



Mechanical and Electrical Considerations

Designing and Constructing to 2021 IECC

May 31, 2023



Commercial Energy Code

–IECC Session 3 Part 1

Mechanical HVAC

Session 3 Part 2

Electric/Lighting

Instructor: Matt Belcher

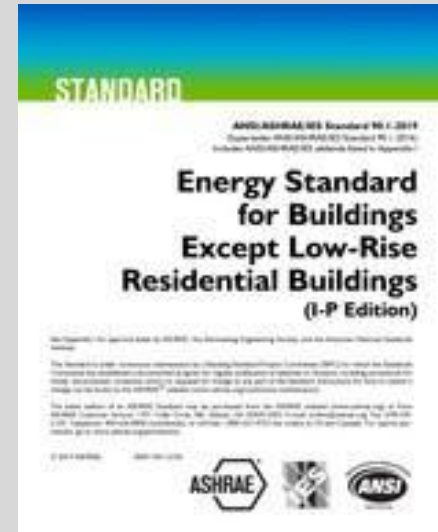
Tuesday, May 31st 11:00 AM-12:30 PM

Two Commercial Compliance Options

(new in 2018)



ASHRAE 90.1-2019
Alternative Method
to IECC





Correlation IECC and 90.1

(IECC Section/90.1 Section)

- Prescriptive and Alternative Envelope and component information/Tables; 402 / Section 5
- ***Mechanical Systems; 403 / Section 6***
- ***Service Water Heating; 404 / Section 7***
- ***Electrical Power and Lighting; 405 / Sections 8,9***
- Additional Energy Efficiency Options: 406 / 11, App G
- Total Building Performance; 407 / Per Section
- Building Maintenance and Commissioning; 408 / Per Section

The Energy Code is Everywhere



- Unlike most other codes, the energy code directly impacts the work of many disparate building trades and systems, including:
 - Framing/Envelope
 - Plumbing
 - HVAC
 - Electric
 - Moisture management
 - Concrete
 - Caulking



IECC and IBC

- Chapter 13 in the International Building Code (IBC) references the energy efficiency requirements found in the IECC





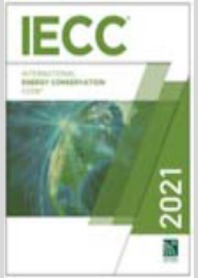
Section 6 – 6.1.1

HVAC Scope

- ✓ New Buildings
- ✓ Additions to Existing Buildings
- ✓ Alterations in Existing Buildings

- ✓ Throughout Section 6, when referring to controls requirements, replaces the words “capable of” with “**capable of and configured to**” so that controls will be set up at time of inspection.

HVAC 101: Load Calculations



- Sizes heating and cooling equipment.
- Accuracy is important!
 - Design conditions
 - Building shell load
 - R/U value
 - Solar heat gain
 - Internal load
 - Ventilation load
 - Infiltration
 - Occupancy schedules
 - **ASHRAE / ACCA 183**
or by an approved equivalent computational procedure using the design parameters specified in [Chapter 3](#)

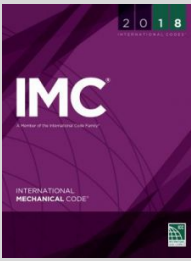


C403.2 System design

Mechanical systems shall be designed to comply with Sections C403.2.1 through C403.2.3. Where elements of a building's mechanical systems are addressed in Sections C403.3 through C403.14, such elements shall comply with the applicable provisions of those sections.

- **C403.2.1 Zone isolation required**

C403.2.2 Ventilation



- Ventilation, either natural or mechanical, shall be provided in accordance with [Chapter 4](#) of the *International Mechanical Code*. Where mechanical ventilation is provided, the system shall provide the capability to reduce the outdoor air supply to the minimum required by [Chapter 4](#) of the *International Mechanical Code*.

C403.1 General.

Mechanical systems and equipment serving the building heating, cooling, ventilating or refrigerating needs shall comply with this section.

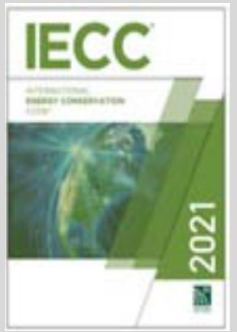
Exception:

Data center systems are exempt from the requirements of [Section C403.4](#) and [C403.5](#).

