ASHRAE 90.1 – The evolution continues

4 March 2009

Mick Schwedler, PE
ASHRAE SSPC 90.1 Chair
Manager, Trane Applications Engineering

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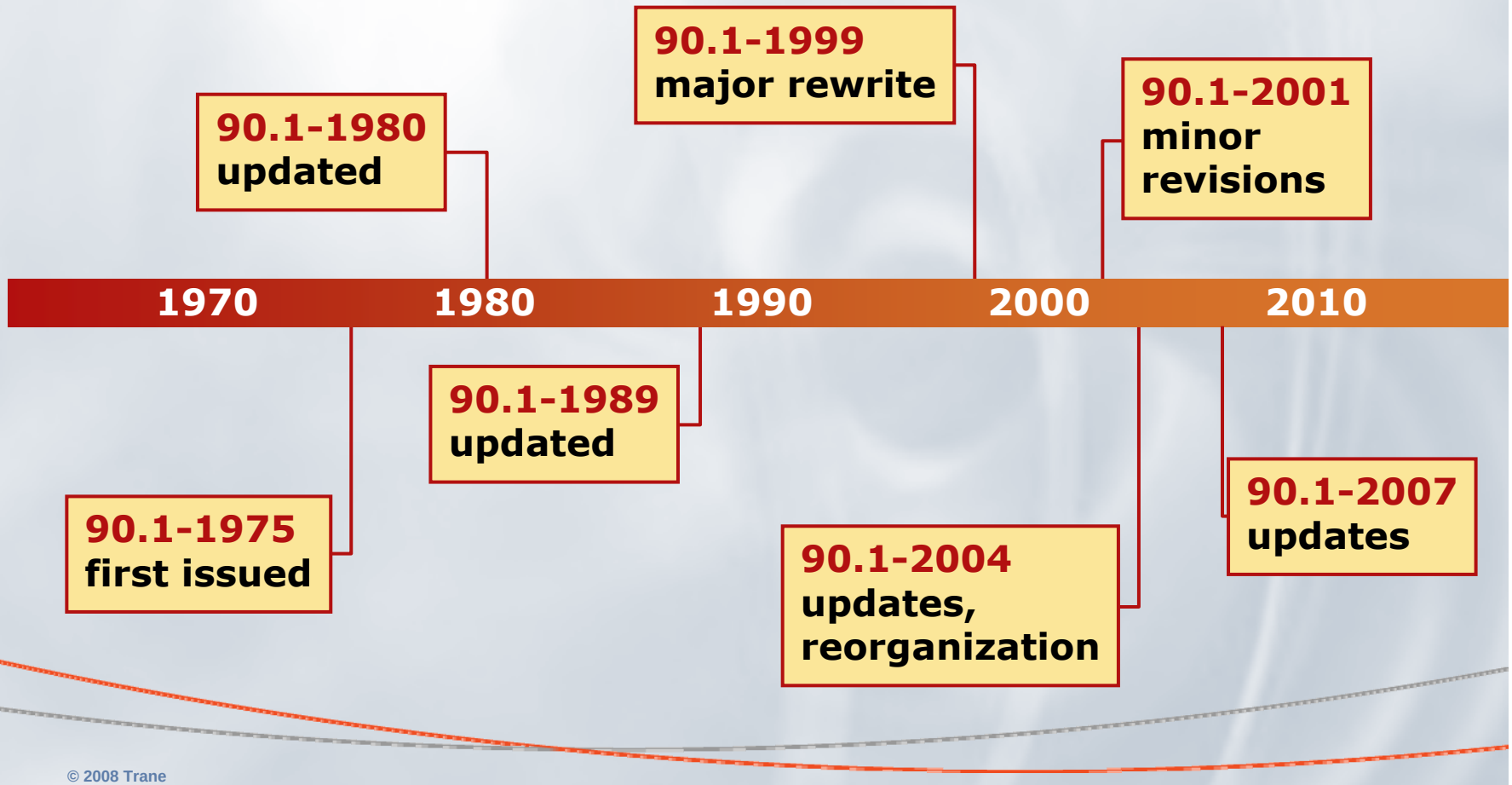
Historical Timeline



