



ASHRAE 90.1 – The evolution continues

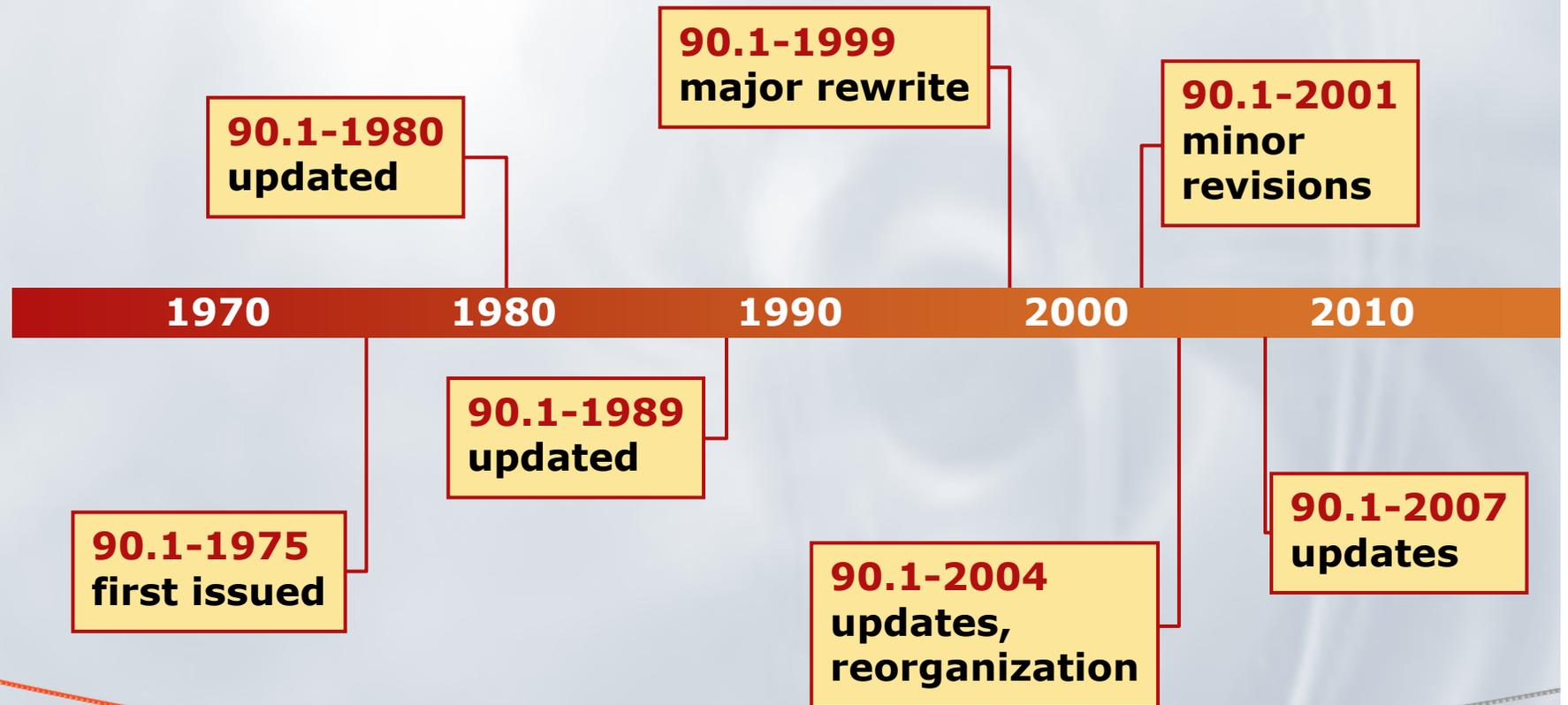


24 July April 2008

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



Historical Timeline





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



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



ASHRAE Standard 90.1 and LEED®-2009

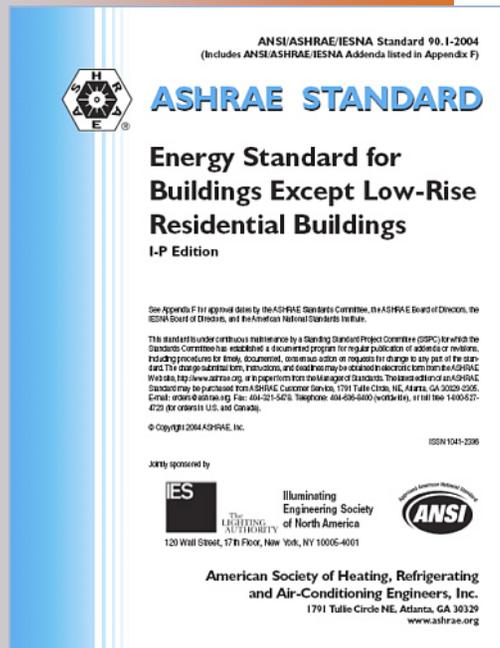
♦ **EAp2: Minimum energy performance**

- 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)

