



## 2012 IECC Commercial Mechanical Requirements

July 2011

# Commercial Compliance Options

1

● 90.1-2010

OR

2

- C402 - Envelope
- C403 - Mechanical
- C404 - SWH
- C405 - Lighting

AND

- Pick One:

C406.2 – Eff. HVAC  
Performance

or

C406.3 – Eff. Lighting Systems

or

C406.4 – On-site Renewable  
Energy

OR

3

2012 IECC

- C407 – Total Building Performance
- C402.4 – Air Leakage
- C403.2 – Provisions applicable to all mechanical systems
- C404 - SWH
- Lighting Mandatory Sections
  - C405.2
  - C405.3
  - C405.4
  - C405.6
  - C405.7
- Building energy cost to be  $\leq 85\%$  of standard reference design building

2



# Additional Efficiency Package Options

## C406

- One additional efficiency feature must be selected to comply with the IECC
  - More efficient lighting system (consistent with 90.1-2010), OR
  - More efficient HVAC system, OR
  - Installation of onsite renewables
    - 3% of the regulated energy



High Efficiency HVAC



More Efficient Lighting System



Onsite Renewables

- Efficient HVAC performance per C406.2 **OR**
  - Per Tables C406.2(1) thru C406.2(7)
  - Only used when efficiencies in the above tables are greater than those in the efficiency tables in C403
- Efficient lighting system per C406.3 **OR**
  - Whole building LPD complies with C406.3.1
  - Determine total LPD of building using reduced whole building interior lighting power in Table 406.3 x floor area for the building types
- On-site supply of renewable energy per C406.4
  - Total minimum ratings to comply with
    - Provide  $\geq 1.75$  Btu or  $\geq 0.50$  watts per ft<sup>2</sup> of conditioned floor area OR
    - Provide  $\geq 3\%$  of energy used for mechanical and SWH equipment and lighting

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





# Does My Project Need to Comply with the IECC?

All Buildings Other Than:

- ✓ One- and two-family residential
- ✓ R-2, R-3, R-4 three stories or less in height



Codes and standards listed in Chapter are considered part of the requirements of this code to the “prescribed extent of each such reference and as further regulated in Sections C106.1.1 and C106.1.2”

- Conflicts, C106.1.1 – where differences occur between this code and the referenced codes and standards, provisions of this code apply
- Provisions in reference codes and standards, C106.1.2 – “where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard”



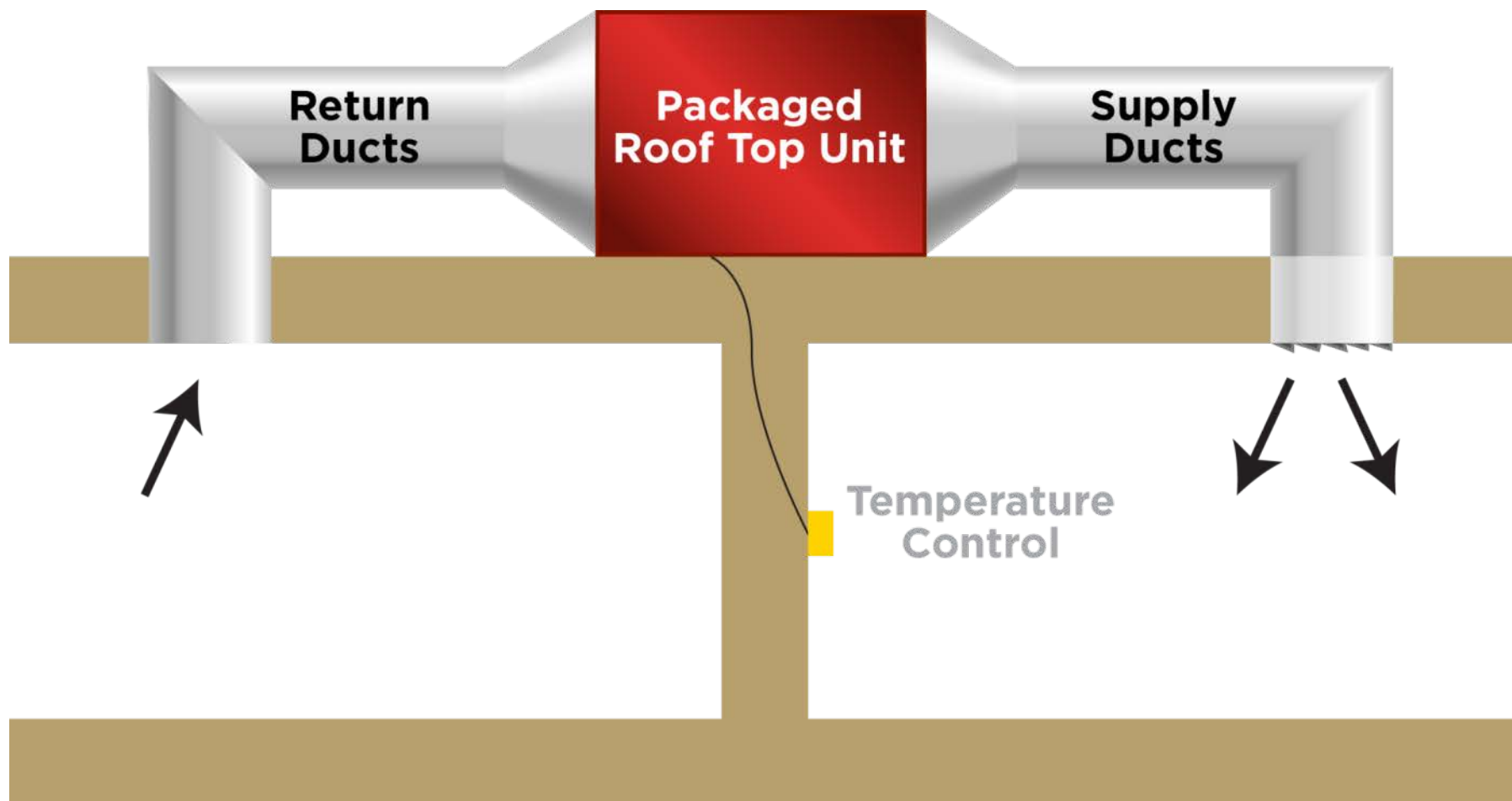
# Simple Versus Complex Systems

## Simple systems

- ✓ Unitary or packaged HVAC equipment
- ✓ Serves one zone and controlled by a single thermostat

### Section C403.3 Simple Systems

Buildings served by unitary or packaged HVAC each serving 1 zone controlled by 1 thermostat. Two-pipe heating systems serving multiple zones are included if no cooling system is installed [Tables C403.2.3(1) through C403.2.3(8)]



