METROPOLITAN
Community College

The Commercial Energy Code: Session 4

Mechanical and HVAC Rightsizing

Instructors: Thomas Yarbrough & Matt Belcher

Tuesday, January 31, 6-8p.m.

Housekeeping

- Attendees are muted upon entry
- Questions? Enter them in the chat box
- Webinar is being recorded – slides and recording will be sent to attendees
- CEUs available for AIA and ICC
- Email canderson@mwalliance.org with questions
- Course information available at: https://www.mwalliance.org/metropolitan-community-college-energy-code-course

Today's Guest Lecturer

- Thomas Yarbrough

- Professor at the University of Missouri School of Science and Technology

Learning Objectives

- Understand prescriptive energy code requirements and updates from 2018 IECC for Mechanical Equipment and Systems
- Understand ASHRAE 90.1 Section 6 as an Alternative
- Understand proper equipment sizing and commissioning to assure “right-sized” HVAC systems

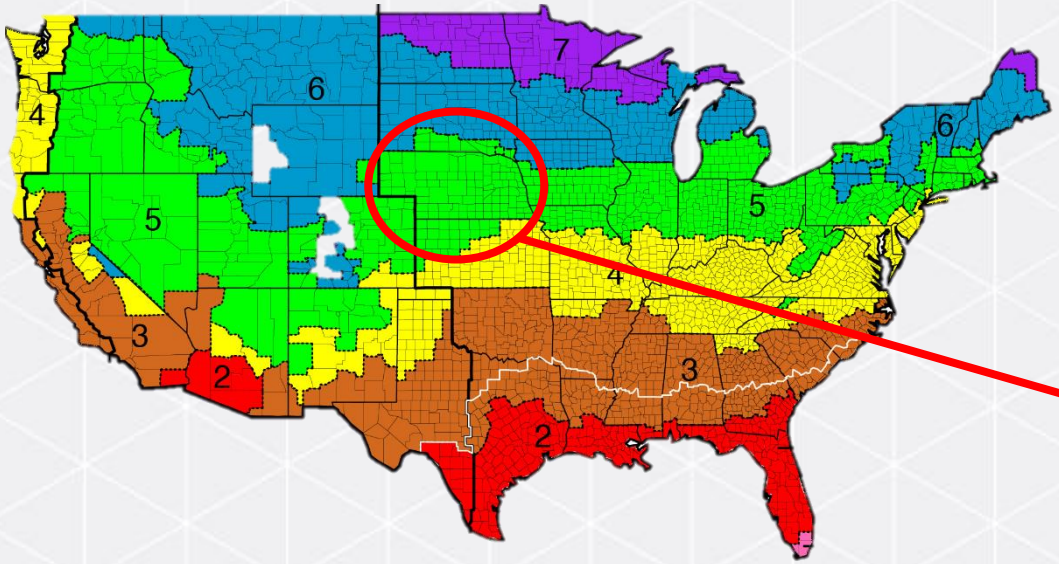
Nebraska Residential Field Study

- Conducted in 2017 by Nebraska Department of Environment and Energy. 2009 IECC was the baseline.
- Collected and analyzed several data points for new homes, including:
  - Envelope air leakage
  - Efficacy in lighting
  - Duct leakage
  - Ceiling & exterior wall insulation
  - Basement & slab insulation
  - Windows

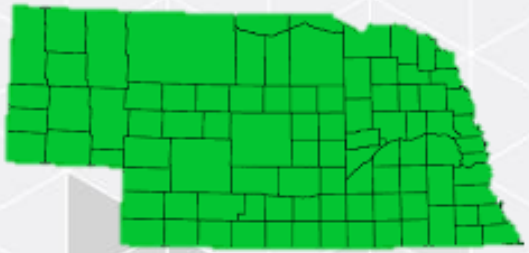
For More Information and Data:

https://www.energycodes.gov/sites/default/files/documents/Nebraska_Residential_Compliance_Evaluation_final.pdf

Climate Zones



- Nebraska has only one climate zone – 5A
- Cold & Moist climate

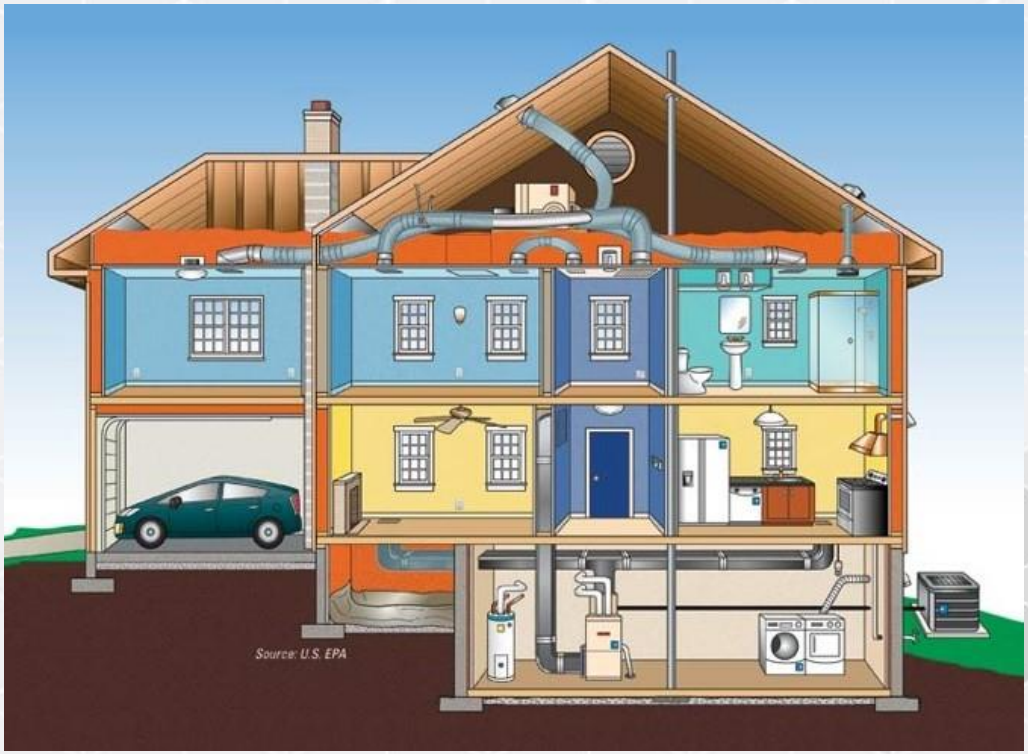


Building Thermal Envelope

IECC Definition

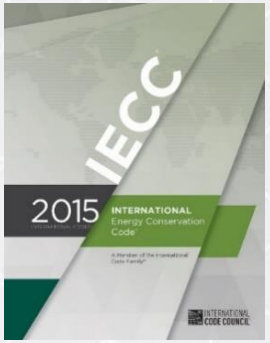
The basement walls, exterior walls, floor, roof and any other building elements that enclose conditioned space or provide a boundary between conditioned space and exempt or unconditioned space.

