + R-11 L3</td>
</tr>
<tr>
<td>Group R</td>
<td>R-19 + R-11 L3</td>
<td>R-19 + R-11 L3</td>
</tr>
</tbody>
</table>

**LINER SYSTEM (Ls), A system that includes the following:**

1. A continuous vapor barrier liner membrane that is installed below the purlins and that is uninterrupted by framing members.

2. An uncompressed, unfaced insulation resting on top of the liner membrane and located between the purlins.

For multilayer installations, the last rated R-value of insulation is for unfaced insulation draped over purlins and then compressed when the metal roof panels are attached.
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.

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.
### C402.2.2 Above-grade walls

- **Comply Table C402.1.3**
- 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.

**“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 of wall surface area.
2. Weigh not less than 25 pounds per square foot of wall surface area where the material weight is not more than 120 pcf.
3. Have a heat capacity exceeding 7 Btu/ft² • °F
4. Have a heat capacity exceeding 5 Btu/ft² • °F where the material weight is not more than 120 pcf.

---

#### Table: Conforming R-values for Above-grade Walls

<table>
<thead>
<tr>
<th>Zone</th>
<th>0 AND 1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 AND 6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>All other</td>
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<td>All other</td>
<td>Group R</td>
<td>All other</td>
<td>Group R</td>
<td>All other</td>
<td>Group R</td>
</tr>
<tr>
<td>Walls, above grade</td>
<td>R-7.6ci</td>
<td>R-7.6ci</td>
<td>R-9.5ci</td>
<td>R-9.5ci</td>
<td>R-9.5ci</td>
<td>R-5.7ci</td>
<td>R-5.7ci</td>
</tr>
<tr>
<td>Wood framed and other</td>
<td>R-12.5ci</td>
<td>R-12.5ci</td>
<td>R-12.5ci</td>
<td>R-12.5ci</td>
<td>R-12.5ci</td>
<td>R-12.5ci</td>
<td>R-12.5ci</td>
</tr>
</tbody>
</table>
C402.2.2 Above-grade walls

• Comply Table C402.1.3
Below-grade walls – Defined

A wall associated with the basement or first story of the building that is part of the building thermal envelope, is not less than 85 percent below grade and is on the exterior of the building.

C402.2.5 Below-grade walls
• Comply with Table C402.1.4
• For a minimum of 10 feet or to the lowest floor of the conditioned space

<table>
<thead>
<tr>
<th>ZONE</th>
<th>O&amp;M</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4 EXCEPT MARINE</th>
<th>5 AND MARINE</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>All other</td>
<td>Group R</td>
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<td>Group R</td>
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<td>Group R</td>
<td>All other</td>
<td>Group R</td>
<td>All other</td>
<td>Group R</td>
</tr>
</tbody>
</table>

Walls, below grade

Below-grade walls

For a minimum of 10 feet or to the lowest floor of the conditioned space.

For Table C402.1.4:
- For an interior wall
- R-15ci
- R-10ci
- R-7.5ci
- NR

For an exterior wall:
- R-15ci
- R-10ci
- R-7.5ci
- NR
C402.2.3 Floors.

- Comply with Table C402.1.3
- Floors over outdoor air or unconditioned spaces
- Insulation in contact with underside of structural slabs

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<thead>
<tr>
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<tr>
<td>0 AND 1</td>
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<td>Group R</td>
<td>All other</td>
<td>Group R</td>
<td>All other</td>
</tr>
<tr>
<td>4 EXCEPT MARINE</td>
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<td>Group R</td>
<td>All other</td>
<td>Group R</td>
<td>All other</td>
<td>Group R</td>
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<td>All other</td>
<td>Group R</td>
<td>All other</td>
</tr>
<tr>
<td>5 AND MARINE</td>
<td>All other</td>
<td>Group R</td>
<td>All other</td>
<td>Group R</td>
<td>All other</td>
<td>Group R</td>
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<td>6</td>
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<td>All other</td>
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<td>Group R</td>
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<td>Group R</td>
<td>All other</td>
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<td>All other</td>
<td>Group R</td>
<td>All other</td>
<td>Group R</td>
<td>All other</td>
</tr>
</tbody>
</table>

"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 of floor surface area.
2. 25 pounds per square foot of floor surface area where the material weight is not more than 120 pounds per cubic foot.