Simple System

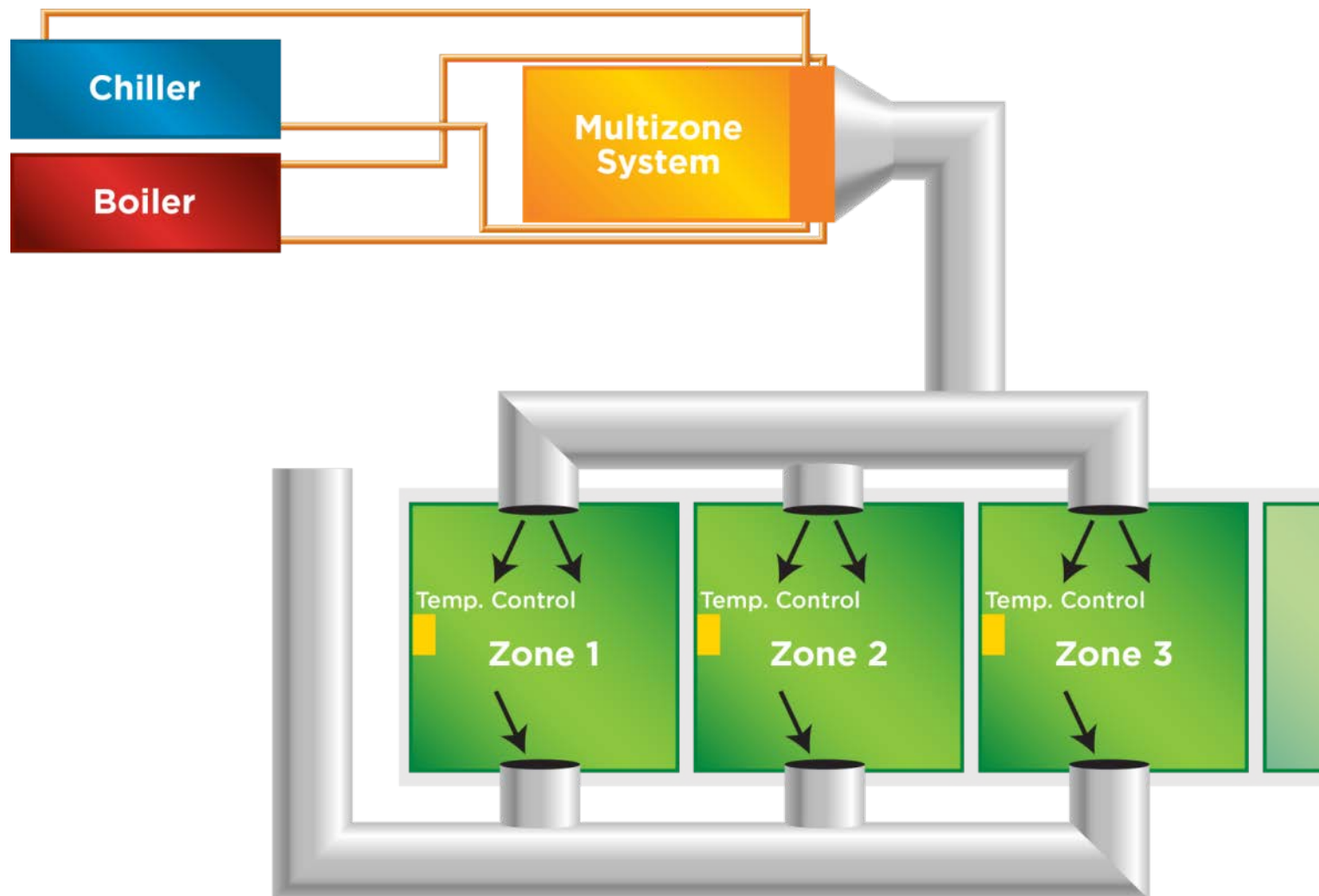


## Complex systems

- ✓ All equipment not covered under Section C403.3  
Simple Systems

Section  
C403.4  
**Complex  
Systems**

All buildings served  
by HVAC systems not  
covered under  
C403.3



### Provisions Applicable to ALL Mechanical Systems

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



# HVAC Load Calculations

## C403.2.1 Mandatory

Heating and cooling load sizing calculations required

- ✓ ASHRAE/ACCA Standard 183
- ✓ Other approved computation procedures – defined in Chapter 3
  - Interior design conditions
    - Specified by Section C302 of the IECC
      - $\leq 72^{\circ}\text{F}$  for heating load
      - $\geq 75^{\circ}\text{F}$  for cooling load



# Equipment and System Sizing

## C403.2.2 Mandatory

Output capacity SHALL NOT exceed sizing

- ✓ Select the system which serves the greater load, heating or cooling
  - **Exceptions**
    - Standby Equipment with Required Controls
    - Multiple Units with Combined Capacities Exceeding Loads
      - Sequencing Controls Required





# HVAC Performance

## C403.2.3 Mandatory Minimum Efficiency Requirements

Applies to all equipment used in heating and cooling of buildings

- ✓ Where components from different manufacturers are used
  - calculations & supporting data demonstrating combined efficiency meets requirements

Must comply with all listed efficiencies

- Equipment not designed for operation at AHRI Standard 550/590 test conditions of 44°F leaving chilled-water temperature and 85°F entering condenser water temperature with 3 gpm/ton condenser water flow
  - To have maximum full-load kW/ton and NPLV ratings adjusted using Equations 403 and 404
- Adjusted full-load and NPLV values only applicable for centrifugal chillers meeting all of these full-load design ranges
  - Leaving evaporator fluid temperature  $\geq 36^{\circ}\text{F}$
  - Leaving condenser fluid temperature  $\leq 115^{\circ}\text{F}$
  - LIFT is not less than 20°F and not greater than 80°F
  - **Exception**
    - Centrifugal chillers designed to operate outside of these ranges



# Table C403.2.3(2)

Mandatory

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

# Positive Displacement (Air- and Water-Cooled Chilling Packages)

## C403.2.3.2

- Equipment with a leaving fluid temperature  $> 32^{\circ}\text{F}$  to meet Table C403.2.3(7) when tested or certified with water at standard rating conditions, in accordance with the referenced test procedure



# System Controls

**C403.2.4.1** (Mandatory)

Control required for each system

✓ if zoned for each zone







### Heat pump systems

- ✓ Heat pump thermostat required when supplying electric resistance heating
- ✓ Control must prevent supplemental heat demand when heat pump can meet the heating load.
  - Except during defrost



# Controls (Mandatory)

## C403.2.4.2 Set Point Overlap Restriction

Thermostats must have at least a 5°F dead band

✓ **Exception**

- Thermostats requiring manual change over between heating and cooling



### Automatic time clock or programmable system

#### ✓ Exceptions

- Zones operated continually
- Zones with full HVAC load demand  $< 6,800$  Btu/h and has a readily accessible shut off switch

### Thermostatic setback capabilities

- ✓ Capability to maintain zone temps down to 55°F or up to 85°F

### Automatic setback and shutdown

- ✓ Seven different daily schedules/week
- ✓ Retain programming  $\geq 10$  hrs with loss of power **AND**
  - ✓ Manual override up to 2 hours **OR**
  - ✓ Manual timer capable of operating up to 2 hours **OR**
  - ✓ Occupancy sensor



### Automatic start controls for each HVAC system

- ✓ Capable of automatically adjusting daily start time to bring each space to desired occupied temperature immediately prior to scheduled occupancy



# Controls (Mandatory)

## C403.2.4.4 Shutoff Dampers

Motorized dampers that will automatically shut when the system or spaces are not in use.

✓ **Exceptions**

- Gravity dampers permitted in buildings < 3 stories
- Gravity dampers permitted for buildings of any height located in **Climate Zones 1-3**
- Gravity dampers permitted for outside air intake or exhaust airflows of 300 cfm (0.14m<sup>3</sup>/s) or less.



Snow- and ice-melting systems, supplied through energy service to the building, shall include

- ✓ automatic controls capable of shutting off the system when the pavement temperature is above 50°F (10°C) and no precipitation is falling
- ✓ an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F (4°C) so that the potential for snow or ice accumulation is negligible



*Photo courtesy of Ken Baker, K energy*



# Demand Controlled Ventilation

## C403.2.5.1 (Mandatory )

DCV must be provided for each zone with spaces  $> 500 \text{ ft}^2$  and the average occupant load  $> 25 \text{ people}/1000 \text{ ft}^2$  of floor area where the HVAC system has:

- ✓ An air-side economizer,
- ✓ Automatic modulating control of the outdoor air damper, or
- ✓ A design outdoor airflow  $> 3,000 \text{ cfm}$

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

### Exceptions:

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



# Energy Recovery Ventilation Systems

## C403.2.6 (Mandatory)

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

*Energy recovery ventilation (ERV) systems:* employ air-to-air heat exchangers to recover energy from exhaust air for the purpose of preheating, precooling, humidifying or dehumidifying outdoor ventilation air prior to supplying the air to a space, either directly or as part of an HVAC system.