C403.1.2 Data centers. P

1. Data center systems shall comply with Sections 6 and 8 of [ASHRAE 90.4](#) with the following changes:
 1. Replace design mechanical load component (MLC) values specified in Table 6.2.1.1 of the [ASHRAE 90.4](#) with the values in [Table C403.1.2\(1\)](#) as applicable in each climate zone.
 2. Replace annualized MLC values specified in Table 6.2.1.2 of the [ASHRAE 90.4](#) with the values in [Table C403.1.2\(2\)](#) as applicable in each climate zone





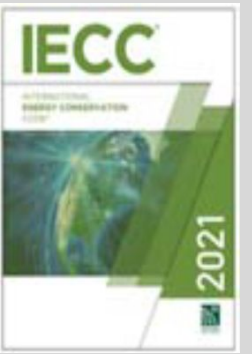
Updates to Tables

- **TABLE C403.1.2(1)**
MAXIMUM DESIGN MECHANICAL LOAD COMPONENT (DESIGN MLC)

CLIMATE ZONE: 4A	DESIGN MLC AT 100% AND AT 50% ITE LOAD: 0.23
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- **TABLE C403.1.2(2)**
MAXIMUM ANNUALIZED MECHANICAL LOAD COMPONENT (ANNUALIZED MLC)

CLIMATE ZONE 4A	HVAC MAXIMUM ANNUALIZED MLC AT 100% AND AT 50% ITE LOAD 0.17
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Ventilation Air – DOAS 6.5.2.6/ C403.5: Exceptions

Ventilation Air (DOAS) Heating Control

Units that provide *ventilation* air to multiple zones and operate in conjunction with zone heating and cooling *systems* shall not use heating or heat recovery to warm supply air above 60°F when:

- representative *building* loads or *outdoor air* temperature indicate that the majority of zones require cooling

This saves energy use by taking advantage of “free cooling”

- *Uses cool outside air when there is a benefit to many zones in the building*
- *Avoids mechanically cooling air that was preheated at the DOAS unit*



HVAC Updates from 2018

C403.2.1 Zone isolation **required.**

^P HVAC systems serving zones that are over 25,000 square feet (2323 m²) in floor area or that span more than one floor and are designed to operate or be occupied non-simultaneously shall be divided into isolation areas

C403.2.2 Ventilation.

^P Ventilation, either natural or mechanical, shall be provided in accordance with Chapter 4 of the *International Mechanical Code*. Where mechanical ventilation is provided, the system shall provide the capability to reduce the outdoor air supply to the minimum required by Chapter 4 of the *International Mechanical Code*.

C403.2.3 Fault detection and diagnostics.

- New buildings with an HVAC system serving a gross conditioned floor area of 100,000 square feet (9290 m²) or larger shall include a fault detection and diagnostics (FDD) system to monitor the HVAC system's performance and automatically identify faults.

The FDD system shall:

1. Include permanently installed sensors and devices to monitor the HVAC system's performance.
2. Sample the HVAC system's performance at least once every 15 minutes.
3. Automatically identify and report HVAC system faults.
4. Automatically notify authorized personnel of identified HVAC system faults.
5. Automatically provide prioritized recommendations for repair of identified faults based on analysis of data collected from the sampling of HVAC system performance.
6. Be capable of transmitting the prioritized fault repair recommendations to remotely located authorized personnel.

- **Exception:**R-1 and R-2 occupancies.