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ASHRAE Standard 90.1 and Model Codes

ASHRAE Standard 90.1 is adopted by:

- National Fire Protection Association
- International Code Council (International Energy Conservation Code)
  - IECC–Chapter 8 adopts 90.1-2004 by reference
  - IECC–Chapter 7 describes an alternate path for compliance

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ASHRAE Standard 90.1 and LEED®-NC Version 2.2

- **EAp2: Minimum energy performance**
  - Mandatory provisions of 90.1-2004 and
  - Prescriptive requirements of 90.1-2004 **or** Energy Cost Budget method of 90.1-2004
- **EAc1: Optimize energy performance**
  - Awards points for improving performance rating of the design building vs. baseline building per 90.1-2004
  - Minimum 14% improvement (2 credit points) is required

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ASHRAE Standard 90.1 and LEED®-2009

- **EAp2: Minimum energy performance**
  - 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 (out of 100)

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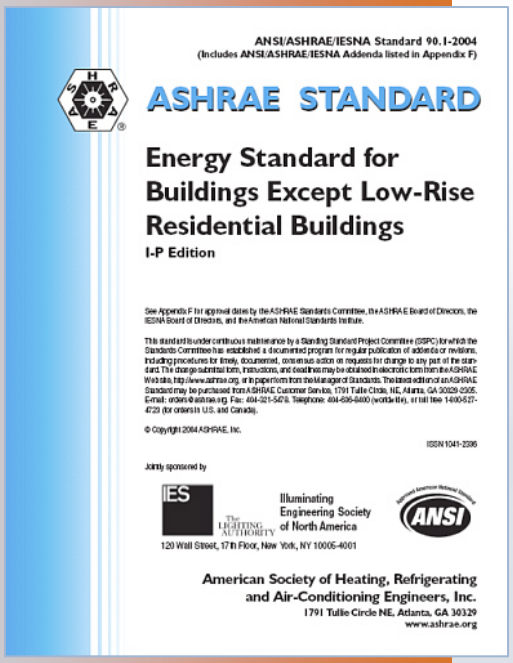
ASHRAE Standard 90.1-2007
Purpose



ANSI/ASHRAE/IESNA Standard 90.1-2004
(Includes ANSI/ASHRAE/IESNA Addenda listed in Appendix F)

ASHRAE STANDARD

Energy Standard for Buildings Except Low-Rise Residential Buildings

I-P Edition

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IESNA Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in U.S. and Canada).

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IES The Lighting Authority — Illuminating Engineering Society of North America
120 Wall Street, 17th Floor, New York, NY 10005-4001

ANSI

American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.
1791 Tullie Circle NE, Atlanta, GA 30329
www.ashrae.org

"… Provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings"

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ASHRAE Standard 90.1-2007
Scope

- New buildings and their systems
- New portions of buildings and their systems
- New systems and equipment in existing buildings

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ASHRAE Standard 90.1-2007
Exclusions

- **Low-rise residential buildings**
  - ASHRAE Standard 90.2 covers low-rise (3 stories or less)
- **Buildings that do not use either electricity or fossil fuel**
- **Equipment and portions of building systems that use energy to primarily to provide for industrial, manufacturing, or commercial processes**

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Standard 90.1-2007

- **Under continuous maintenance**
- **Published**
- **90.1-2004 plus 44 addenda**
  - Will highlight a few of the significant addenda

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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: Electric Motors
- Section 11: Energy Cost Budget (ECB) Method
- Section 12: Normative References
- Appendices

ASHRAE Standard 90.1-2007

Section 5: Building Envelope

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Envelope Addenda

90.1
2007
Change

- **as: Modifies opaque envelope requirements**
- **at: Modifies fenestration (glass) requirements**