### Exceptions:

- ✓ Where energy recovery ventilation systems prohibited by the IMC
- ✓ Lab fume hood system with at least one of the following:
  - VAV hood exhaust and room supply systems capable of reducing exhaust and makeup air volume to  $\leq 50\%$  of design values
  - Direct makeup (auxiliary) air supply equal to at least 75% of exhaust rate, heated no warmer than 2°F below room setpoint, cooled to no cooler than 3°F above room setpoint, no humidification added, and no simultaneous heating and cooling use for dehumidification control
- ✓ Systems serving uncooled spaces and heated to  $< 60^{\circ}\text{F}$
- ✓ Where  $> 60\%$  of outdoor heating energy is from site-recovered or site solar energy
- ✓ Heating energy recovery in **Climate Zones 1-2**
- ✓ Cooling energy recovery in **Climate Zones 3C, 4C, 5B, 5C, 6B, 7, and 8**
- ✓ Systems requiring dehumidification that employ energy recovery in series with the cooling coil
- ✓ Where largest source of air exhausted at a single location at building exterior is  $< 75\%$  of design outside air flow rate



# Duct and Plenum Insulation & Sealing

## C403.2.7 (Mandatory)

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy



Insulation required for supply and return ducts and plenums

- ✓ Located in unconditioned space – minimum R-5
- ✓ Located outside the building - minimum R-8

### Exceptions

- ✓ When located within equipment
- ✓ When design temperature difference between interior and exterior of the duct or plenum doesn't exceed 15°F



# Low & Medium Pressure Duct Systems

*C403.2.7.1.1 and C403.2.7.1.2* (Mandatory)

U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy

Ducts designed to operate at static pressures  $\leq 2$  in. wg

Securely fastened and sealed

✓ Exceptions

- When located within equipment
- Design temperature difference between interior and exterior of duct or plenum  $< 15^{\circ}\text{F}$

Ducts designed to operate at static pressures > 3 in. wg to be leak tested in accordance with SMACNA HVAC Air Duct Leakage Test Manual

- ✓ Air leakage rate  $\leq 6.0$
- ✓  $CL = F/P^{0.65}$ 
  - Where
    - F = leakage rate per 100 sf of duct surface area
    - P = test condition static pressure

Must test  $\geq 25\%$  of the duct area and meet the requirements





# Piping Insulation

## C403.2.8 (Mandatory)

All piping serving heating or cooling system must be insulated in accordance with Table C403.2.8

**Minimum Pipe Insulation**  
(thickness in inches)

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		NOMINAL PIPE OR TUBE SIZE (Inches)				
	Conductivity Btu · in./(h · ft <sup>2</sup> · °F) <sup>a</sup>	Mean Rating Temperature, °F	< 1	1 to < 1½	1½ to < 4	4 to < 8	≤ 8
> 350	0.32 – 0.34	250	4.5	5.0	5.0	5.0	5.0
251 – 350	0.29 – 0.32	200	3.0	4.0	4.5	4.5	4.5
201 – 250	0.27 – 0.30	150	2.5	2.5	2.5	3.0	3.0

(Partial table)

### Exceptions:

- ✓ Piping internal to HVAC equipment (*including fan coil units*) factory installed and tested
- ✓ Piping for fluid in temperature range
  - $60 < \text{temp} < 105^{\circ}\text{F}$
- ✓ Piping for fluid not heated or cooled by electricity or fossil fuels
- ✓ Strainers, control valves, and balancing valves associated with piping  $\leq 1''$  in diameter
- ✓ Direct buried piping for fluids  $\leq 60^{\circ}\text{F}$

- ✓ If exposed to weather,
  - protect from damage, including
    - Sunlight
    - Moisture
    - Equipment maintenance
    - Wind
  - Provide shielding from solar radiation that can cause degradation of material
  - Adhesive tape is not allowed

# Mechanical Systems Commissioning and Completion

**C403.2.9** (Mandatory)

Mechanical system to be commissioned and completed per  
Section C408.2



# Air System Design and Control

## C403.2.10 (Mandatory)

- ✓ Maximum fan power requirements
- ✓ Applies to HVAC systems with total fan system power > 5 hp
- ✓ Each HVAC system at design conditions can not exceed allowable fan system motor nameplate hp (Option 1) or fan system bhp (Options 2) in Table C403.2.10.1(1)
- ✓ Single zone VAV systems to comply with constant volume fan power limitations

**TABLE C403.2.10.1.1(1) FAN POWER LIMITATION**

	<b>LIMIT</b>	<b>CONSTANT VOLUME</b>	<b>VARIABLE VOLUME</b>
<b>Option 1: Fan System Motor Nameplate hp</b>	Allowable Nameplate Motor hp	$hp \leq CFMS * 0.0011$	$hp \leq CFMS * 0.0015$
<b>Option 2: Fan System bhp</b>	Allowable Fan System bhp	$bhp \leq CFMS * 0.00094 + A$	$bhp \leq CFMS * 0.0013 + A$



# Allowable Fan Motor Horsepower

## C403.2.10.1 (Mandatory)

BHP option includes  
adjustment “adders”  
certain devices

**Table C403.1.10.1(2)**  
**Fan Power Limitation Pressure Drop Adjustment**

DEVICE	ADJUSTMENT
<b>Credits</b>	
Fully ducted return and/or exhaust air systems	0.5 in w.c. (2.15 in w.c. for laboratory and vivarium systems)
Return and/or exhaust air flow control devices	0.5 in w.c.
Exhaust filters, scrubbers, or other exhaust treatment.	The pressure drop of device calculated at fan system design condition.
Particulate Filtration Credit: MERV 9 thru 12	0.5 in w.c.
Particulate Filtration Credit: MERV 13 thru 15	0.9 in w.c.
Particulate Filtration Credit: MERV 16 and greater and electronically enhanced filters	Pressure drop calculated at 2x clean filter pressure drop at fan system design condition.
Carbon and Other gas-phase air cleaners	Clean filter pressure drop at fan system design condition.

(Partial table)

### Exceptions

- ✓ Hospital, vivarium, and laboratory systems using flow control devices on exhaust and/or return for health and safety or environmental control permitted to use variable fan power limitation
- ✓ Individual exhaust fans  $\leq 1$  hp

Selected fan motor to be no larger than first available motor size greater than bhp

Fan bhp on design documents

### Exceptions

- ✓ Fans  $< 6$  bhp, where first available motor larger than bhp has nameplate rating within 50% of bhp, next larger nameplate motor size may be selected
- ✓ Fans  $\geq 6$  bhp, where first available motor larger than bhp has nameplate rating within 30% of bhp, next larger nameplate motor size may be selected

bhp = brake horsepower





# Heating Outside a Building

## C403.2.11 (Mandatory)

Systems are to be radiant systems

Controlled by an occupancy sensing device or timer switch

- ✓ So system is automatically deenergized when no occupants are present

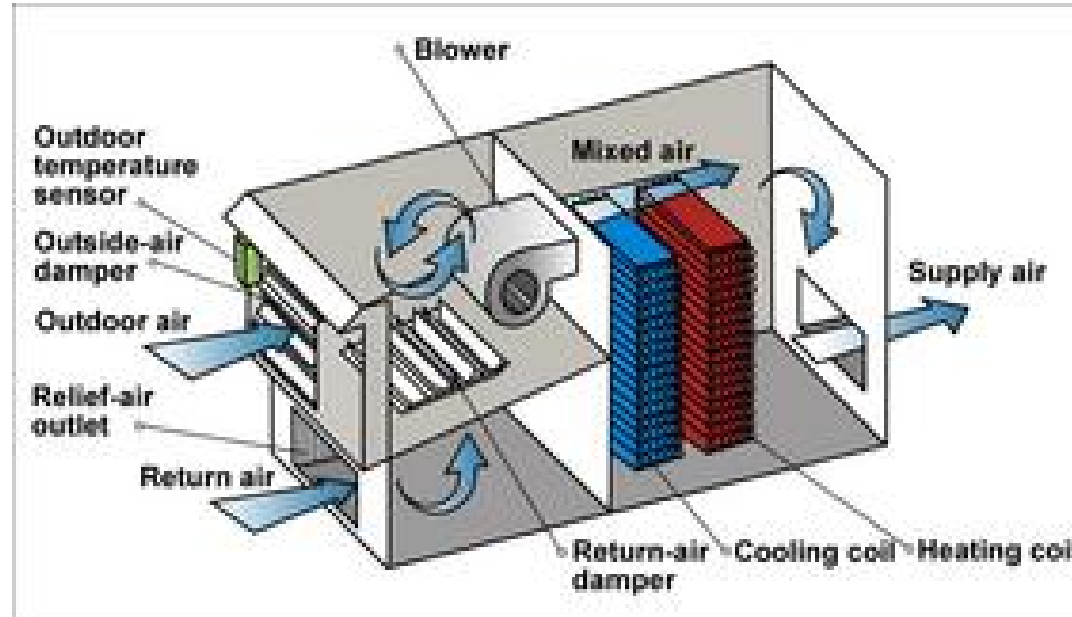


Unitary or packaged, single zone controlled by a single thermostat in the zone served.

