What You Need to Know about the New Energy Standard for Commercial Buildings: Standard 90.1-2016

U.S. Department of Energy Building Energy Codes Program
Energy Codes Commentator Webinar Series
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Course Description

ANSI/ASHRAE/IES Standard 90.1, the Energy Standard for Buildings Except Low-Rise Residential Buildings, has been a benchmark and national model code for commercial buildings for over 35 years and is indispensable for engineers and other professionals involved in the design of buildings and building their systems. Now, with many new addenda incorporated since the 2013 edition, Standard 90.1-2016 will significantly change the way buildings are built as these new modifications find their way into the world's energy codes. This webinar highlights some of the major changes that you can expect to see in building envelope, mechanical system and lighting requirements. In addition, the session will highlight Appendix G, a new compliance path that enables a single, simple performance-based option for both minimum code requirements and above-code programs. This session is for anyone who wants advanced insight into the new Standard’s expected impacts on the industry.

Learning Objectives

At the end of this course, participants should be able to understand:

1. Provide an overview of the major requirements of the 90.1-2016 Standard that are of interest to engineers, designers, architects, contractors and policy makers.
2. Understand the significant changes in the Envelope, Mechanical, Lighting Sections, and Performance Compliance Path sections of Standard 90.1-2016 versus the 2013 edition.
3. Provide insights into appropriate application of the major new requirements.
4. Receive a better understanding of the design changes needed to meet the new requirements.

Our Speakers Today:

Drake Erbe, Airxchange Inc. (SSPC 90.1 Chair)

Richard Lord, United Technologies Carrier Corp (SSPC 90.1 Vice Chair)

Eric Richman, Pacific Northwest National Laboratory (Chair, 90.1 Lighting Subcommittee)

Michael Rosenberg, Pacific Northwest National Laboratory (Member, 90.1 ECB Subcommittee)

Overview and Envelope Changes

Drake Erbe
SSPC 90.1 Chair

Outline/Agenda

- Overview/Objectives
- Results
- Section 5 – envelope
- Section 6 – mechanical
- Section 7 – service water
- Section 8 – power
- Section 9 – lighting
- Section 11/Appendix G – building performance

Objectives

- It is the overall goal of each version to create a consensus standard that saves energy and is technically feasible and cost effective.
- During the 2013 cycle, a strategic initiative developed additional objectives
  - ease of use
  - preparation for moving to the electronic environment
  - considering the energy for the entire building
  - a better system for inclusion of the climate data and other reference standards information
  - moving towards performance methodologies

Results

- Over 120 addenda were included
- Major format changes for ease of use
- Weather data alignment with 169
- Appendix G Compliance Path
- Determination and simulations are based on Whole Building energy

Format Changes

1. 1 column format for easier reading
2. Exceptions separated, indented and set apart with a smaller font size
3. Defined terms are Italicized
4. Alternating coloring scheme for table rows

Climate

- Reference Standard Reproduction Annex 1 (located at the end of the Standard) identifies the appropriate climate zones in the United States, Canada, and other international locations from ASHRAE Standard 169, Climatic Data for Building Design Standards . (Appendix B has been deleted.)

- Approximately 10% of the counties in the U.S. have been re-assigned to a different climate zone due to updates in climatic data. Further, the previous Climate Zone 1 has been subdivided into Climate Zones 0 and 1. This material, is now cited in Section 5.1.4 and applies to the Building Envelope, Mechanical, Lighting, and all other sections of the Standard.