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

C402.2.4.1 Insulation installation.
Where installed, the 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.
C402.2.1.1 Skylight Curbs

- Curbs insulated to roof above roof deck – or
- Curb insulation R-5

Which ever is less

**SKYLIGHTS C402.4.2**

- Certain occupancies
  - 2,500 ft²
  - 75% of roof minimum 15 ft height

- Office
- Lobby
- Atrium
- Concourse
- Corridor
- Storage space
- Gymnasium/exercise
- Convention center

- Automotive service area
- Manufacturing space
- Non refrigeration warehouse
- Retail store
- Distribution/sorting area
- Transportation depot
- Workshop

| 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** | | | | | | | | |
| Fixed fenestration | 0.50 | 0.45 | 0.42 | 0.36 | 0.36 | 0.34 | 0.29 | 0.26 |
| 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 |
| **PF < 0.2** | | | | | | | | |
| 0.23 | 0.21 | 0.25 | 0.23 | 0.23 | 0.36 | 0.33 | 0.36 | 0.33 | 0.36 |
| **2 ≤ PF < 0.5** | | | | | | | | |
| 0.28 | 0.25 | 0.30 | 0.28 | 0.30 | 0.43 | 0.40 | 0.40 | 0.40 | 0.40 |
| **PF ≥ 0.5** | | | | | | | | |
| 0.37 | 0.34 | 0.40 | 0.37 | 0.40 | 0.58 | 0.53 | 0.54 | 0.56 | 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 | 0.30 | 0.40 | 0.40 | 0.40 | 0.40 |
TABLE C402.4
BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

<table>
<thead>
<tr>
<th>Climates Zone</th>
<th>SHGC</th>
<th>4 Operable</th>
<th>3 Operable</th>
<th>2 Operable</th>
<th>1 Fixed</th>
<th>4 Except Marine</th>
<th>3 Except Marine</th>
<th>2 Except Marine</th>
<th>1 Fixed</th>
<th>4 Except Marine</th>
<th>3 Except Marine</th>
<th>2 Except Marine</th>
</tr>
</thead>
<tbody>
<tr>
<td>PF ≤ 0.2</td>
<td>0.23</td>
<td>0.21</td>
<td>0.25</td>
<td>0.23</td>
<td>0.28</td>
<td>0.26</td>
<td>0.28</td>
<td>0.28</td>
<td>0.31</td>
<td>0.25</td>
<td>0.28</td>
<td>0.28</td>
</tr>
<tr>
<td>0.2 ≤ PF &lt; 0.5</td>
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<td>0.25</td>
<td>0.30</td>
<td>0.28</td>
<td>0.30</td>
<td>0.28</td>
<td>0.30</td>
<td>0.30</td>
<td>0.31</td>
<td>0.25</td>
<td>0.28</td>
<td>0.28</td>
</tr>
<tr>
<td>PF ≥ 0.5</td>
<td>0.31</td>
<td>0.34</td>
<td>0.40</td>
<td>0.37</td>
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<td>0.37</td>
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<td>0.37</td>
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</table>

INFORMATION NOT USUALLY PLACED ON PLANS BUT SHOULD

NFRC CERTIFICATE
FOR PLAN REVIEW
Compliance certificate typically from the frame manufacturer.

FOR INSPECTION
NFRC certificate

Commercial Energy Reports

- Framing Manufacturer Certificate

Thermal Transmittance (J/Hr • °R)

<table>
<thead>
<tr>
<th>Glass U-Factor</th>
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<tr>
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<tr>
<td>0.36</td>
<td>0.50</td>
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<tr>
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<td>0.49</td>
</tr>
<tr>
<td>0.38</td>
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<td>0.45</td>
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<td>0.22</td>
<td>0.40</td>
</tr>
<tr>
<td>0.20</td>
<td>0.38</td>
</tr>
</tbody>
</table>
C103.2 Information on construction documents.

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.

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.

2021 IECC - Air Leakage
C402.5 Air leakage—thermal envelope (Mandatory).
• Comply with Sections C402.5.1 through C402.5.11.1
OR
• Test in accordance with Section C402.5.2 or C402.5.3
• Comply with Sections C402.5.7, C402.5.8 and C402.5.9

C402.5 - Comply with Sections C402.5.1 through C402.5.11.1

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.
C402.5.2 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.

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.

R402.4.1.2 Testing (RESIDENTIAL AIR TESTING REQUIREMENTS - not the full sections)
Exception: When testing individual dwelling units, an air leakage rate not exceeding 0.30 cubic feet per minute per square foot [0.008 m³/(s × m²)] 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 and multiple-family building dwelling units.
2. Buildings or dwelling units that are 1,500 square feet (139.4 m²) or smaller.

0.30 cfm/ft² is equal to about 5 ach
Unguarded Blower Door Test

Single point measures dwelling unit air leakage using single blower door fan.

One at a time

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C402.5 - Comply with Sections C402.5.1 through C402.5.11.1

2021 Prescriptive Approach

C402.5.2 Dwelling and sleeping unit enclosure testing.

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.