ASHRAE Standard 90.1-2007 Purpose



“... Provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings”

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**

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**



Standard 90.1-2007

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

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



90.1
2007
Change

Envelope Addenda

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



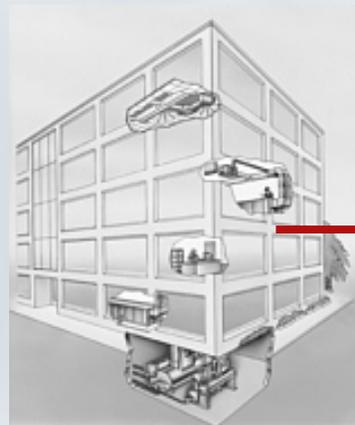
ASHRAE Standard 90.1-2007



Section 6 HVAC



section 6: HVAC Mandatory Provisions



**proposed
HVAC design**

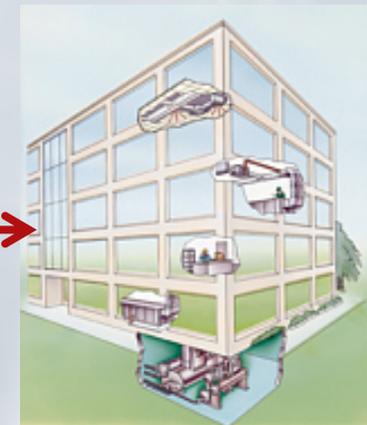
**mandatory
provisions
(§6.4)**

**prescriptive
requirements
(§6.5)**

**Energy Cost
Budget Method
(ECB, §11)**

**Simplified
Approach
Option (§6.3)**

(small buildings only)



**90.1-compliant
HVAC system**



section 6: HVAC

Mandatory Provisions

- ◆ **Equipment efficiencies**
- ◆ **Load calculations**
- ◆ **Controls**
- ◆ **Construction and insulation**
- ◆ **Completion requirements**
Drawings, manuals, balancing, and
commissioning

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



ASHRAE 62.1 Reference

90.1
2007
Change

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

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

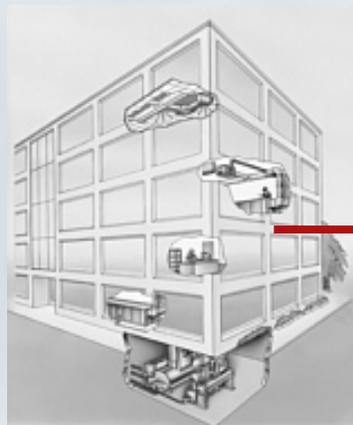


90.1
2007
Change

Off-hour Controls

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

section 6: HVAC Prescriptive Requirements



**proposed
HVAC design**

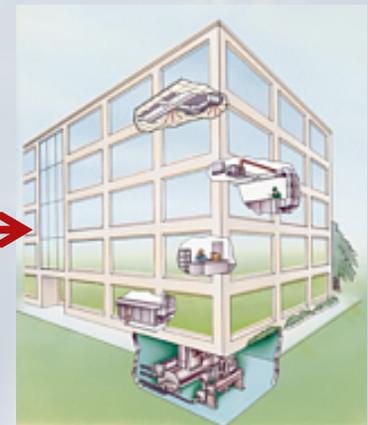
**mandatory
provisions
(§6.4)**

**prescriptive
requirements
(§6.5)**

**Energy Cost
Budget Method
(ECB, §11)**

**Simplified
Approach
Option (§6.3)**

(small buildings only)



**90.1-compliant
HVAC system**

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**

prescriptive HVAC requirements Air System Design & Control



90.1
2007
Change

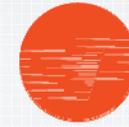
Fan system power limitation:

- ◆ Applies to systems > 5 hp

Option	Constant volume	Variable volume
1) Nameplate hp	$hp \leq CFMs \times 0.0011$	$hp \leq CFMs \times 0.0015$
2) System bhp	$bhp \leq CFMs \times 0.00094 + A$	$bhp \leq CFMs \times 0.0013 + A$

Fan Power Limitation

Pressure Drop Adjustment



TRANE

90.1
2007
Change

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

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**

prescriptive HVAC requirements Air System Design & Control



90.1
2007
Change

VAV fan control

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

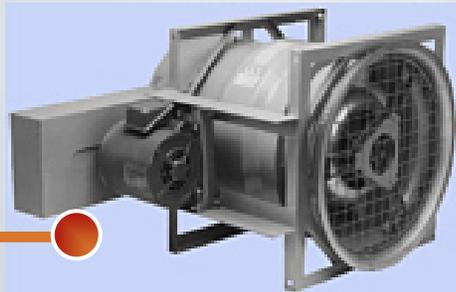
(was 15 hp)