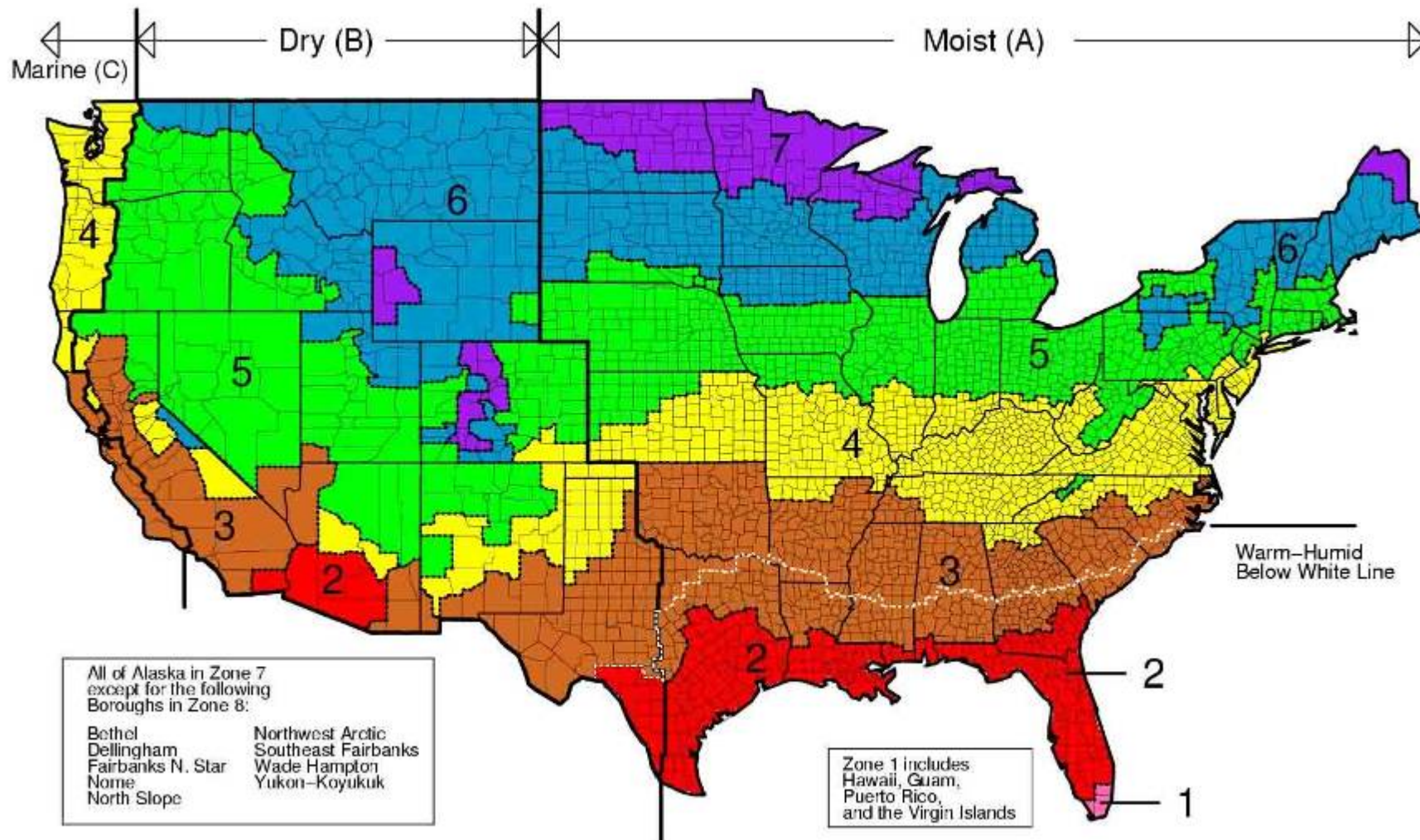
### **Simple Systems**

- ✓ Unitary packaged heating and cooling systems
- ✓ Split system heating and cooling systems
- ✓ Packaged terminal A/C and HPs
- ✓ Fuel-fired furnace
- ✓ Electrical resistance heating
- ✓ Two-pipe heating systems w/o cooling

- ✓ Must include economizers dependent on climate zone
- ✓ Capable of providing 100-percent outdoor air even if additional mechanical cooling is required (*integrated economizer*)
- ✓ Must provide a means to relieve excess outdoor air



# Climate Zones - 2012 IECC





# Economizers

## C403.3

Table C403.3.1(1)

CLIMATE ZONES	ECONOMIZER REQUIREMENT
1A, 1B	No requirement
2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	Economizers on cooling systems $\geq 33,000$ Btu/h <sup>a</sup>

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

### Exceptions (economizers not required)

- ✓ Individual fan-cooling units with supply capacity < Table C403.3.1(1)
- ✓ Where > 25% of air designed to be supplied by the system is to spaces that are designed to be humidified > 35°F dew-point temperature to satisfy process needs
- ✓ Systems that serve residential spaces where system capacity is < 5 times requirement in Table C403.3.1(1)
- ✓ Systems expected to operate < 20 hours/week
- ✓ Where use of outdoor air for cooling will affect supermarket open refrigerated casework systems
- ✓ Where cooling efficiency meets or exceeds efficiency requirements in Table C403.3.1(2)

### Trade-off high cooling efficiency for economizer

**Table C403.3.1(2)**

<b>CLIMATE ZONES</b>	<b>COOLING EQUIPMENT PERFORMANCE IMPROVEMENT (EER OR IPLV)</b>
2B	10% Efficiency Improvement
3B	15% Efficiency Improvement
4B	20% Efficiency Improvement

Capable of modulating outdoor air and return air dampers to provide up to 100% of design supply air quantity as outdoor air for cooling



Economizer dampers to be capable of being sequenced with mechanical cooling equipment and not be controlled by only mixed air temperature

### **Exception:**

- ✓ Can use mixed air temperature limit control for systems controlled from space temperature

Example: single-zone systems

- ✓ Air economizers to be capable of automatically reducing outdoor air intake to design minimum outdoor air quantity when outdoor air intake will no longer reduce cooling energy usage
- ✓ High-limit shutoff control types to be chosen from Table C403.3.1.1.3(1) for specific climates
- ✓ Specifications for high-limit shutoff control type settings per Table C403.3.1.1.3(2)

- ✓ Systems to be capable of relieving excess outdoor air during air economizer operation to prevent over-pressurizing the building
- ✓ Relief air outlet to be located to avoid recirculation into the building

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

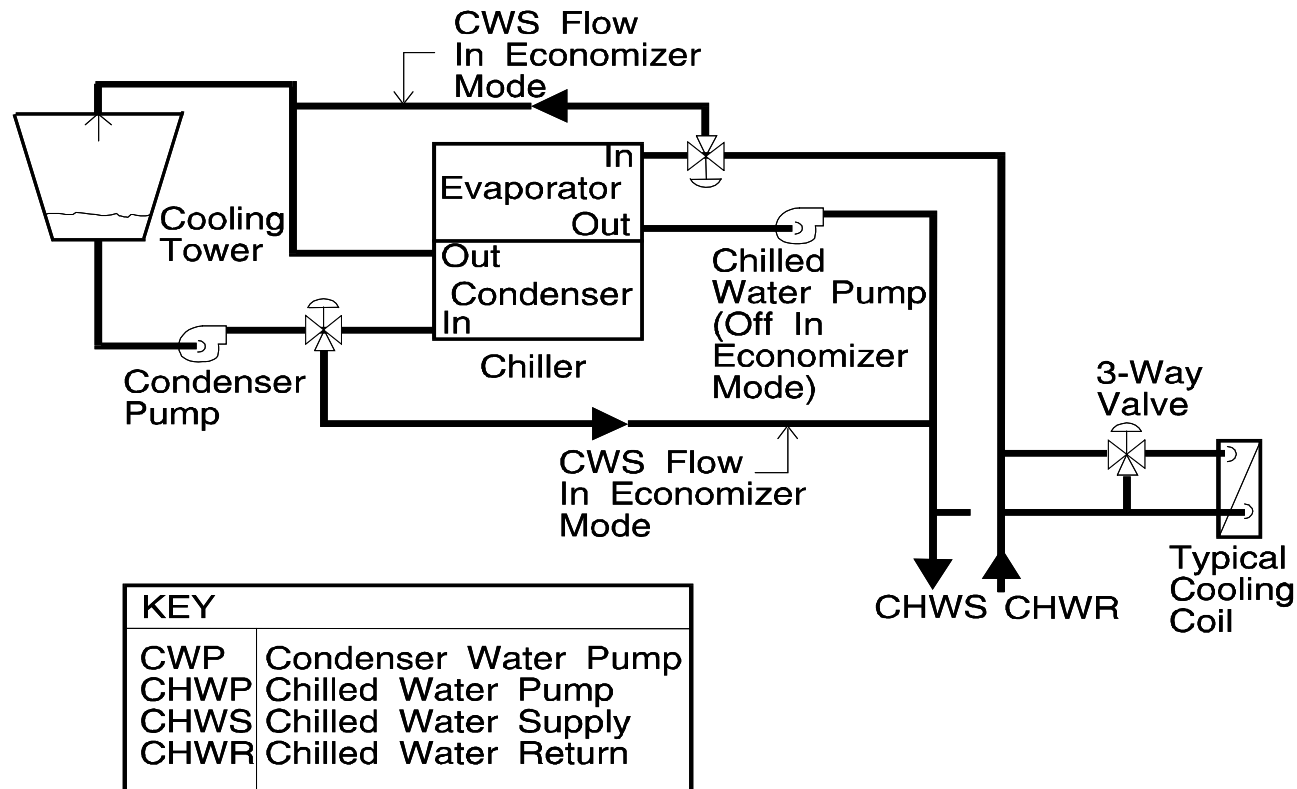
This section applies to all HVAC equipment and systems not included in Section C403.3