7 units – or 20%
C402.5 - Comply with Sections C402.5.1 through C402.5.11.1  2021 Prescriptive Approach

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 E1627 or an equivalent method approved by the code official. 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).

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.
C402.5.3 Building thermal envelope testing.

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.

C402.5.1.2 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.
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 m²) floor area in Climate Zones 0B, 1, 2A, 4B and 4C.
   3. Buildings between 5,000 square feet (464.5 m²) and 50,000 square feet (4645 m²) floor area in Climate Zones 0A, 3A and 3B.
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.

C402.5.5 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.
C402.5.1.5 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.

C402.5.1.1 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.

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

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.
3. Cont. 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 C402.5.8(2015 & 2018) C402.5.10(2021). Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

C402.5.1.2.1 Materials.

Materials with an air permeability not greater than 0.004 cfm/ft² (0.02 L/s • m²) 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”
2. Oriented strand board having a thickness of not less than 3/8”
3. Extruded polystyrene insulation board having a thickness of not less than ½”
4. Foil-back polyisocyanurate insulation board having a thickness of not less than ½”
5. Closed-cell spray foam having a minimum density of 1.5pcf and having a thickness of not less than 1½”
6. Open-cell spray foam with a density between 0.4 and 1.5pcf and having a thickness of not less than 4.5 inches
7. Exterior or interior gypsum board having a thickness of not less than ½”
8. Cement board having a thickness of not less than ½”
9. Built-up roofing membrane
10. Modified bituminous roof membrane
11. Fully adhered single-ply roof membrane
12. A Portland cement/sand parge, or gypsum plaster having a thickness of not less than 5/8”
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

C402.5.1.2.2 Assemblies.

Assemblies of materials and components with an average air leakage not greater than 0.04 cfm/ under a pressure differential of 0.3 inch of water gauge (w.g.)(75 Pa) when tested in accordance with ASTM E2357, ASTM E1677 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 or more.
3. A Portland cement/sand parge, stucco or plaster not less than 1/2 inch in thickness.
WHAT MATERIALS ARE NOT LISTED?

WATER-RESISTIVE BARRIER. A material behind an exterior wall covering that is intended to resist liquid water that has penetrated behind the exterior covering from further intruding into the exterior wall assembly.

• 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.
[BF] FIRE RESISTANCE. The property of materials or their assemblies that prevents or retards the passage of excessive heat, hot gases or flames under conditions of use.

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.

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C402.5 - Comply with C402.5.1 through C402.5.8(2015 & 2018) or C402.5.11.1(2021) Prescriptive Approach

2021, 2018, & 2015 IECC

Materials. Materials with an air permeability not greater than 0.004 cfm/ft² (0.02 L/s × m²) under a pressure differential of 0.3 inch water gauge (75 Pa) when tested in accordance with ASTM E2178 shall comply with this section.

What is the air barrier, and where is it located?

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C402.5.3 Materials.

Materials with an air permeability not greater than 0.004 cfm/ft² (0.02 L/s × m²) 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.

7. Exterior or interior gypsum board having a thickness of not less than 1/2 inch (12.7 mm).
C402.5.4 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:
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.
C402.5.6(2021 IECC) 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 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(2021 IECC) 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(2021 IECC) 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(2021 IECC) 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:
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 m²) 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 (2021 IECC) 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 Operable openings interlocking. Where occupancies utilize operable openings to the outdoors that are larger than 40 square feet (3.7 m²) 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.

C403.14 Operable opening interlocking controls.
The heating and cooling systems shall have controls that will interlock these mechanical systems to the set temperatures of 90°F (32°C) for cooling and 55°F (12.7°C) for heating when the conditions of Section C402.5.8 exist. The controls shall configure to shut off the systems entirely when the outdoor temperatures are below 90°F (32°C) or above 55°F (12.7°C).
Mechanical Load Calculations

**C403.1.1**

Design loads associated with heating, ventilating and air conditioning of the building shall be determined in accordance with ANSI/ASHRAE/ACCA Standard 183 or by an approved equivalent computational procedure using the design parameters specified in Chapter 3. Heating and cooling loads shall be adjusted to account for load reductions that are achieved where energy recovery systems are utilized in the HVAC system in accordance with the ASHRAE HVAC Systems and Equipment Handbook by an approved equivalent computational procedure.

What kind of things go into calculating the heating and cooling loads?

- Elevation
- Heating and cooling degree days
- Amount of glazing
- Direction of glazing
- Types of glazing
- SHGC
- Overhangs
- Insulation values
- Roofing material—light or dark
- Number of lights
- Kind of lights
- Occupant load

**C403.3.1 Equipment sizing**

The output capacity of heating and cooling equipment shall be not greater than that of the smallest available equipment size that exceeds the loads calculated in accordance with Section C403.1.1. A single piece of equipment providing both heating and cooling shall satisfy this provision for one function with the capacity for the other function as small as possible, within available equipment options.

