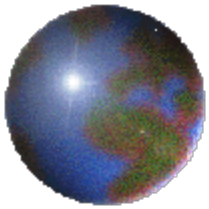

The ASHRAE 90.1-2010 Energy Code: How it Will Affect Your Projects

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Presenter

Jeff Boldt, PE, LEED® AP, HBDP

KJWW Engineering

Principal – Director of Engineering

- Voting Member ASHRAE SSPC-90.1
  - Member SSPC 90.1 and Mechanical Sub-Committee (MSC)
    - Chair - 90.1 Healthcare Working Group (WG)
    - Chair - 90.1 Hydronic WG, Elevator WG, Duct Leakage WG, & Drive Efficiency WG
    - Member - 90.1 Radiant Heating & Cooling WG & Heat Recovery WG
- Member AEDG Small Healthcare

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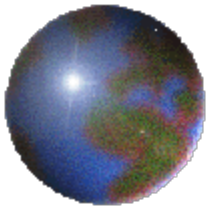
Agenda

- What is ASHRAE 90.1?
- How is ASHRAE 90.1 enforced?
- What will change in 90.1-2010?
  - Challenges?
  - Suggestions for compliance



What is ANSI/ASHRAE/IES Standard 90.1?

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ASHRAE 90.1

- World's most adopted building energy code
- Basis for International Energy Conservation Code (IECC)
- A compliance option in IECC
- Minimum code standards

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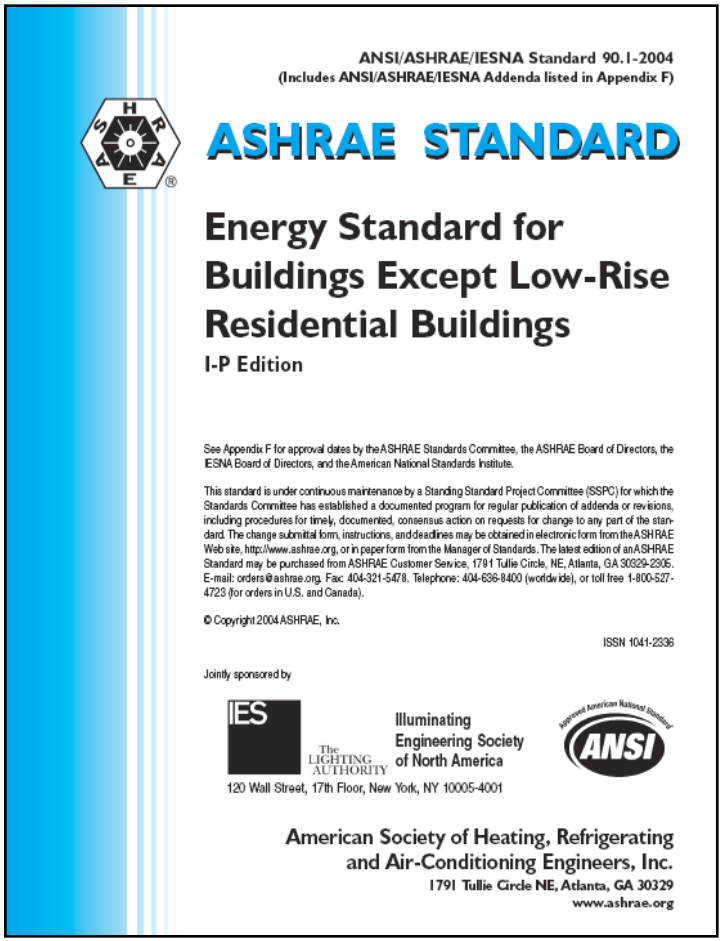
Scope of ASHRAE 90.1

- Energy conservation code for buildings, except low-rise residential
  - Envelope
  - HVAC
  - Service Water Heating
  - Power & Lighting
  - Other



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Scope of ASHRAE 90.1

- Buildings, except low-rise residential
  - Not 3 stories or less residential or any single-family residences
  - Low-rise hotel, prison, etc. are covered
- New buildings and their systems
- New portions of buildings & systems
- New systems (equipment) in existing buildings

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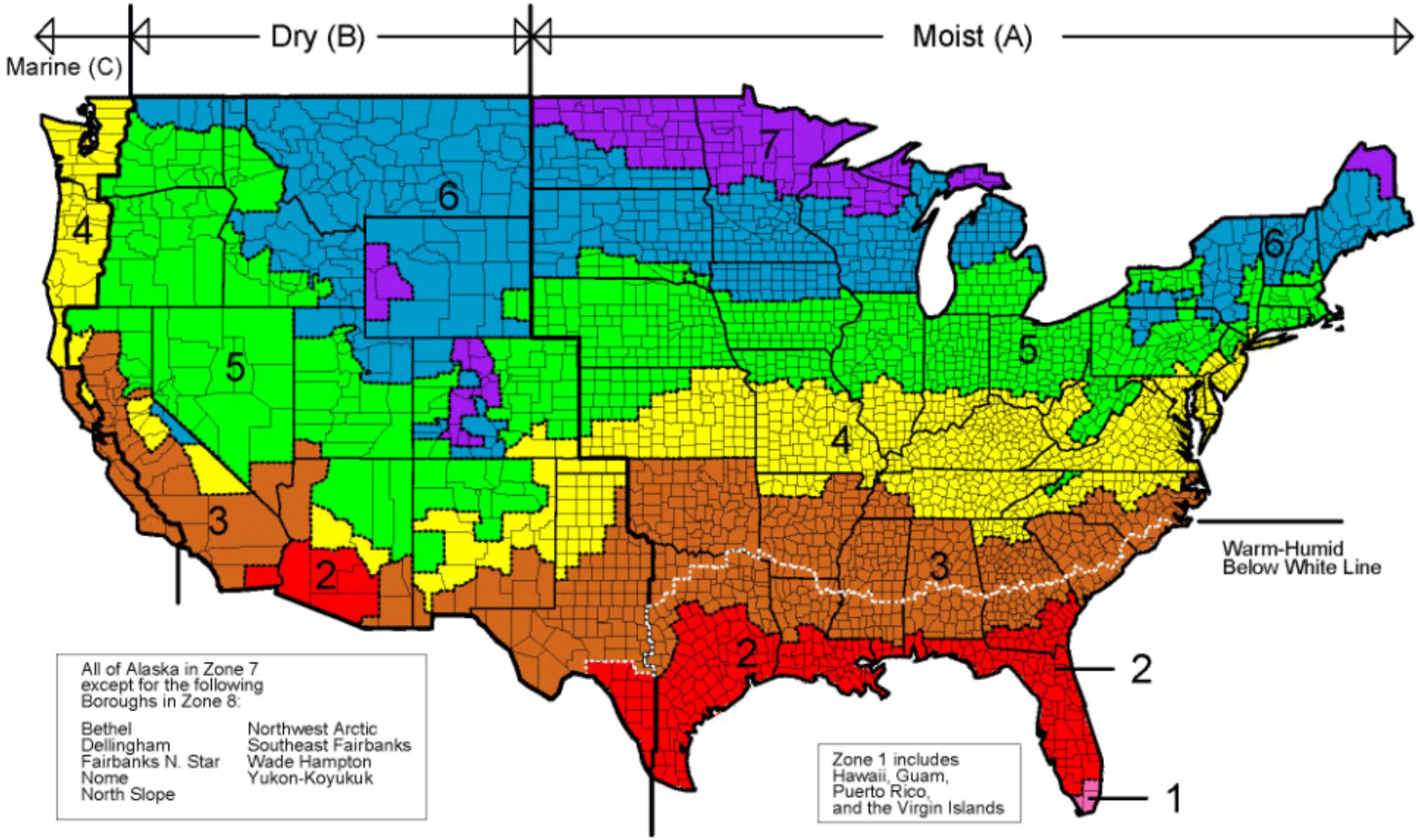
9 Climate 'zones' + ABC = 17



Scope Addition

- New equipment or building systems specifically identified in the standard that are part of industrial or manufacturing processes
  - Computer rooms are the first application

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How is ASHRAE 90.1 Enforced?

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How 90.1 is Enforced

- EPAct 1992 requires DOE to review each version of 90.1 & require all states to have energy codes substantially equal to the latest ‘approved’ version
- DOE issues “Determinations”
  - Theoretically, within one year
  - States are given two years to comply (December 30, 2010 for 90.1-2004)