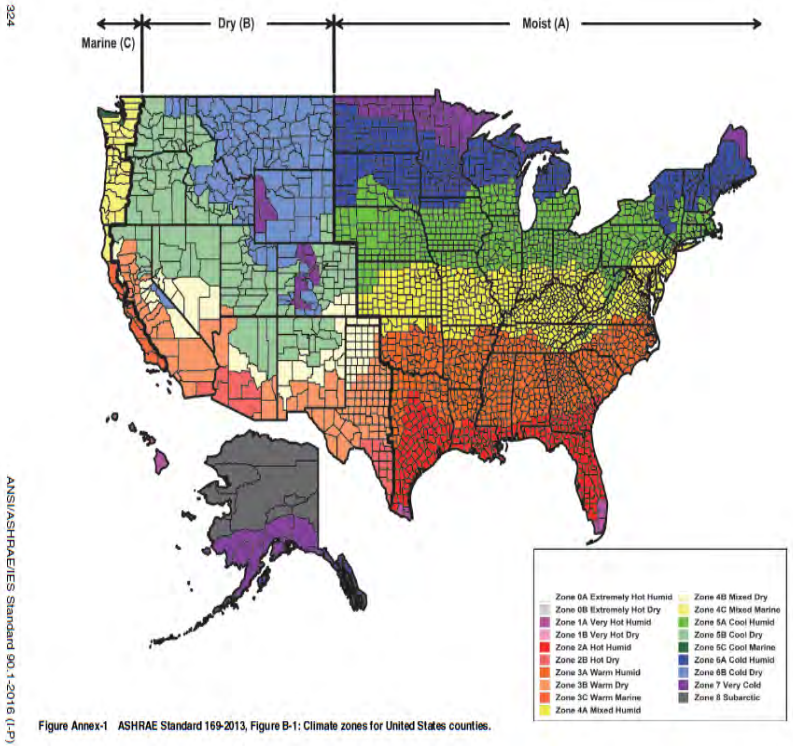
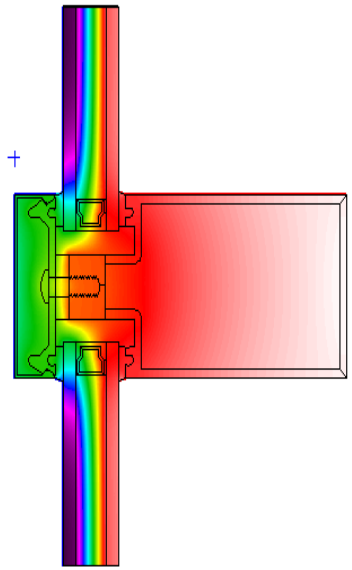


Figure Annex-1 ASHRAE Standard 169-2013, Figure B-1: Climate zones for United States counties.

Section 5 - Envelope

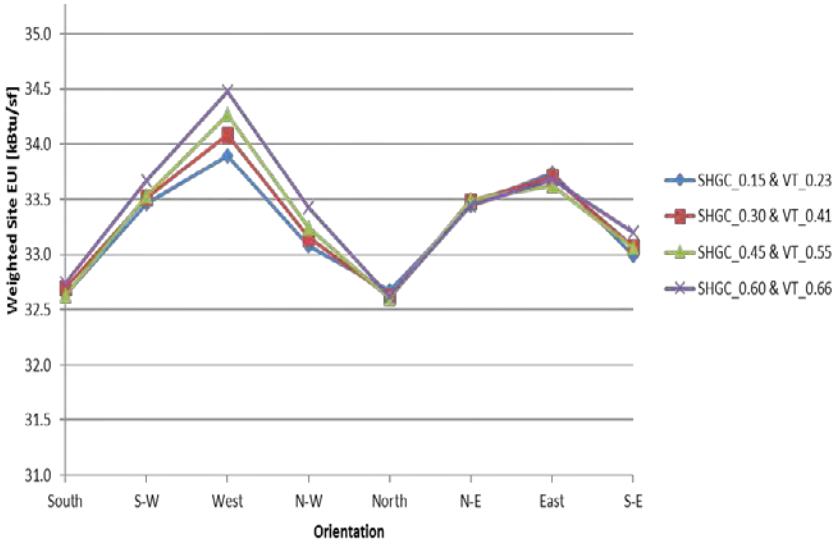
Fenestration



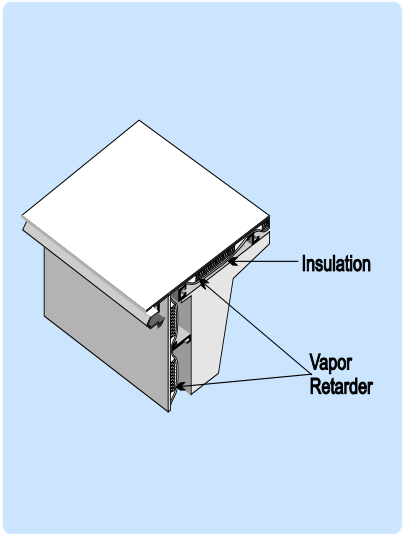
- 90.1-2016 includes a comprehensive update to the **fenestration prescriptive requirements** in Tables 5.5-1 through 5.5-8. Following detailed analysis of performance and cost effectiveness,
  - U-factor reduced by 8-22% in northern zones, and 0-10% in southern zones.
  - SHGC reduced 12% in the new extremely hot zone 0, and 5-10% in zones 4-5.