### **Complex Systems**

- ✓ Packaged VAV reheat
- ✓ Built-up VAV reheat
- ✓ Built-up single-fan, dual-duct VAV
- ✓ Built-up or packaged dual-fan, dual-duct VAV
- ✓ Four-pipe fan coil system with central plant
- ✓ Water Source heat pump with central plant
- ✓ Any other multiple-zone system
- ✓ Hydronic space heating and cooling system

# Complex System Economizers

## C403.4.1



- ✓ Water economizer systems
  - Capable of providing 100% of the cooling system load at 50°F dry bulb/45°F wet bulb and below

### **Exception:**

Water economizer systems where dehumidification requirements can't be met at 50°F dry bulb/45°F wet bulb

- Satisfy 100% of expected cooling load at 45°F dry bulb/40°F wet bulb



- ✓ Precooling coils and water-to-water heat exchangers in water economizer systems to have either a
  - Waterside pressure drop of  $< 15$  ft of water **OR**
  - Secondary loop created so coil or heat exchanger drop isn't seen by circulating pumps when system is in normal cooling mode



### ✓ Economizers

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

### Exceptions:

Direct expansion systems with controls that reduce quantity of outdoor air

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

Individual direct expansion units with rated cooling capacity  $< 54,000$  Btu/h and using nonintegrated economizer controls that preclude simultaneous operation of the economizer and mechanical cooling

- ✓ Economizer operation to not increase building heating energy use during normal operation

### **Exception:**

- ✓ Economizers on VAV systems that cause zone level heating to increase due to a reduction in supply air temperature

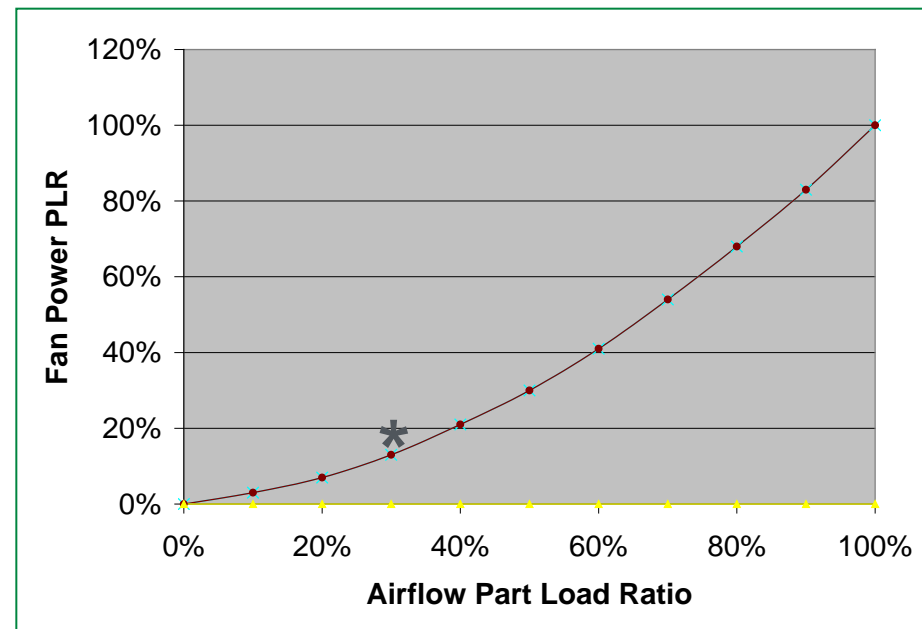


# Variable Air Volume Fan Control

## C403.4.2

Individual VAV fans with motors  $\geq 7.5\text{hp}$  must be:

- ✓ Driven by a mechanical or electrical variable speed drive **OR**
- ✓ Driven by a vane-axial fan with variable-pitch blades **OR**
- ✓ Have controls or devices to result in fan motor demand  $\leq 30\%$  of their design wattage at 50% of design airflow



- ✓ Sensors used to control VAV fans
  - Placed so that the controller setpoint is  $\leq 1/3$  the total design fan static pressure
    - Exception: systems with zone reset control complying with C403.4.2.2
- ✓ Sensors installed downstream of major duct splits
  - At least one sensor to be located on each major branch so that static pressure can be maintained in each branch

- Systems with direct digital control of individual zone boxes reporting to the central control panel
  - Static pressure reset point to be reset based on the zone requiring the most pressure (i.e., the set point is reset lower until one zone damper is nearly wide open)

- ✓ Limit reheat/recool of fluids
- ✓ Multiple boiler heating plants must include automatic controls capable of sequencing operation of the boilers
- ✓ Single boilers > 500,000 Btu/h input design capacity must include multi-staged or modulating burner





# Hydronic Systems

## C403.4.3

### 3-Pipe System – not allowed

- ✓ Can't use a common return

### 2-Pipe Changeover System

- ✓ Dead band between changeover  $\geq 15^{\circ}\text{F}$  outside temperature

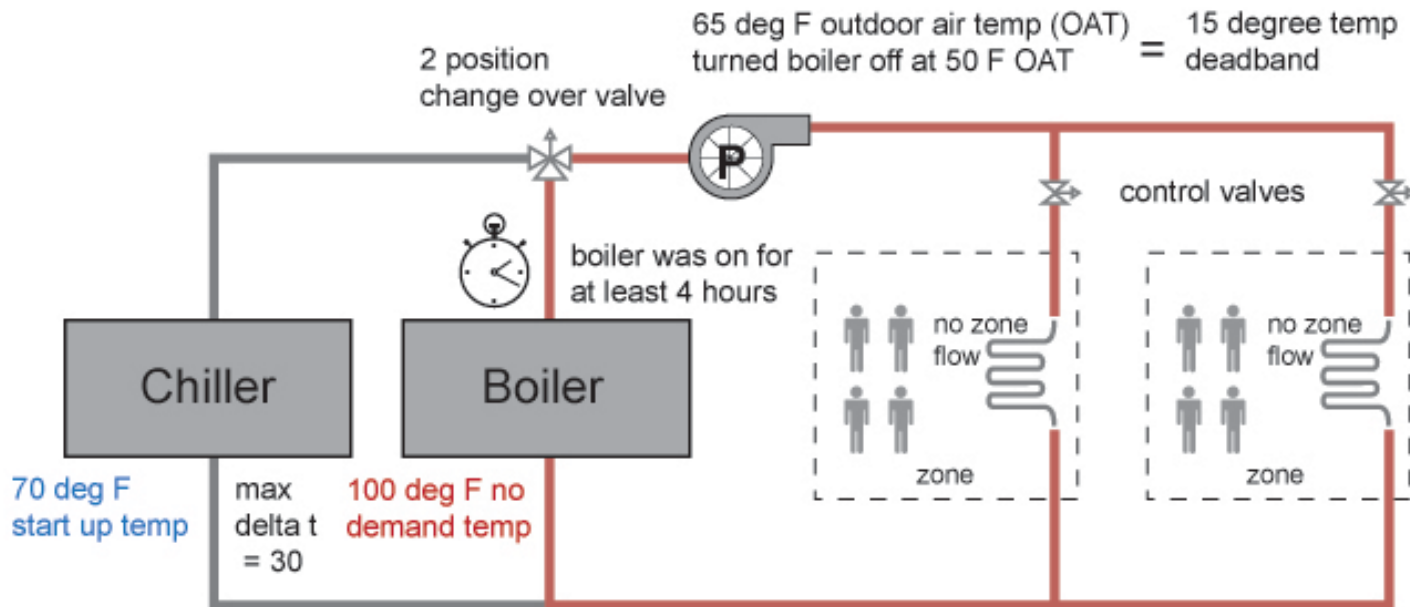


Diagram Courtesy of Ken Baker

### Temperature dead band of at least 20°F (C403.4.3.3.1)

#### ✓ Exception

- Where system loop temp optimization controller is installed and can determine the most efficient operating temp based on realtime conditions of demand and capacity