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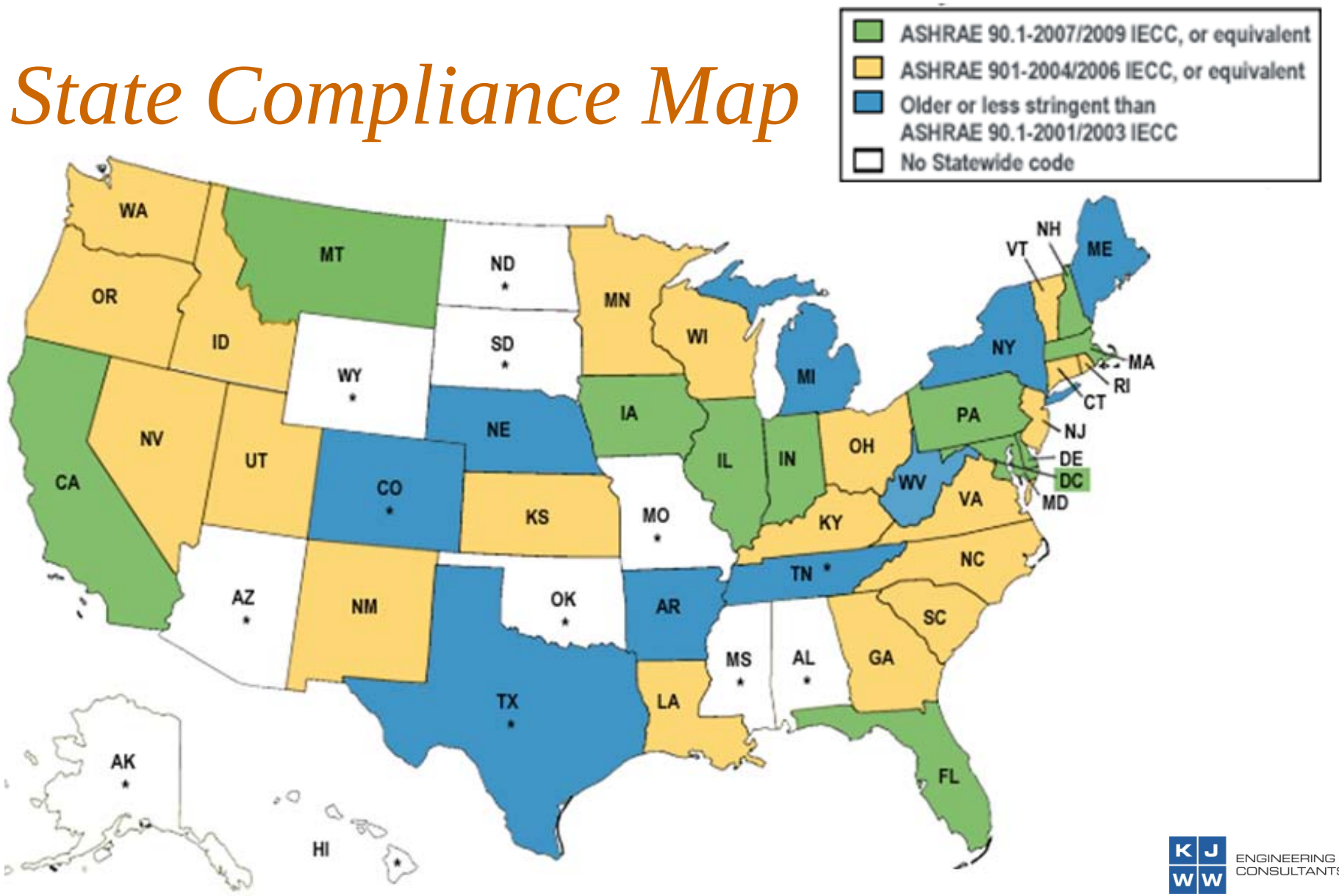
Most States Do Comply

- Wisconsin will adopt the 2009 IECC with amendments – probably mid-summer
- Illinois and Iowa adopt the 2009 IECC
- Indiana adopted 90.1-2007
- The 2009 IECC includes 90.1-2007 as a compliance option

State Compliance Map



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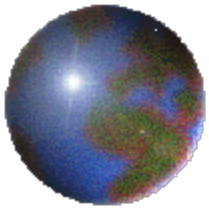
Why Should I Comply?

- Required for LEED Certification
  - Prerequisite
  - Appendix G for points
- Required for all federal facilities
- Saves energy
  - Easy way to require energy efficient designs



What will Change in ASHRAE 90.1 - 2010?

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ASHRAE 90.1-2010

- New version to be released in October 2010
  - Goal was 30% less energy than 90.1-2004
  - 2007 version saved only a few %
- IECC will incorporate most of the changes
  - 2009
  - 2011 interim update
  - 2012 major edition
- LEED will move to ASHRAE 90.1-2010

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ASHRAE 90.1-2010

- Committee took final votes June 28
- ASHRAE BOD rejected 2 items
- Blue items are probably postponed to 2013
- Many Changes
  - Elevators was addendum DF!!
  - 118 addenda proposed

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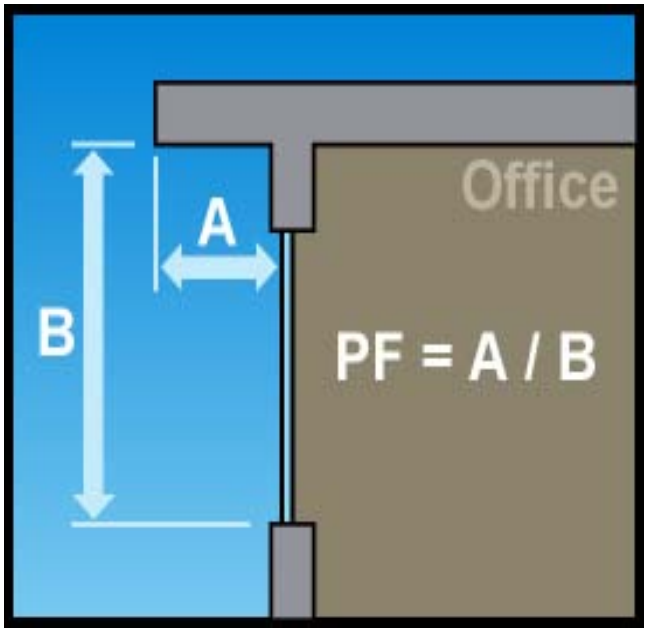
Building Envelope

- 2007 Requirements
  - Specifies wall, floor, and roof R-values
  - Windows and doors
    - 40% window limit
    - Window U and SHGF (NFRC 400)
    - Vestibules



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Building Envelope

- Roof Insul R~~20~~/16 cz1 >> R~~35~~/20 cz8
- SHGF ~~0.40~~/0.25 cz1 >> ~~0.34~~/0.45 cz8
- U-values ~~0.65~~/1.2 cz1 >> ~~0.34~~/0.45 cz8
- ~~VT/SHGC ratio 1.1 includes frame~~

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Building Envelope – Addendum (bb)

- Insulation (appeal upheld : not in 2010)
  - Example – Zone 6 (Madison) Steel Framed
    - 2007 – R-13 + R-7.5 c.i.
      - 2” of expanded polystyrene (bead board)
    - 2010 – R-13 + R-15 c.i.
      - 4.0” of expanded polystyrene (at 3.8/inch)
      - Potential conflict between 90.1 and IBC
      - R-18.8 in Zone 7 = 5” EPS, 4” XPS, or 3.5” ISO
      - R-10 in Zone 4 = 3” EPS, 2.5” XPS or 2” ISO

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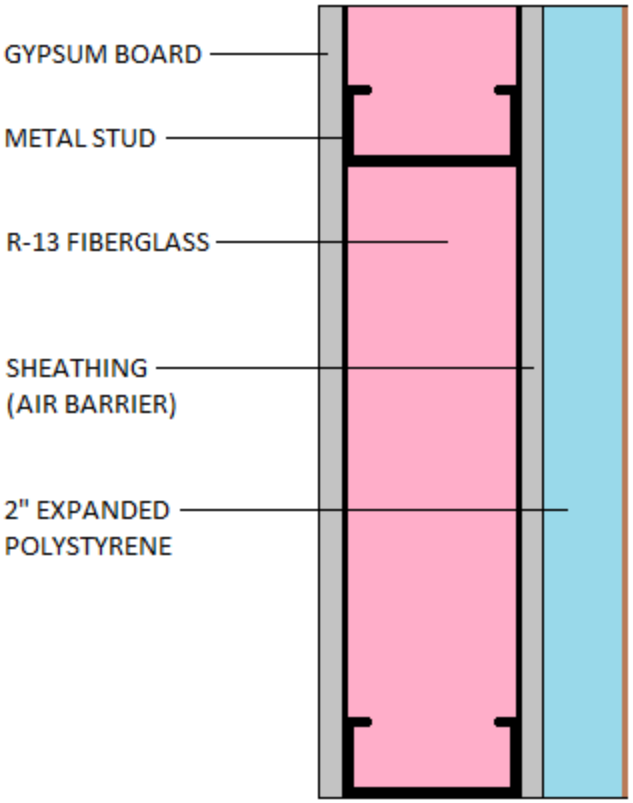
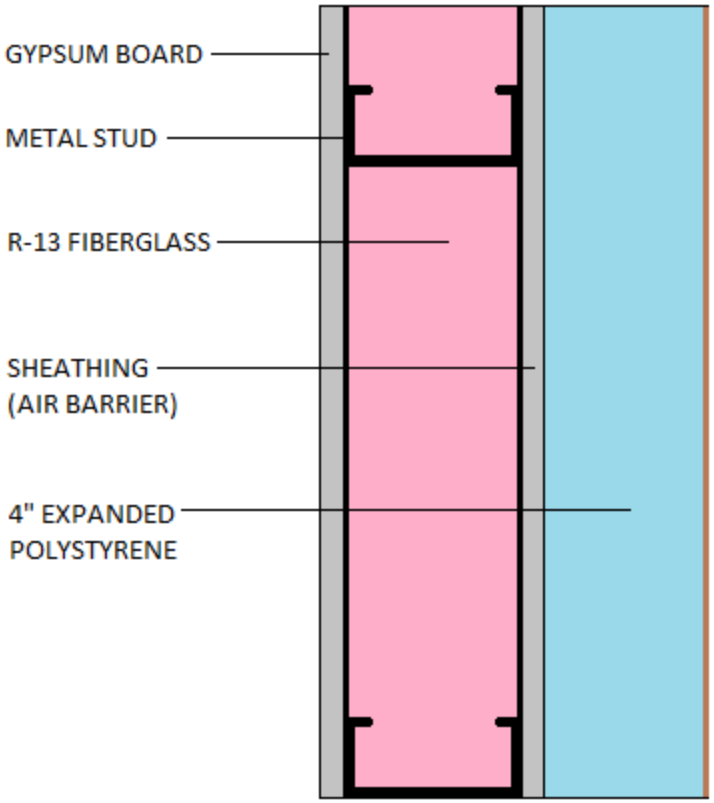
Building Envelope