Exceptions:
1. Required standby equipment and systems provided with controls and devices that allow such systems or equipment to operate automatically only when the primary equipment is not operating.
2. Multiple units of the same equipment type with combined capacities exceeding the design load and provided with controls that are configured to sequence the operation of each unit based on load.
Equipment shall meet the minimum efficiency requirements of Tables C403.3(1-16). Efficiencies updated in many of the tables.

C403.5 Economizers

- Comply with sections C403.5.1 – C403.5.5
- Big damper that provides free air conditioning
- Controls
- Fault Detection Diagnostics (FDD)
- Info found on Mechanical Compliance Certificate

C403.5 through C403.5.5 Economizers

- Integrated economizer controls C403.5.1
- Economizer heating system impact C403.5.2
- Air economizer C403.5.3
  - Design capacity C403.5.3.1
  - Control signal C403.5.3.2
  - High limit shut off C403.5.3.3
  - Relief of excess outdoor air C403.5.3.4
  - Economizer dampers C403.5.3.5
- Water side economizer C403.5.4
  - Design capacity C403.5.4.1
  - Maximum pressure drop C403.5.4.2
- Economizer fault detection and diagnostics C403.5.5

Economizer exceptions:
- Individual fan systems not served by chilled water in Climate Zones 0A, 0B, 1A and 1B
- Where more than 25% of the air designed to be supplied by the system is to spaces that are designed to be humidified above 38 degrees dewpoint temperature to satisfy process needs
- Systems expected to operate less than 20 hours per week.
- Systems serving supermarket areas with open refrigerated casework.
- Where the cooling efficiency is greater than or equal to the efficiency in Table C403.5(2) (Climate zones 2-4 only)
- Systems that include a heat recovery system in accordance with Section C403.10.5
- VRF systems installed with a dedicated outdoor air system.
Heating and Cooling System Controls

C403.4

Control required for each system
Capable of responding to the temperature in each zone

Exceptions for certain independent perimeter systems
C403.4.1.1 Heat pump supplementary heat.

Heat pumps having supplementary electric resistance heat shall have controls that 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.

IECC C403.4.1.4 Heated or cooled vestibules

Requires separate thermostat within the vestibule to limit the amount of heating and cooling within a vestibule.
C403.7.1 Demand Control Ventilation

- Required in:
  - Spaces > 500 SF
  - With occupant density > 15 per 1000 SF per Table 403.3.1.1 of IMC
  - All single-zone systems with Economizers
  - There are some exceptions

Enclosed parking garage ventilation controls.

Enclosed parking garages used for storing or handling automobiles operating under their own power shall employ 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.

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.
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.

Automatic control of HVAC systems serving guestrooms.

In Group R-1 buildings containing more than 50 guestrooms, each guestroom shall be provided with controls complying with the provisions of Sections C403.7.6.1 and C403.7.6.2. Card key controls comply with these requirements.

Card key controls comply with these requirements.
C403.7.6.1 Temperature setpoint controls.

Controls shall be provided on each HVAC system that are capable of and configured with three modes of temperature control.

1. When the guestroom is rented but unoccupied, the controls shall automatically raise the cooling setpoint and lower the heating setpoint by not less than 4°F (2°C) from the occupant setpoint within 30 minutes after the occupants have left the guestroom.

2. When the guestroom is unrented and unoccupied, the controls shall automatically raise the cooling setpoint to not lower than 80°F (27°C) and lower the heating setpoint to not higher than 60°F (16°C). Unrented and unoccupied guestroom mode shall be initiated within 16 hours of the guestroom being continuously occupied or where a networked guestroom control system indicates that the guestroom is unrented and the guestroom is unoccupied for more than 20 minutes. A networked guestroom control system that is capable of returning the thermostat setpoints to default occupied setpoints 60 minutes prior to the time a guestroom is scheduled to be occupied is not precluded by this section. Cooling that is capable of limiting relative humidity with a setpoint not lower than 65-percent relative humidity during unoccupied periods is not precluded by this section.

3. When the guestroom is occupied, HVAC setpoints shall return to their occupied setpoints once occupancy is sensed.

C403.7.6.2 Ventilation controls.

Controls shall be provided on each HVAC system that are capable of and configured to automatically turn off the ventilation and exhaust fans within 20 minutes of the occupants leaving the guestroom, or isolation devices shall be provided to each guestroom that are capable of automatically shutting off the supply of outdoor air to and exhaust air from the guestroom.

