Agenda and Objectives

Trane Engineers Newsletter Live Series

ASHRAE Standard 90.1-2010

Abstract: Major envelope, mechanical, lighting, and modeling addenda that will be incorporated into 90.1-2010 will be discussed.

Presenters: Mick Schwedler, Susanna Hanson, Mike Patterson, Matthew Bye,

What the viewer can expect to learn:

1. Summarize how 90.1-2010 saved close to 30% energy cost over 2004
2. Summarize major changes, with specific emphasis on mechanical related system design, control and modeling.
3. Mechanical updates: equipment efficiencies, design requirements for hydronics, airside, and ventilation.
4. Controls updates for system design and operation.
5. Modeling changes for Appendix G baseline definitions and proposed buildings.
6. Summaries for lighting, envelope and other changes
7. Trane expertise in systems and controls can help meet requirements
8. Learn where to go for help

Program Outline:

2) Introduction
   a) Energy savings of 30% over 2004, addenda processed
3) Envelope highlights
   a) Insulation
   b) Air barrier
   c) Fenestration
   d) Lighting, daylighting and skylights
   f) WWR, orientation
4) Mechanical with examples
   a) Equipment efficiency updates.
   b) Unitary system design
   c) Waterside system design
   d) Airside system design
   e) Ventilation and exhaust
5) Controls with examples
   a) Reheat minimums
   b) VAV heating temp
   c) Ventilation reset
   d) Zone DCV
   e) Supply air reset
6) ECB with examples
   a) Change G to normative (what this means)
   b) Purchased heating and cooling
   c) Lab exhaust modeling
   d) Fan power limit definition in Appendix G (different than in Ch. 6)
   e) What prescriptive changes weren't yet picked

Presenters

Trane Engineers Newsletter Live Series

ASHRAE Standard 90.1-2010

Susanna Hanson | applications engineer | Trane
Susanna is an applications engineer at Trane with over twelve years of experience with chilled-water systems and HVAC building load and energy analysis. Her primary responsibility is to aid system design engineers and Trane personnel in the proper design and application of HVAC systems through one-on-one support, authoring technical articles and presenting seminars. Her main areas of expertise include chilled-water systems and ASHRAE Standard 90.1. She is also a Certified Energy Manager.

Susanna is a member of ASHRAE SSPC 90.1 She earned a B.S. in industrial and systems engineering from the University of Florida, where she focused on building energy management and simulation.

Mike Patterson, LEED AP BD+C | chiller support | Trane
Mike joined Trane as a Marketing Engineer with Customer Direct Service (C.D.S.), the group responsible Trane HVAC design and analysis software. As a CDS engineer he developed expertise in the areas of energy modeling and ASHRAE Standard 90.1 through software development and customer training and support.

Mike earned his B.S. degree in Engineering Mechanics from the United States Air Force Academy, where he was a pilot for 10 years. He also holds a Master's in Business Administration from Regis University.

Mick Schwedler, PE | manager, applications engineering | Trane
Mick joined Trane in 1982. His expertise is in system optimization and control (in which he holds patents), and in chilled-water system design, Mick's primary responsibility is to help designers properly apply Trane products and systems through one-on-one support, authoring technical publications, and presenting seminars. Mick is a past Chair of SSPC 90.1. He also contributed to the ASHRAE GreenGuide and is a former member of the LEED Energy and Atmospheric Technical Advisory Group (TAG). Mick earned a B>S and an M.S. in mechanical engineering.

Matthew Bye, LEED AP |product engineer | Trane
Matt is a Product Engineer at Trane with over 15 years of experience designing, managing, and implementing energy management related products and services. Currently, his primary responsibility is the definition of product requirements for Building Automation Systems and related software applications. Matt has also supported the development of software on behalf of the Electric Power Research Institute (EPRI). EPRI products he has supported are used by electric utilities across the country to model incentives for energy efficiency programs, design demand response programs, and aid in the development of tariffs.

Matt began his career implementing demand side management programs for a local electric utility. He earned a Bachelor of Science degree in Energy Management at Minnesota State University.


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Energy Standard for Buildings Except
Low-Rise Residential Buildings
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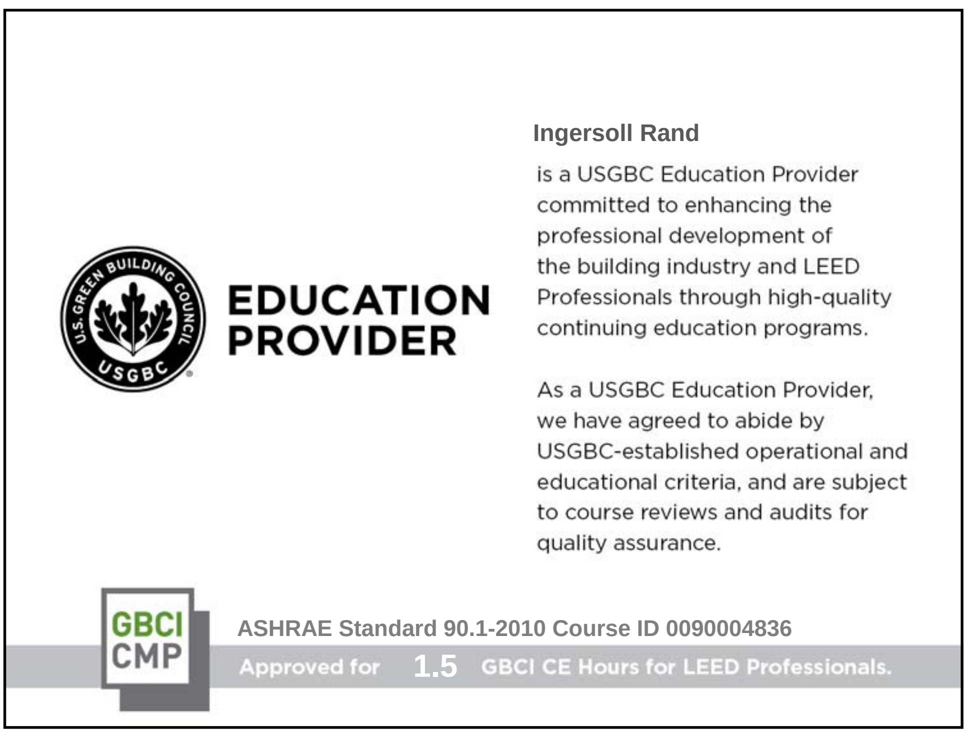
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ASHRAE Standard 90.1-2010
What you'll learn…

- Evolution of Standard 90.1
- Overview of the major changes
- Mechanical updates
- Control updates
- Modeling changes Appendix G
- Summary

Today's Presenters

Mick Schwedler
Applications
Engineering Manager

Susanna Hanson
Applications
Engineer

Today's Presenters

Matthew Bye
Product Engineer

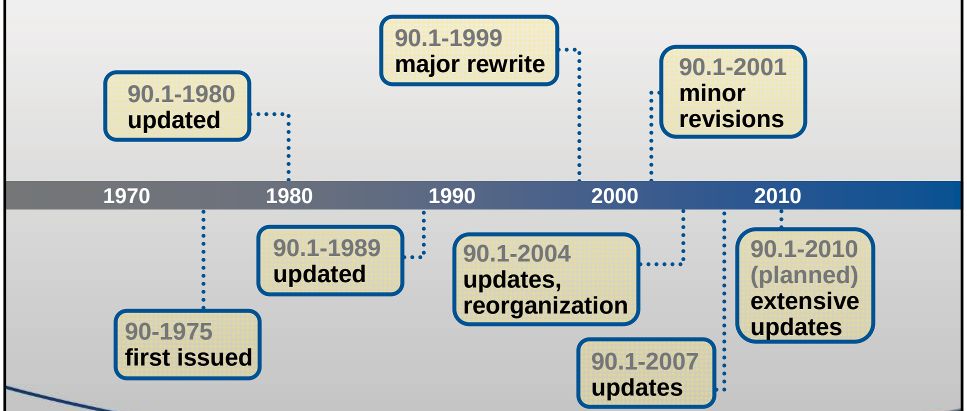
Mike Patterson
Sales Training Manager

ASHRAE/IES 90.1-2010

engineers newsletter LIVE

Development Overview of 90.1

Historical Timeline
Cognizant TC, 7.6 Systems Energy Utilization



ASHRAE Standard 90.1 and
Model Codes

ASHRAE Standard 90.1 is adopted by:

- National Fire Protection Association by reference
- International Code Council (2009) (International Energy Conservation Code®)
  - Chapter 5: Commercial Energy Code
    - Comply with 90.1-2007 or
    - Comply with the rest of Chapter 5

ASHRAE Standard 90.1 and
USGBC, LEED®-2009 (v3)

- EAp2: Minimum energy performance
  - Comply with 90.1-2007
    - Mandatory provisions of 90.1-2007 and
    - Prescriptive requirements of 90.1-2007 **or** Energy Cost Budget method of 90.1-2007 **and**
    - 10% improvement over 90.1-2007
- EAc1: Optimize energy performance
  - 1 point for 12% savings
  - 3 points for 16% savings
  - Up to 19 points (of 100)

SSPC 90.1 Work Plan
(unanimous June 2007)

- Goal: A 2010 standard that results in 30% total energy cost savings improvement compared to Standard 90.1-2004
  - Measurement is aggregated, may not be met for every building in every location
- 90.1-2010 = 90.1-2007 + All IES and ASHRAE BOD approved addenda

How is 90.1 Updated? Through Addenda

- Developed and voted on by 90.1 committee
  - SSPC 90.1 uses economic criteria
- Approved by ASHRAE oversight committees
- Public Review
  - Comments require formal response
  - Changes must be re-approved and sent subsequent public review
  - Resolution of commenters is the goal
    - If not resolved, they may appeal
- Must reach consensus

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Where Have Addenda Come From?