90.1-2007
ZONE 5



90.1-2010
ZONE 5

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Building Envelope

- ~~Maximum 30% glass (bb)~~
  - ~~Exception: 40% if~~
    - ~~Distribute glass to daylight > 50% of floor area~~
    - ~~Install daylight dimming~~

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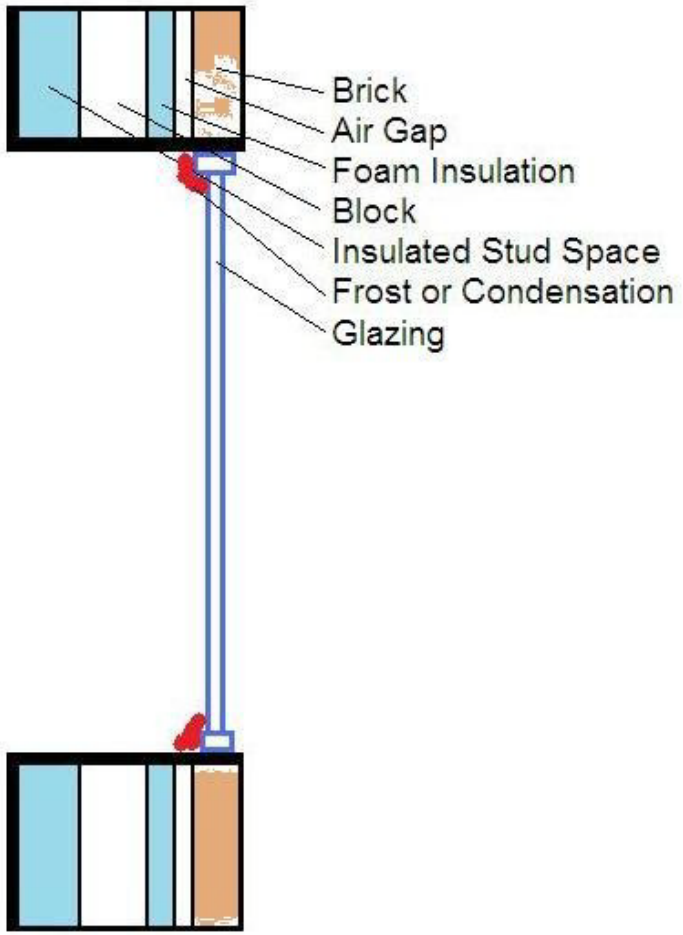
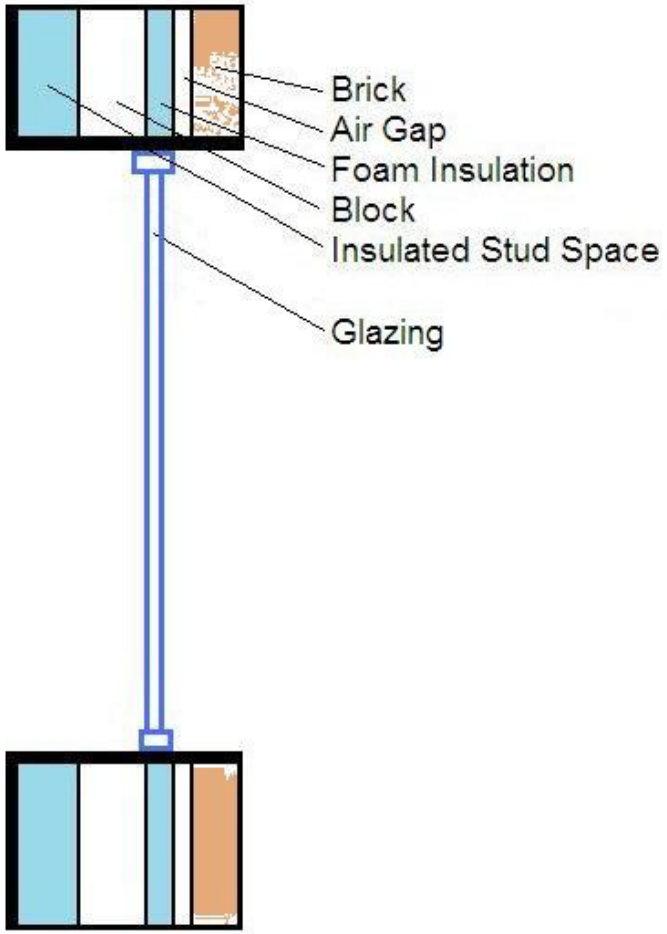
Envelope – Continuity – Too Late



Poor Thermal Location



Preferred Thermal Location

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Building Envelope – Air Barrier (bf)

- Air barrier & joints must be detailed
- OR - Pressure test must be performed

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Building Envelope

- More S glazing than either E or W (bn)
  - Building orientation
  - Land purchases and campus planning
  - No public review comments
- Exceptions
  - Storefront, Shaded building, Infill with nearby building on south, Alterations with no increase in glazing

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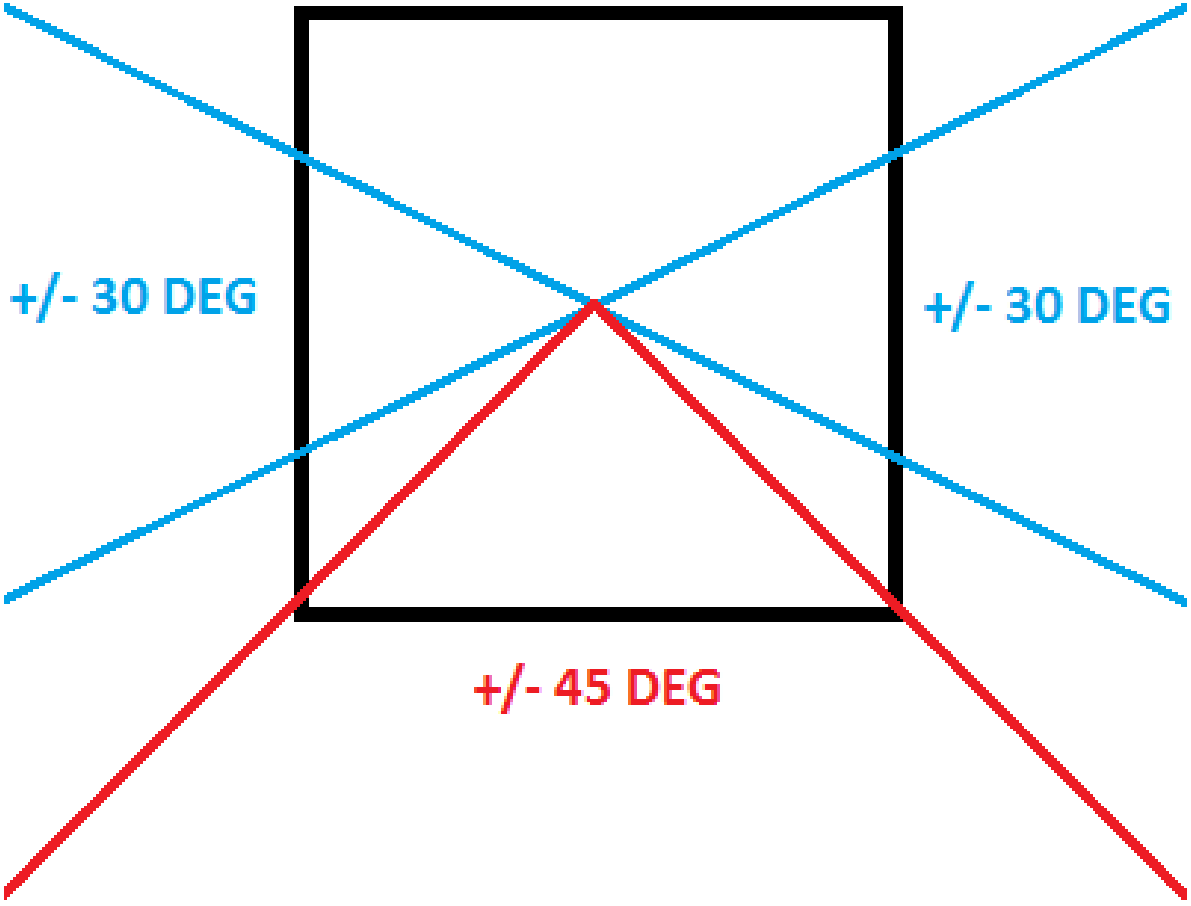
Building Envelope