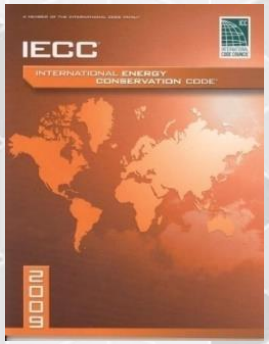
What parts of this Building are enclosed by the thermal envelope?



Scope of the Energy Code

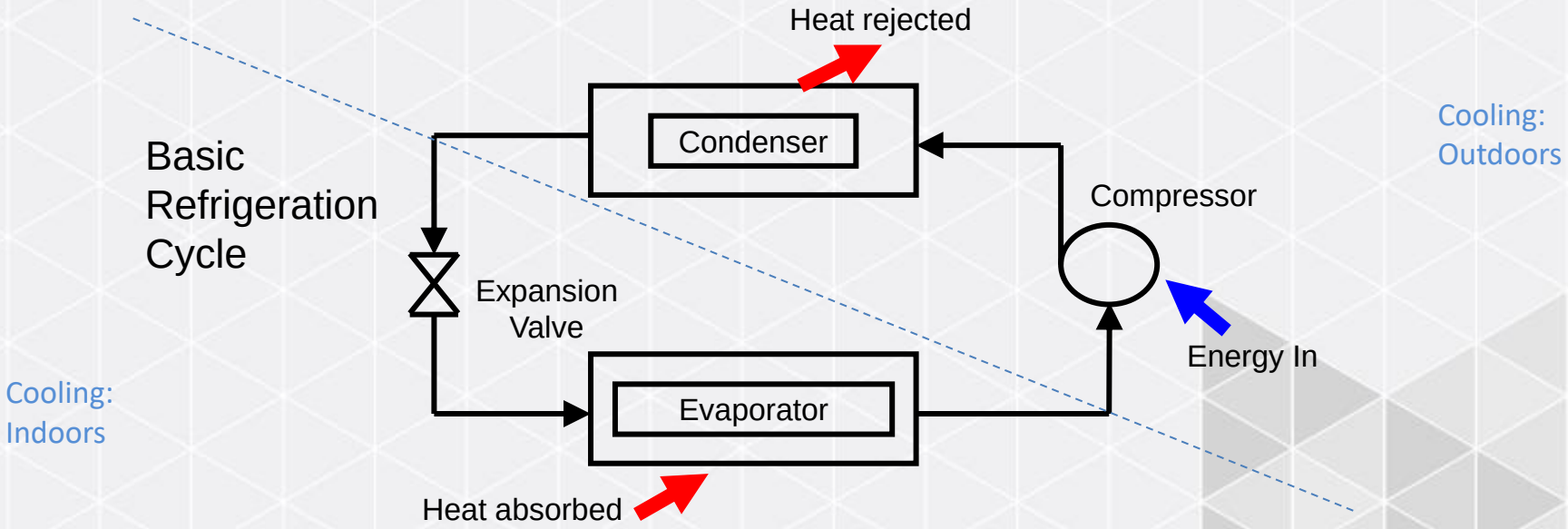
- Focus is on building envelope
  - Ceilings, walls, windows, floors, foundations
  - Sets insulation levels, window U-factors and SHGC
  - Infiltration control
    - Caulk and seal to prevent air leaks
    - Verify envelope tightness with blower door test
    - Ducts
  - No building cavities as ducts (post-2009)
  - Seal properly and insulate even if all ductwork is in conditioned space
  - Verify tight with duct pressurization test
- Lighting equipment
  - High-efficacy bulbs required (50%, 75%, 90%)
- HVAC equipment efficiencies covered by different DOE standard