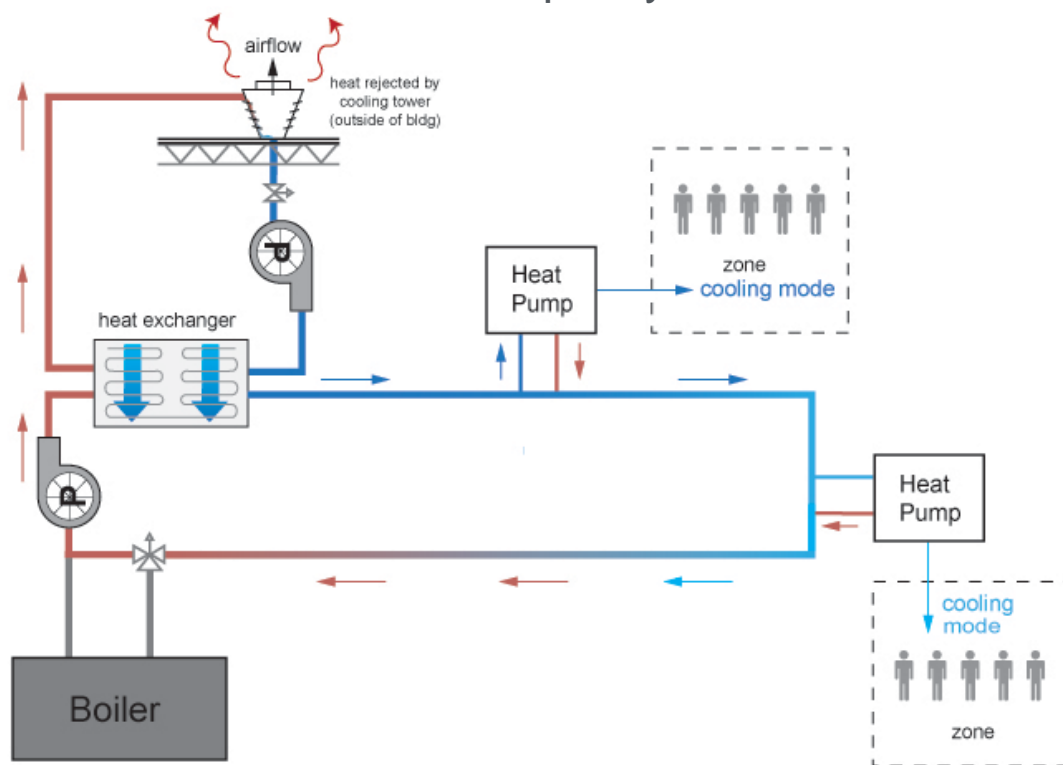


Diagram Courtesy of Ken Baker





### Heat rejection equipment in Climate Zones 3 and 4 (C403.4.3.3.2)

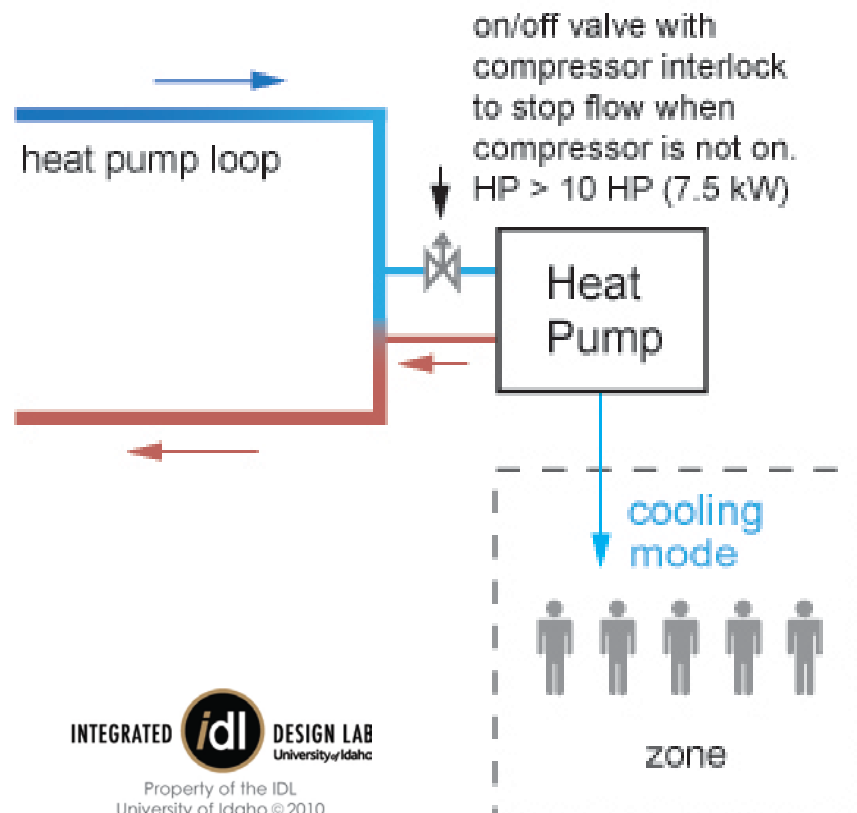
- ✓ Closed-circuit cooling tower used directly in heat pump loop
  - Install either automatic valve to bypass all but a minimal flow of water around tower OR lower leakage positive closure dampers to be provided
- ✓ Open-circuit tower used directly in heat pump loop
  - Install automatic valve to bypass all heat pump water flow around tower
- ✓ Open- or closed-circuit used in conjunction with separate heat exchanger to isolate cooling tower from heat pump loop
  - Heat loss controlled by shutting down the circulation pump on cooling tower loop

### Heat rejection equipment in Climate Zones 5 - 8

- ✓ Open- or closed-circuit cooling tower used
  - Must have a separate heat exchanger to isolate cooling tower from heat pump loop
  - Heat loss controlled by shutting down circulation pump on cooling tower loop and providing an automatic valve to stop flow of fluid

### Two position valve (C403.4.3.3.3)

- ✓ Required on each hydronic heat pump with total pump system power > 10 hp

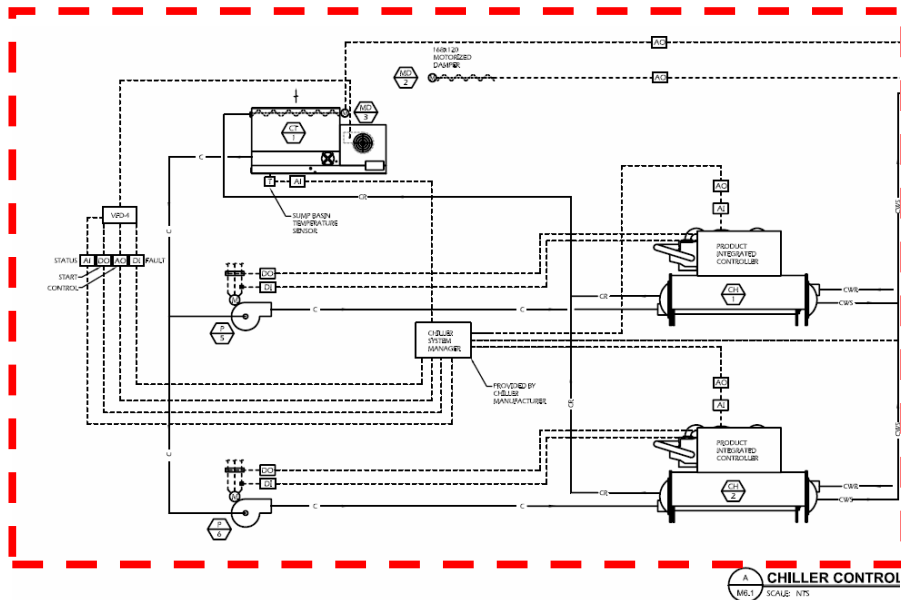


System  $\geq 300,000$  Btu/h must include

- ✓ Temperature reset or variable flow
  - Automatic resets for supply water temperature by at least 25% of design supply-to-return temperature differences **or**
  - Reduce system pump flow by 50% of design flow using
    - Multiple Staged Pumps
    - Adjustable Speed Drives
    - Control Valves that modulate as a function of load