Exception: Guestroom ventilation systems are not precluded from having an automatic daily pre-occupancy purge cycle that provides daily outdoor air ventilation during unrented periods at the design ventilation rate for 60 minutes, or at a rate and duration equivalent to one air change.

Shutoff Dampers C403.7.7 (C402.5.5)

- Class I motorized dampers
- Air leakage rate < 4 cfm/ft²
- Labeled

Some exceptions:
- Buildings 2 stories or less
- Any height in climate zones 1, 2, or 3
- Exhaust capacity less than 300 cfm

Not required to be motorized in CZ2
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.

C403.8.2 Motor nameplate horsepower.
For each fan, the fan brake horsepower (bhp) shall be indicated on the construction documents and the selected motor shall be not larger than the following:
1. For fans less than 6 bhp (4476 W), 1.5 times the fan brake horsepower.
2. For fans 6 bhp (4476 W) and larger, 1.3 times the fan brake horsepower.

Exceptions:
1. Fans equipped with electronic speed control devices to vary the fan airflow as a function of load.
2. Fans with a fan nameplate electrical input power of less than 0.89 kW.
3. Systems complying with Section C403.8.1 fan system motor nameplate hp (Option 1).
4. Fans with motor nameplate horsepower less than 1 hp (746 W).

C403.8.3 Fan efficiency.
Each fan and fan array shall have a fan energy index (FEI) of not less than 1.00 at the design point of operation, as determined in accordance with AMCA 208 by an approved independent testing laboratory and labeled by the manufacturer. Each fan and fan array used for a variable-air-volume system shall have an FEI of not less than 0.95 at the design point of operation, as determined in accordance with AMCA 208 by an approved independent testing laboratory and labeled by the manufacturer. The FEI for fan arrays shall be calculated in accordance with AMCA 208 Annex C.

Exceptions: The following fans are not required to have a fan energy index:
1. Fans that are not embedded fans with motor nameplate horsepower of less than 1.0 hp (0.75 kW) or with a nameplate electrical input power of less than 0.89 kW.
2. Embedded fans that have a motor nameplate horsepower of 5 hp (3.7 kW) or less, or with a fan system electrical input power of 4.1 kW or less.
3. Multiple fans operated in series or parallel as the functional equivalent of a single fan that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less.
4. Fans that are part of equipment covered in Section C403.3.2.
5. Fans included in an equipment package certified by an approved agency for air or energy performance.
6. Ceiling fans, which are defined as nonportable devices suspended from a ceiling or overhead structure for circulating air via the rotation of the blades.
7. Fans used for moving gases at temperatures above 482°F (250°C).
8. Fans used for operation in explosive atmospheres.
9. Reversible fans used for tunnel ventilation.
10. Fans that are intended to operate only during emergency conditions.
11. Fans outside the scope of AMCA 208.
C403.8.5 Low-capacity ventilation fans.
Mechanical ventilation system fans with motors less than 1/2 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.

<table>
<thead>
<tr>
<th>TABLE C403.8.5 LOW-CAPACITY VENTILATION FAN EFFICACY®</th>
</tr>
</thead>
<tbody>
<tr>
<td>FAN LOCATION</td>
</tr>
<tr>
<td>HIV or ERV</td>
</tr>
<tr>
<td>Interi</td>
</tr>
<tr>
<td>Bathroom, utility room</td>
</tr>
<tr>
<td>Bathroom, utility room</td>
</tr>
</tbody>
</table>

**TABLE C403.12 Minimum Pipe Insulation Thickness (in inches)™**

<table>
<thead>
<tr>
<th>FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)</th>
<th>INSULATION CONDUCTIVITY</th>
<th>NOMINAL PIPE OR TUBE SIZE (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to &lt; 8</td>
<td>1/2 to &lt; 4</td>
<td>4 to &lt; 8</td>
</tr>
<tr>
<td>&gt; 350</td>
<td>0.32-0.34</td>
<td>0.32-0.34</td>
</tr>
<tr>
<td>251-350</td>
<td>0.25-0.32</td>
<td>0.25-0.32</td>
</tr>
<tr>
<td>201-250</td>
<td>0.25-0.32</td>
<td>0.25-0.32</td>
</tr>
<tr>
<td>141-200</td>
<td>0.15-0.29</td>
<td>0.15-0.29</td>
</tr>
<tr>
<td>105-140</td>
<td>0.15-0.29</td>
<td>0.15-0.29</td>
</tr>
<tr>
<td>40-80</td>
<td>0.15-0.29</td>
<td>0.15-0.29</td>
</tr>
</tbody>
</table>