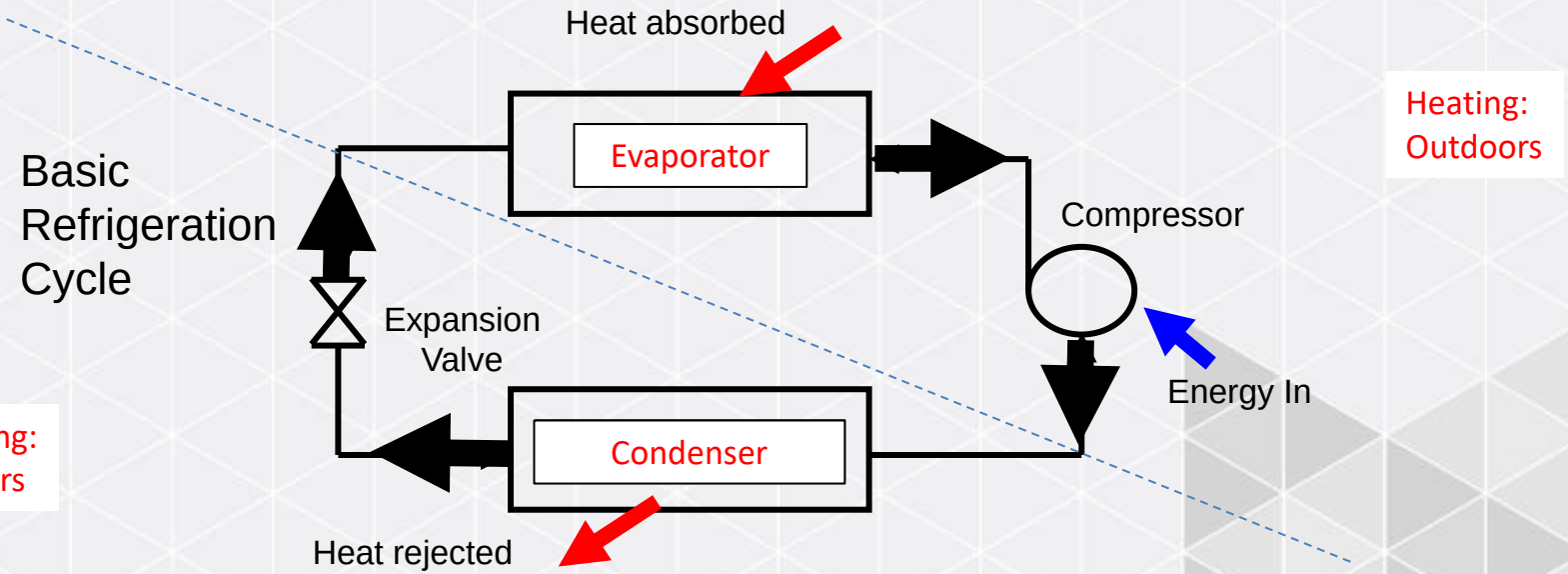
HVAC 101: Basic Concepts

- Heating, Ventilation and Air Conditioning
- Provides *comfort* for people
- Allows humans to *exist* under adverse conditions



HVAC 101: Basic Concepts

- Heat pump in heating mode – compressor drives refrigerant in opposite direction (by means of a reversing valve)

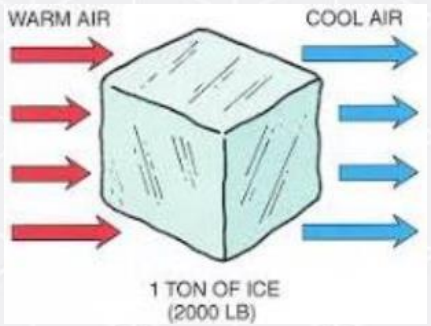


HVAC 101: Load Calculations

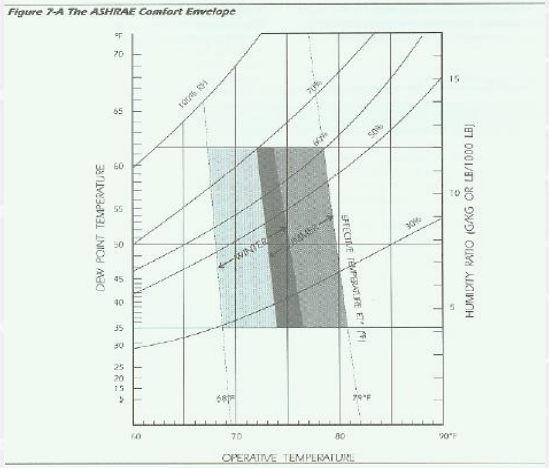
- Sizes heating and cooling equipment.
- Accuracy is important!
  - Design conditions
  - Building shell load
  - R/U value
  - Solar heat gain
  - Internal load
  - Ventilation load
  - Infiltration
  - Occupancy schedules

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 (e.g., Lincoln, NE 2°F winter, 93°F summer)
- Interior design conditions
  - Specified the IECC
  - ≤ 72°F for heating load
  - ≥ 75°F for cooling load