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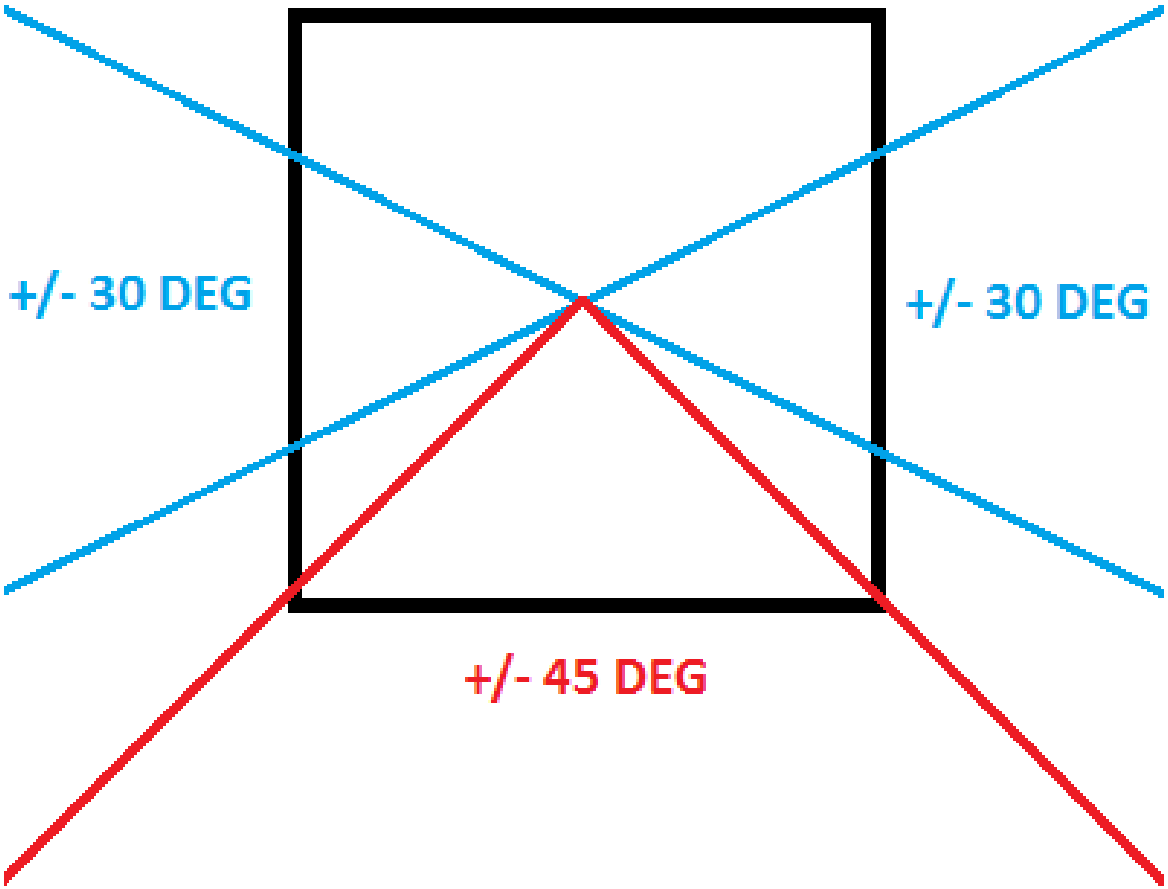
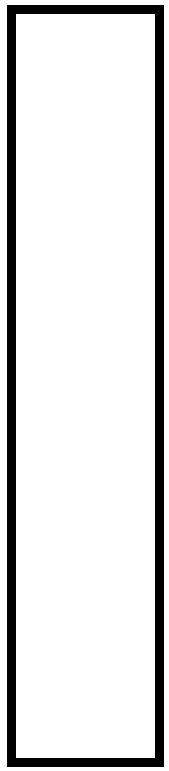
Building Envelope





Hmm...

Miscellaneous

- Cool roofs (f)
  - Cz1-3, with exceptions
- Skylights with daylighting

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Skylights in Large Interior Spaces

- **5.5.4.2.3 Minimum** ***Skylight Fenestration Area.*** In enclosed spaces that are:

  i. greater than 10,000ft^2, and [5,000 ft^2*]

  ii. directly under a roof with ceiling heights greater than 15 ft, and

  iii. one of the following space types: office, lobby, atrium, concourse, corridor, storage, gymnasium/exercise center, convention center, automotive service, manufacturing, non-refrigerated warehouse, retail, distribution/sorting area, transportation, or workshop.

The total *skylight area shall be either;*

- a. a minimum of 3% of the roof area of that enclosed space with a skylight VLT at least 0.40, or
- b. such that the *daylight area under skylights will be a minimum of half the* floor area and provide a minimum *skylight effective aperture of at least* 1%.

These skylights shall have a glazing material or diffuser with a measured haze value greater than 90% when tested according to ASTM D1003. *General lighting in the* daylight area shall be controlled as described in Section 9.4.1.4.

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Building Envelope

- Suggestions for compliance
  - Plan building orientation early
  - Shade glass or use low SHGF
  - Early integration of architecture and MEP engineering
    - Envelope design affects HVAC design
    - Energy modeling for comparing options and balancing efficiency with cost

HVAC

- Scope
  - Equipment efficiency ratings
  - Fan Power
  - Energy recovery
  - Reheat limitations
  - Economizers
  - Duct sealing and leakage
  - Other

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Fan Power

- 2010 requirements (VAV)
  - Offices <1.5 BHP/1000 cfm
  - Labs & Hospitals <2.3 BHP/1000 cfm
    - Based on brake HP
    - Includes all fans running at peak cooling load
    - Also in IECC 2009
    - Post 2010 maybe drive efficiency requirements

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Fan Power

- Suggestions for compliance
  - Efficient fans
  - Low static systems
    - Larger air handling units (but smaller motors)
    - Fewer duct turns
    - Shorter duct runs
    - Requires early coordination of architectural design with HVAC design
    - Sell the advantages!

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Fan Power

- 2007 ERU allowance
  - Whatever the pressure drop is
- 2010 ERU allowance (dj)
  - 2.2*effectiveness – 0.5, except
  - Runaround coils = 0.6”
  - Provides incentive for higher efficiency

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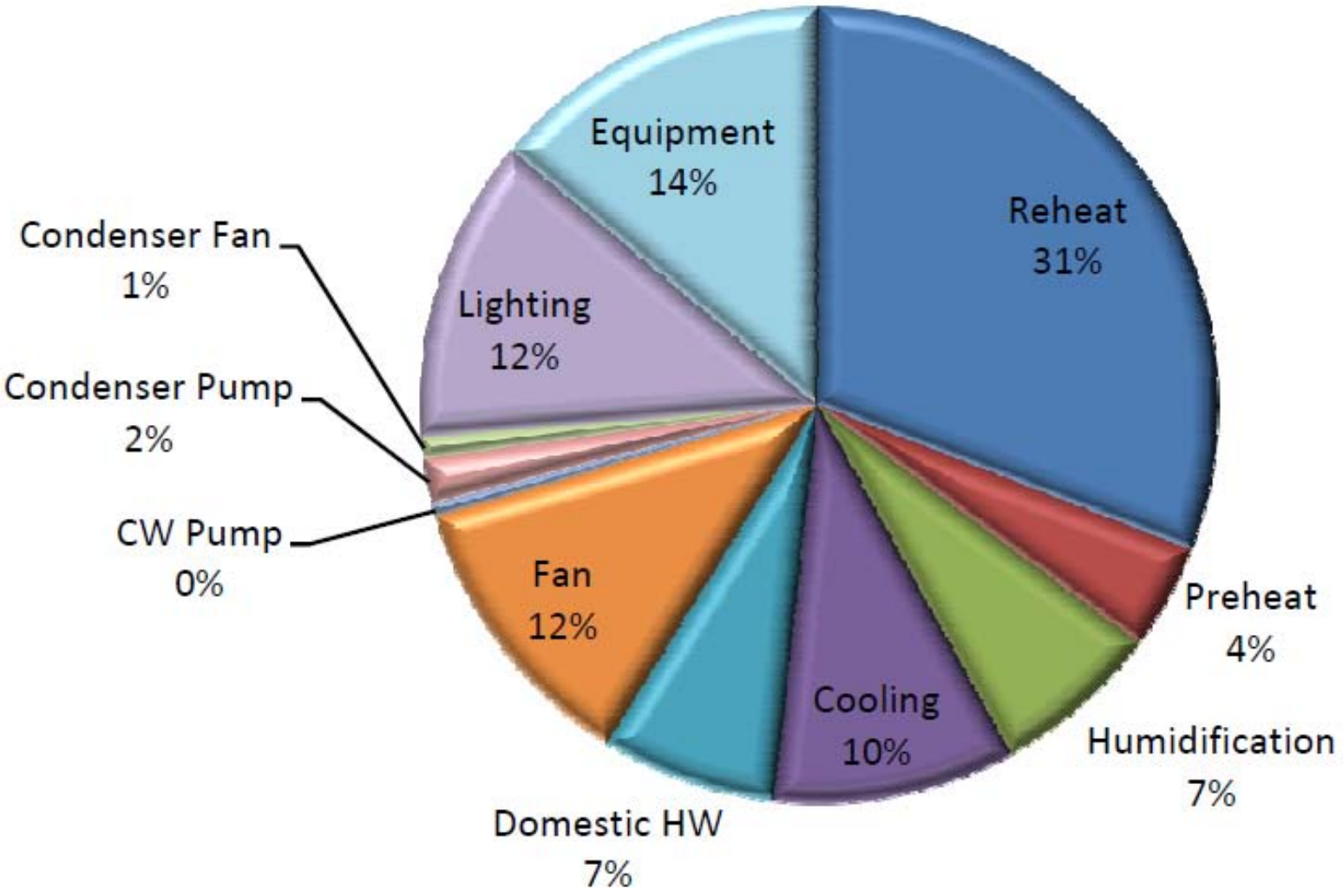
Energy Recovery

- Current – if >70% OA and >5,000 cfm

Table 6.5.6.1 A Energy Recovery Requirement (IP)