- You
- Other publications
  - Advanced Energy Design Guides
  - California Title 24
  - ASHRAE Standard 189.1
- ASHRAE Technical Committees
- Stakeholders (working groups)
- Energy conscious owners
- SSPC 90.1 volunteers
  - 4 meetings per year (3–4 days each, 8 a.m.–9 p.m.)
  - Additional web meetings
  - Monthly (or more often) conference calls

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SSPC 90.1 Accomplishments
06/2007 through 07/31/2010

- 119 Addenda processed
  - 111 approved with no appeals
  - 1 approved and is being appealed
  - 7 still in comment resolution and will not be in 90.1-2010
- 2010 User's Manual in progress

ASHRAE Standard 90.1-2007 Sections

- Section 1: Purpose
- Section 2: Scope
- Section 3: Definitions, Abbreviations, and Acronyms
- Section 4: Administration and Enforcement
- Section 5: Building Envelope
- Section 6: HVAC
- Section 7: Service Water Heating
- Section 8: Power
- Section 9: Lighting
- Section 10: Other Equipment
- Section 11: Energy Cost Budget (ECB) Method
- Section 12: Normative References
- Appendices

ASHRAE Standard 90.1-2010 (AQ)
Purpose

"To establish the minimum energy efficiency requirements of buildings, other than low rise residential buildings, for:

1. design, construction, and a plan for operation and maintenance, and
2. utilization of on-site, renewable energy resources."

ASHRAE Standard 90.1-2010 (AQ)
Scope

- New buildings and their systems
- New portions of buildings and their systems
- New systems and equipment in existing buildings
- New equipment or building systems specifically identified in the standard that are part of industrial or manufacturing processes

ASHRAE Standard 90.1-2010 (AQ)

Does Not Apply To

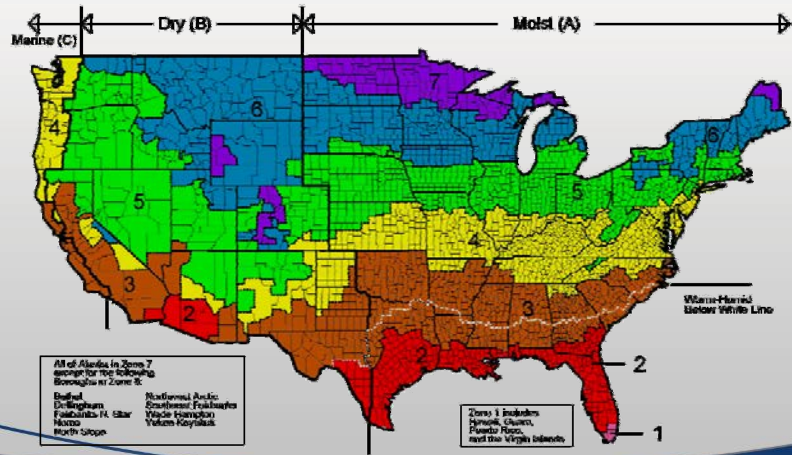
- Single-family houses, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes), and manufactured houses (modular), or
- Buildings that use neither electricity nor fossil fuel

Addendum BB—Building Envelope More Insulation and Better Glass

- Opaque
  - Roofs
  - Walls
  - Floors
  - Slab-on-grade insulation
  - Doors
- Fenestration (glass)
  - 30% maximum window to wall ratio (WWR)
  - Better U-Factor
  - Lower Solar Heat Gain Coefficient (SHGC)
  - Visible transmittance/SHGC Ratio
    - **VT/SHGC > 1.10**
- Allowance up to 40% WWR (Addendum CX)
  - Proper daylighting layout
  - Automatic dimming controls on lights

Climate Zones and Climatic Data Normative Appendices B and D

Figure B-1 and Table B-1 US Climate Zones



Climate Zone 4 Requirements

	90.1-2007	90.1 – 2010 (Addendum BB)
Roof—insulation entirely above deck	R-20 c.i.	R-30 c.i.
Mass wall above grade	U-0.104 or R-9.5	U-0.104 or R-9.5
Heated slab-on-grade floor	c.i.F-0.860 or R-15 for 24 in.	c.i.F-0.843 or R-20 for 24 in.
Opaque swinging door	U-0.70	U-0.50
Non-metal-framed vertical fenestration	U-0.40 and 0.40 SHGC	U-0.32 and 0.30 SHGC

c.i. - continuous insulation

90.1-2010 Envelope Changes

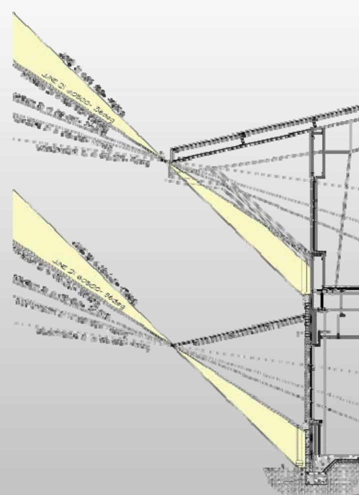
- BN fenestration orientation
- BF continuous air barrier
- F cool roofs
- Envelope/lighting interactions

addendum BN
Orient Buildings with More Glass On South

- **5.5.4.5. Fenestration Orientation**

  The ***vertical fenestration area*** shall meet the following requirement:

  Area South ≥ Area West
  and
  Area South ≥ Area East



addendum BN
Orient Buildings with More Glass On South

Exceptions to 5.5.4.5:

Vertical fenestration that complies with the exception to 5.5.4.4.1 (c).

(Storefronts)

Buildings that have an existing building or existing permanent infrastructure within 20 ft (6 m) to the south (north in the southern hemisphere) which is at least half as tall as the proposed building.

(Urban infill buildings)

Buildings with shade on 75% of the west and east oriented *vertical fenestration areas* façade from permanent projections, existing buildings, existing permanent infrastructure or topography at 9 a.m. and 3 p.m. on the summer solstice (June 21 in the northern hemisphere).

(Shaded buildings)

Alterations and additions with no increase in vertical fenestration area.

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addendum BF
Continuous Air Barrier

- Using **individual materials** that have an air permeability ≤ 0.004 cfm/ft^2
- Using **assemblies of materials** and components that have an average air leakage ≤ 0.04 cfm/ft^2

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addendum F
Cool Roofs

5.5.3.1.2 Roof Solar Reflectance and Thermal Emittance.
Roofs in *climate zones* 1 through 3 shall have one of the following:

- A minimum three-year-aged solar reflectance of 0.55 when tested in accordance with ASTM C1549 or ASTM E1918, and in addition, a minimum three-year-aged thermal emittance of 0.75 when tested in accordance with ASTM C1371 or ASTM E408
- A minimum three-year-aged Solar Reflectance Index of 64 when determined in accordance with the Solar Reflectance Index method in ASTM E1980 using a convection coefficient of 2.1 BTU/h-ft^2 (12 W/m2.K), or
- Increased roof insulation levels that meet the following:

Roofs: Insulation entirely above deck

Nonresidential	*Residential*
U-0.030/R-33	U-0.029/R-34

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addendum F
Cool Roofs


- **Exceptions to 5.5.3.1.2:**

a. Ballasted *roofs with a minimum stone ballast of 17 lbs/ft^2 (74 kg/m^2) or 23 lbs/ft^2* pavers (117 kg/m^2).

b. *Vegetated Roofs Systems that are either extensively and/or intensively vegetated,* containing a minimum thickness of 32.5 inches (76 63.5 mm) of growing medium and covering a minimum of 75% of the roof area with durable plantings.

c. *Roofs, where a minimum of 75% of the roof area:*

i. is shaded during the peak sun angle on June 21st by permanent components or features of the building, or

ii. is covered by off-set photovoltaic arrays, building-integrated photovoltaic arrays, or solar air or water collectors, or

iii. is permitted to be interpolated using a combination of parts i and ii above.

d. Metal building roofs in climate zone 3. Steep sloped *roofs*

e. *Roofs over ventilated attics or roofs over semi-heated spaces or roofs over conditioned spaces that are not cooled spaces. Low sloped metal building roofs in* climate zones 2 and 3.

f. Asphaltic membranes in climate zone 3. *Roofs over ventilated attics or roofs over semi-heated spaces or roofs over conditioned spaces that are not cooled spaces.*

g. Asphaltic membranes in climate zones 2 and 3.

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addendum AL
Skylights in Large Spaces

- **5.5.4.2.2 Maximum *Skylight* Fenestration Area**. The total skylight area shall be less than 5% of the gross roof area.
- **5.5.4.2.3 Minimum *Skylight* Fenestration Area**. In *enclosed spaces* that are:
  - i. greater than 10,000ft^2, and
  - 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.

example
Building Lighting Power Density (LPD) Changes

TABLE 9.5.1 Lighting Power Densities Using the Building Area Method

Building Area Type[a]	LPD (W/ft^2)	
Automotive facility	~~0.9~~	0.82
Convention center	~~1.2~~	1.08
Courthouse	~~1.2~~	1.05
Dining: bar lounge/leisure	~~1.3~~	0.99
Dining: cafeteria/fast food	~~1.4~~	0.90
Dining: family	~~1.6~~	0.89
Dormitory	~~1.0~~	0.61
Exercise center	~~1.0~~	0.88
Gymnasium	~~1.1~~	1.00
Health-care clinic	~~1.0~~	0.87
Hospital	~~1.2~~	1.21
Hotel	~~1.0~~	1.00
Library	~~1.3~~	1.18
Manufacturing facility	~~1.3~~	1.11
Motel	~~1.0~~	0.88
Motion picture theater	~~1.2~~	0.83
Multifamily	~~0.7~~	0.60
Museum	~~1.1~~	1.06
Office	~~1.0~~	0.90
Parking garage	~~0.3~~	0.25

Most whole building values reduced or unchanged

[Addendum BY - completed]

example
Space Type LPD Changes

Mixed reduction and increase in LPDs based on technology improvements and model corrections.