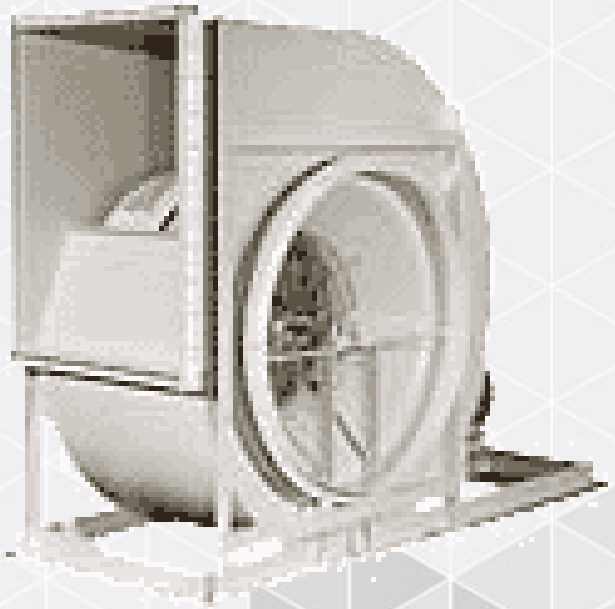
1 ton = 12,000 Btu/hr



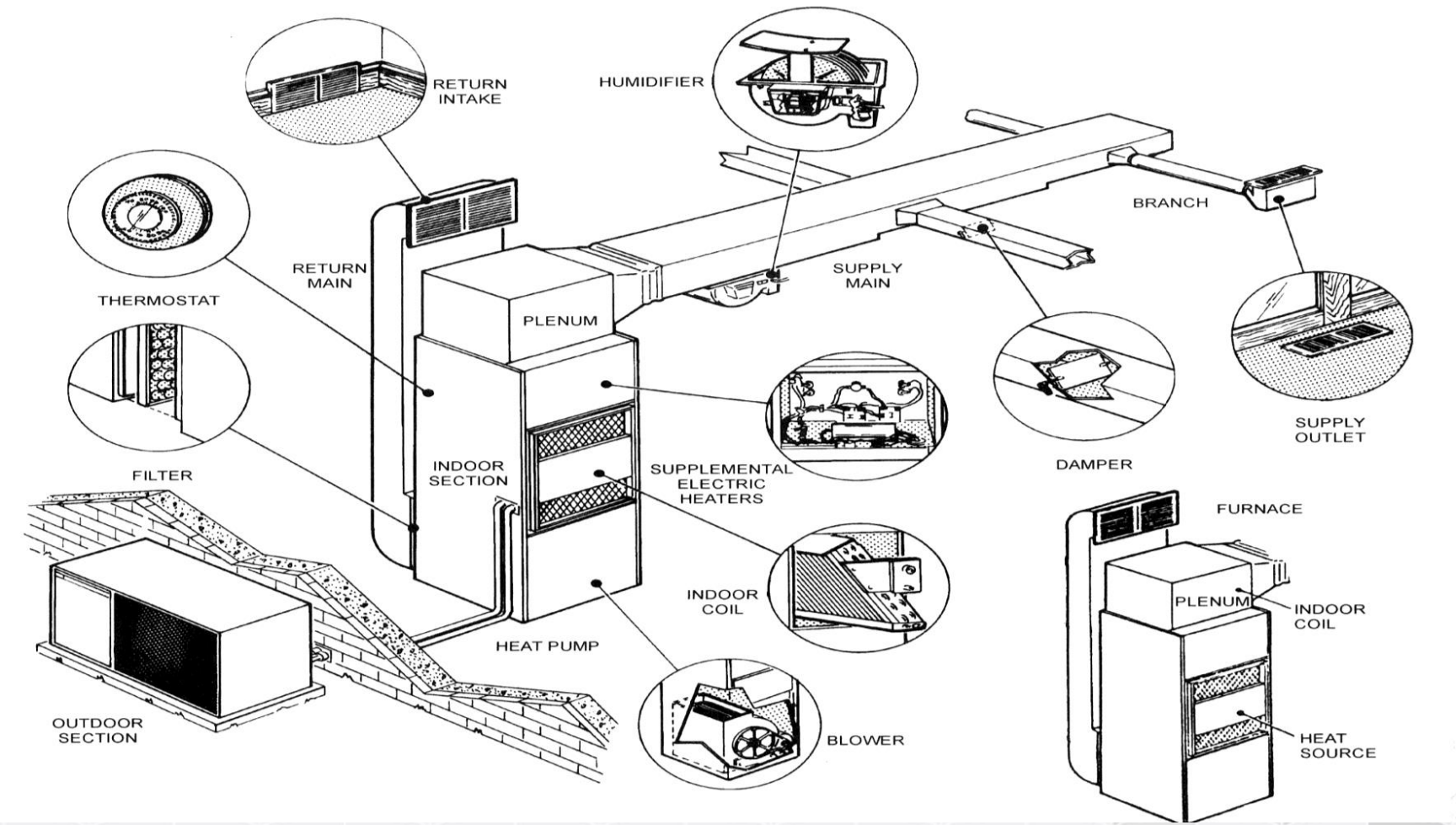
HVAC 101: Components

Basic HVAC Equipment

- Fans / Blowers
- Furnace / Heating unit
- Filters
- Compressor
- Condensing units
- Evaporator (cooling coil)
- Control System
- Air Distribution System

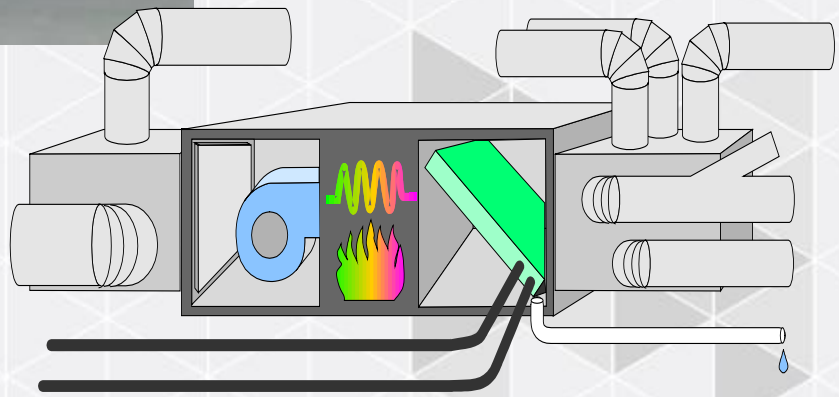


HVAC 101: Anatomy of a Split System



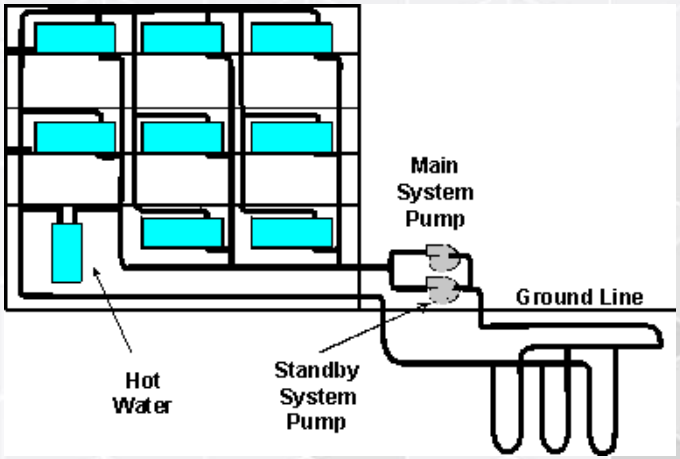
HVAC 101: System Types

Packaged versus Split Systems



HVAC 101: Heat Pumps

- Operate on basic refrigeration cycle
- Reversing the cycle provides heating
- Temperature limitations
- Extract/Reject heat
  - Air to air
  - Geothermal
  - Lake coupled
- Water source



HVAC 101 – Using Water to Move Heat

Hydronic Systems

- Pumps
- Piping
- Valves
- Coils

HVAC 101: Large Systems

Major Equipment

- Chillers
- Boilers
- Cooling Towers

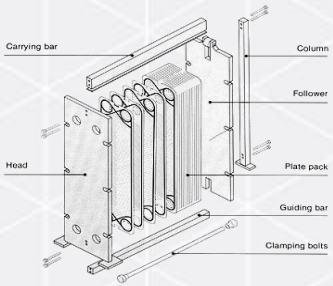
HVAC 101: Controls

Control Devices

- Thermostats
  - Manual
  - Programmable
- DDC Systems
- Automatic Valves and Dampers
- Outdoor Sensors
- Optimum Start
- Variable Speed Drives