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ASHRAE Standard 90.1-2007

Section 6
HVAC

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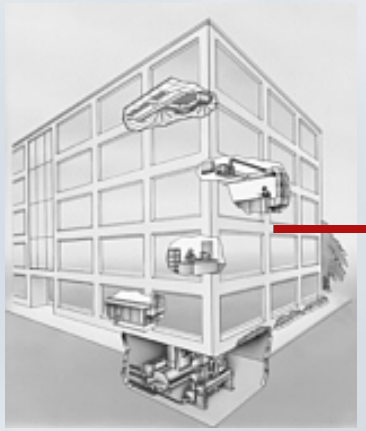
section 6: HVAC

Mandatory Provisions



proposed HVAC design

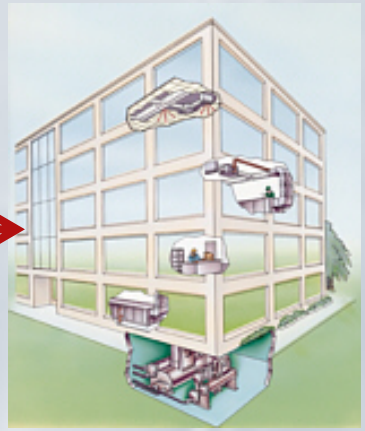
mandatory provisions (§6.4)

prescriptive requirements (§6.5)

Energy Cost Budget Method (ECB, §11)

Simplified Approach Option (§6.3)

(small buildings only)



90.1-compliant HVAC system

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section 6: HVAC

Mandatory Provisions

- **Equipment efficiencies**
- **Load calculations**
- **Controls**
- **Construction and insulation**
- **Completion requirements**

  Drawings, manuals, balancing, and commissioning

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section 6: HVAC

Equipment Efficiencies

90.1 2007 Change

- an: Boiler efficiencies
  18 trillion Btu of gas or oil annually as stock turns
- F: Three-phase air-cooled AC and heat pumps
  2.3 quads by 2035
- g: Air-cooled AC and heat pumps
  1.05 quads by 2035

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ASHRAE 62.1 Reference

90.1
2007
Change

- **Changed from 62.1-1999 to 62.1-2004**
  - Ventilation rates changed

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mandatory HVAC provisions

Ventilation: High Occupancy

90.1 2007 Change

Demand Control Ventilation (DCV) required for Spaces > 500 ft² and design occupancy > 40 people/1000 ft²:

(was 3000 cfm and 100 people/1000 ft²)

Served by systems with one of the following:

- **Air-side economizer**
- **Automatic OA Damper control**
- **Design outdoor airflow > 3000 cfm**

- **4 Exceptions including:**
  - **Systems with exhaust-air energy recovery complying with Section 6.5.6.1**

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Off-hour Controls

90.1
2007
Change

- **Exception was deleted for HVAC systems serving hotel/motel guest rooms**

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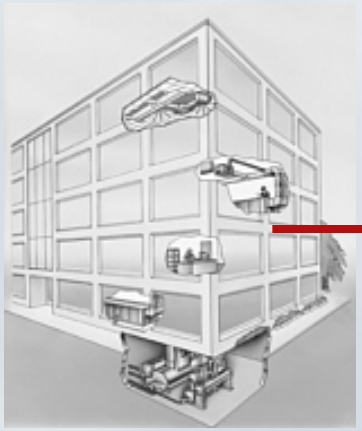
section 6: HVAC

Prescriptive Requirements



proposed HVAC design

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prescriptive requirements (§6.5)

Energy Cost Budget Method (ECB, §11)