**TABLE C404.5.1 PIPING VOLUME AND MAXIMUM PIPING LENGTHS™**

<table>
<thead>
<tr>
<th>NOMINAL PIPE SIZE (inches)</th>
<th>VOLUME (liquid ounces per foot length)</th>
<th>MAXIMUM PIPING LENGTH (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/4</td>
<td>0.33</td>
<td>60</td>
</tr>
<tr>
<td>1/2</td>
<td>0.5</td>
<td>40</td>
</tr>
<tr>
<td>1/2</td>
<td>0.35</td>
<td>30</td>
</tr>
<tr>
<td>3/8</td>
<td>0.2</td>
<td>20</td>
</tr>
<tr>
<td>1/2</td>
<td>0.2</td>
<td>30</td>
</tr>
<tr>
<td>1/2</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>3/4</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>1</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>1-1/2</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>2-1/2</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>3-1/2</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>4-1/2</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>8</td>
<td>0.2</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>0.2</td>
<td>10</td>
</tr>
</tbody>
</table>

**TABLE C404.5.2 PIPING VOLUME AND MAXIMUM PIPING LENGTHS™**

**FIG. 1 Layout 1/2 hall down**
C404.6.1 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 thermo-syphon 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 not a demand for hot water. The controls shall limit the temperature of the water entering the cold water piping to not greater than 104°F (40°C).

C404.6.1.1 Demand recirculation controls.
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.

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Energy consumption of pools and permanent spas

C404.8.1 Heaters
- Controlled by an on-off switch on the exterior of the heater or external to within 3 feet of heater, and with ready access.
- Gas-fired heaters shall not have continuously burning ignition pilots.

C404.8.2 Time switches
- Time switch or other controls to automatically turn off and on heaters and pump motors.

Exceptions:
1. Public health standards require 24-hour pump operation
2. Pumps operate solar-and waste heat recovery pool heating systems

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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 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 and C405.3.

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:
   - Monitoring occupant activity to brighten or dim lighting when occupied or unoccupied, respectively.
   - Monitoring ambient light, both electric light and daylight, and brighten or dim artificial light to maintain desired light level.
   - For each control strategy, configuration and reconfiguration of performance parameters including; bright and dim setpoints, timeout, 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 Occupant sensor controls.
Occupant sensor controls shall be installed to control lights in the following space types:
1. Classrooms/lecture/training rooms.
2. Conference/meeting/multipurpose rooms.
3. Copy/print rooms.
4. Lounges/breakrooms.
5. Enclosed offices.
6. Open plan office areas.
7. Restrooms.
8. Storage rooms.
9. Locker rooms.
10. Corridors.
11. Warehouse storage areas.
12. Other spaces 300 square feet (28 m2) or less that are enclosed by floor-to-ceiling height partitions.

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.
C405.2.1.4 Occupant sensor control function in corridors.
Occupant sensor controls in corridors shall uniformly reduce lighting power to an occupied setpoint not more than 50 percent of full power within 20 minutes after all occupants have left the space.
Exception: Corridors provided with less than two footcandles of illumination on the floor at the darkest point with all lights on.

C405.2.1.2 Occupant sensor control function in warehouse storage areas.
Lighting in warehouse storage areas shall be controlled as follows:
1. Lighting in each aisleway shall be controlled independently of lighting in all other aisleways and open areas.
2. Occupant sensors shall automatically reduce lighting power within each controlled area to an unoccupied setpoint of not more than 50 percent of full power within 20 minutes after all occupants have left the controlled area.
3. Lights that are not turned off by occupant sensors shall be turned off by time-switch control complying with Section C405.2.2.1.
4. A manual control shall be provided to allow occupants to turn off lights in the space.

- Independent controls for aisleways and open areas
- Reduce power by 50% with 20 minutes of no occupants in area
- If not on occupancy sensor must be on time-switch control
- Provide manual control
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.

C405.2.2.1 Time-switch control function.
Time-switch controls shall comply with all of the following:
1. Automatically turn off lights when the space is scheduled to be unoccupied.
2. Have a minimum 7-day clock.
3. Be capable of being set for seven different day types per week.
4. Incorporate an automatic holiday "shutoff" feature, which turns off all controlled lighting loads for not fewer than 24 hours and then resumes normally scheduled operations.
5. Have program backup capabilities, which prevent the loss of program and time settings for not fewer than 10 hours, if power is interrupted.
6. Include an override switch that complies with the following:
   6.1. The override switch shall be a manual control.
   6.2. The override switch, when initiated, shall permit the controlled lighting to remain on for not more than 2 hours.
   6.3. Any individual override switch shall control the lighting for an area not larger than 5,000 square feet.

Exception: Within mall concourses, auditoriums, sales areas, manufacturing facilities and sports arenas:
The time limit shall be permitted to be greater than 2 hours, provided that the switch is a captive key device.
The area controlled by the override switch shall not be limited to 5,000 square feet provided that such area is less than 20,000 square feet.
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.
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 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.