C403.3.2 HVAC equipment performance requirements



New Tables 2021:



TABLE C403.3.2(1)
ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND
CONDENSING UNITS—MINIMUM EFFICIENCY REQUIREMENTS ^{c, d}

TABLE C403.3.2(2)
ELECTRICALLY OPERATED AIR-COOLED UNITARY HEAT PUMPS—MINIMUM EFFICIENCY
REQUIREMENTS ^{c, d}

TABLE C403.3.2(3)
WATER-CHILLING PACKAGES—MINIMUM EFFICIENCY REQUIREMENTS ^{a, b, e, f}

C403.3.2HVAC equipment performance requirements New Tables 2021:



TABLE C403.3.2(4)

ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS, PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS, SINGLE-PACKAGE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS—MINIMUM EFFICIENCY REQUIREMENTS^e



TABLE C403.3.2(5)

WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS, WARM-AIR DUCT FURNACES AND UNIT HEATERS—MINIMUM EFFICIENCY REQUIREMENTS^g

TABLE C403.3.2(6)

GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTSⁱ

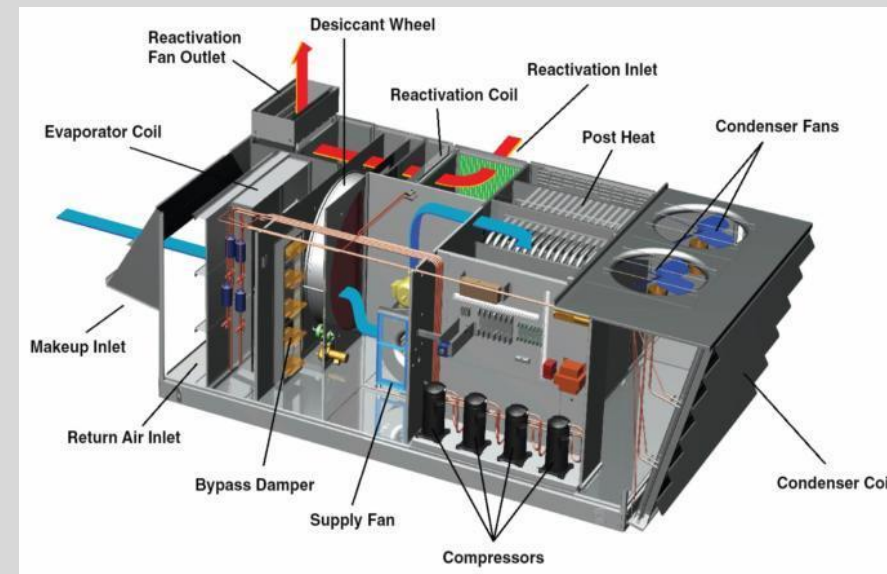
Many Other Tables Brought into IECC '21 Section 4 from ASHRAE 90.1 '19 Section 6

HVAC: DOAS



- Dedicated Outdoor Air Systems (DOAS)
 - Secondary air systems that regulate temperature, humidity, and gasses in buildings.
- A typical DOAS configuration
 - Shown to the right:

Typical DX-DOAS (Air Cooled)



Tables 403.3.2 now in IECC '21



C403.4.1.1 Heat pump supplementary heat.

P

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.

C403.4.2.3 Automatic start and stop.



P
E

Automatic start controls shall be provided for each HVAC system. The automatic start controls shall be configured to automatically adjust the daily start time of the HVAC system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy. **Automatic stop controls shall be provided for each HVAC system with direct digital control of individual zones. The automatic stop controls shall be configured to reduce the HVAC system's heating temperature setpoint and increase the cooling temperature setpoint by not less than 2°F (-16.6°C) before scheduled unoccupied periods based on the thermal lag and acceptable drift in space temperature that is within comfort limits.**

C403.7.4 Energy recovery systems.

Energy recovery ventilation systems shall be provided as specified in either [Section C403.7.4.1](#) or [C403.7.4.2](#), as applicable.

C403.8 Fans and fan controls.

Fans in HVAC systems shall comply with [Sections C403.8.1](#) through [C403.8.6.1](#).

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.

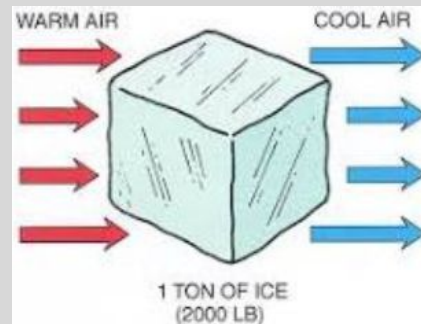
C403.9 Large-diameter ceiling fans.