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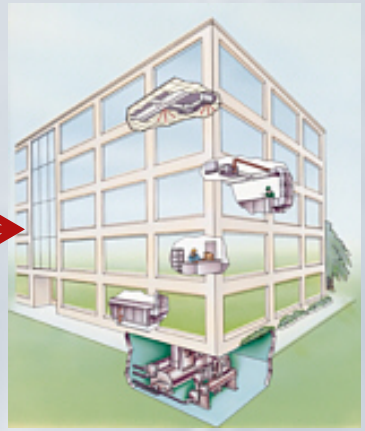
(small buildings only)



90.1-compliant HVAC system

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section 6: HVAC

Prescriptive Requirements

- Economizers
- Simultaneous heating and cooling
- Air system design and control
- Hydronic system design and control
- Heat rejection equipment
- Energy recovery
- Exhaust hoods
- Radiant heating
- Hot gas bypass limitation

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prescriptive HVAC requirements
Air System Design & Control

90.1 2007 Change

Fan system power limitation:

- Applies to systems > 5 hp

Option	Constant volume	Variable volume
1) Nameplate hp	**hp ≤ CFMs x 0.0011**	**hp ≤ CFMs x 0.0015**
2) System bhp	**bhp ≤CFMs x 0.00094 + A**	**bhp ≤CFMs x 0.0013 + A**

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Fan Power Limitation
Pressure Drop Adjustment

90.1 2007 Change

- **$A = \Sigma\ (PD \times CFM_{design} / 4131)$**
- **PD specified for**
  - Ducts
  - Filters
  - Gas-phase air cleaners
  - Heat recovery devices
  - Sound attenuation sections
  - Other devices

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Fan System Power Limitation: Exceptions

90.1 2007 Change

- Hospital or laboratory systems that provide special pressure relationships necessary for health and safety may use VAV fan power limitation
- Individual exhaust fans with motor nameplate ≤ 1 hp
- Fans exhausting air from fume hoods

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prescriptive HVAC requirements
Air System Design & Control

90.1 2007 Change

VAV fan control

- Motors ≥ 10 hp require one of the following: *(was 15 hp)*
  - Variable-speed drive
  - Vaneaxial fan with variable-pitch blades
  - Design wattage ≤ 30% at 50% air volume
- DDC systems must include setpoint reset (fan-pressure optimization)