TABLE 9.6.1 Lighting Power Densities Using Space-by-Space Method
Common Space Types

	LPD, W/ft²		RCR Threshold
Atrium—First Three Floors First 40 feet in Height	0.6	0.03 per ft (height)	NA
Atrium—Each Additional Floor Height Above 40 Feet	0.2	0.02 per ft (height)	NA
Classroom/ Lecture/ Training	1.4	1.24	4
For Penitentiary	1.3		
Conference/ Meeting/ Multipurpose	1.3	1.23	6
Corridor/ Transition	0.5	0.66	Width < 8 ft
Laboratory	1.4		
For Classrooms		1.28	6
For Medical/ Industrial/ Research		1.81	6

	LPD, W/ft²		RCR Threshold
Lobby	1.3	0.65	4
For Hotel	1.1		
For Performing Arts Theater	3.3	2.00	6
For Motion Picture Theater	1.1	0.52	4
Dressing/ Locker/ Fitting Room	0.6	0.75	6
Lounge/ Recreation	1.2	0.73	4
For Hospital	0.8		
Office—Enclosed	1.1	1.11	8
Office—Open Plan	1.1	0.98	4
Restrooms	0.9	0.98	8
Sales Area [for accent lighting, see Section 9.6.2(b)]	1.7	1.68	6
Stairs—Active Stairway	0.6	0.69	10
Active Storage	0.8	0.63	6

Lighting Addenda

- Envelope/lighting interaction
  - D, AB, AL: daylighting control
  - CT, DD: modify the area thresholds for top and side daylighting
- AV: changes alteration threshold (10%) at which replacement lighting and controls must comply
- CE: requires bi-level switching
- CZ: parking garage lighting control
- BS: control of 50% of receptacles

addenda D, AB, and AL
Daylighting Control Additions

- Three separate addenda that:

  Require the control of electric lighting when top and side daylight is present
  and
  Require the installation of skylights when appropriate
- Additional addenda CT and DD modify the area thresholds for top and side daylighting

addendum CE
"Bi-Level" Space Lighting Control

Requires the controlled lighting have at least one control step between 30% and 70% (inclusive) of full lighting power in addition to all off.

- Exceptions:
  - Lights in corridors, electrical/mechanical rooms, public lobbies, restrooms, stairways, and storage rooms
  - Spaces with only one luminaire with rated input power less than 100W
  - Spaces types with a lighting power allowance of less than 0.6 W/ft^2

addendum AV
Changes to Alterations Requirements

Requires that BOTH Interior and Exterior alterations comply with LPD and automatic shutoff requirements.

- Includes retrofits where luminaires are added, replaced, or removed
- Also includes lamp plus ballast retrofits
- Alterations of less than 10% of connected lighting load are exempted

addendum CZ
Parking Garage Control

Requires parking garage lighting to be automatically controlled including daylighting

- Must reduce lighting power by minimum of 30% when no activity detected within a lighting zone (< 3,600 sf)
- Daylight transition zone lighting (66 ft wide by 50 ft) must be separately controlled to turn lighting on during daylight hours and off at sunset
- Daylight control required for luminaires within 20 feet of perimeter wall with net opening to wall ratio of 40%
- Exceptions:
  - Daylight transitions zones and ramps without parking are exempt from 30% reduction and daylight control
  - Applications using HID of 150 watts or less or Induction lamps are exempt from 30% reduction

addendum BS

Receptacle (Wall Plug) Control

Requires that 50% of receptacles (wall plugs) in a space have automatic shutoff control.

- Applies to 125 volt 15- and 20-ampere receptacles in private offices, open offices, and computer classrooms
- Requires automatic control using:
  - Time-of-day schedule,
  - Occupancy sensor, or
  - Other automatic control based on occupancy
- Exceptions:
  - Spaces where automatic shutoff would be safety/security issue
  - Spaces where all loads require 24-hour operation

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ASHRAE Standard 90.1-2010

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Mechanical Section

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Mechanical

- Equipment efficiency
- System design requirements

Equipment Efficiency

- Unitary
- Chillers
- Heat rejection
- Fans and pumps

Table 6.8.1A Electrically Operated Unitary Air Conditioners and Condensing Units—Minimum Efficiency Requirements

Equipment Type
Air Conditioners, Air Cooled

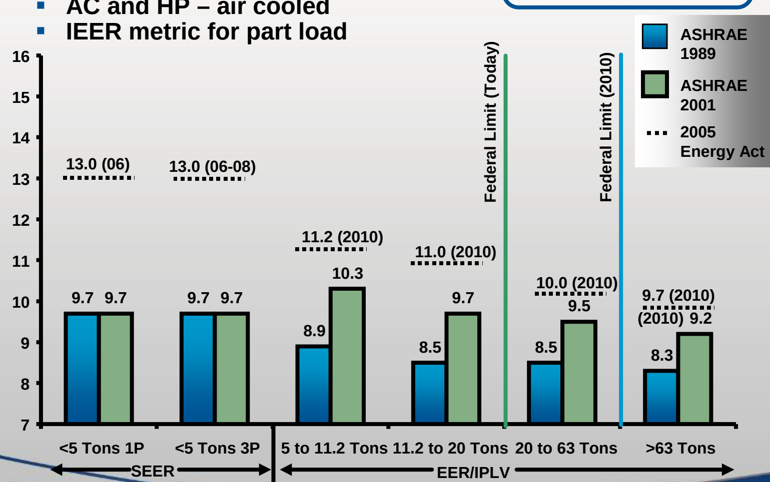
Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 11.4 IEER	
	All other	Split System and Single Package	11.0 EER 11.2 IEER	
	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	
	All other	Split System and Single Package	10.8 EER 11.0 IEER	ARI 340/360
≥240,000 Btu/h and <760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 10.1 IEER	
	All other	Split System and Single Package	9.8 EER 9.9 IEER	
≥760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 9.8 IEER	
	All other	Split System and Single Package	9.5 EER 9.6 IEER	
< 65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	ARI 210/240
≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.5 EER 11.7 IEER	

equipment efficiency

Unitary

- AC and HP – air cooled
- IEER metric for part load

2010 Unitary addenda:
S, K, N, Y, AO, S, T, BG, BU, BW, CO, CP



ASHRAE/IESNA Standard 90.1-2010,
Energy Standard for Buildings Except Low-Rise Residential Buildings

equipment efficiency
Unitary

- What is IEER?
  - A new metric, the *Integrated Energy Efficiency Ratio*
  - Used on unitary products to replace IPLV
  - Designed to encourage better part load performance by putting different spices in the soup
    - i.e. Manufacturers are rewarded for designs that save energy but were not reflected in the IPLV metric

IEER = 0.02A + 0.617B + 0.238C + 0.125D
A = EER at AHRI standard rating condition
B = EER at 75% net capacity, reduced ambient
C = EER at 50% net capacity, reduced ambient
D = EER at 25% net capacity, reduced ambient

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equipment efficiency
Unitary

Addendum N

- In 2012 (DX) and 2010 (chilled water)
- Single zone systems
  - DX ≥ 110,000 Btu/h (9.2 tons)
  - Chilled water AHUs with fan motors ≥ 5hp
- Two-speed motors or VFDs
- Required for implementing
  - Discharge temperature sensors or multiple stages of compression
  - Care needed to meet ventilation codes
    - Damper position compensation for fan speed
    - Airflow measurement and variable OA dampers

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equipment efficiency
Unitary

Addendum CO

- Water- and evaporatively-cooled AC and HP
- Water- and evaporatively-cooled condensing units are now two different categories
- 3%–5% more stringent than 2001–2007 levels
- Effective 6/1/2011

equipment efficiency
Unitary

Addenda T, BW

- PTACs and PTHPs
- ‘Non-standard’ size defined
  - Less than 16” high or less than 42” wide and
  - Less than 670 in^2 area
- All others meet requirement

TABLE 6.8.1D

Subcategory or Rating Condition	Minimum Efficiency
95.0°F db	12.5 – (0.213 ×
	13.8 - (0.300 × Cap/1000)^c EER (as 10/08/2012)
95.0°F db *Outdoor air*	12.3 – (0.213 × Cap/1000)^c EER (before 10/08/2012) 14.0 - (0.300 ×

equipment efficiency
Unitary

Addendum BG

Water-water heat pump efficiency levels <11.25 tons

Minimum Efficiency Requirements *(continued)*

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
Water source water to water (cooling mode)	<135,000 Btu/h	All	86°F entering water	10.6 EER	ISO-13256-2
Groundwater source water to water (cooling mode)	<135,000 Btu/h	All	59°F entering water	16.3 EER	ISO-13256-2
Ground source Brine to water (cooling mode)	<135,000 Btu/h	All	77°F entering water	12.1 EER	ISO-13256-2
Water source water to water (heating mode)	<135,000 Btu/h (cooling capacity)	---	68°F entering water	3.7 COP	ISO-13256-2
Groundwater source water to water (heating mode)	<135,000 Btu/h (cooling capacity)	---	50°F entering water	3.1 COP	ISO-13256-2

equipment efficiency
Unitary

Addendum BU

- Computer room air conditioners (CRAC)
- ASHRAE 127 test procedure
  - Conditions reflect sensible (mostly) data center cooling
  - SCOP is defined (sensible coefficient of performance)

equipment efficiency
Unitary

Addendum CP

- Minisplits have been covered under 210-240
- Multi-splits (VRF)
  - Certification program likely fall 2010

equipment efficiency
Unitary

Addendum CP

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.0 EER 12.3 IEER 12.9 IEER (as of 7/1/2012)	
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System with Heat Recovery	10.8 EER 12.1 IEER 12.7 IEER (as of 7/1/2012)	
VRF Air Cooled, (cooling mode)	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	10.6 EER 11.8 IEER 12.3 IEER (as of 7/1/2012)	AHRI 1230
	≥135,000 Btu/h	Electric	VRF Multi-split	10.4 EER	