# Pump Isolation

## C403.4.3.5



## Multiple chiller chilled water plants

- ✓ Capability to reduce flow through the chiller automatically when chiller is shut down
- ✓ Chillers piped in series considered one chiller

## Multiple boiler plants

- ✓ Capability to reduce flow through the boiler automatically when boiler is shut down



# Heat Rejection Equipment Fan Speed Control

## C403.4.4

Each tower fan powered by a motor  $\geq 7.5$  hp must include variable speed or two speed fan

- ✓ Have controls to automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device
- ✓ **Exception**
  - Factory-installed heat rejection devices within condensers and chillers tested and rated in accordance with Tables C403.2.3(6) and C403.2.3(7)



- ✓ Must be variable air volume (VAV) systems
- ✓ VAV systems must be designed and capable of being controlled to reduce the primary air supply to each zone before reheat, recool, or mixing take place
- ✓ Maximum reheat, recool, or mixing
  - 30% of the maximum supply air to each zone
  - $\leq 300$  cfm where the maximum flow rate is  $<10\%$  of total fan system supply airflow rate
  - Minimum ventilation requirements from Chapter 4 of the IMC

### Exceptions:

- ✓ Zones with special pressurization or cross-contamination requirements
- ✓ Where 75% of reheat energy comes from site-recovered or site-solar energy source
- ✓ Zones with special humidity requirements
- ✓ Zones with  $\leq 300$  cfm peak supply and flow rate is  $< 10\%$  of total fan system supply airflow rate
- ✓ Zones where reheated, recooled or mixed air volume  $<$  minimum ventilation requirements (Chapter 4 of IMC)
- ✓ Systems with controls capable of preventing reheating, recooling, mixing or simultaneous supply of air previously heated or cooled

Single duct VAV systems to use terminal devices capable of reducing the supply of primary supply air before reheating or recooling takes place



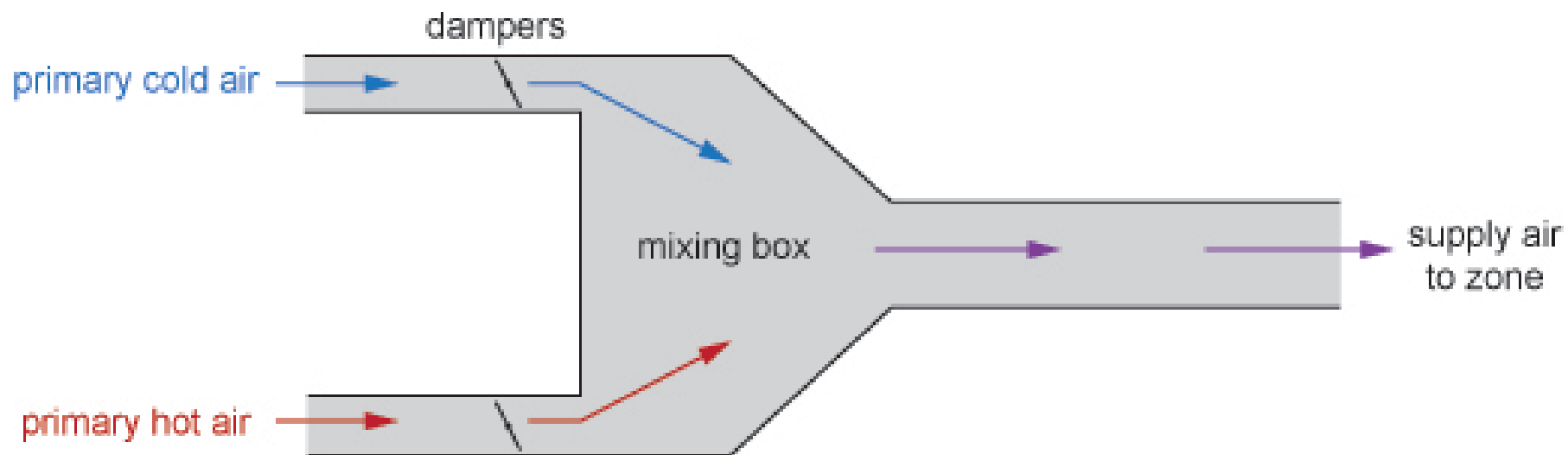




# Dual Duct and Mixing VAV Systems, Terminal Devices

## C403.4.5.2

Systems with one warm air duct and one cool air duct to use terminal devices capable of reducing flow from one duct to a minimum before mixing of air from the other duct takes place



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University of Idaho





# Single Fan Dual Duct and Mixing VAV Systems, Economizers C403.4.5.3

Individual dual duct or mixing reheating and cooling systems with a single fan and with total capacities  $> 90,000$  Btu/h (7.5 tons) should not have economizers

Multiple zone HVAC systems to have controls to automatically reset supply-air temperature in response to building loads or outdoor air temperature

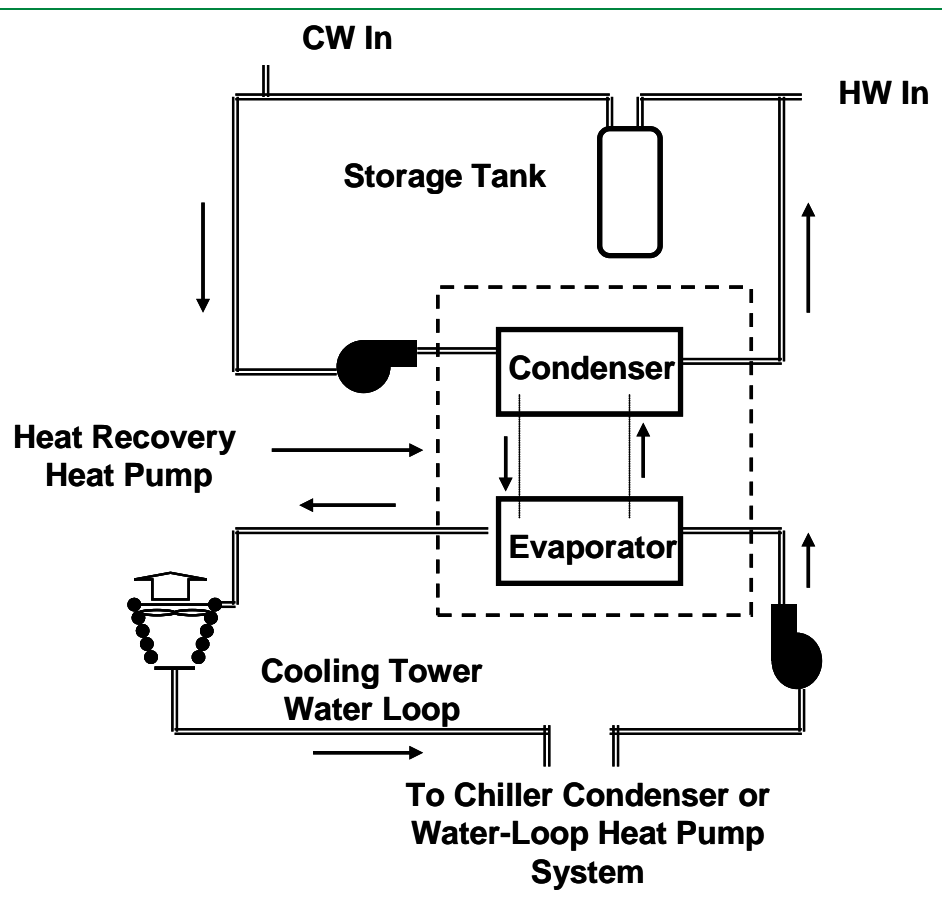
Controls to be capable of resetting supply air temperature at least 25% of difference between design supply-air temperature and design room air temperature