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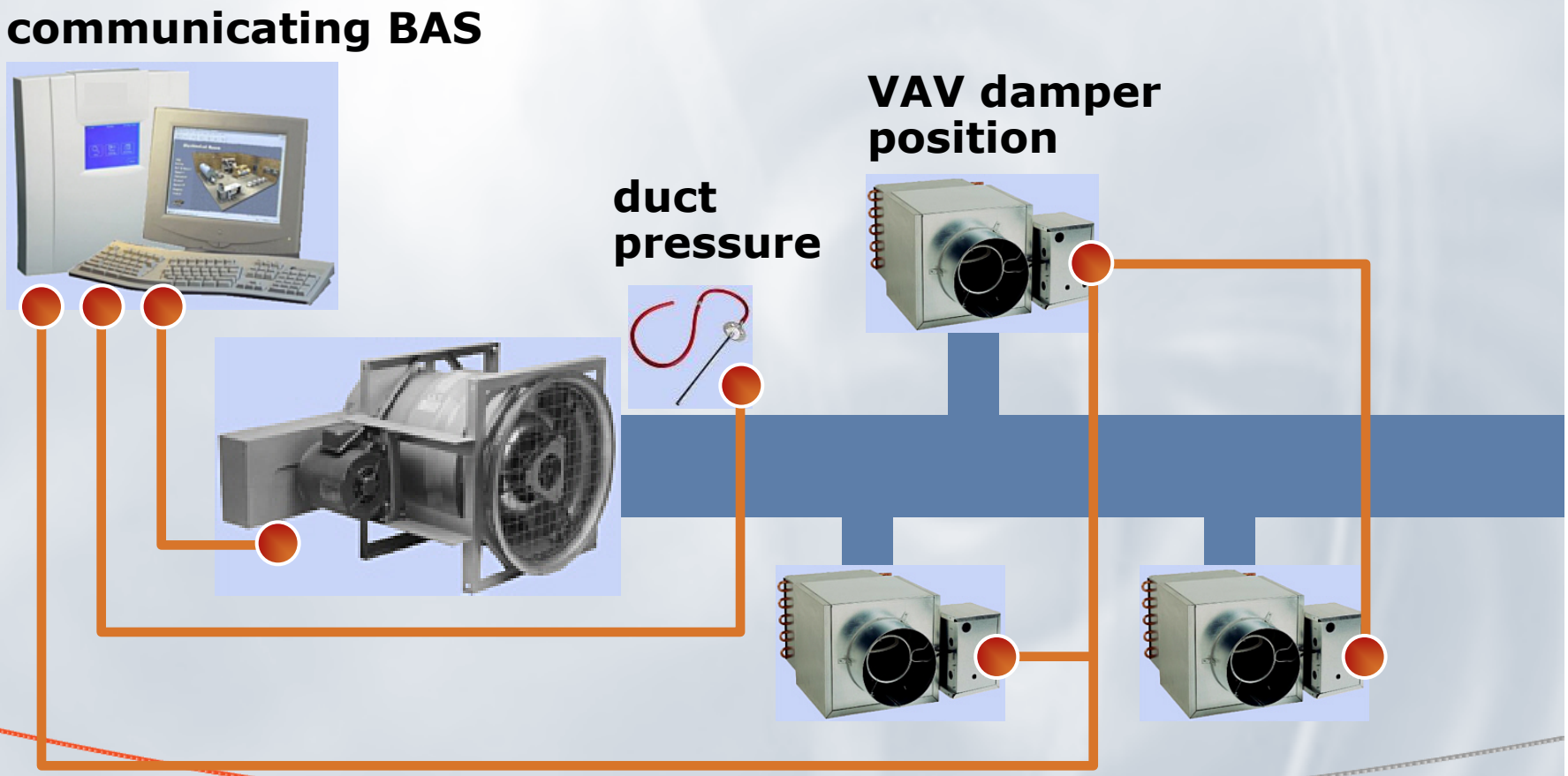
Fan-Pressure Optimization