Fan-Pressure Optimization



Not changed – but a lot of people miss this one

communicating BAS



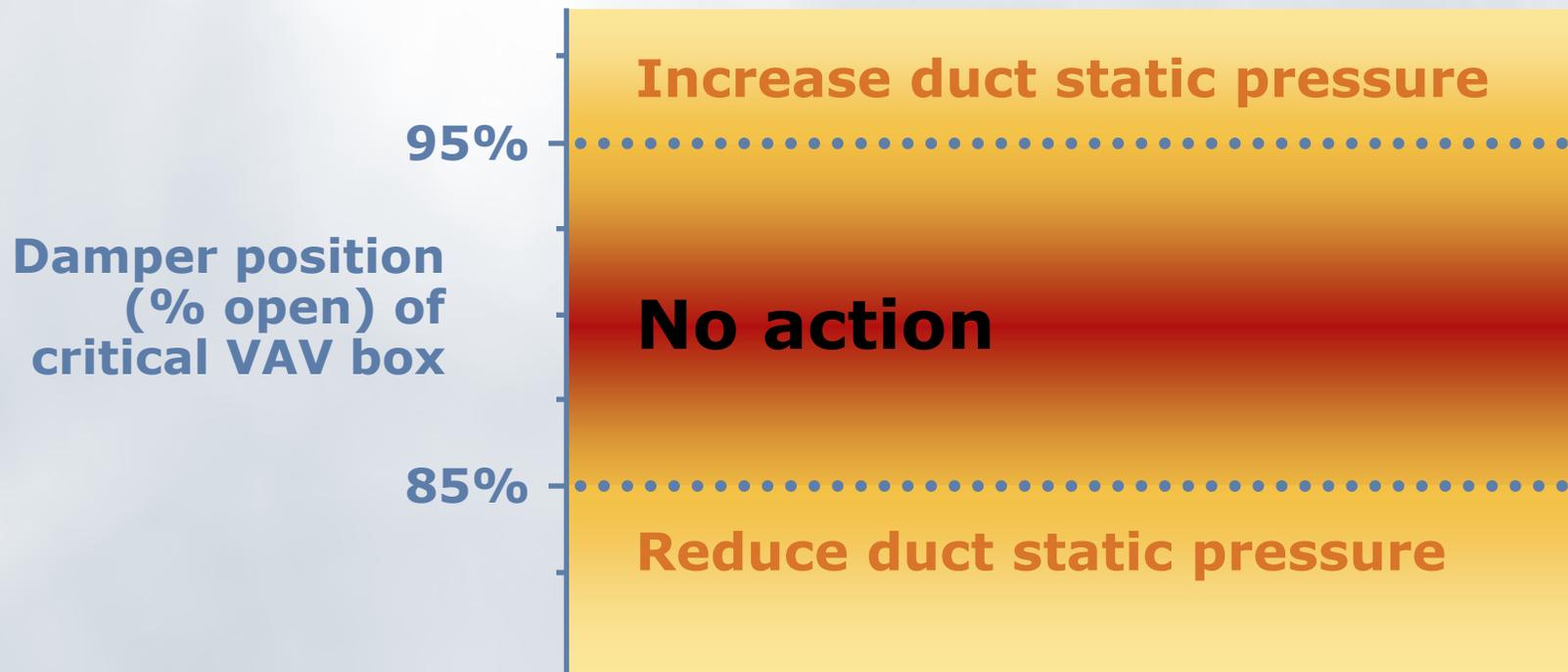
duct pressure



VAV damper position



fan-pressure optimization Control Logic





ASHRAE Standard 90.1-2007



Section 9: Lighting



90.1
2007
Change

Lighting Addenda

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



ASHRAE Standard 90.1 – Moving forward



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

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

June 2007 through June 2008, addenda



- ◆ **Addenda processed**
 - ◆ 15 finished
 - ◆ 6 almost finished
 - ◆ 1 has finished 1st public review
 - ◆ 3 have finished 2nd public review
 - ◆ June 13, 2008 public reviews
 - 6 new
 - 4 ISC or 2nd PR
- ◆ **June 20-23, 2008 meetings, possible addenda**
 - ◆ 5 new
 - ◆ 1 ISC
- ◆ **2007 Supplement**
 - ◆ At least 15 addenda
 - ◆ Possibly up to 6 more

June 2007 through June 2008...other



- ◆ **Four appeals defended**
- ◆ **EISA guidance and appeal**
- ◆ **Interpretations**
 - ◆ 15 official
 - ◆ 10 unofficial
- ◆ **90.1-2007 User's Manual**



Public
Review

Addenda to 90.1-2007:

♦ 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)

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...