HVAC 101: Economizers

Air Side



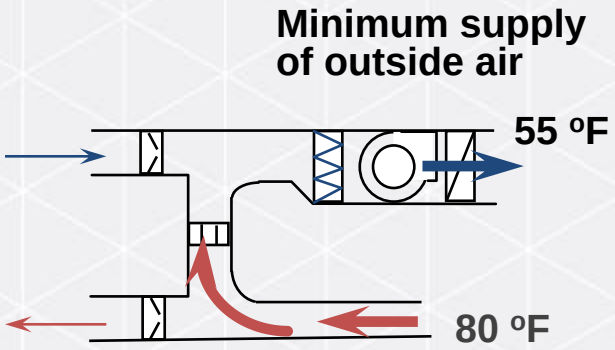
Water Side

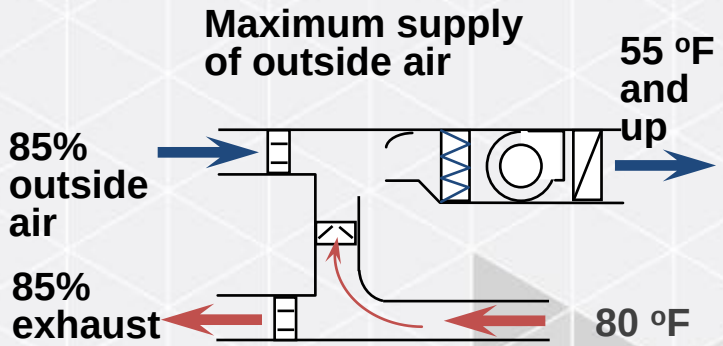
Normal Operation

Outside air dampers provide minimum outside air

Economizer Operation

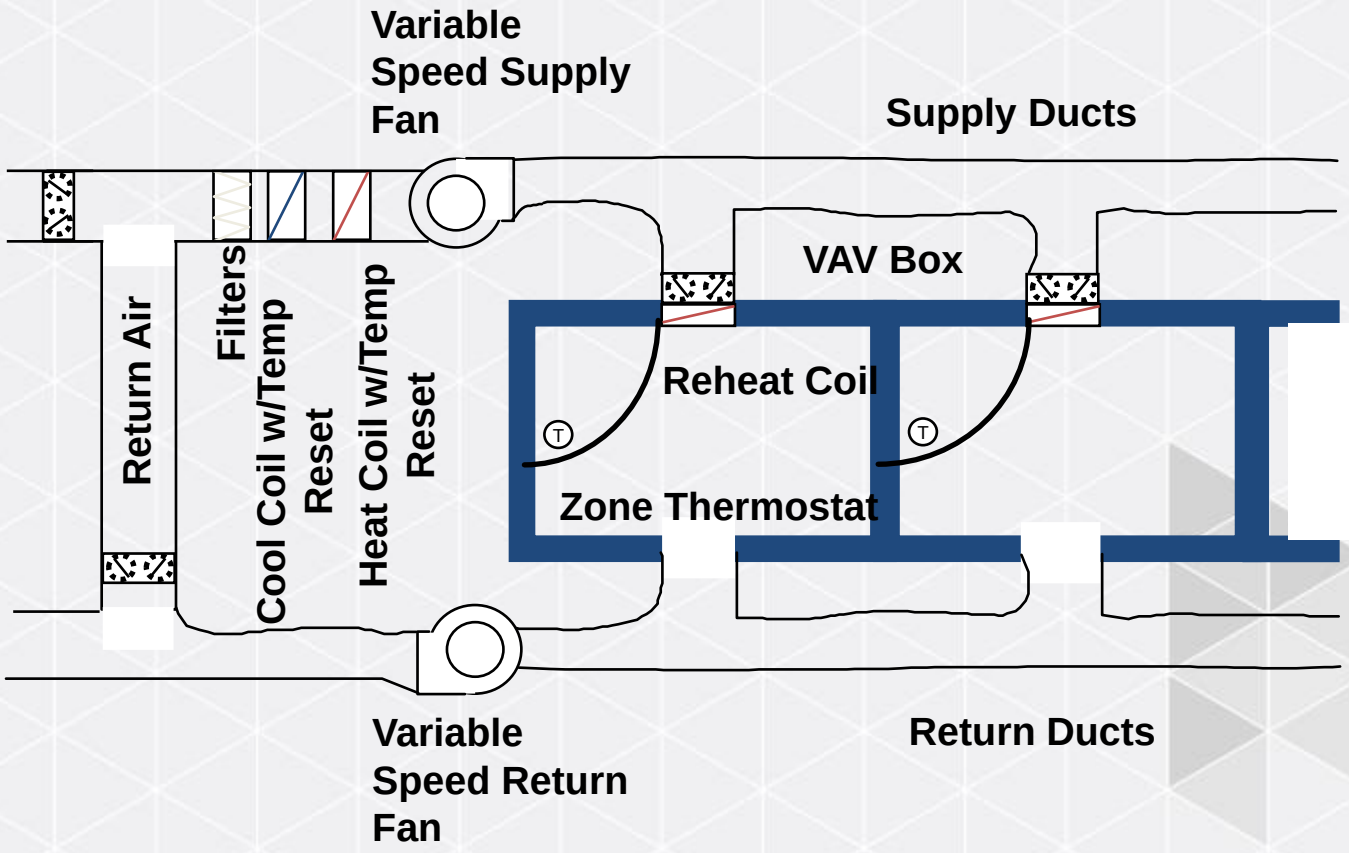
Outside air dampers are open to provide maximum outside air





HVAC 101: Distribution

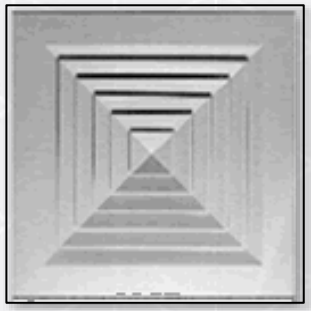
Variable Air Volume



HVAC 101: Distribution

Air Distribution

- Ductwork
  - Metal
  - Flexible
  - Ductboard
- Grilles, Louvers, & Registers
- Dampers
  - Shut off
  - Fire
  - Smoke
- Sealants
- Supports
- UFAD