Zone	% Outside Air at full design cfm					
	≥30% and < 40%	≥40% and < 50%	≥50% and < 60%	≥60% and < 70%	≥70% and < 80%	≥80%
	Design Supply Fan CFM					
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	≥5000	≥5000
1B, 2B,5C	NR	NR	≥26000	≥12000	≥5000	≥4000
6B	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
1A, 2A, 3A, 4A, 5A, 6A	≥5500	≥4500	≥3500	≥2000	≥1000	>0
7,8	≥2500	≥1000	>0	>0	>0	>0

Reheat – Typical VAV Hospital



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Reheat

- Current requirements
  - Unlimited reheat if there are any pressure controlled spaces – many constant volume hospitals and labs
  - Many exceptions
  - IECC is less restrictive

Reheat

- 2010 requirements
  - No reheat allowed unless:
    - ≤30% of peak flow or
    - Flow no more than required air changes
  - Bans CAV systems in most hospitals & labs
  - ORs only pressurized when unoccupied
  - "BX" restricts overhead air heat to 20F above room temperature – Supplemental heat may be needed

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Reheat

- Suggestions for compliance
  - VAV systems
  - Perimeter heating
  - Condenser reheat
  - Heat pumps, fan coils, or chilled beams with dedicated outside air systems (DOAS) and enthalpy recovery

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Economizers

- 2007 requirements
  - Exempt if over 25% of area served is humidified above 35F dew-point (~22% RH)
  - Exempt if <11 tons
  - Not required in 1a&b, 2a, 3a & 4a

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Economizers

- 2007

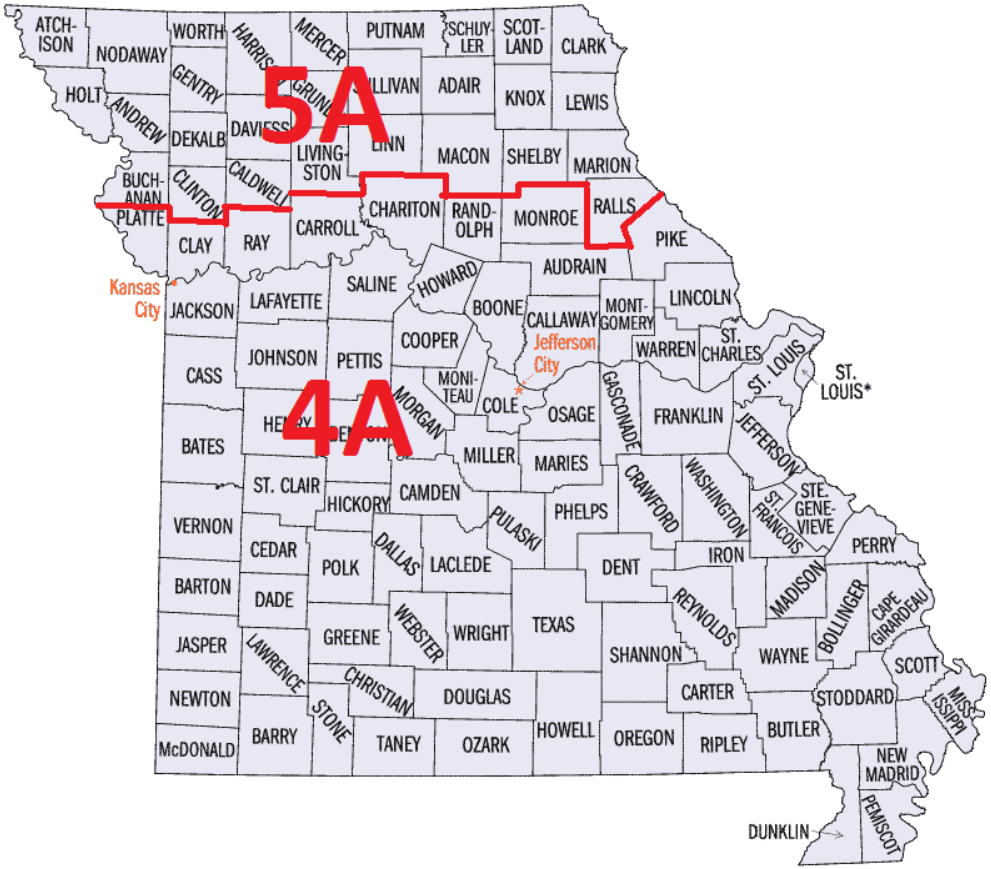
TABLE 6.5.1 Minimum System Size for Which an Economizer is Required

Climate Zones	Cooling Capacity for Which an Economizer is Required
1a, 1b, 2a, 3a, 4a	No economizer requirement
2b, 5a, 6a, 7, 8	≥135,000 Btu/h
3b, 3c, 4b, 4c, 5b, 5c, 6b	≥65,000 Btu/h

- 2010 Proposed (cy)

TABLE 6.5.1a Minimum Fan-cooling Unit Size for Which an Economizer is Required for Comfort Cooling

Climate Zones	Cooling Capacity for Which an Economizer is Required
1a, 1b	No economizer requirement
2a, 2b, 3a, 4a, 5a, 6a 3b, 3c, 4b, 4c, 5b, 5c, 6b, 7, 8	≥54,000 Btu/h



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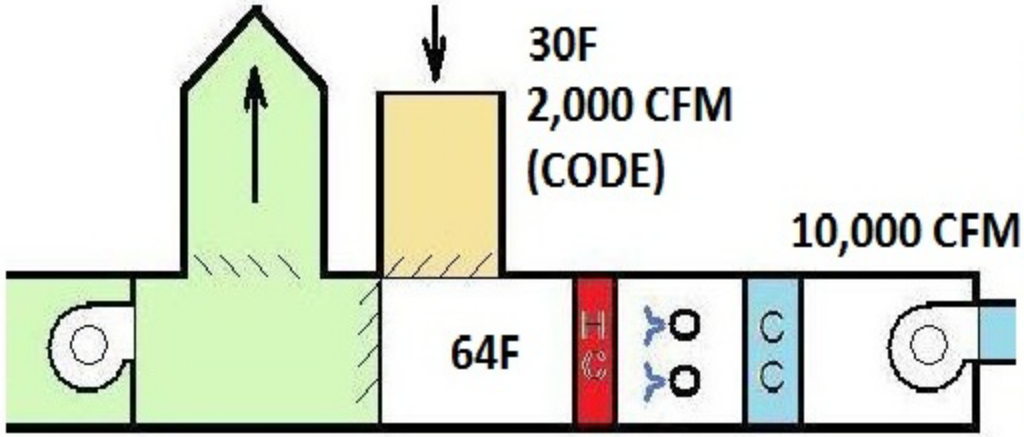
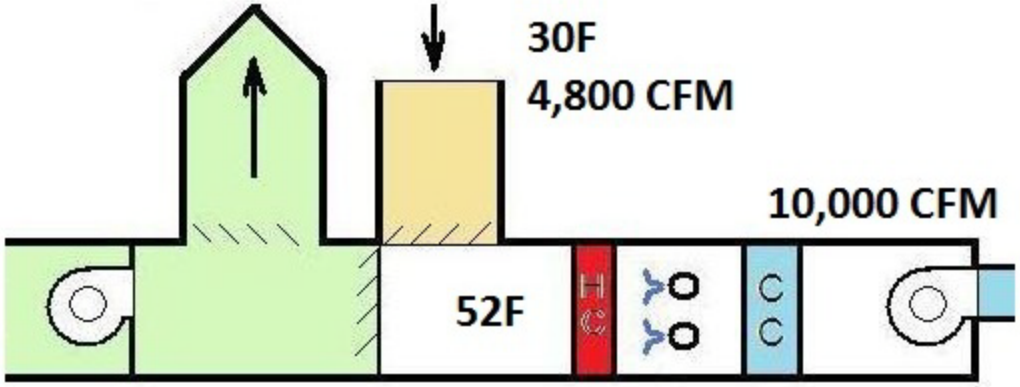
Economizers – None vs. Air



No Economizer

Cooling = 126,440 Btuh
Humidifier = 22,388 Btuh
Pump = 0 Btuh
Cooling Tower = 0 Btuh
Reheat (Baseline) 0 Btuh
Total = 148,828 Btuh



Air Economizer

Cooling = 0 Btuh
Humidifier = 53,305 Btuh
Pump = 0 Btuh
Cooling Tower = 0 Btuh
Reheat (Baseline) 0 Btuh
Total = 53,305 Btuh