ASHRAE/IESNA Standard 90.1-2010,
Energy Standard for Buildings Except Low-Rise Residential Buildings

equipment efficiency

Chiller

Addendum M

- Two compliance paths for water-cooled chillers
  - Full load and part load metrics in both paths
  - Water-cooled positive displacement classed together

chiller

Table 6.8.1C—Excerpt

Addendum M

		Path A	Path B
Air cooled < 150 tons		9.562 EER 12.5 IPLV	
Air cooled 150+ tons		9.562 EER 12.75 IPLV	
Water cool. pos. displ. tons	>75	0.780 kW/ton 0.630 IPLV	0.800 kW/ton 0.600 IPLV
	75 - less than 150 tons	0.775 kW/ton 0.615 IPLV	0.790 kW/ton 0.586 IPLV
	150 - less than 300 tons	0.680 kW/ton 0.580 IPLV	0.718 kW/ton 0.540 IPLV
	300+ tons	0.620 kW/ton 0.540 IPLV	0.639 kW/ton 0.490IPLV
Centrifugals tons	< 300	0.634 kW/ton 0.596 IPLV	0.639 kW/ton 0.450 IPLV
	300 – less than 600 tons	0.576 kW/ton 0.549 IPLV	0.600 kW/ton 0.400 IPLV
	600+ tons	0.570 kW/ton 0.539 IPLV	0.590 kW/ton 0.400 IPLV

equipment efficiency
Chiller

Addendum M

- Two compliance paths for water-cooled chillers
  - Full load and part load metrics in both paths
  - Water-cooled positive displacement classed together
- Air-cooled chillers part load improvement
- New categories
  - Less than and 150+ tons air-cooled categories
  - 600+ tons water-cooled centrifugal category
- Removed categories
  - Air-cooled chillers without condensers (use matched)
  - Reciprocating chillers now with screw and scroll

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equipment efficiency
Chiller

Interpretations

- Test tolerances and fouling
  - Deviations from test procedures are at the discretion of the customer, but 90.1 values correspond to data collected using the referenced test procedure
  - Performance degradations must be absorbed by the design
- Starter and drive losses
  - Measurements occur on line side of starter or drive

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equipment efficiency
Chiller

Addendum BL

- Different treatment for glycol
  - No more blanket exception from scope, depends on operating temperatures
    - Positive displacement: greater than 32°F leaving evap
    - Centrifugal: 36°F or higher leaving evap (and other reqs.)
    - Absorption: 40°F or higher leaving evap
  - Dual mode chillers, where one or both modes are outside the covered temperatures, continue to be out of scope

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equipment efficiency
Chiller

Addendum BT

- Scope changes—centrifugals
  - 36°F or higher leaving evaporator
  - 115°F or lower leaving condenser temperature
  - 20°F–80°F lift range (leaving cond minus leaving evap)
- New non-standard centrifugal equation
  - Tables removed—equation only
  - Spreadsheet calculator on User's Manual CD
  - Examples in User's Manual (see support material)

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equipment efficiency
Heat Rejection

Addenda A, L, U, and AD

- Limits on centrifugal fan cooling tower use
  - Above 1,100 gpm, centrifugal fan towers have to meet axial fan power levels (≥ 38.2 gpm/hp)
  - Some exceptions
- Closed circuit cooling towers
  - Requirements added (14 gpm/hp axial, 7 gpm/hp centrifugal)
  - Rating conditions 90°F–102°F water, 75°F entering wb
- Liquid-liquid heat exchanger certification
  - No efficiency requirements, test procedure AHRI 400
  - More heat exchanger manufacturers are choosing to certify, rather than pay for independent lab testing

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summary
Equipment Efficiency

- Equipment efficiencies are more stringent
  - Chillers: once a path is chosen both full and part load requirements must be met
  - Unitary equipment now uses Integrated Energy Efficiency Ratio (IEER)
- New coverage
  - Computer room air conditioners
  - Variable refrigerant flow (VRF) equipment
  - Closed-circuit cooling towers
  - Water-water heat pumps

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System Design

- Hydronics
- Outdoor air
- System fan power

system design
Hydronics

Addenda AK and CV

- Water-cooled unitary
  - Shut-off valves required in all (formerly only required in water source hp, now also water-cooled self-contained)
  - If system power >5hp, need a VFD on the pump
- Lower threshold for VFD on pump motors
  - Formerly only on 50hp pumps with 100' head, now each 5+hp pump when system power is at least 10hp
- Booster pumps (limits on pressure-reducing valves)
  - Measure pressure and vary pump speed or stage pumps

system design

Hydronics

Addenda V, AF, and CC

- Pump pressure optimization
  - DP setpoint no more than 110% of design flow's DP
  - Reset DP setpoint until one valve nearly wide open
- Pipe and pump sizing
  - Based on pressure limits and economics
  - Applies to both chilled water and condenser water
  - Pump head must be calculated for sizing pumps

system design

Hydronics

Addenda V, AF, and CC

Table 6.5.4.5: Piping System Design Maximum Flow Rate in GPM (IP)

Operating hours/yr	≤2000 hours/yr		>2000 and ≤4400 hours/year		>4400 ~~and ≤8760~~ hours/year	
Nominal Pipe Size (in.)	Other	Variable Flow/ Variable Speed	Other	Variable Flow/ Variable Speed	Other	Variable Flow/ Variable Speed
2 1/2	120	180	85	130	68	110
3	180	270	140	210	110	170
4	350	530	260	400	210	320
5	410	620	310	470	250	370
6	740	1100	570	860	440	680
8	1200	1800	900	1400	700	1100
10	1800	2700	1300	2000	1000	1600
12	2500	3800	1900	2900	1500	2300
Maximum Velocity for Pipes Over 12" Size	8.5 fps	13.0 fps	6.5 fps	9.5 fps	5.0 fps	7.5 fps

system design

Hydronics

Addenda BA and BI

- Pipe insulation
  - Biggest changes are in steam and hot water piping
  - When pipes are in the interior walls between conditioned spaces
  - Non-metallic pipe optional path if > schedule 80

system design

Hydronics

Table 6.8.3A Minimum Pipe Insulation Thickness
Heating and Hot Water Systems[a,b,c,d]
(Steam, Steam Condensate, Hot Water Heating and Domestic Water Systems)

Fluid Operating Temperature Range (°F) and Usage	Insulation Conductivity		Nominal Pipe or Tube Size (in)				
	Conductivity Btu·in./(h·ft²·°F)	Mean Rating Temperature, °F	<1	1 to <1-1/2	1-1/2 to <4	4 to <8	≥8
			Insulation Thickness (in)				
>350 °F	0.32 - 0.34	250	4.5	5.0	5.0	5.0	5.0
251 - 350°F	0.29 - 0.32	200	3.0	4.0	4.5	4.5	4.5
201 - 250°F	0.27 - 0.30	150	2.5	2.5	2.5	3.0	3.0
141 - 200°F	0.25 - 0.29	125	1.5	1.5	2.0	2.0	2.0
105 - 140°F	0.22 - 0.28	100	1.0	1.0	1.5	1.5	1.5

a For insulation outside the stated conductivity range, the minimum thickness (*T*) shall be determined as follows:

$$T = r\{(1 + t/r)^{K/k} - 1\}$$

where T = minimum insulation thickness (in.), r = actual outside radius of pipe (in.), t = insulation thickness listed in this table for applicable fluid temperature and pipe size, K = conductivity of alternate material at mean rating temperature indicated for the applicable fluid temperature (Btu·in./h·ft2·°F); and k = the upper value of the conductivity range listed in this table for the applicable fluid temperature.

b These thicknesses are based on energy efficiency considerations only. Additional insulation is sometimes required relative to safety issues/surface temperature.

c For piping smaller than 1½" and located within interior partitions, reduction of these thicknesses by 1" shall be permitted (before thickness adjustment required in footnote a) but not to thicknesses below 1".

summary
System Design: Hydronic

- VSD-like performance required on much smaller systems
- Pump pressure optimization is required
- Maximum flow rates defined
- Pipe insulation more stringent

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System Design: Airside

- Economizers
- Energy recovery
- Dampers
- Ventilation and exhaust

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airside system design

Economizers

Addenda AU, BU, and CY

- In all climates, except
  - 1A: hot, humid: such as South Florida, parts of Hawaii, the Caribbean, India, Indonesia
  - 1B: hot, dry: such as Dubai, Saudi Arabia

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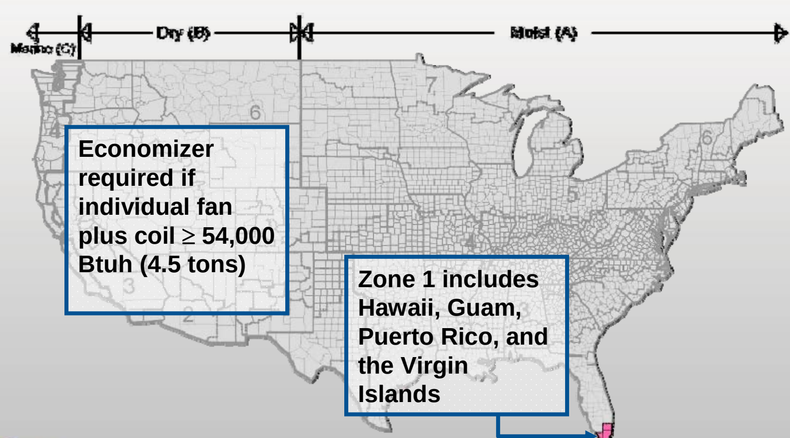
airside system design

Economizers

Addenda AU, BU, and CY



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airside system design
Economizers

Addenda AU, BU, and CY

- In all climates, except
  - 1A: hot, humid—such as South Florida, parts of Hawaii, the Caribbean, India, Indonesia
  - 1B: hot, dry—such as Dubai, Saudi Arabia
- Down to 54,000 Btu/h
- Must be integrated
  - Economize, then supplement with mechanical cooling
- Efficiency tradeoff for applied as well as unitary
  - Percent improvement over full or part load metric

airside system design
Economizers

Addenda AU, BU, and CY

Economizer tradeoff with equipment efficiency

Table 6.3.2 Eliminate Required Economizer for Comfort Cooling by Increasing Cooling Efficiency