Not changed – but a lot of people miss this one



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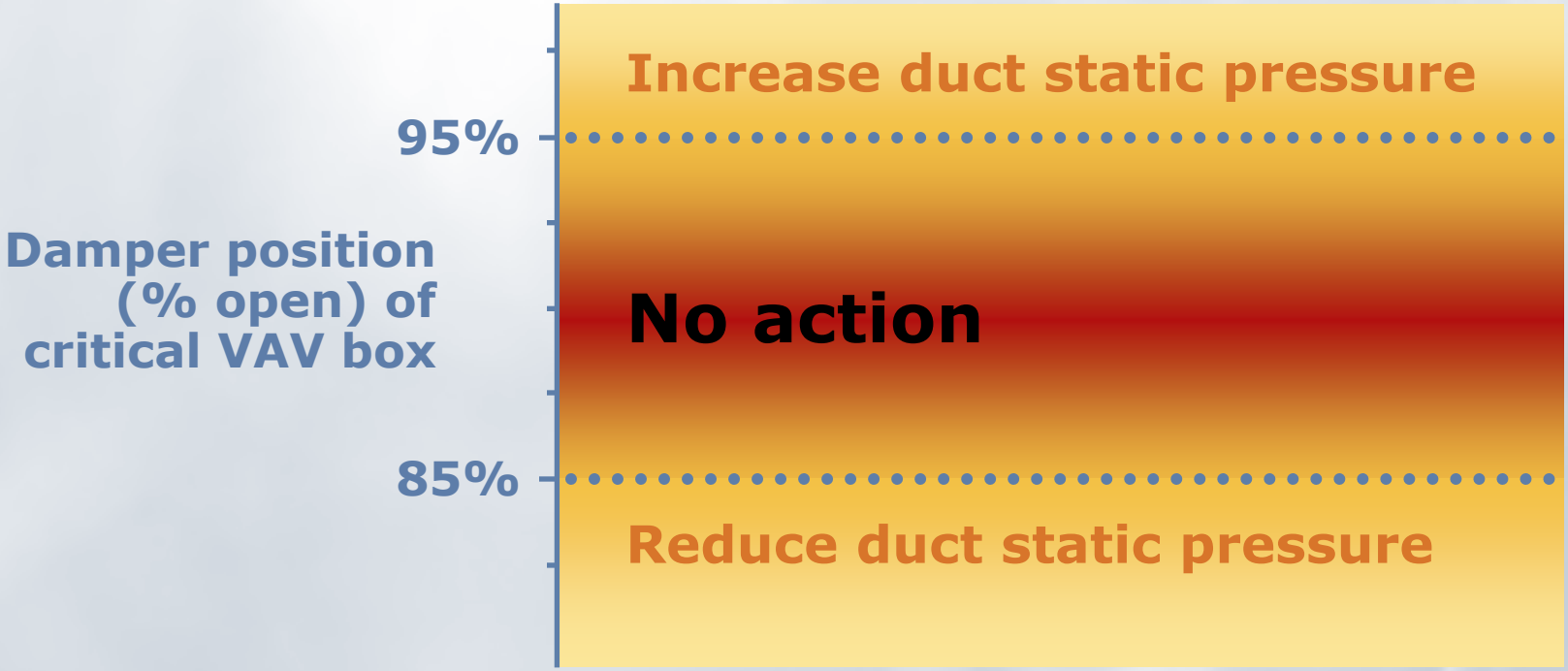
fan-pressure optimization
Control Logic

application TIP



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ASHRAE Standard 90.1-2007

Section 9: Lighting

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Lighting Addenda

90.1
2007
Change

- **ai: retail display lighting. Gives lighting designers flexibility**

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ASHRAE Standard 90.1 – Moving forward

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SSPC 90.1 Work Plan 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

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Where will addenda come from?

- **You**
- **Other publications**
  - Advanced Energy Design Guides
  - California Title 24
  - ASHRAE Standard 189P
- **Energy conscious owners**
- **SSPC 90.1 volunteers**
  - 4 meetings per year (3-4 days each, 8 am – 9 pm)
  - Monthly conference calls

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SSPC 90.1 Accomplishments
06/2007 through 01/19/2009

- **46 Addenda processed**
  - 24 finished
  - 5 Awaiting BOD approval
  - 3 with unresolved objections, not BOD approved yet
  - 9 in comment resolution
  - 6 in Public review as of January 2009
    - Including TPS modification
- **90.1-2007 publications**
  - User's Manual
  - Supplement (1Q-2009) incorporates 20 addenda
- **EISA guidance and appeal**
- **Appeals**
  - 2 defended
  - 2 on one addendum (z) upheld
- **Interpretations**
  - 11 official
  - ~12 unofficial

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Addenda to 90.1-2007:

Public Review

- **Fall 2007 public reviews**
  - D – Daylighting (finished)
  - E – Airside Energy Recovery changes (PR2)
  - F – Ballasted and vented roofs (PR2)
  - H – Dual minimum zone controls (finished)
  - L – Closed circuit cooling towers addition
  - M – Chiller efficiencies, A & B columns (pending)
  - N – Single zone VAV control (finished)
  - R – Change Appendix G to normative (mandatory language)

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Addendum h
Dual Minimum Zone Controls

Suppl. To 2007

- **Limit on zone reheat airflow**
  - 30% minimum on VAV box, or
  - Ventilation required to meet 62.1
  - Or…

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Addendum h
Dual Minimum Zone Controls