- The **orientation requirements** for vertical fenestration in Section 5.5.4.5 were tightened based on climate zone.
  - This will continue to encourage lower SHGC on east / west sides, but allows flexibility to comply through SHGC, external shading, or window distribution.

- The SHGC credit for **shading by permanent projections** in Section 5.5.4.4.1 was modified to correct how it addressed north-facing fenestration.
  - SHGC shading multipliers in Table 5.5.4.4.1 now only apply to the south, east, and west orientations.
  - North-facing fenestration is simply allowed to use the same SHGC as the average of the other orientations.

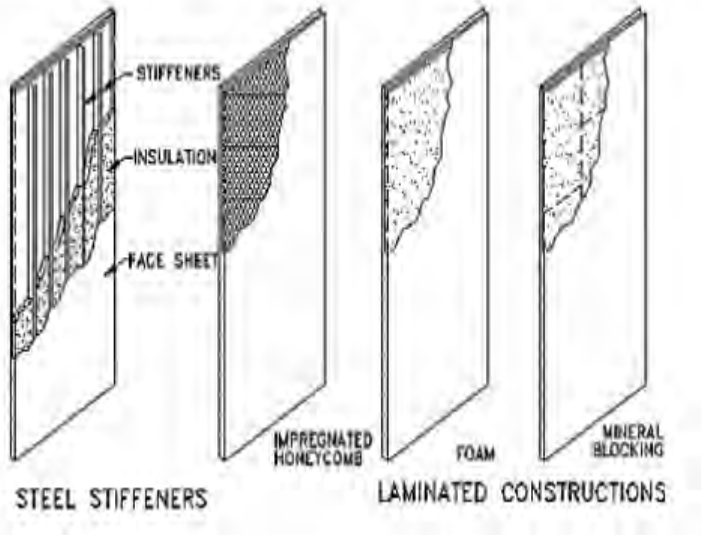


Walls, Roofs, & Doors



Sections of Appendix A have been adjusted to reflect the new metal building wall envelope requirements in Tables 5.5-1 through 5.5-8. (Appendix A)

Prescriptive requirements for Oversized (garage) and ordinary personnel doors in Tables 5.5-1 through 5.5-8 and associated text in section 5.5.4.5 have been modified.



Infiltration

Maximum air leakage threshold values have been added for sectional garage doors. This is a new requirement for the 2016 edition of the Standard. (5.4.3.2)

Whole building air leakage testing was added to Section 5.4.3.1.3. Testing is now an option for compliance in addition to the existing continuous air barrier options. (5.4.3.1.3)

If whole building testing is not performed, then an air barrier design and installation verification program is required.