Climate Zone	Efficiency Improvement[a]
2a	17%
2b	21%
3a	27%
3b	32%
3c	65%
4a	42%
4b	49%
4c	64%
5a	49%
5b	59%
5c	74%
6a	56%
6b	65%
7	72%
8	77%

[a] If a unit is rated with an IPLV, IEER or SEER then to eliminate the required air or water economizer, the minimum cooling efficiency of the HVAC unit must be increased by the percentage shown. If the HVAC unit is only rated with a full load metric like EER or COP cooling then these must be increased by the percentage shown.

airside system design
Economizers

Addenda AU, BU, and CY

- In all climates, except
  - 1A: hot, humid—such as South Florida, parts of Hawaii, the Caribbean, India, Indonesia
  - 1B: hot, dry—such as Dubai, Saudi Arabia
- Down to 54,000 Btu/h
- Must be integrated
  - Economize, then supplement with mechanical cooling
- Efficiency tradeoff for applied as well as unitary
  - Percent improvement over full or part load metric
- Some data centers will need economizer (water or air)

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airside system design
Economizers

- Heat recovery exception expanded
  - No longer requires 6,000,000 Btu/h heat rejection and 1,000,000 Btu/h service water heating
  - May be useful on large air-cooled systems with DOAS
    - e.g. VRF, fan coils with air-cooled chiller (54,000+ terminals)
  - HR may be preferred in some climates, applications
  - Requires heating peak service hot water draw to 85°F
  - Or 60% of the peak service water heating load

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airside system design

Energy Recovery

Addendum E

- Energy recovery ventilation system
  - Threshold changes
  - Climate specific
  - Exempted from ventilation optimization control

airside system design

Energy Recovery

- Example: 40% OA system with 5,000 cfm
  - Prior to 2010, less than 70% OA, so no ERV required
  - Now, ERV required in climates 1A through 6A, 7, 8

Table 6.5.6.1 Energy Recovery Requirement (IP)

Zone	% *Outdoor air* at full design airflow rate					
	≥30% and < 40%	≥40% and < 50%	≥50% and < 60%	≥60% and < 70%	≥70% and < 80%	≥80%
	Design Supply Fan airflow rate (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

airside system design

Dampers

Addenda AT and CB

- Motorized dampers required on ventilation air intakes in cool and cold climates
- Climate 5a now requires low leak dampers (4 cfm/ft^2)
- Leakage class per damper style unchanged

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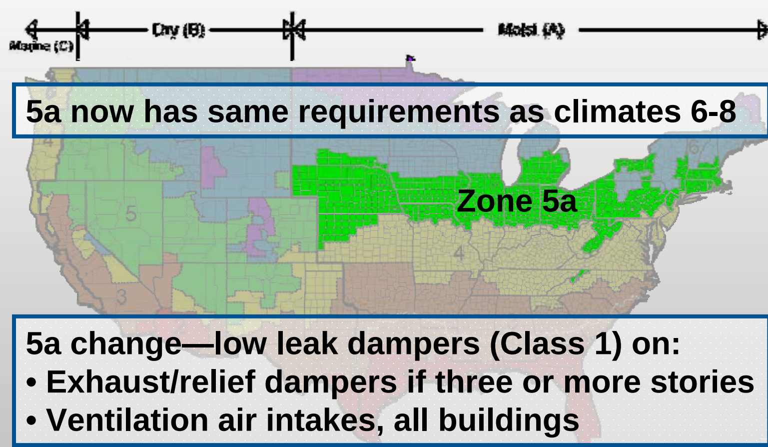
Dampers



5a now has same requirements as climates 6-8

5a change—low leak dampers (Class 1) on:
- **Exhaust/relief dampers if three or more stories**
- **Ventilation air intakes, all buildings**

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Fan Power Limitation

Addenda P, AS

- Exhaust system credits
  - Fully ducted return and/or exhaust air system in lab and vivariums, 0.5 in w.g.
  - Exhaust system serving fume hoods, 0.35 in. w.g.
  - Lab and vivarium exhaust systems in high-rise buildings 0.25 in. w.g. per 100 ft of vertical duct exceeding 75 ft
- Pressure-dependent spaces can reheat more if they have VAV meeting 6.5.7.2

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airside system design

Fan Power Limitation

Addendum DJ

- Energy recovery ventilator pressure drop credit tied to effectiveness
  - If more effective, can have more pressure drop and have equivalent system energy performance
- Coil run around loops treated differently, reflecting that use in applications where other types of ERV are not feasible

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- Definition of VAV for fan power column use
  - Single zone VAV has to use the constant volume limit

- Motor efficiency (general purpose)
- Elevator lighting and ventilation allowances
- Garage ventilation controls
- Duct leakage to seal class A
  - Tested sections selected by the building owner
- Kitchen exhaust hoods—large ones listed
- Radiant panels—insulate ineffective surfaces
- Heat pump pool heaters
- Furnace and water heating cleanup

airside system design

Summary

- Economizers now required in most climate zones
- Airside energy recovery will be required in many more systems and based on:
  - Climate zone
  - Percent OA at design

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ASHRAE Standard 90.1-2010

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Controls

Controls and ASHRAE 90.1-2010

- Existing controls requirements
  - Fan pressure optimization
  - Demand control ventilation (DCV)
- Changes to controls requirements
  - Ventilation reset
  - Pump pressure optimization
  - Supply air temperature reset
  - VAV minimum airflow/maximum reheat

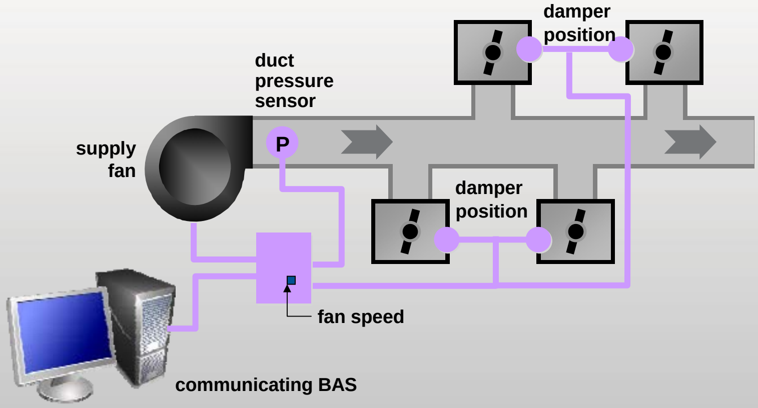
existing requirements

Fan Pressure Optimization

- Required by ASHRAE 90.1 since 1999
- Goal:
  - Control system static pressure to the lowest level while maintaining zone airflow requirements; thereby minimizing fan energy consumption
- What is needed to implement?
  - Communicating controls on the VAV boxes
  - Static pressure sensor
  - Building automation system

existing requirements

Fan Pressure Optimization



controls and ASHRAE 90.1—existing requirements

Fan Pressure Optimization

- More information available:
  - *Engineer's Newsletter Live presentation* from November, 2009 titled "Air-Handling Systems, Energy and IAQ"
  - Engineer's newsletter article "Energy-Saving Control Strategies for Rooftop VAV Systems," 2006, volume 35-4

controls and ASHRAE 90.1—existing requirements

Demand Control Ventilation (DCV)

- Background:
  - VAV systems are *designed* to bring in at least the minimum outdoor airflow at worst case condition
  - At any other condition, design airflow results in over-ventilation
- Goal:
  - Reduce over-ventilating a space by resetting the level of outdoor air introduced during times when occupancy is lower than design conditions

controls and ASHRAE 90.1—existing requirements

DCV Methods

- Occupancy Sensors
- Occupancy Schedules
- CO_2 Sensors
- Each method is appropriate for different types of zones

controls and ASHRAE 90.1—existing requirements

Demand-Controlled Ventilation (DCV)

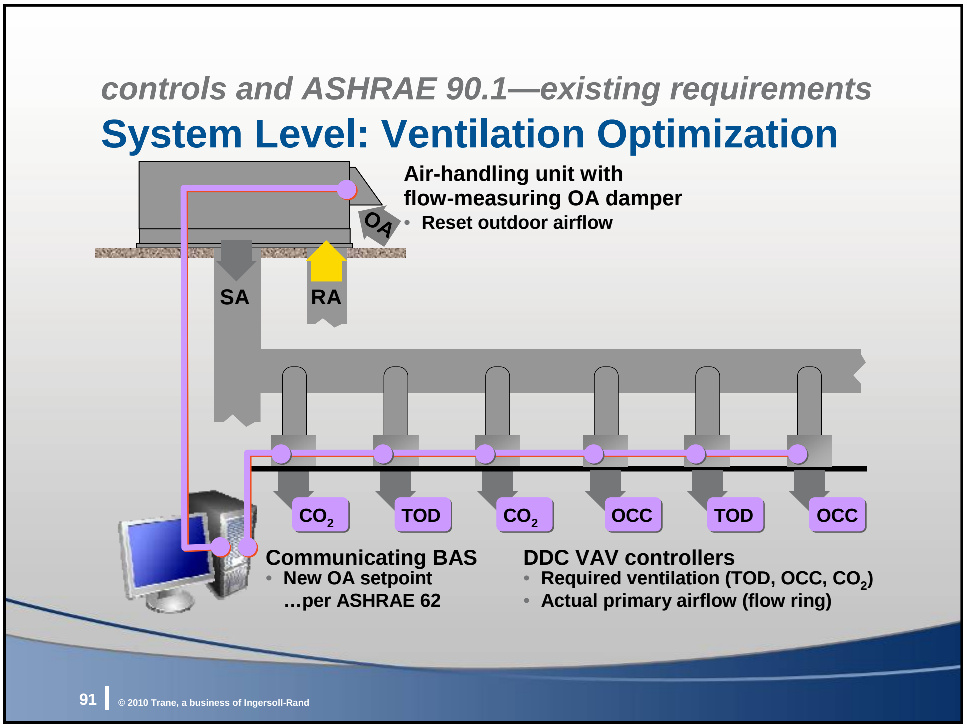
- Required at zone level if:
  - Larger than 500 ft^2
  - Design occupant density greater than 40 people per 1,000 ft^2
  - Served by systems with one or more of the following
    - An air-side economizer
    - Automatic modulating control of the outdoor air damper