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.

Addendum L Closed Circuit Cooling Towers



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

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.

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**

Pending Addenda to 90.1-2007



◆ 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

Addendum M

Chiller Efficiencies

Path B



- ◆ **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 \geq 600 tons**

Addendum M Chiller Efficiencies Path B



Pending

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	
Air-cooled	<150 tons	EER	≥9.562	≥10.416	≥9.562	≥12.50	NA	NA	ARI 550/590
	≥150 tons	EER	≥9.562	≥10.416	≥9.562	≥12.75	NA	NA	
Water Cooled Electrically Operated, Positive Displacement	<75 tons	kW/ton			≤0.780	≤0.630	≤0.800	≤0.600	
	≥75 tons and <150 tons	kW/ton	≤0.790	≤0.676	≤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					
	≥150 tons and <300 tons	kW/ton	≤0.634	≤0.596	≤0.634	≤0.596	≤0.639	≤0.450	
	≥300 tons and <600 tons	kW/ton			≤0.576	≤0.549	≤0.600	≤0.400	
	≥600 tons	kW/ton	≤0.576	≤0.549	≤0.570	≤0.539	≤0.590	≤0.400	

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**

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 non-standard size applications only: not to be installed in new construction projects.”*

Addendum u Centrifugal Fan Open Cooling Towers



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

Pending Addenda to 90.1-2007



Pending

◆ Spring 2008 Reviews

◆ Y – Heat pump pool heater reference

◆ aa – Lighting, “Manual on” allowance

◆ Ab – Daylighting – II

◆ Ac – lighting control incentives

◆ Ad – liquid to liquid heat exchangers

◆ Ae – Radiant panels

◆ Af – Pipe sizing limitations

Public Reviews

June 13, 2008



Public
Review

♦ 2nd PR or ISC

- ♦ E – Airside Energy Recovery changes, 2PR
- ♦ V – Loads, ISC
- ♦ X – Space Controls, ISC
- ♦ R – Appendix G to normative, ISC

♦ First PR

- ♦ Ag – Rigid board insulation overlap
- ♦ Ai – Appendix G purchased heating and cooling
- ♦ Aj – Motors
- ♦ Ak – Hydronic Variable flow systems
- ♦ AL – Skylights in large, enclosed spaces

prescriptive HVAC
requirements - 2004



Airside Energy Recovery

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

Addendum e Airside Energy Recovery



<u>Zone</u>	<u>% Outside Air at full design cfm</u>					
	<u>≥ 30%</u>	<u>≥ 40%</u>	<u>≥ 50%</u>	<u>≥ 60%</u>	<u>≥ 70%</u>	<u>≥ 80%</u>
	<u>And</u> <u>< 40%</u>	<u>And</u> <u>< 50%</u>	<u>And</u> <u>< 60%</u>	<u>And</u> <u>< 70%</u>	<u>And</u> <u>< 80%</u>	
	<u>Design Supply Fan CFM</u>					
<u>3B, 3C, 4B, 4C, 5B</u>	<u>NR</u>	<u>NR</u>	<u>NR</u>	<u>NR</u>	<u>≥ 5000</u>	<u>≥ 5000</u>
<u>1B, 2B, 5c</u>	<u>NR</u>	<u>NR</u>	<u>≥ 26000</u>	<u>≥ 12000</u>	<u>≥ 5000</u>	<u>≥ 4000</u>
<u>6b</u>	<u>≥ 1100</u>	<u>≥ 5500</u>	<u>≥ 4500</u>	<u>≥ 3500</u>	<u>≥ 2500</u>	<u>≥ 1500</u>
<u>1A, 2A, 3A, 4A, 5A, 6A</u>	<u>≥ 5500</u>	<u>≥ 4500</u>	<u>≥ 3500</u>	<u>≥ 2000</u>	<u>≥ 1000</u>	<u>> 0</u>
<u>7,8</u>	<u>≥ 2500</u>	<u>≥ 1000</u>	<u>> 0</u>	<u>> 0</u>	<u>> 0</u>	<u>> 0</u>

Addendum ak **Hydronic variable flow**



TRANE

Public
Review

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

Addendum aL Skylights in large, enclosed spaces



Public
Review

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

Possible Addenda for Public Review



◆ **More to come**

- ◆ Recommended change to Scope to include processes (June 2008)
- ◆ Considerations for Fall of 2008
 - Small motor efficiency
 - Fan efficiency
 - Additional heat recovery requirements
 - Computer room air-conditioning requirements
 - Chiller type limitations
 - Economizers



Future Addenda

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



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