Where provided, large-diameter ceiling fans shall be tested and labeled in accordance with [AMCA 230](#)



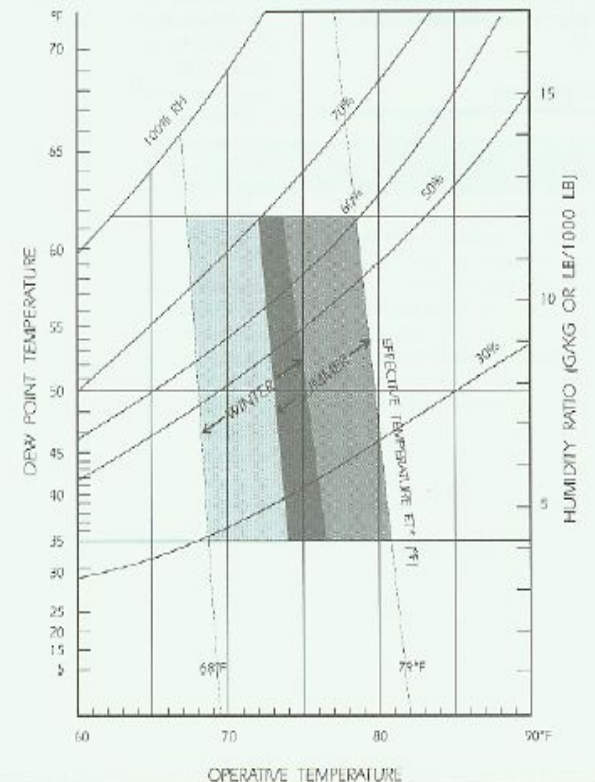
Load Calculations are Mandatory

- Must calculate heating and cooling system design loads
- Must base calculations on generally accepted engineering standards and handbooks – ASHRAE / ACCA 183
- Other approved computation procedures
- Outdoor design conditions
 - Specified by ASHRAE
- Interior design conditions
 - Specified the IECC
 - $\leq 72^{\circ}\text{F}$ for heating load
 - $\geq 75^{\circ}\text{F}$ for cooling load



1 ton = 12,000 Btu/hr

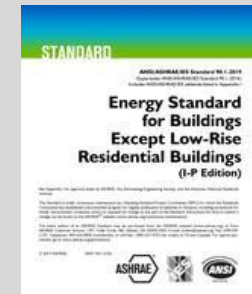
Figure 7-A The ASHRAE Comfort Envelope



IECC C 404 Service Water Heating



ASHRAE 90.1-2019 Section 7

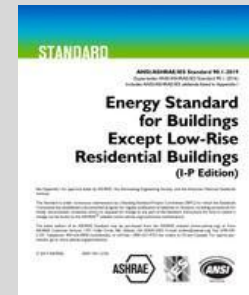


- Minimal Changes Mostly Editorial in nature
- New Table C404.5.2.1 *Water Tubing Volume*

IECC C 405 Lighting and Power



ASHRAE 90.1-2019 Sections 8 & 9



Many Changes to:

- Descriptions,
- Automation/Controls
- Updated Numbers in Tables
- Better descriptions for Daylighting and Daylight Zones

When do the Lighting and Power Requirements Apply?



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

Exceptions:

- Alterations where less than 10% of the luminaires in a space are replaced and installed interior power lighting is not increased
- Lighting within dwelling units
 - Where $\geq 75\%$ of permanently installed fixtures (except low-voltage) are fitted for and include high-efficacy lamps

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.

Electrical Lighting and Power Systems Requirements

- Mandatory Interior Lighting requirements
 - Required Controls
 - Wattage/Efficiency Limits
- Interior Lighting Power Allowances (watts/ft²)
- Exterior Lighting Controls
 - Required Controls
 - Lamp Efficiency
- Exterior Lighting Power Allowances (watts/ft²)
- Dwelling Electric Meters
- Electrical Transformers and Motors
- Vertical and Horizontal Transportation Systems and Equipment



Image: U.S. Dept of Energy

High-Efficacy Lamps: Definition

- Compact fluorescent lamps, LED lamps, T8 or smaller diameter linear fluorescent lamps, or other lamps with an efficacy based on lamp wattage