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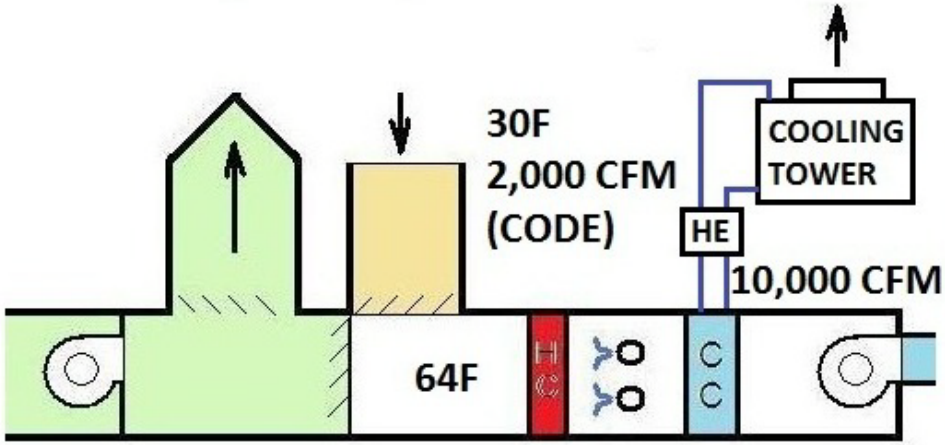
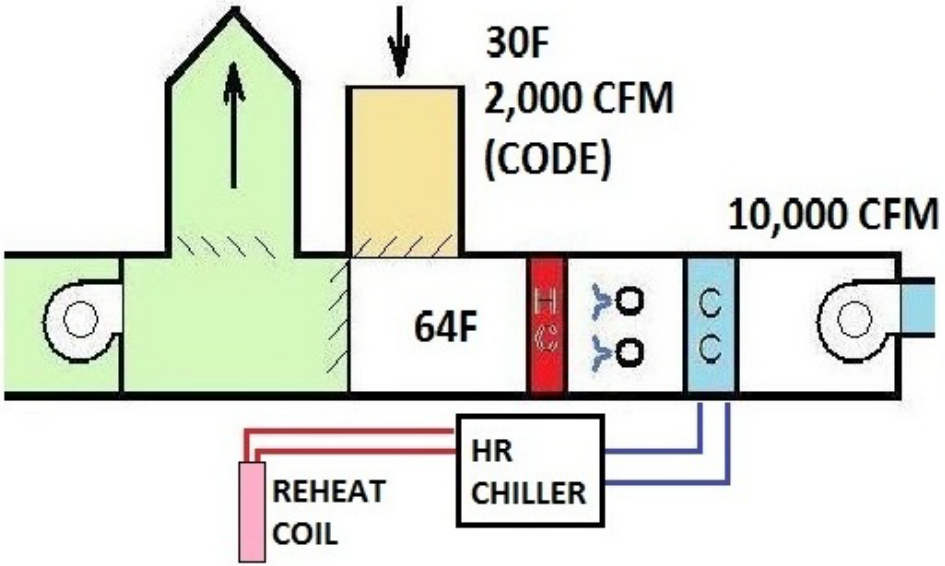
Economizers – Water vs. Condenser



Water Economizer

Cooling =	0 Btuh
Humidifier =	22,388 Btuh
Pump =	2,545 Btuh
C Tower =	2,545 Btuh
Reheat (Baseline)	0 Btuh
Total =	**27,478 Btuh**



Condenser Reheat

Cooling =	50,576 Btuh
Humidifier =	22,388 Btuh
Pump =	1,273 Btuh
Cooling Tower =	0 Btuh
Reheat =	-177,016 Btuh
Total =	**-102,779 Btuh**

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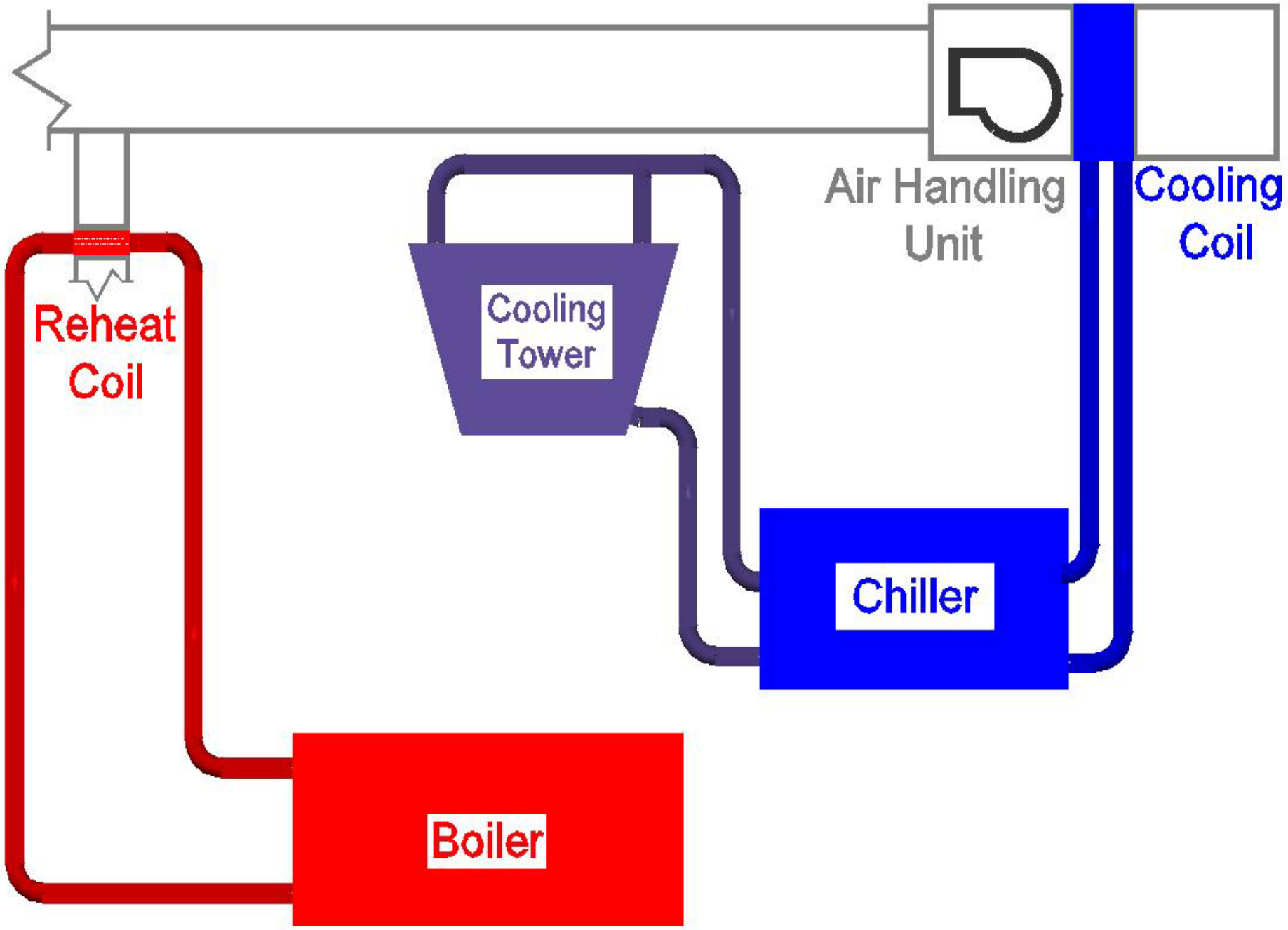

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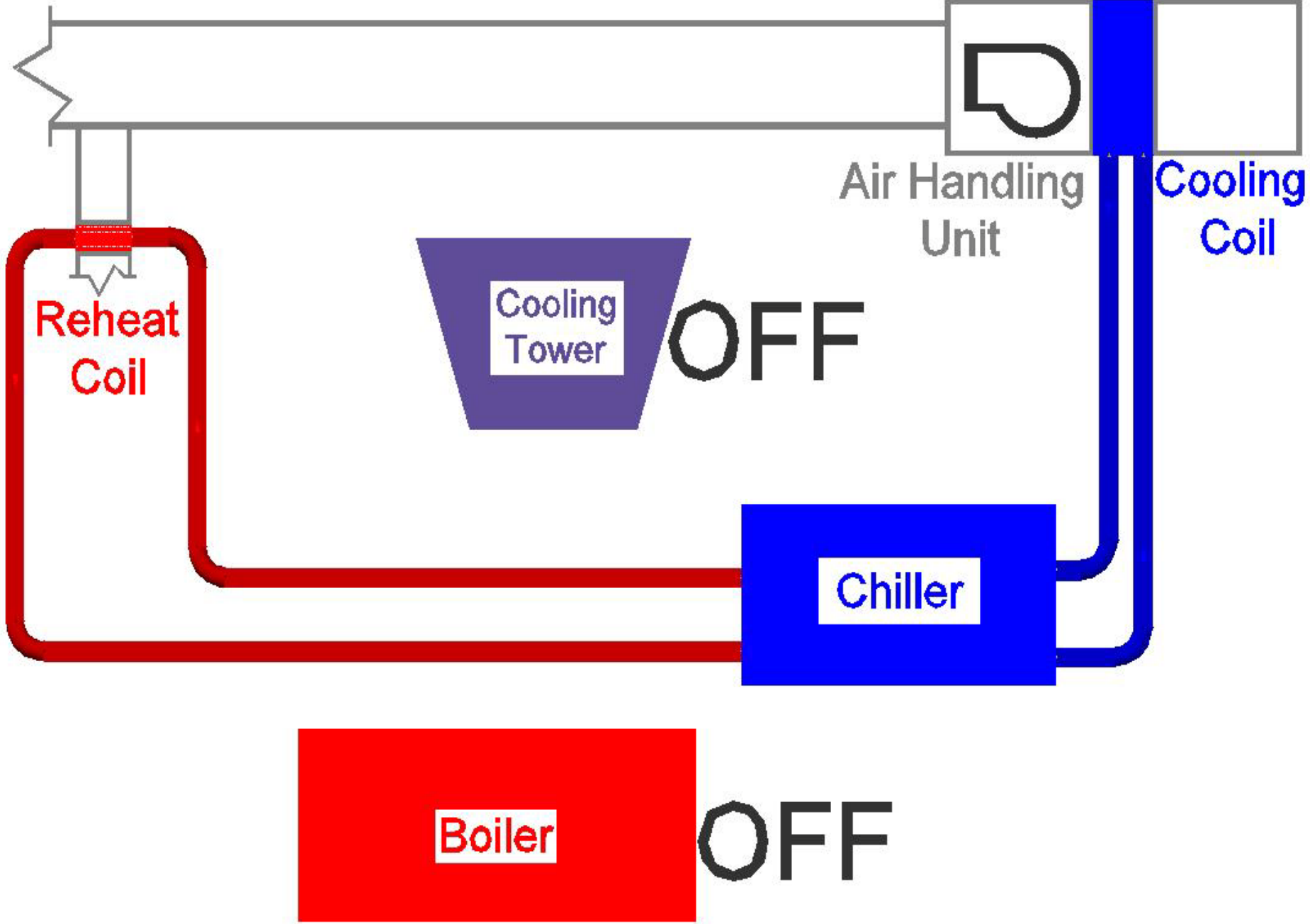