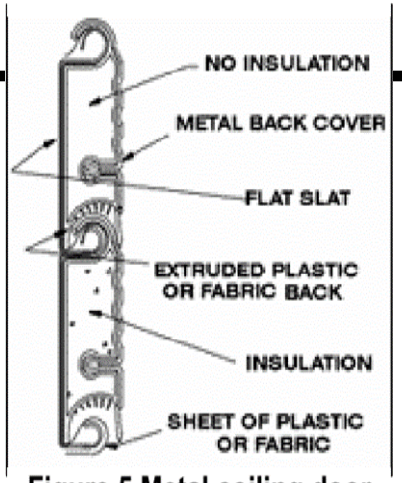


Figure 5 Metal coiling door slats may be insulated

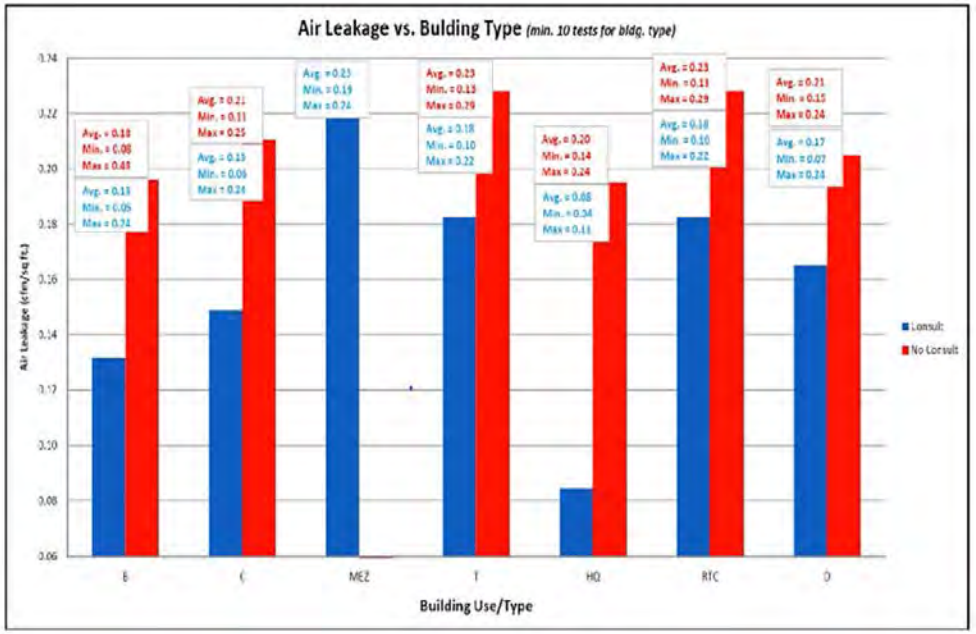


Figure 11. Summary of air leakage test results of 200 buildings by a building type.

Additional Items

The thresholds for conditioned space (which are based on the output capacity of space heating and space cooling systems, and are located in Table 3.2 in Section 3 Definitions) have been lowered to catch up with the reduction in loads due to the greater building envelope efficiency in Section 5 which has been achieved over the last dozen years.

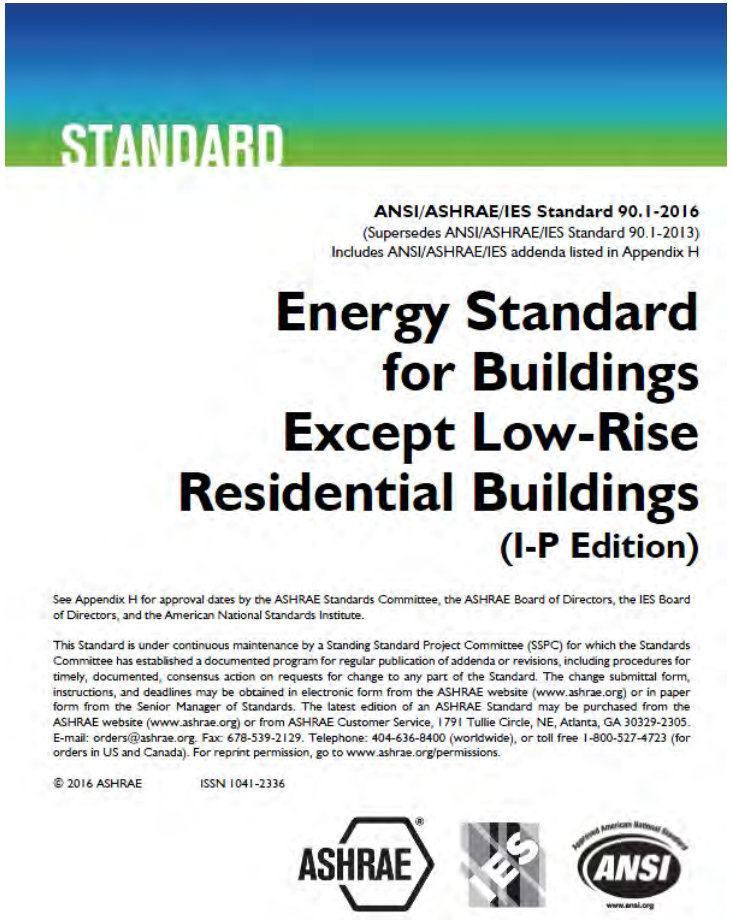
A new Section 5.9 was added to the standard to increase delivered performance by inspecting and verifying that the requirements of Section 5 are adequately met.

Table 3.2 *Heated Space* Criteria

Climate Zone	Heating Output, Btu/h·ft^2
0	>5
1	>5
2	>5
3A, 3B	>9
3C	>7
4A, 4B	>10
4C	>8
5	>12
6	>14
7	>16
8	>19