      or
    - A design outdoor airflow greater than 3,000 cfm

controls and ASHRAE 90.1—existing requirements

System Level: Ventilation Optimization

- Multiple zone VAV systems with DDC shall
  - Automatically reduce outdoor air intake flow below design rates in response to changes in *system ventilation efficiency* as defined by ASHRAE Standard 62.1, Appendix A
- Exceptions
  - Systems required to have energy recovery in 6.5.6.1
  - Some dual-path systems, such as dual-duct dual-fan or fan-powered VAV systems
  - Systems where the design exhaust airflow is more than 70% of the design outdoor air intake airflow


controls and ASHRAE 90.1—existing requirements
System Level: Ventilation Optimization
Air-handling unit with
flow-measuring OA damper
• Reset outdoor airflow
OA
SA
RA
CO2
TOD
CO2
OCC
TOD
OCC
Communicating BAS
• New OA setpoint
…per ASHRAE 62
DDC VAV controllers
• Required ventilation (TOD, OCC, CO2)
• Actual primary airflow (flow ring)
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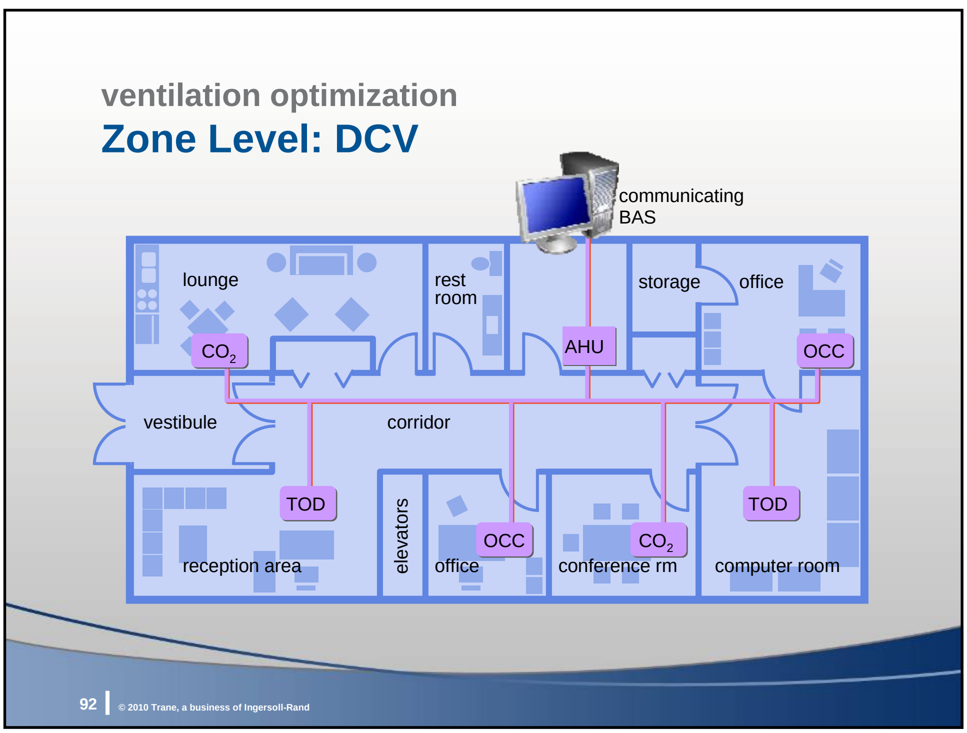
ventilation optimization
Zone Level: DCV
communicating
BAS
lounge
rest
room
storage
office
CO2
AHU
OCC
vestibule
corridor
TOD
elevators
OCC
CO2
TOD
reception area
office
conference rm
computer room
92
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controls and ASHRAE 90.1

Pump Pressure Optimization

- Control system pump pressure to the lowest level while maintaining chilled (or hot) water flow requirements—minimize pump energy
- When is it required?
  - Systems having a total pump system power exceeding 10 hp
    - Reduce pump flow rates to 50% or less of the design flow rate
  - Individual chiller water pumps exceeding 5 hp
    - Limit demand to less than 30% of design wattage at 50% design water flow
  - When more than 3 water control valves are used
- What is needed to implement?
  - Communicating controls on the AHU or terminal unit valves
  - Pressure differential controller
  - Building Automation System

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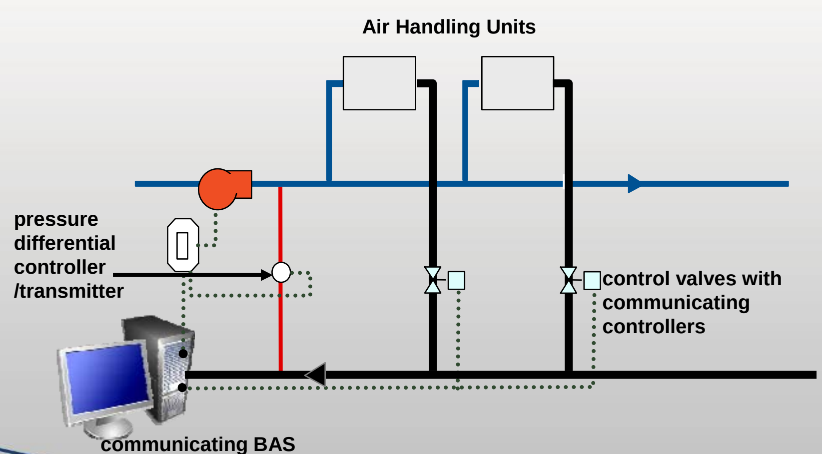
controls and ASHRAE 90.1

Pump Pressure Optimization



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controls and ASHRAE 90.1

Supply Air Temperature Reset

- Background:
  - HVAC systems designed to meet peak cooling loads
  - Cooling load is many times below peak conditions
  - Load can be met with a higher supply air temperature
- Goals:
  - Decrease compressor energy usage
  - Decrease reheat
  - Increase the effectiveness of economizer
- Control Sequence
  - Outside air temperature
  - Critical zone load

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controls and ASHRAE 90.1

Supply Air Temperature Reset

- Tradeoffs between
  - Compressor energy
  - Reheat energy
  - Fan energy, and
  - Space humidity levels
- Simple control works well
  - Reduce supply airflow first, taking advantage of the significant energy savings from unloading the fan
  - Then raise the supply-air temperature to minimize reheat energy and extend airside economizer hours

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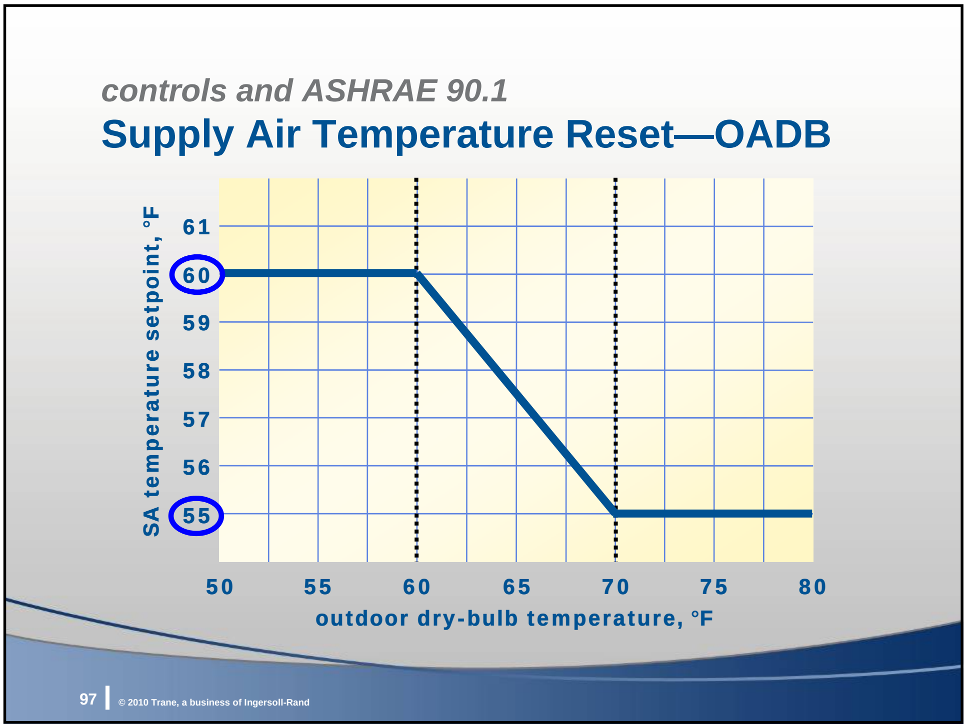
controls and ASHRAE 90.1
Supply Air Temperature Reset—OADB
SA temperature setpoint, °F
61
60
59
58
57
56
55
50
55
60
65
70
75
80
outdoor dry-bulb temperature, °F
97
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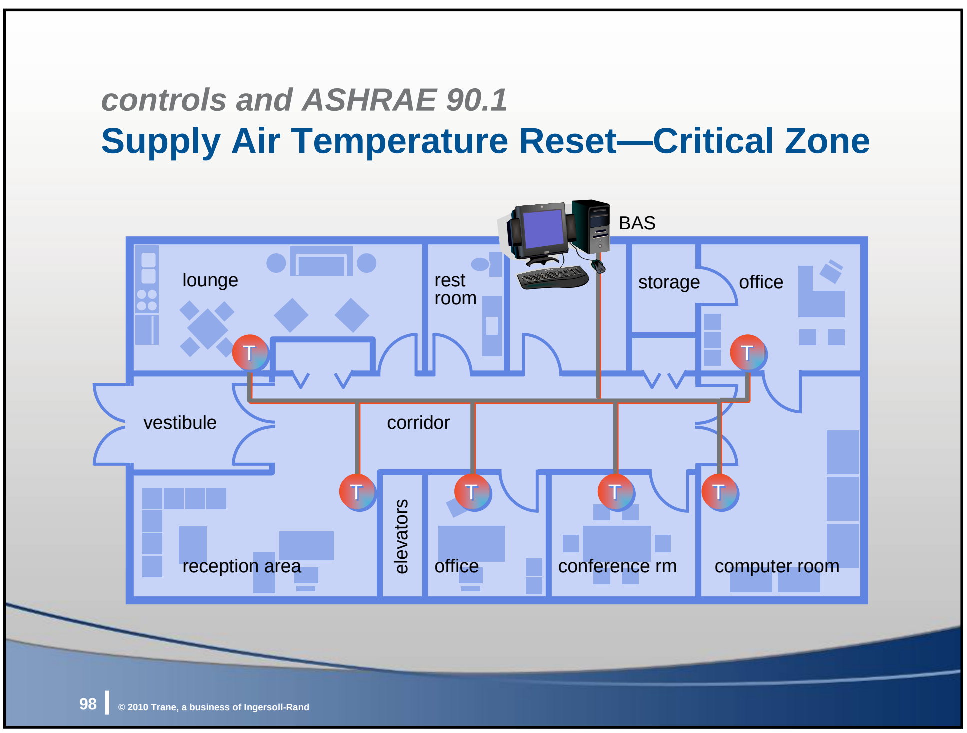
controls and ASHRAE 90.1
Supply Air Temperature Reset—Critical Zone
BAS
lounge
rest room
storage
office
T
vestibule
corridor
elevators
reception area
office
conference rm
computer room
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Supply Air Temp Reset—Considerations