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Duct Sealing (cq)

- Ductwork and plenums with pressure ratings shall be seal class A
- Shaft openings require bushings
- 25% of duct systems over 3” w.g. and ALL outdoor ducts shall be leak tested
  - Tested sections chosen by owner
- Leakage class = 4 for all ducts

Other HVAC Changes

- Pump head calculation
- Chilled water pipe sizing
- Chilled water pump VSDs & pressure reset
- Radiant panel insulation
- Single-zone VAV requirements
- Supply air temperature reset
  - One of the larger savings

Lighting

- Covers
  - Interior spaces of buildings
  - Exterior building features
  - Exterior grounds lighting powered through building
    - Exceptions
      - Emergency lighting that is normally off
      - Lighting required by life safety statute
      - Lighting in dwelling units

Lighting

- ~ 30 lighting addenda
- 2 wattage reduction addenda
- 28 lighting control addenda
- Retail display – add 60-250% depending on merchandise
- LPD dropped a little ~10% on average

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Lighting

- Lighting power density changes for 2010

LPD W/SF)	1989	1999	2001	2004*	2010
Clinic	1.44	1.60	1.60	1.00	0.87
Hospital	1.44	1.60	1.60	1.20	1.21

* Few changes between 2004 and 2007

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Lighting Controls

- No daylighting rules until 2010
- Addenda d, ab, al, ct
- Obstructions >5’ tall end daylit areas

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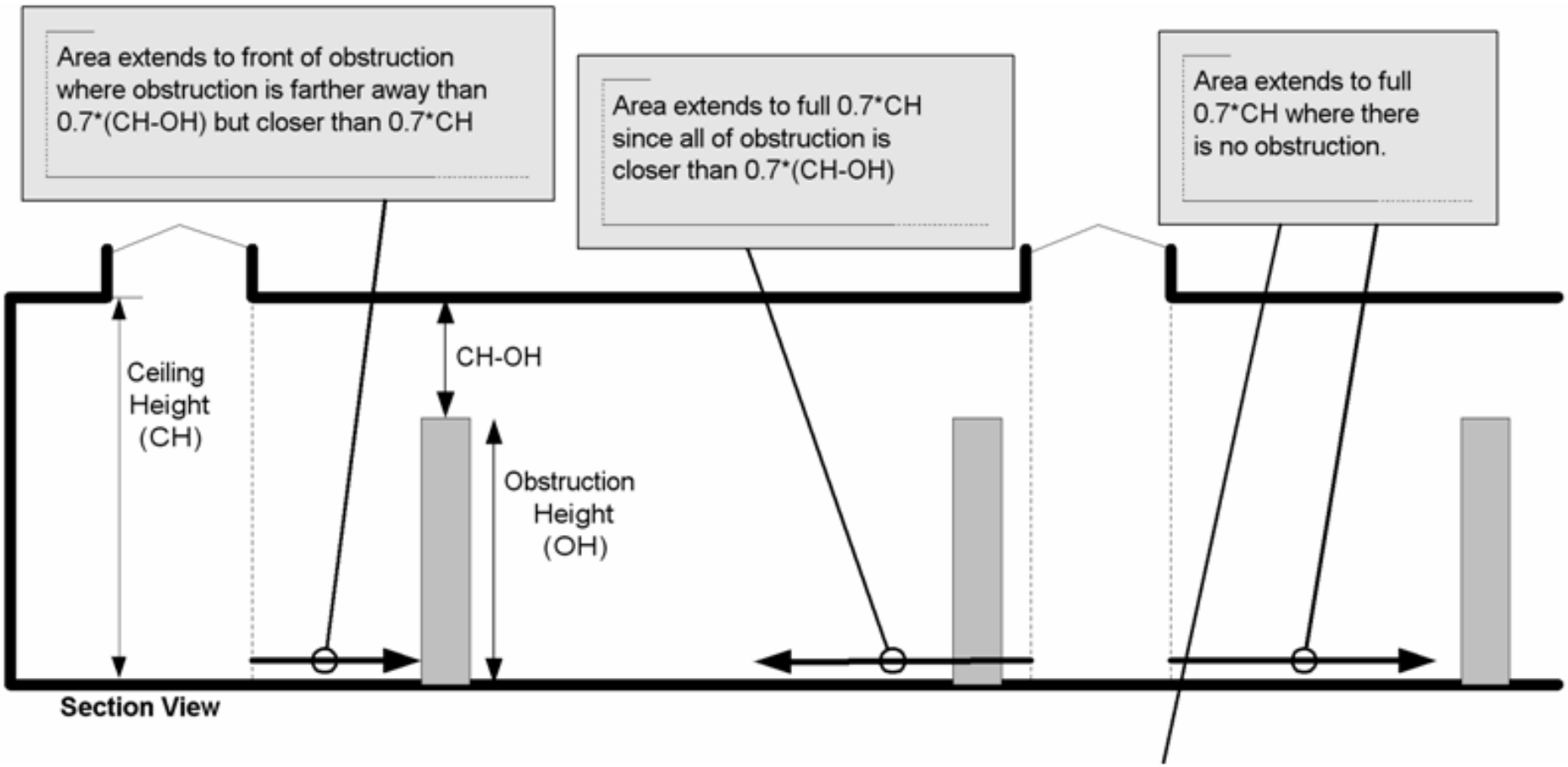
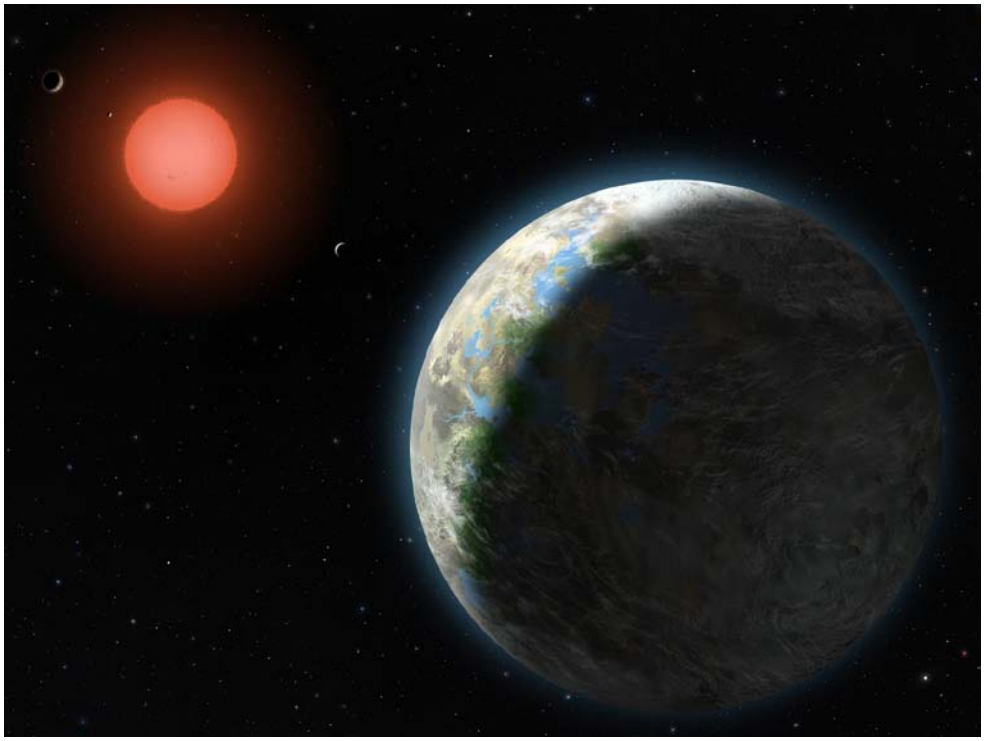
“Daylight Area Under Skylights”



Exterior Lighting



- 4 zones (i)
  - National parks
  - Residential
  - Other
  - Metro
- 500 – 1300W + .04-.80 W/SF

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Occupancy Sensors

- Added training rooms, lecture halls, storage 50-1000sf
- Manual on
  - Exceptions – restrooms, public corridors and stairs
- Bi-level control for most spaces
  - Not corridors

Alterations

- Interior and exterior alterations must comply
- Includes lamp+ballast replacements

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Parking Garage

- Reduce power 30% if no activity in >3600SF area

Exterior (cd)

- MUST turn off exterior lighting when plenty of sun
- Off midnight or closing to 6am

Functional Testing (az)

- Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions.