### Exceptions

- ✓ Systems that prevent reheating, recooling or mixing of heated and cooled supply air
- ✓ 75% of energy for reheating is from site-recovered or site solar energy sources
- ✓ Zones with peak supply air quantities of  $\leq 300$  cfm

# Heat Recovery for Service Hot Water Heating

## C403.4.6



Condenser heat recovery required for heating/reheating of SWH provided:

- ✓ Facility operates 24 hours/day
- ✓ Total installed heat capacity of the heat rejection of water-cooled systems >6,000,000 Btu/hr
- ✓ Design SWH load >1,000,000 Btu/hr

Capacity to provide the smaller of

- ✓ 60% of peak heat rejection load at design conditions OR
- ✓ Preheating to raise peak SHW to 85°F

### Exceptions

- ✓ Recovered heat is used for space heating or when SHW is provided by renewables or site recovered energy sources

Cooling systems can't use unless system designed with

- ✓ multiple steps of unloading **OR**
- ✓ Continuous capacity modulation

Capacity limited per Table C403.4.7

### Exception

- ✓ Unitary packaged systems with cooling capacities < 90,000 Btu/h

Rated Capacity	Maximum Hot Gas Bypass Capacity (% of total capacity)
≤ 240,000 Btu/h	50%
> 240,000 Btu/h	25%

### Table C404.2 Minimum Performance of Water-Heating Equipment

- ✓ Water Heater Types Covered
  - Electric Storage
  - Gas and Oil Storage
  - Instantaneous Water Heaters – Gas and Oil
  - Hot water boilers – gas and oil
  - Pool heaters
  - Unfired storage tanks

Temperature Controls (C404.3)  
Heat Traps (C404.4)



### Noncirculating system insulation requirements

- ✓ First eight feet of outlet piping on systems with no integral heat traps
- ✓ 1/2 inch of insulation required

### Circulating systems

- ✓  $\geq 1$  inch of insulation

### Exceptions

- ✓ Heat-traced piping systems meet insulation requirements per manufacturers' installation instructions
- ✓ Untraced piping within heat traced systems  $\geq 1$  inch of insulation





# Hot Water System Controls

## C404.6

Ability to turn off circulating hot water pumps and heat trace tape when there is limited demand

- ✓ Automatically or manually
- ✓ Ready access to controls







# Pools and Inground Permanently Installed Spas

## C404.7 Mandatory

### Heaters (C404.7.1)

- ✓ Readily accessible on-off switch mounted outside heater so heater can be shut off without adjusting thermostat setting
- ✓ Natural gas or LPG fired pool heaters will not have continuously burning pilot lights

### Time switches or other control method (C404.7.2)

- ✓ Automatic controls required to turn heaters and pumps on a preset schedule
- ✓ **Exceptions**
  - Where public health standards require 24 hour operation
  - Where pumps are required to operate solar and waste heat recovery pool heating systems

Note: heaters, pumps and motors with built-in timers meet this requirement

Heated pools and inground permanently installed spas required to have a cover

- ✓ Cover must be vapor retardant



### Exception

- ✓ Pools deriving > 70% energy for heating from site-recovered energy

# Mechanical Systems Commissioning and Completion Requirements

## C408.2

- ✓ Prior to passing final mechanical inspection
  - Registered design profession to provide evidence of commissioning and completion
- ✓ Construction document notes to clearly indicate provisions for commissioning and completion requirements
  - Permitted to refer to specifications
- ✓ Copies of all documents to be provided to the owner and made available to code official upon request

# Mechanical Systems Commissioning and Completion Requirements

## *C408.2 Exceptions*

- ✓ These systems are exempt from commissioning requirements
  - In buildings where total mechanical equipment capacity is < 480,000 Btu/h cooling capacity and 600,000 Btu/h heating capacity
  - Included in Section C403.3 that serve dwelling units and sleeping units in hotels, motels, boarding houses or similar units

- ✓ Developed by registered design professional or agency and include:
  - ✓ Narrative description of activities to be accomplished during each phase of commissioning
    - ✓ Including personnel who will do each activity
  - ✓ Listing of specific equipment, appliances or systems to be tested and description of tests to be performed
  - ✓ Functions to be tested, including, but not limited to calibrations and economizer controls
  - ✓ Conditions under which test will be performed
    - ✓ At a minimum, testing will affirm winter and summer design conditions and full outside air conditions
  - ✓ Measurable criteria for performance

- ✓ HVAC systems balanced per generally accepted engineering standards
- ✓ Air and water flow rates measured and adjusted to deliver final flow rates within tolerances in product specifications
- ✓ Test and balance activities to include air system and hydronic system balancing

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

**Exception** – fans with motors  $\leq 1$  hp

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

### **Exceptions**

- ✓ Pumps with pump motors  $\leq 5$ hp
- ✓ Where throttling results in  $\leq 5\%$  of nameplate hp draw above that required if the impeller were trimmed



- ✓ To demonstrate the installation and operation of components, systems, and system-to-system interfacing relationships in accordance with approved plans and specifications, such that operation, function, and maintenance serviceability for each of the commissioned systems is confirmed
- ✓ Testing to include all modes and sequence of operation, including under full-load, part-load and the following emergency conditions:
  - ✓ All modes as described in the sequence of operation
  - ✓ Redundant or automatic back-up mode
  - ✓ Performance of alarms, and
  - ✓ Mode of operation upon a lost off power and restoration of power

**Exception** – unitary or packaged HVAC equipment listed in Tables C403.2.3(1) through C403.2.3(3) that don't require supply air economizers

- ✓ HVAC control systems to be tested to document that control devices, components, equipment, and systems are calibrated, adjusted and operate in accordance with approved plans and specifications
- ✓ Sequences of operation to be functionally tested to document they operate in accordance with approved plans and specifications

# Functional Performance Testing

## C408.2.3.3 Economizers

- ✓ Air economizers to undergo a functional test to determine they operate in accordance with manufacturer's specifications

- ✓ Registered design professional or approved agency to complete, certify, and submit to the building owner and will identify:
  - ✓ Itemization of deficiencies found during testing that haven't been corrected at the time of report preparation
  - ✓ Deferred tests that can't be performed at the time of report preparation due to climatic conditions
  - ✓ Climatic conditions required for performance of deferred tests

# Preliminary Commissioning Report

## C408.2.4.1 Acceptance of Report

- ✓ Buildings or portions of buildings can't pass final mechanical inspection until code official has received a letter of transmittal from the building owner acknowledging the building owner has received the Preliminary Commissioning Report

# Preliminary Commissioning Report

## C408.2.4.2 Copy of Report

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Energy Efficiency &  
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- ✓ Code official is permitted to require a copy of the report be made available for review

- ✓ Construction documents to specify that documents described in C408.2.5 be provided to building owner within 90 days of receipt of certificate of occupancy
  - ✓ Drawings
  - ✓ Manuals
  - ✓ System balancing report
  - ✓ Final commissioning report

# Documentation Requirements

## C408.2.5.1 Drawings

- ✓ Include location and performance data on each piece of equipment



- ✓ O&M manual to be provided to include all of the following:
  - ✓ Submittal data stating equipment size and selected options for each piece of equipment requiring maintenance
  - ✓ Manufacturer's operation and maintenance manuals for each piece of equipment requiring maintenance (except equipment not furnished as part of the project). Required routine maintenance actions to be clearly identified.
  - ✓ Name and address of at least one service agency
  - ✓ HVAC controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints to be permanently recorded on control drawings at control devices or, for digital control systems, in system programming instructions
  - ✓ Narrative of how each system is intended to operate, including recommended setpoints

# Documentation Requirements

## C408.2.5.3 System Balancing Report

- ✓ To include descriptions of the activities and measurements completed per Section C408.2.2 (systems adjusting and balancing)

# Documentation Requirements

## C408.2.5.4 Final Commissioning Report

- ✓ Delivered to building owner and include:
  - ✓ Results of functional performance tests
  - ✓ Disposition of deficiencies found during testing, including corrective measure details – used or proposed
  - ✓ Functional performance test procedures used during commissioning process including measurable criteria for test acceptance

**Exception** – deferred tests which can't be performed at time of report preparation due to climatic conditions