ASHRAE 90.1-2016 Standard Mechanical Section Change Summary

Richard Lord 12-08-2016
ASHRAE 90.1 Co-Vice Chair
ASHRAE Fellow



Mechanical Update Overview

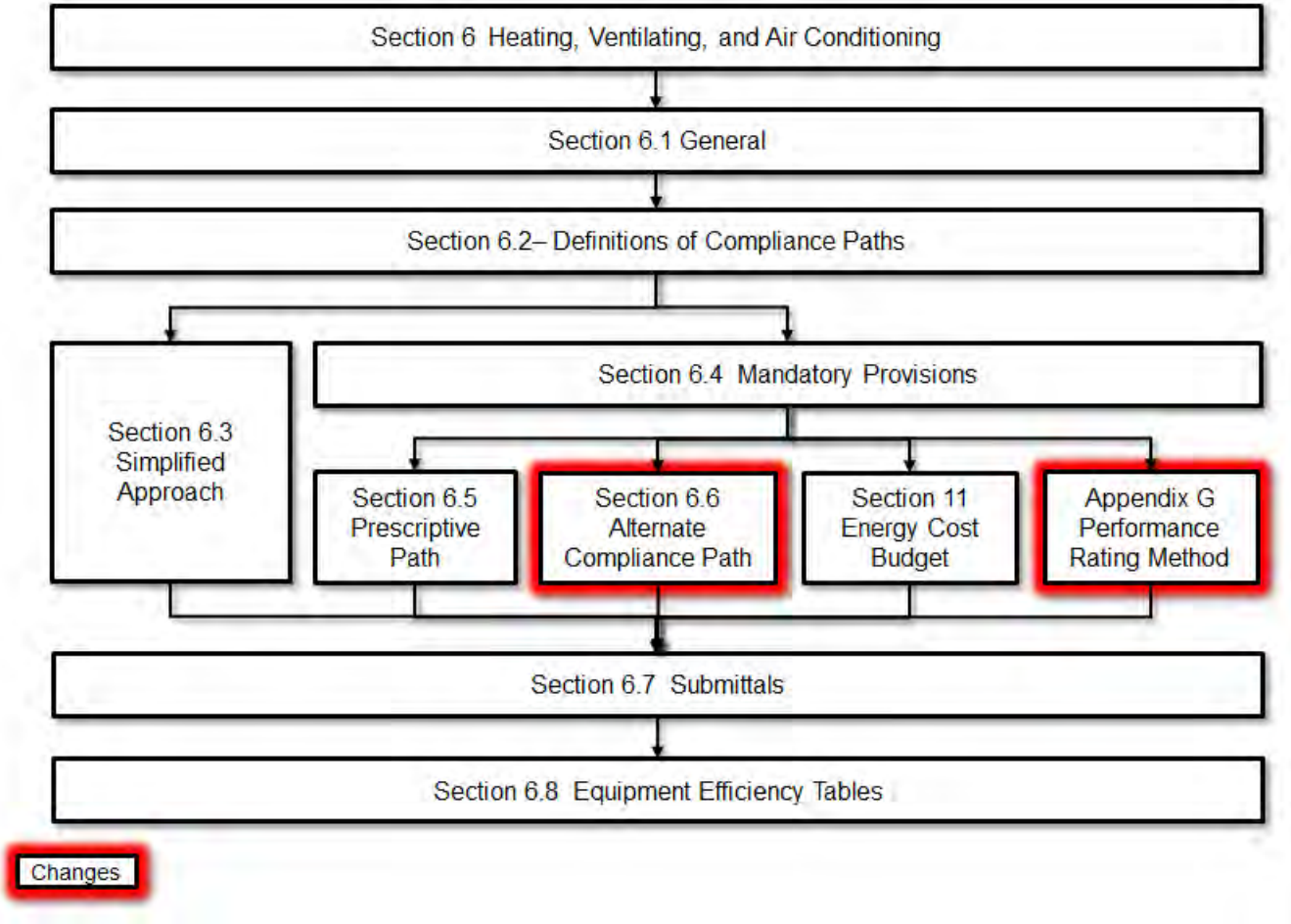
- The ASHRAE 90.1-2016 standard included 52 addenda that made changes to mechanical system requirements and these will be included in this review.
- In addition to the addenda changes several date specific requirements in the ASHRAE 90.1-2013 Standard were meet and now are in effect and these will also be included in this review
- Mechanical Systems are defined in section 5, 7 and section 10
  - Section 6 – Heating, Ventilating, and Air Conditioning
  - Section 7 – Service Water Heating
  - Section 10 – Other Equipment