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Lighting Automatic Shutoff

- Whole-building shutoff
  - Exceptions for:
    - Patient care areas
    - Lighting required for 24-hour use
    - Where automatic-off would be unsafe
- Individual space controls
- Exterior – astronomical timer or daylight sensor

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Exit Signs Limited to 5 Watts

Power – Controversial! (overturned)

- "BZ" may add separate monitoring of:
  - Total electrical energy
  - HVAC systems electricity
  - Exterior lighting
  - Interior lighting
  - Receptacle circuits
- 15-minute reporting

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Power - Receptacles (bs)

- 50% of 120V need automatic control
  - Includes modular partitions
- Options
  - Time of day
  - Occupancy sensor
  - Another control or alarm system

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Power - Receptacles (bs)

- **Exceptions:**
  - Receptacles specifically designated for equipment requiring 24 hour operation
  - Spaces where patient care is rendered
  - Spaces where an automatic shutoff would endanger the safety or security of the room or building occupant(s).

Other Equipment

- Booster Pumps
  - Sensor to start and/or control speed
  - Remote sensor or simulation logic
  - No PRV at pumps
  - Pumps off when no flow

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Other Equipment

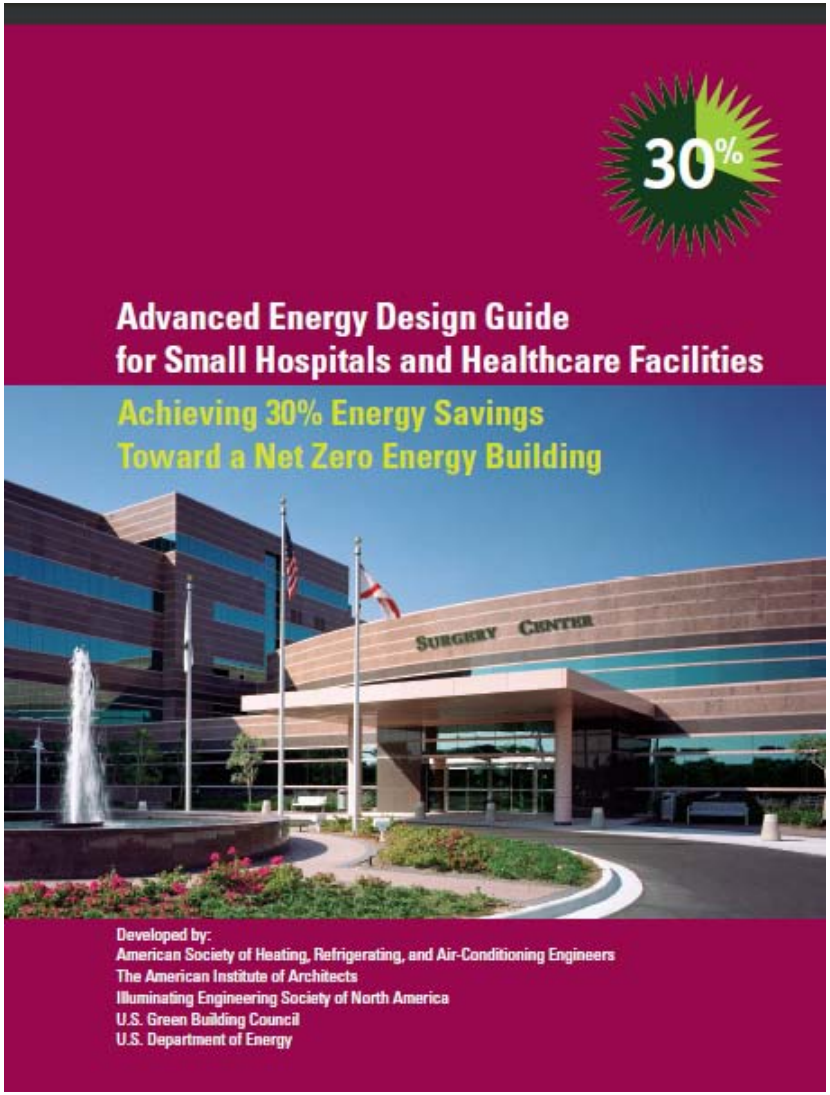
- Elevators
  - Lighting efficacy ≥35 LPW
  - Ventilation ≤ 0.33 W/cfm
  - Lights & fans off if unused for >15 minutes
  - Future – Movement efficiency
  - Future – Escalators & fast-walks

What if I Want More?

- IGCC 2010 (includes 189.1)
- ASHRAE-USGBC-IESNA Standard 189.1
- VAV complies, but won't save big
  - Good savings with condenser reheat
- Advanced Energy Design Guide series
  - Office, school, small healthcare, warehouse

AEDG

- Small Healthcare
  - Hospitals
  - Clinics
  - Cookbook method to achieve ~40% savings over 90.1-1999



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AEDG – Small Healthcare

- Similar savings to ASHRAE 90.1-2010
- AEDGs qualify for LEED Energy Prerequisite without energy modeling
  - Documentation is still required
- Existing AEDGs also qualify for 1 point

AEDG – Large Healthcare

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Bing

- 16 buildings, 17 climate zones
- Weighting factors
- Hospital 2.8% of USA SF, Clinic 3.5%
- Warehouse 13%, Stand-alone retail 12%
- 44 addenda for 2007
- 64 more for 2010

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90.1 Progress Indicator

- 1,632 runs = 16 buildings x 17 climate zones x three 90.1 standards x two 62.1 standards

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90.1-2010 Savings over 90.1-2004

62.1 – 2001

- 21.7% including plug loads
- 27.4% excluding plug loads

62.1 - 2007

- 24.8% including plug loads
- 30.9% excluding plug loads

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90.1 Progress Indicator 2010-06-28

- Additional addenda to be included
  - F – Cool Roofs
  - S – DX efficiency
  - CK – ventilation reset
  - CT, DD – Daylighting
  - BF – Continuous air barrier
  - others

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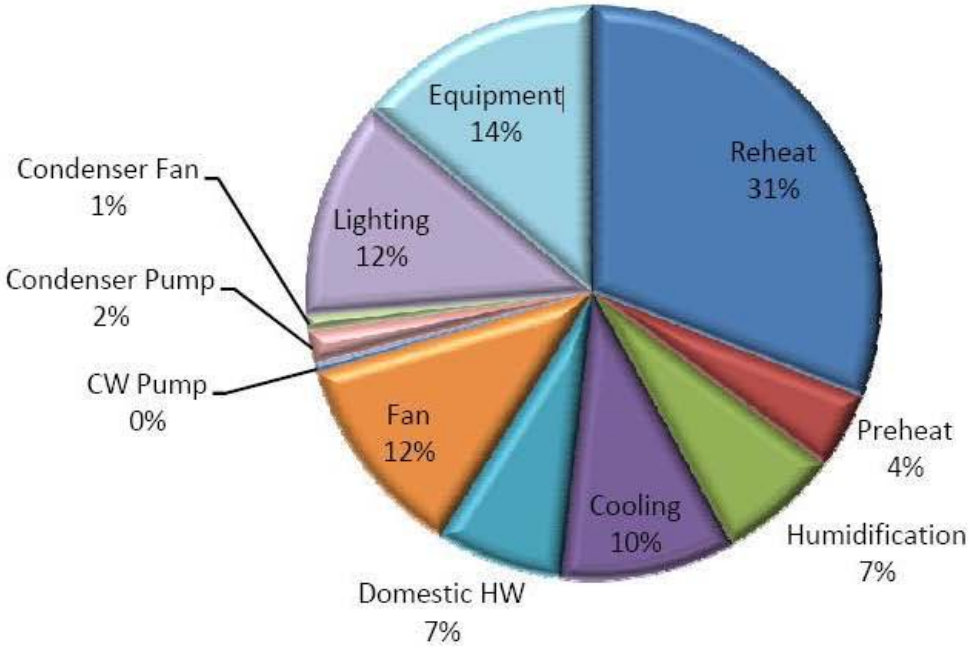
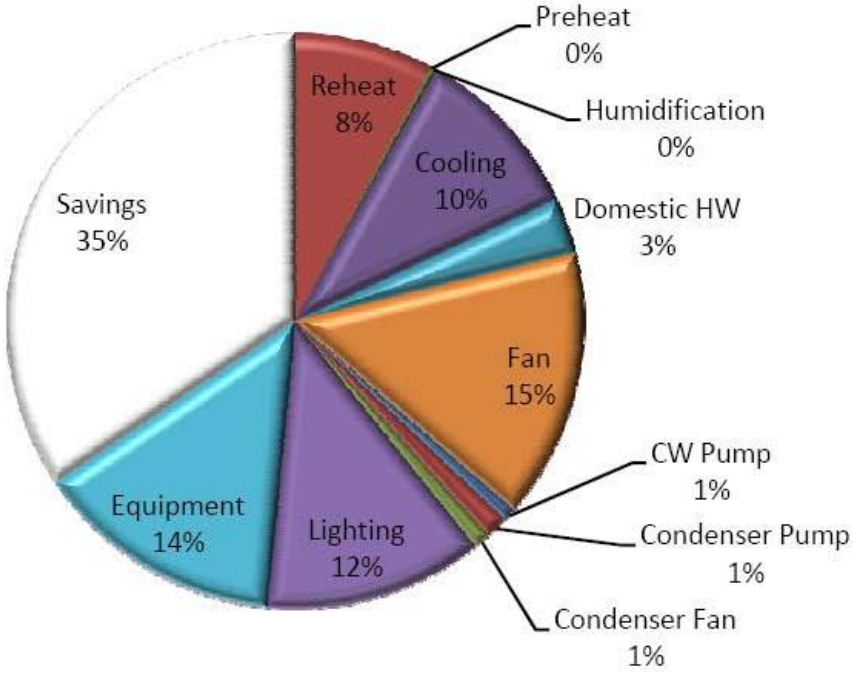
Which Facility Do You Want to Own?





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