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 general 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 (LPAdj) calculated in accordance with Equation 4-9.

C405.2.4.1 Daylight-responsive control function.
Where required, daylight-responsive controls shall be provided within each space for control of lights in that space and shall comply with all of the following:
1. Lights in toplit daylight zones in accordance with Section C405.2.4.3 shall be controlled independently of lights in sidelit daylight zones in accordance with Section C405.2.4.2.
2. Lights in the primary sidelit daylight zone shall be controlled independently of lights in the secondary sidelit daylight zone.
3. Daylight responsive controls within each space shall be configured so that they can be calibrated from within that space by authorized personnel.
4. Calibration mechanisms shall be in a location with ready access.
5. Daylight responsive controls shall dim lights continuously from full light output to 15 percent of full light output or lower.
6. Daylight responsive controls shall be configured to completely shut off all controlled lights.
7. When occupant sensor controls have reduced the lighting power to an unoccupied setpoint in accordance with Sections C405.2.1.2 through C405.2.1.4, daylight responsive controls shall continue to adjust electric light levels in response to available daylight, but shall be configured to not increase the lighting power above the specified unoccupied setpoint.
8. Lights in sidelit daylight zones in accordance with Section C405.2.4.2 facing different cardinal orientations [within 45 degrees (0.79 rad) of due north, east, south, west] shall be controlled independently of each other.
Exceptions:
1. Within each space, up to 150 watts of lighting within the primary sidelit daylight zone is permitted to be controlled together with lighting in a primary sidelit daylight zone facing a different cardinal orientation.
2. Within each space, up to 150 watts of lighting within the secondary sidelit daylight zone is permitted to be controlled together with lighting in a secondary sidelit daylight zone facing a different cardinal orientation.
Sidelit daylight zone:
The sidelite 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 sidelite 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 sidelite 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 sidelite daylight zone is directly adjacent to the primary sidelite 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).

4. The area of the fenestration is not less than 24 square feet (2.23 m²).

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 geological 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.

SIDELITE REQUIREMENTS

- 2 zones - primary & secondary
- >150 watts of primary zone
- >300 watts total of both zones
- Exempt:
  - Healthcare patient care provided
  - 1st floor above grade A-2 or M
- Total connected lighting power calculated equation 4-10 < the adjusted lighting power allowance with equation 4-9
- Each zone controlled independently
- Calibrated from within space at a location ready access
- Dim continuously from full to 15%
- Shut off all controlled lights
- Occ sensors reduce lighting in unoccupied areas per code with additional controls for light levels and power
- Zone facing different directions independently controlled
- 2 exceptions for the controls

Sidelite zones comply with all of these

- From floor to top of fenestration distance horizontally or to wall
- Sidelite in rooftop monitor extend to obstruction or .7 of ceiling height or 1 times the height from floor to bottom of fenestration – less…………
- Second zone double the first or to full height wall
- Window must be 24 sq ft for lighting
- Takes into account of building or geological items that block light from entering fenestration
- Visible transmittance must be a minimum of 20
- Projection factor of overhangs not greater than 1 for north facing and 1.5 for all others
C405.2.4.3 Toplit daylight zone.
The toplit daylight zone is the floor area underneath a roof fenestration assembly that complies with all of the following:

1. The toplit daylight zone shall extend laterally and longitudinally beyond the edge of the roof fenestration assembly to the nearest obstruction that is taller than 0.7 times the ceiling height, or up to 0.7 times the ceiling height, whichever is less, as indicated in Figure C405.2.4.3.

2. Direct sunlight is not blocked from hitting the roof fenestration assembly at the peak solar angle on the summer solstice by buildings or geological formations.

3. The product of the visible transmittance of the roof fenestration assembly and the area of the rough opening of the roof fenestration assembly divided by the area of the toplit zone is not less than 0.008.
C405.2.4.4 Atriums.
Daylight zones at atrium spaces shall be established at the top floor surrounding the atrium and at the floor of the atrium space, and not on intermediate floors, as indicated in Figure C405.2.4.4.

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.
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.
C405.2.7 Exterior lighting controls. Exterior lighting systems shall be provided with controls that comply with Sections C405.2.7.1 through C405.2.7.4. Exceptions:

1. Lighting for covered vehicle entrances and exits from buildings and parking structures where required for eye adaptation.
2. Lighting controlled from within dwelling units.

C405.2.7.1 Daylight shutoff. Lights shall be automatically turned off when daylight is present and satisfies the lighting needs.

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.

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. Not more than 1,500 watts of lighting power shall be controlled together.