Lamp Wattage	Efficacy
> 40 watts	60 lumens/watt
15-40 watts	50 lumens/watt
< 15 watts	40 lumens/watt

NOTE: You can now get a 100w LED equivalent bulb with ~100 lumens/watt



Interior Lighting Power Allowance

Section C405.3.2

Two methods to determine Lighting Power Allowance:

- Building Area Method (C405.3.2.1)
 - 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
- Space-by-Space Method (C405.3.2.2)
 - Floor area of each space x value for the area
 - Then sum the allowances for all the spaces
 - Some tradeoffs among spaces are allowed

Updates/Changes/Additions to C405.2

- **C405.2.4 Daylight-responsive controls**
- **C405.2.4.1 Daylight-responsive control function.**
- **C405.2.4.2 Sidelit daylight zone.**
- **C405.2.4.3 Toplit **daylight** zone.**
- **C405.2.4.4 Atriums.**



Updates/Changes/Additions to C405.2

• C405.2.8 Parking garage lighting control (New)

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.

C405.5.2 Exterior lighting power allowance.

The exterior lighting power allowance (watts) is calculated as follows:

1. Determine the Lighting Zone (LZ) for the building according to [Table C405.5.2\(1\)](#), unless otherwise specified by the code official.
2. For each exterior area that is to be illuminated by lighting that is powered through the energy service for the building, determine the applicable area type from [Table C405.5.2\(2\)](#). For area types not listed, select the area type that most closely represents the proposed use of the area.
3. Determine the total area or length of each area type and multiply by the value for the area type in [Table C405.5.2\(2\)](#) to determine the lighting power (watts) allowed for each area type.
4. The total exterior lighting power allowance (watts) is the sum of the base site allowance determined according to [Table C405.5.2\(2\)](#), plus the watts from each area type.

Updates/Changes/Additions to C405.5,7,8

- **C405.5.2.1** Additional exterior lighting power.
- **C405.5.3** Gas lighting.
- **C405.7** Electrical transformers.

Renumbered/Clarified Tables for Motors

- **TABLE C405.7**
- **TABLE C405.8(1)**
- **TABLE C405.8(2)**
- **TABLE C405.8(3)**
- **TABLE C405.8(4)**



Updates/Changes/Additions to C405.9

- **C405.9** Vertical and horizontal transportation systems and equipment.
- **C405.9.1** Elevator cabs.
- **C405.9.2** Escalators and moving walks
- **C405.9.2.1** Energy recovery.

Escalators shall be designed to recover electrical energy when resisting overspeed in the down direction. The escalator shall be designed to recover, on average, more power than is consumed by the power recovery feature of its motor controller system.



And *finally*: Changes/Additions to C405 (Almost completely New!)

- **C405.10 Voltage drop (Added Requirement)**
- **C405.11 Automatic receptacle control. (New)**
- **C405.11.1 Automatic receptacle control function. (New)**
- **C405.12 Energy monitoring. (New)**
- **C405.12.1 Electrical energy metering. (New)**
- **C405.12.2 End-use metering categories. (New)**
- **TABLE C405.12.2: ENERGY USE CATEGORIES (New)**
- **C405.12.3 Meters. (New)**
- **C405.12.4 Data acquisition system.(New)(3 Yr storage of data)**
- **C405.12.5 Graphical energy report.**

*In Two
Weeks:*

Commercial Energy Code

–IECC Session 4 Part 1

Com Check

Session 4 Part 2

Advanced Technology

Instructor: Matt Belcher

Tuesday, June 14th 11:00 AM-12:30 pm

Don't Forget to Register!

www.be-exkc.org/news

Designing + Building to **2021 IECC**

April 10th: Gear Up for 2021 IECC Kick-Off Event

May 3rd: Commercial Energy Code Basics*

May 17th: Digging into IECC vs. ASHRAE*

May 31st: Mechanical and Electrical Considerations*

June 14th: ComCheck + Advanced Technology*

***1.5 AIA Credits Each**

May 3rd-June 14th are virtual events, April 10th is in-person



Questions? Contact: Ashley Sadowski, asadowski@be-exkc.org



Commercial Energy & Building Codes Updates and Applications;

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