- Raises humidity levels in the zones
  - Climate zones 1a, 2a, and 3a are exempted from using supply air temperature reset in ASHRAE 90.1 2010
  - May incorporate zone humidity into reset sequence
- Zones with constant loads must be designed for fully reset SAT
  - Enables SAT reset while still providing needed cooling to these zones
  - May require larger VAV terminals and ductwork
- Increases fan energy
  - Supply air is warmer
  - Zones that require cooling will need more air
  - Employ fan-pressure optimization

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controls and ASHRAE 90.1

VAV Reheat Limits

- For VAV reheat systems, here are two ways to meet the reheat limit
  - 30% minimum airflow setting (maximum reheat)
    - Can go lower than this airflow in cooling mode
  - New: alternate sequence for VAV with reheat
    - Raises amount of reheated air to 50% for heating provided 20% airflow in dead band between heating and cooling and modulated between
      - Requires a discharge air temperature sensor
- These limits can be exceeded if site-sourced or site-recovered energy is used

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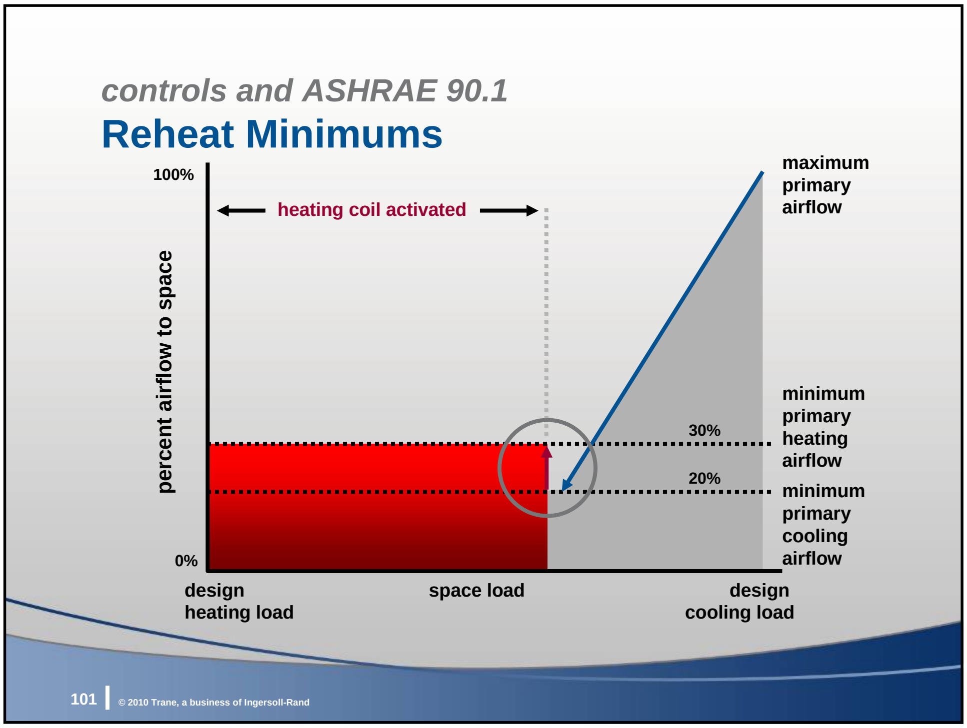
controls and ASHRAE 90.1
Reheat Minimums
100%
0%
percent airflow to space
heating coil activated
maximum primary airflow
30%
minimum primary heating airflow
20%
minimum primary cooling airflow
design heating load
space load
design cooling load
101
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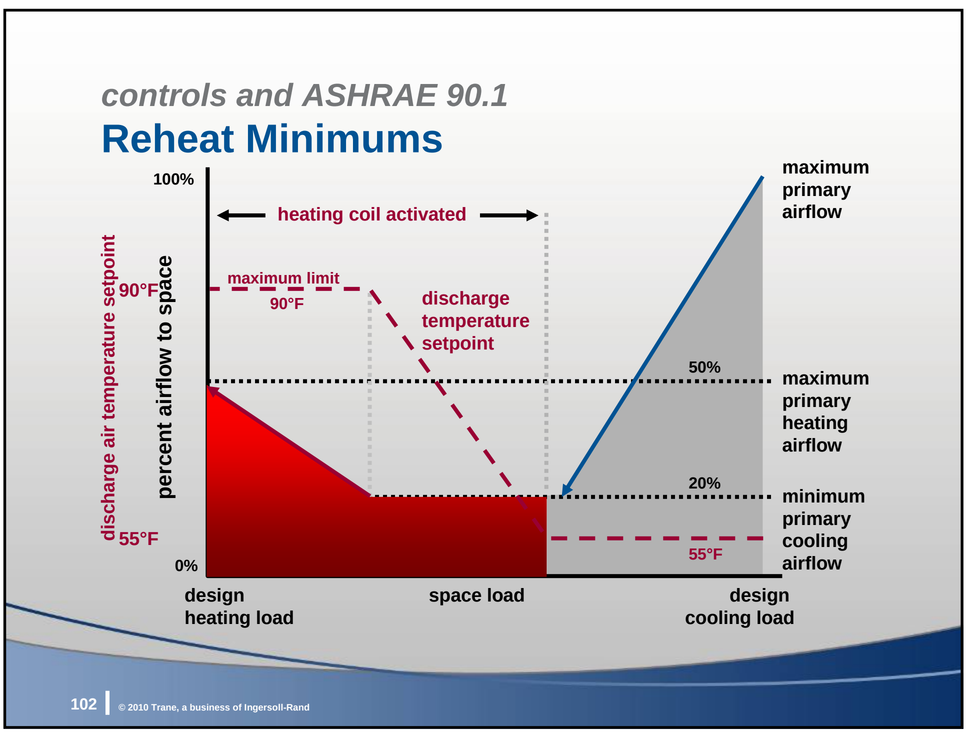
controls and ASHRAE 90.1
Reheat Minimums
100%
0%
discharge air temperature setpoint
90°F
55°F
percent airflow to space
heating coil activated
maximum limit
90°F
discharge temperature setpoint
maximum primary airflow
50%
maximum primary heating airflow
20%
minimum primary cooling airflow
55°F
design heating load
space load
design cooling load
102
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controls and ASHRAE 90.1

Reheat Minimums

- Benefits of traditional VAV reheat sequence
  - Pre-engineered control sequences
  - Doesn't require a discharge air temperature sensor
- Benefits of alternative VAV reheat sequence
  - Uses a lower discharge air temperature for less temperature stratification
- Energy used by these strategies could be comparable
  - Using a single minimum setting on the box for both cooling and heating leads to more reheat
  - Increases fan energy at over 30% airflow, decreases fan energy between 20%–30% airflow

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Modeling

Appendix G Overview

- Changes that clarify existing requirements
- Changes specific to laboratory applications
- New baseline system types

2007 Ventilation Requirements

without addenda

G3.1.2.5 Ventilation

Minimum outdoor air ventilation rates shall be the same for the proposed and baseline building designs.

Exception: When modeling demand-control ventilation in the proposed design when it is not required by Section 6.4.3.8.

appendix G

Ventilation Requirements

Addendum DA

G3.1.2.5 Ventilation

Exceptions:

b. When designing systems in accordance with Standard 62.1 Section 6.2 Ventilation Rate Procedure, reduced ventilation airflow rates may be calculated for each HVAC zone in the proposed design with a zone air distribution effectiveness (Ez) > 1.0 as defined by Table 6-2 in Standard 62.1.

Baseline ventilation airflow rates in those zones shall be calculated using the proposed design Ventilation Rate Procedure calculation with the following change only. Zone air distribution effectiveness shall be changed to (Ez)=1.0 in each zone having a zone air distribution effectiveness (Ez)>1.0.

Proposed design and baseline design Ventilation Rate Procedure calculations, as described in Standard 62.1, shall be submitted to the rating authority to claim credit for this exception.

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appendix G

Ventilation Requirements

Addendum DA

G3.1.2.5 Ventilation (continued)

Exceptions (continued):

c. If the minimum outdoor air intake flow in the proposed design is provided in excess of the amount required by the rating authority or building official then the baseline building design shall be modeled to reflect the greater of that required by the rating authority or building official and will be less than the proposed design.