C405.2.7.4 Exterior time-switch control function. Time-switch controls for exterior lighting shall comply with the following:

1. They shall have a clock capable of being programmed for not fewer than 7 days.
2. They shall be capable of being set for seven different day types per week.
3. They shall incorporate an automatic holiday setback feature.
4. They shall have program backup capabilities that prevent the loss of program and time settings for a period of not less than 10 hours in the event that power is interrupted.
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 30 percent when there is no activity detected within a lighting zone for 20 minutes. Lighting zones for this requirement shall be not larger than 3,600 square feet (334.5 m²).

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 shall be separately controlled by a device that automatically reduces lighting power by at least 50 percent 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.

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

• Occ sensor or time switch
• Reduce >30% after 20 min of no occupancy
• Zones no bigger than 3,600 sq ft
  • Exception if footcandles are >1.5
• Entrance and exits separate lighting controls for eye adaptation to ≥50%
• Lighting within 20ft of exterior wall opening reduce ≥50%
• Exceptions
  • Opening to wall ratio >40% with vertical distance
  • Daylight obstructions requirements
  • Opening obstructed by screens or elements to restrict daylight
Additional Interior Lighting Power Allowance = 1000 watts + 
(Retail Area 1 x 0.45 W/ft²) + 
(Retail Area 2 x 0.45 W/ft²) + 
(Retail Area 3 x 1.05 W/ft²) + 
(Retail Area 4 x 1.87 W/ft²),

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.

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.
C405.11 Automatic receptacle control.
The following shall have automatic receptacle control complying with Section C405.11.1:
1. At least 50 percent of all 125V, 15- and 20-amp receptacles installed in enclosed offices, conference rooms, rooms used primarily for copy or print functions, breakrooms, classrooms and individual workstations, including those installed in modular partitions and module office workstation systems.
2. At least 25 percent of branch circuit feeders installed for modular furniture not shown on the construction documents.

C405.11.1 Automatic receptacle control function.
Automatic receptacle controls shall comply with the following:
1. Either split controlled receptacles shall be provided with the top receptacle controlled, or a controlled receptacle shall be located within 12 inches (304.8 mm) of each uncontrolled receptacle.
2. One of the following methods shall be used to provide control:
   2.1. A scheduled basis using a time-of-day operated control device that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be configured to provide an independent schedule for each portion of the building of not more than 5,000 square feet (464.5 m²) and not more than one floor. The occupant shall be able to manually override an area for not more than 2 hours. Any individual override switch shall control the receptacles of not more than 5,000 feet (1524 m).
   2.2. An occupant sensor control that shall turn off receptacles within 20 minutes of all occupants leaving a space.
   2.3. An automated signal from another control or alarm system that shall turn off receptacles within 20 minutes after determining that the area is unoccupied.
3. All controlled receptacles shall be permanently marked in accordance with NFPA 70 and be uniformly distributed throughout the space.
4. Plug-in devices shall not comply.

Exceptions: Automatic receptacle controls are not required for the following:
1. Receptacles specifically designated for equipment requiring continuous operation (24 hours per day, 365 days per year).
2. Spaces where an automatic control would endanger the safety or security of the room or building occupants.
3. Within a single modular office workstation, noncontrolled receptacles are permitted to be located more than 12 inches (304.8 mm), but not more than 72 inches (1828 mm) from the controlled receptacles serving that workstation.
C405.12 Energy monitoring.
New buildings with a gross conditioned floor area of 25,000 square feet (2322 m2) or larger shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.12 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 square feet (464.5 m2) of conditioned floor area.

C405.12.1 Electrical energy metering.
For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.12.2.

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 m2) where a dedicated source meter complying with Section C405.12.3 is provided.

<table>
<thead>
<tr>
<th>LOAD CATEGORY</th>
<th>DESCRIPTION OF ENERGY USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total HVAC system</td>
<td>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.</td>
</tr>
<tr>
<td>Interior lighting</td>
<td>Lighting systems located within the building.</td>
</tr>
<tr>
<td>Exterior lighting</td>
<td>Lighting systems located on the building site but not within the building.</td>
</tr>
<tr>
<td>Plug loads</td>
<td>Devices, appliances and equipment connected to convenience receptacle outlets.</td>
</tr>
<tr>
<td>Process load</td>
<td>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.</td>
</tr>
<tr>
<td>Building operations and other miscellaneous loads</td>
<td>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.</td>
</tr>
</tbody>
</table>

C405.12.3 Meters.
Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.12.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ±2 percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.12.4 and C405.12.5.

C405.12.4 Data acquisition system.
A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.12.2.

C405.12.5 Graphical energy report.
A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the energy consumption for each end-use category required by Section C405.12.2 at least every hour, day, month and year for the previous 36 months.