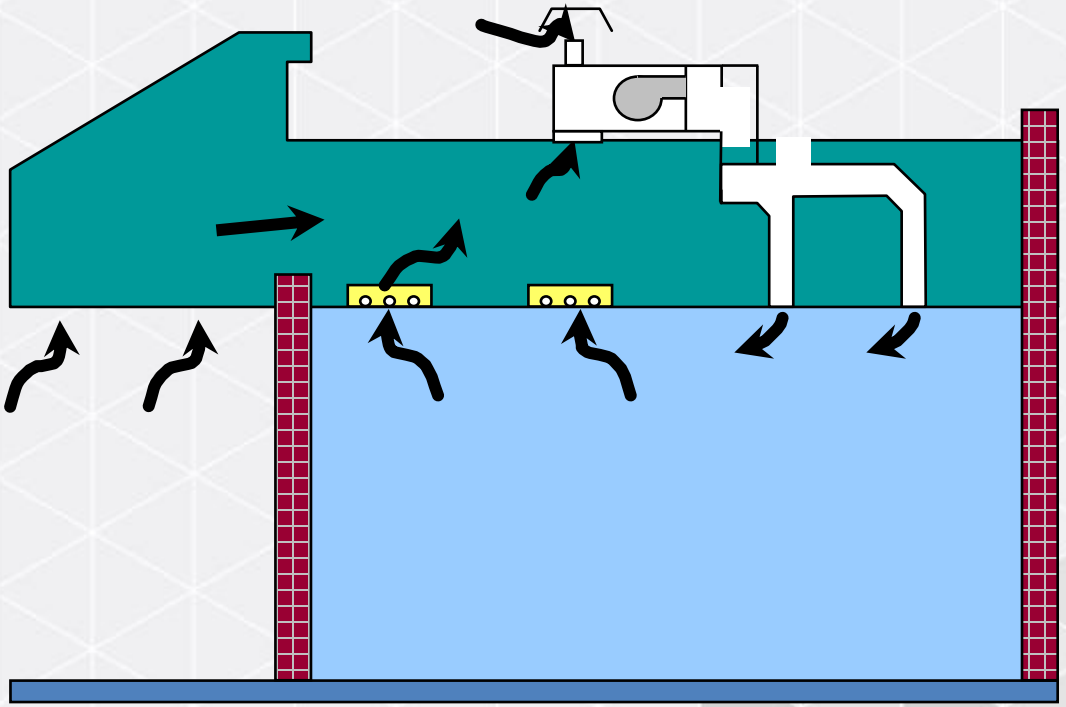
Impacts of Non-Ducted Return Air Plenums

- Reduced HVAC system costs of about 10% to 20% of the total HVAC system cost.
- Reduced efforts for coordination of overhead utilities.
- Assumed reduced fan energy costs due to lower pressure drop of the plenum return system.

Photo by Yuji Sakai

Problems of Non-Ducted Return Air Plenums

What could possibly go wrong here?



Problems of Non-Ducted Return Air Plenums

- Cavities above suspended ceilings are used as equipment tunnels and chases causing major air leakage
- These areas are highly (de)pressurized, which exacerbates the air leakage
- They are often adjacent to unconditioned spaces (storage, plant, warehouse, etc.)

Water, Water Everywhere

Roof leak or something else?

Please type in chat or unmute

QUESTIONS SO FAR?

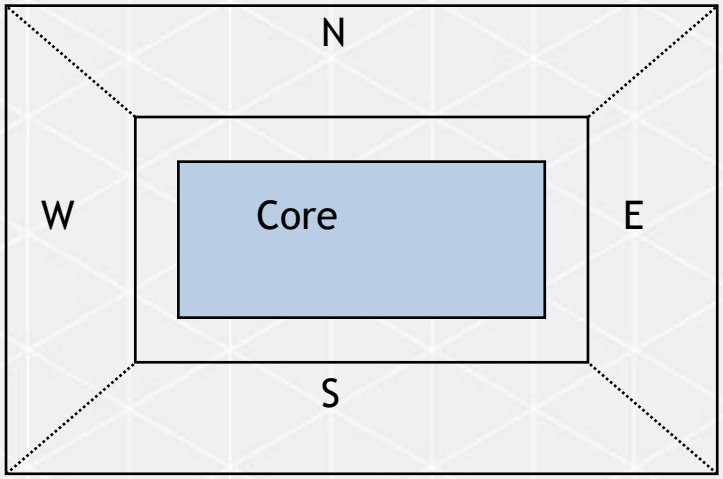
Plenum Insulation

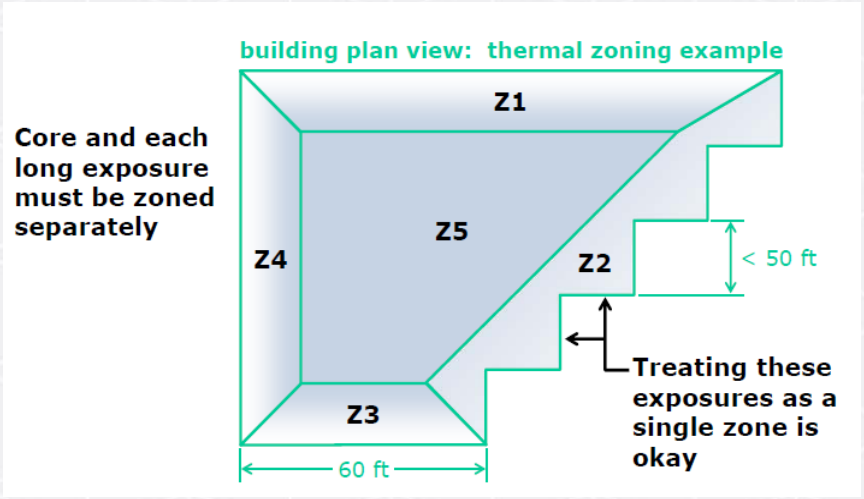
- C403.2.9 Duct and plenum insulation and sealing
- Supply and return air ducts and plenums shall be insulated with a minimum of R-6 insulation where located in unconditioned spaces and where located outside the building with a minimum of R-8.
- Where located within a building envelope assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by a minimum of R-8 insulation.

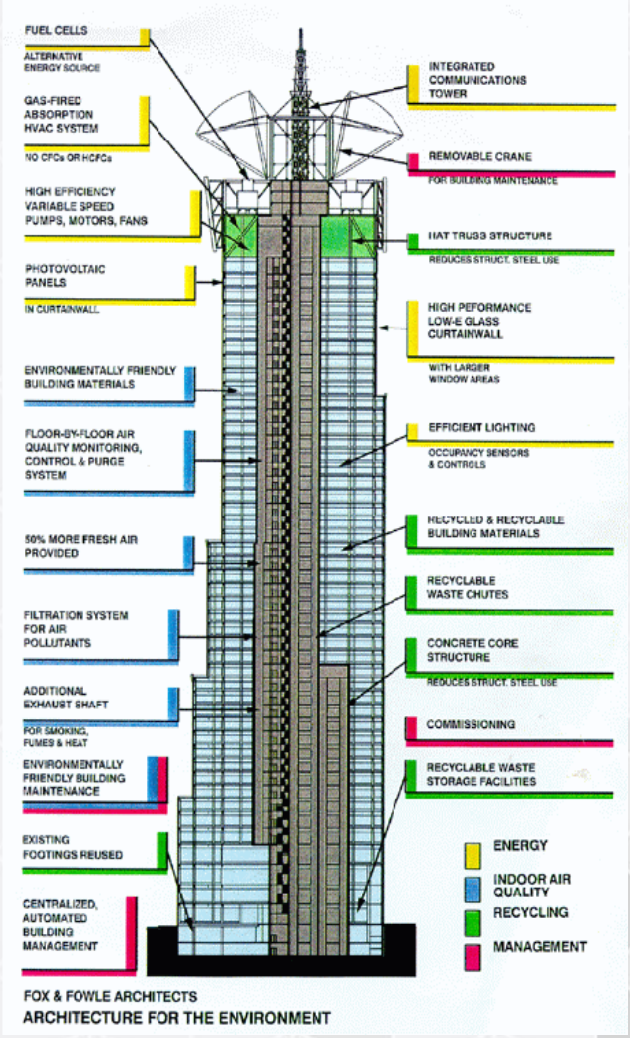
Healthcare Facilities

- The 2018 or later Facility Guidelines Institute standards were adopted in many states.
- Those standards **require** ducted returns in many healthcare-related facilities to reduce the spread of infections.