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appendix G
Ventilation Requirements
Addendum DA

- **IEQ Credit 2, Case 1 Requirement**
- **ASHRAE 62.1-2007—Proposed**
  - People based
    5 cfm/person * 1.3 = 6.5 cfm/person
  - Area based
    0.06 cfm/ft^2 * 1.3 = 0.078 cfm/ft^2
- **ASHRAE 62.1-2007—Baseline**
  - People based—5 cfm/person
  - Area based—0.06 cfm/ft^2

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appendix G
Purchased Chilled Water/Heat
Addendum AI

G3.1.1.3.2 Purchased Chilled Water Only

System 1 & 2 shall be constant volume fan coils with fossil fuel boilers
System 3 & 4 shall be constant volume single zone air handlers with fossil fuel furnace(s)
System 7 shall be used in place of System 5
System 8 shall be used in place of System 6

G3.1.1.3.3 Purchased Chilled Water and Purchased Heat

System 1 shall be constant volume fan coil units
System 3 shall be constant volume single zone air handlers
System 7 shall be used in place of System 5

G3.1.1.3.4 On-site Distribution Pumps

"All on-site distribution pumps shall be modeled in both the baseline and proposed designs."

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appendix G
Unmet Load Hours Requirement
Addendum CR

Temperature control throttling range:

The number of degrees that room temperature must change in order to go from full heating to no heating or from full cooling to no cooling.

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appendix G
Unmet Load Hours Requirement
Addendum CR

2007 Unmet load hours definition:
An hour in which one or more zones is outside of the thermostat setpoint range.

2010 Unmet load hours definition:
An hour in which one or more zones is outside of the thermostat setpoint plus or minus one half of the temperature control throttling range. Any hour with one or more zones with an unmet cooling load or unmet heating load is defined as an unmet load hour.

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appendix G
Unmet Load Hours Requirement

Addendum CR

Throttling range:	**2°F**
½ Throttling range:	**1°F**
Setpoint:	**75°F**
Thermostat Setpoint Range:	**74°F–76°F**

appendix G
Laboratory Requirements

Addendum CH

G3.1.3.13 VAV Minimum Flow Setpoints (Systems 5 and 7)

Exception: Systems serving laboratory spaces shall reduce the exhaust and makeup air volume during unoccupied periods to the largest of 50% of zone peak air flow, the minimum outdoor air flow rate, of the air flow rate required to comply with applicable codes or accreditation standards.

appendix G

Laboratory Requirements

Addendum DB

G3.1.2.8 Design Air Flow Rates

Exception: For systems serving laboratory spaces, use a supply-air-to-room-air temperature difference of 17°F or the required ventilation air or makeup air, whichever is greater.

appendix G

New Systems

Addendum DN

G3.1.1 Baseline HVAC System Type & Description

Exceptions:

e. Thermal zones designed with heating only systems in the proposed design, serving storage rooms, stairwells, vestibules, electrical/mechanical rooms, and restrooms not exhausting or transferring air from mechanically cooled thermal zones in the proposed design shall use system type 10 or 11 in the baseline building design.

appendix G
New Systems

Addendum DN

G3.1.2.6 Economizers

Outdoor air economizers shall not be included in baseline HVAC Systems 1, 2, 10, and 11.

G3.1.2.8.2 Baseline System Types 10 and 11

System design supply airflow rates for the baseline building design shall be based on the temperature difference between a supply air temperature setpoint of 105°F and the design space heating temperature setpoint, the minimum outdoor airflow rate, or the airflow rate required to comply with applicable codes or accreditation standards, whichever is greater.

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appendix G
New Systems

Addendum CR

G3.1.2.9 System Fan Power

For Systems 10 and 11 (supply fan)

- $P_{fan} = CFM_S * 0.3$

For Systems 10 and 11 (non-mechanical cooling fan if required by Section G3.1.2.8.2)

- $P_{fan} = CFM_{nmc} * 0.054$

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appendix G

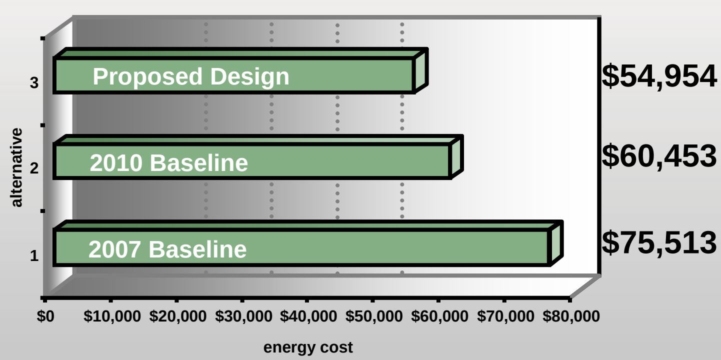
Baseline Design Comparison

- General Parameters
  - 75,600 ft^2
  - Office building
  - Columbus, Ohio
  - Rooftop VAV
- Proposed Design
  - High efficiency equipment
  - Daylighting
  - Enthalpy economizer
  - Improved supply air temperature reset

baseline design comparison

Results

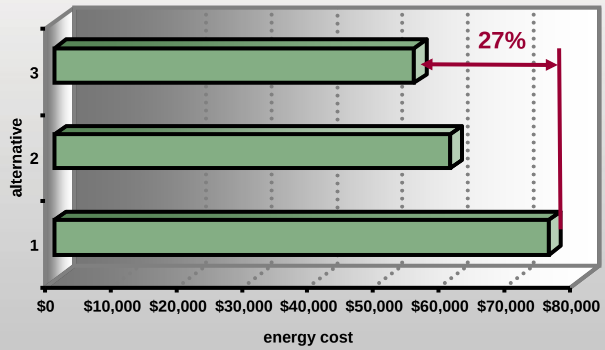
ASHRAE Standard 90.1 Appendix G Analysis



baseline design comparison

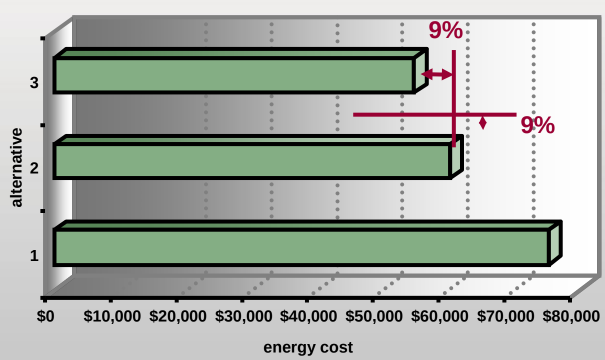
Results

ASHRAE Standard 90.1 Appendix G Analysis



Comparison Results

ASHRAE Standard 90.1 Appendix G Analysis



ASHRAE Standard 90.1-2010

engineers newsletter LIVE

Summary

Ingersoll Rand

Publication and Final Savings Estimates

- Performed by Pacific Northwest National Laboratory (PNNL)
  - Savings shared are modeled as of June 28, 2010
  - Addenda approved by the ASHRAE and IES Boards of Directors will be added to the models
  - Final PNNL savings estimates planned for November 2010

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90.1 Progress Indicator

- Including receptacle loads in modeling
- Including receptacle load in % savings calculation

	Energy cost savings %	Energy savings %
Ventilation rate changes between 62.1-1999 and 62.1-2007	23.4	24.8

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90.1 Progress Indicator
Excluding receptacle loads in % savings calculation only

- Including receptacle loads in modeling
- **Excluding** receptacle load in % savings calculation

	Energy cost savings %	Energy savings %
Ventilation rate changes between 62.1-1999 and 62.1-2007	28.9	30.9

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90.1 Progress Indicator
as of June 28, 2010

- Additional addenda to be included
  - F: Cool Roofs
  - S: DX efficiency
  - CK: Ventilation reset
  - CT, DD: Daylighting
  - BF: Continuous air barrier
  - Others
- Final savings expected to be higher
- Many thanks to PNNL

Thanks To…

- Mark Hydeman
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- John Hogan
- Hy Kaplan
- Michael Lane
- Dick Lord
- Ron Majette
- Mike Tillou
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- Ron Burton
- Charles Cottrell
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- Public
  - Commenters
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  - Presenters at meetings
  - CMP proposers
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  - Emily Sigman
  - Matt Walker
  - Mark Weber
  - Jan Young
  - Gordon Holness
  - Lynn Bellenger

Steve Ferguson,
ASHRAE Staff Liaison aka "Radar"

summary
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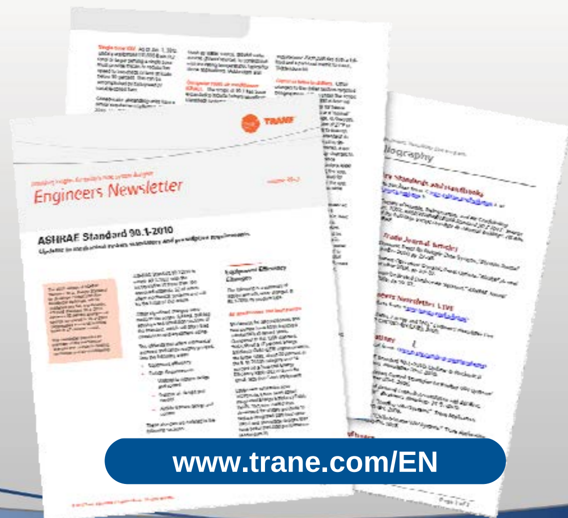
Where to Learn More



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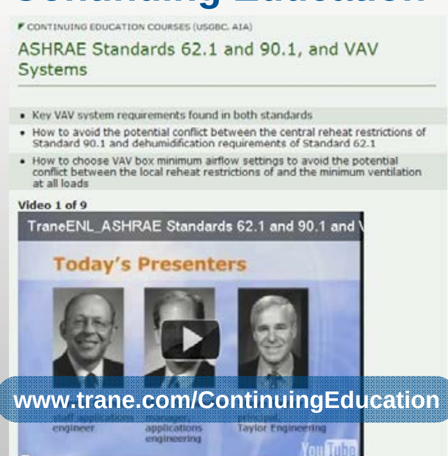

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