Suppl. To 2007

- *Zones* that comply with all of the following:
  - 1. The volume of air that is reheated, recooled, or mixed in *dead band* between heating and cooling does not exceed the larger of the following:
    - » a. 20% of the *zone* design peak supply rate,
    - » b. the volume of *outdoor air* required to meet the ventilation requirements of Section 6.2 of ASHRAE Standard 62.1 for the *zone*,
    - » *c*. any higher rate that can be demonstrated, to the satisfaction of the *authority having jurisdiction*, to reduce overall system annual energy usage by offsetting reheat/recool energy losses through a reduction in *outdoor air* intake.
  - 2. The volume of air that is reheated, recooled, or mixed in peak heating demand shall be less than 50% of the *zone* design peak supply rate
  - 3. Airflow between *dead band* and full heating or full cooling shall be modulated.

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Addendum L
Closed Circuit Cooling Towers

Suppl. To 2007

Equipment Type [d]	Total System Heat Rejection Capacity at Rated Conditions	Subcategory or Rating Condition	Performance Required[a,b,c]	Test Procedure[c d, e]
Propeller or Axial Fan Open Circuit Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75°F wb *Outdoor air Entering wb*	≥38.2 gpm/hp	CTI ATC-105 and CTI STD-201
Centrifugal Fan Open Circuit Cooling Towers	All	95°F Entering Water 85°F Leaving Water 75°F wb *Outdoor air Entering wb*	≥20.0 gpm/hp	CTI ATC-105 and CTI STD-201
Propeller or Axial Fan Closed Circuit Cooling Towers	All	102°F Entering Water 90°F Leaving Water 75°F *Entering wb*	≥14.0 gpm/hp	CTI ATC-105S and CTI STD-201
Centrifugal Closed Circuit Cooling Towers	All	102°F Entering Water 90°F Leaving Water 75°F *Entering wb*	≥ 7.0 gpm/hp	CTI ATC-105S and CTI STD-201

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Addendum N
Single Zone VAV

Suppl. To 2007

- **6.4.3.10 Single Zone Variable Air Volume Controls**
- **Effective January 1/2012 all air conditioning equipment and air-handling units with cooling capacity at ARI conditions greater than or equal to 110,000 Btu/hr that serve single zones shall have their supply fans controlled by two-speed motors or variable speed drives. The supply fan controls shall be able to reduce the airflow to less than or equal to the larger of the following:**
  - Two-thirds of the full fan speed at low cooling demand., or
  - The volume of outdoor air required to meet the ventilation requirements of Standard 62.1.

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Public Review: Addendum R
Change App. G to Normative

- **Appendix G used for LEED®**
- **Will allow Appendix G to be referenced by other standards – e.g. Standard 189**

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Pending Addenda to 90.1-2007

Pending

- **February 2008 public reviews**
  - S – Change the Heat Pump tables. Add IEER (rather than IPLV)
  - T – Replacement PTACs
  - U – Centrifugal Fan Cooling Tower limitation
  - V – Pump head calculation requirement
  - W – ECB changes
  - X – Lighting Control

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Addendum M
Chiller Efficiencies
Path B

Suppl. To 2007

- Effective 1/1/2010
- Reciprocating chillers put into the "positive displacement chillers" category
- Allows Path A and Path B options
- Adds additional category for centrifugal chillers ≥ 600 tons

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Addendum M
Chiller Efficiencies
Path B