HVAC 101: Zones



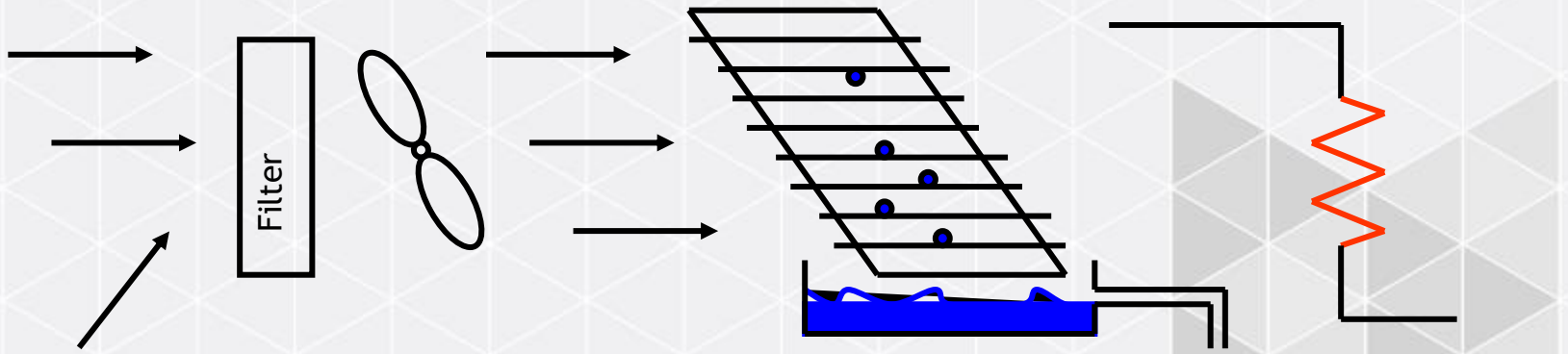




HVAC 101 – Moisture Removal

Mechanical Dehumidification

- Return air is mixed with ventilation air
- Cold coil condenses moisture
- Heat is sometimes added back (electric or gas) so that room air is not over cooled - Reheat



HVAC 101 – Energy Recovery

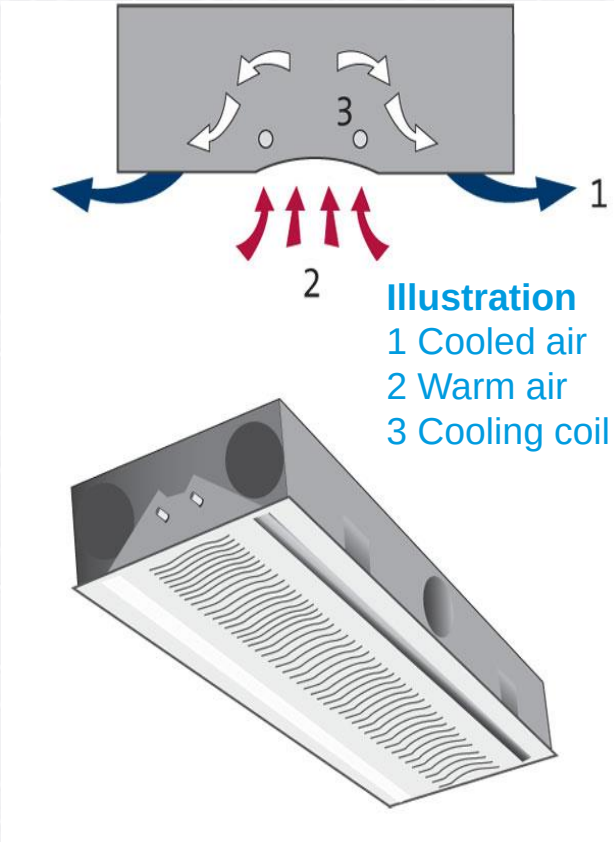
Additional Equipment

- Energy Recovery Units
- Desiccant Systems

HVAC 101: “New” Stuff

New Technologies

- Chilled beams
- Radiant cooling



HVAC 101: “New” Stuff

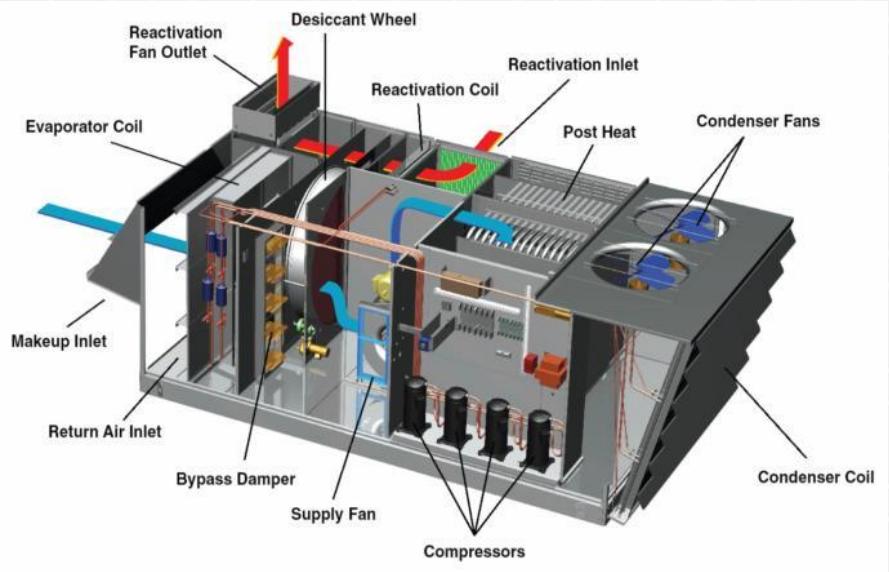
New Technologies

- VRF (variable refrigerant flow)
- Evaporative Mesh

HVAC 10: 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:

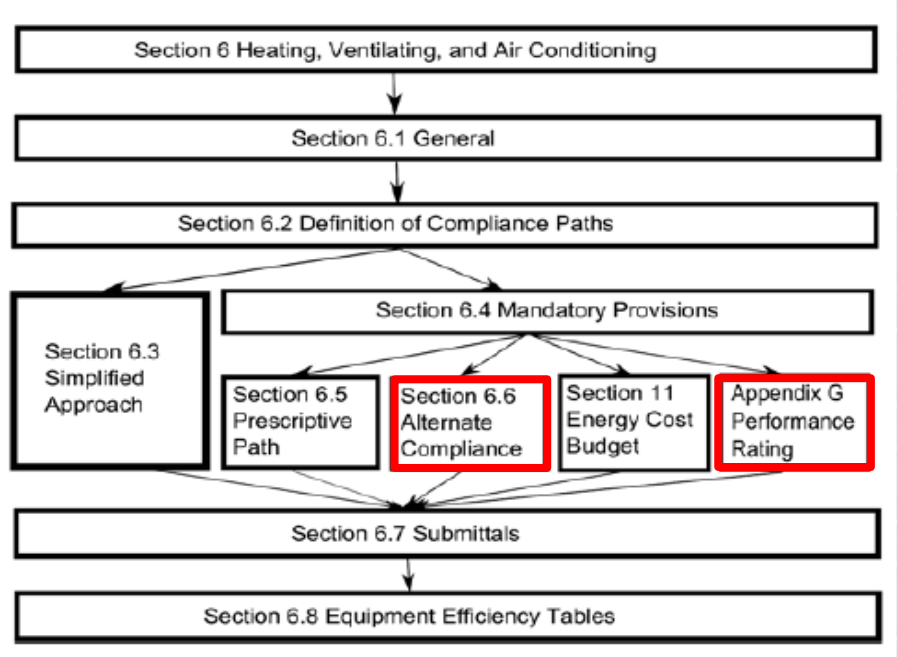
Typical DX-DOAS (Air Cooled)



New Compliance Pathways

- 6.6 Alternative Compliance Path (for Computer Rooms)
- Appendix G is a new alternative compliance pathway

ASHRAE 90.1-2019



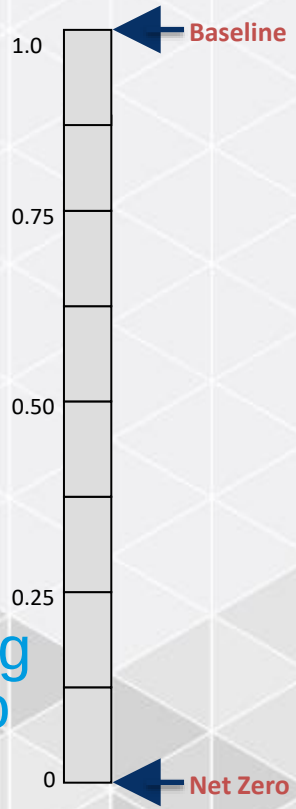
2 New Compliance Pathways added in 2016

Appendix G – Performance Rating

- Requires a Performance Cost Index (PCI) specific to building type and climate zone

$$PCI = \frac{Proposed\ Building\ Performance}{Baseline\ Building\ Performance}$$

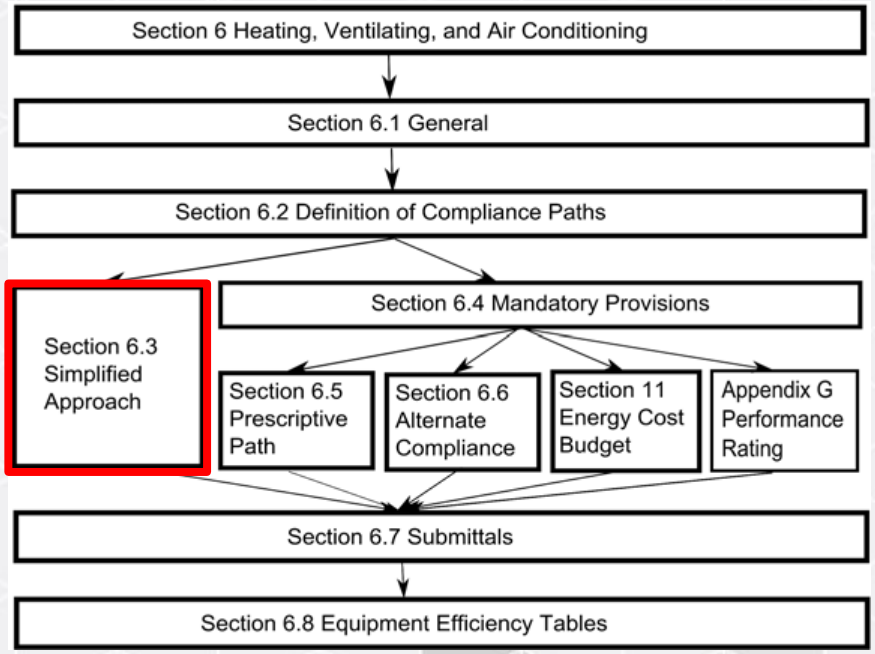
PCI of 1.0 = baseline building
PCI of 0.0 = zero net energy
For compliance, PCI < PCIt



- PCI is specified in standard and varies by building type, climate zone, and proportion of regulated to unregulated load

Mechanical Compliance

- Simplified Approach is still the easiest pathway
- According to the Department of Energy, 80 to 85% of the building stock is this type of building



90.1 Simplified Approach Option for HVAC Systems

Must meet these criteria:

- Building is two stories or fewer in height.
- Gross floor area is less than 25,000 sq. ft.
- System serving single HVAC zone
- Each HVAC system in the building must comply with all 19 requirements.

Next Week

- February 7, 2023, 6-8p.m.
- Topic: IECC vs. ASHRAE
- Contact Matt with Questions: matt@verda-solutions.com

SEE YOU NEXT WEEK!