Suppl. To 2007

Equipment Type	Size Category	Units	Before 1/1/2010		As of 1/1/2010[c]				Test Procedure[b]
					Path A		Path B[d]		
			Full Load	IPLV	Full Load	IPLV	Full Load	IPLV	ARI 550/590
Air-cooled	<150 tons	EER	≥9.562	≥10.416	≥9.562	≥12.50	NA	NA	
	≥150 tons	EER	≥9.562	≥10.416	≥9.562	≥12.75	NA	NA	
Water Cooled Electrically Operated, Positive Displacement	<75 tons	kW/ton	≤0.790	≤0.676	≤0.780	≤0.630	≤0.800	≤0.600	
	≥75 tons and < 150 tons	kW/ton			≤0.775	≤0.615	≤0.790	≤0.586	
	≥150 tons and < 300 tons	kW/ton	≤0.717	≤0.627	≤0.680	≤0.580	≤0.718	≤0.540	
	≥300 tons	kW/ton	≤0.639	≤0.571	≤0.620	≤0.540	≤0.639	≤0.490	
Water Cooled Electrically Operated, Centrifugal	<150 tons	kW/ton	≤0.703	≤0.669	≤0.634	≤0.596	≤0.639	≤0.450	
	≥150 tons and < 300 tons	kW/ton	≤0.634	≤0.596					
	≥300 tons and < 600 tons	kW/ton	≤0.576	≤0.549	≤0.576	≤0.549	≤0.600	≤0.400	
	≥600 tons	kW/ton			≤0.570	≤0.539	≤0.590	≤0.400	

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Addendum s
Heat Pump Part Load Eff.

Pending

- **Defines IEER (ARI 340/360 2007)**
  - *integrated energy efficiency ratio (IEER):* a single-number figure of merit expressing cooling part-load EER efficiency for commercial unitary air-conditioning and heat pump equipment on the basis of weighted operation at various load capacities for the equipment.
- **New IEER efficiencies for all sizes**
- **Delete IPLV**
- **Effective 1/1/2010**

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Addendum t
Replacement PTACs

Pending

- **Uses "Non-standard" rather than replacement**
- **Existing Sleeves**
  - Less than 16 in. high
  - Less than 42 in. wide
  - Less than 670 in.^{2}
- **Must be labeled**
  - *"Manufactured for replacement <u>non-standard size</u> applications only: not to be installed in new construction projects."*

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Addendum u
Centrifugal Fan Open Cooling Towers

Pending

- **If > 1100 gpm, must meet efficiency requirements of Axial fan cooling towers (≥ 38.2 gpm/hp)**
  - Exceptions: Ducted, or require external sound attenuation

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prescriptive HVAC requirements - 2004

Airside Energy Recovery

- **Required if:**
  - Supply air capacity ≥ 5,000 cfm
  - Minimum outdoor air ≥ 70%
- **Recovery system effectiveness ≥ 50%**
- **Exceptions (9)**
  - Labs, toxic exhaust, etc.
  - Largest exhaust < 75% outdoor airflow

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Addendum e
Airside Energy Recovery

ISC likely

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	≥ 1100	≥ 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

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Addendum ak
Hydronic variable flow

Finished

- VFDs on pumps 5 hp and greater
- "Critical valve reset"
- Shutoff valves for water cooled unitary air conditioners (self-contained)

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Addendum aL
Skylights in large, enclosed spaces

Responding to Comments

- ≥ 10,000 ft2
- Directly under the roof with ceiling height > 15 ft
- Space list: Including office, retail, distribution/sorting

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Work so far in 2009

- **SSPC responding to comments**
  - AQ – Title Purpose and Scope – to include processes
  - AR – Exterior Lighting Power
  - AV – Lighting Alterations
- **Likely public review in March 2009**
  - AX – Kitchen Hoods
  - AZ – Lighting Functional Testing
  - Envelope (all)
  - Skylights in Unconditioned Spaces

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Considerations for 2009?

- Small motor efficiency
- Fan efficiency
- Additional heat recovery requirements
- Computer room air-conditioning requirements
- Chiller type limitations
- Economizers
- Lighting Power Densities

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Future Addenda

- Open to your suggestions through the Continuous Maintenance Proposal process
- All meetings open to the public
- Hard working members are welcome

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Remember…

- **Minimum standards define the worst buildings allowed**
- **Increased stringency in minimum standards is**
  - Possible
  - Being done
  - An important step on the march to net-zero

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