Section 6 - Heating, Ventilating, and Air Conditioning

Changes

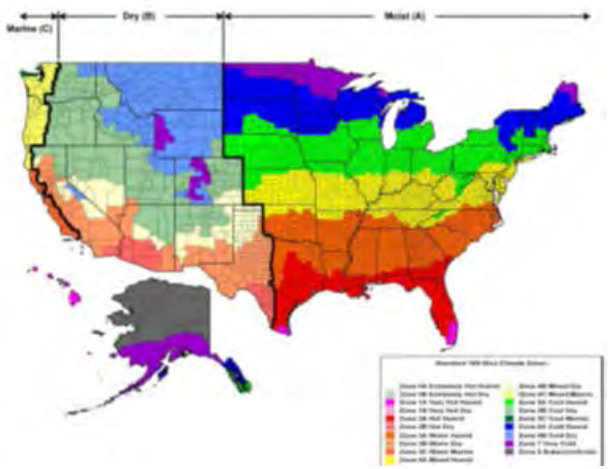
Section 6 Compliance Flowchart

- At the beginning of each section there is a flowchart showing the overall structure and compliance paths for the requirements.
- As part of the updates to section 6, the flowchart was updated to reflect the compliance paths options for HVAC



Climate Zone Requirements

With the ASHRAE 169 redefinition of climate zones and the addition of new climate zone 0A and 0B changes were made to the climate specific section 6 requirements Climate zones are referenced to Section 5.1.4



Changes were made in the following tables and sections

- Table 6.4.3.4.3 Damper leakage
- Economizer requirements in 6.5.1
- Table 6.5.1-1 Minimum Fan Cooling Unit Size for which economizers are Required
- Table 6.5.1.1.3 High-Limit Shutoff Control Settings for Air Economizers
- Table 6.5.1.2.1 Fluid Economizer Sizing Dry-Bulb and Wet-Bulb Requirements for Computer Rooms (new table)
- Supply air temperature reset in section 6.5.3.5
- Table 6.5.4.2 Pump Flow Control Requirements (new table)
- Exhaust Air Energy Recovery in 6.5.6.1 and tables 6.5.6.1-1 & 2
- Table 6.6.1 Power Usage Effectiveness (PUE) Maximum
- Table 6.8.2 Minimum Duct Insulation R-Value
- Table 6.8.3-1 Minimum Piping Insulation Thickness Heating and Hot Water Systems

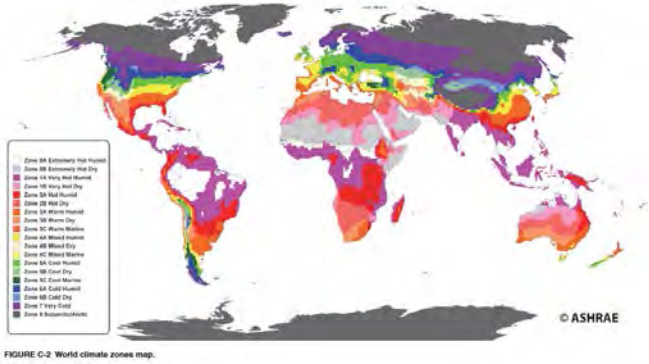


FIGURE C-2 World climate zones map.

Replacement Equipment

New requirements have been added to section 6.1.1.3 to define requirements for replacement equipment which in prior versions of 90.1 were only required on new construction

6.1.1.3.1 New HVACR *equipment* as a direct replacement of existing HVACR *equipment* shall comply with the following sections as applicable for the *equipment* being replaced:

a. 6.3, “Simplified Approach Option for HVAC Systems”
b. 6.4.1, “Equipment Efficiencies, Verification, and Labeling Requirements”
c. 6.4.3.1, “Zone Thermostatic Controls”
d. 6.4.3.2, “Set-Point Overlap Restrictions”
e. 6.4.3.3, “Off-Hour Controls” except for Section 6.4.3.3.4, “Zone Isolation”
f. 6.4.3.4, “Ventilation System Controls”
g. g. 6.4.3.7, “Freeze Protection and Snow/Ice Melting Systems”
h. 6.4.3.8, “Ventilation Controls for High-Occupancy Areas” only for single-zone equipment
i. 6.4.3.9, “Heated or Cooled Vestibules”
j. 6.4.5, “*Walk-In Coolers* and *Walk-In Freezers*”
k. 6.5.1.1, “*Air Economizers*” for units located outdoors
l. 6.5.1.3, “Integrated Economizer *Control*”
m. 6.5.1.4, “Economizer Heating *System* Impact”
n. 6.5.3.1.3, “Fan *Efficiency*”
o. 6.5.3.2.1, “Supply Fan Airflow *Control*”
p. 6.5.3.6, “Fractional Horsepower Fan Motors”
q. 6.5.4.1, “*Boiler* Turndown”
r. 6.5.4.3, “Chiller and *Boiler* Isolation”
s. 6.5.5.2, “Fan Speed *Control*”

New Equipment Efficiency Requirements

Several changes were made to the equipment efficiency requirements defined in section 6.4.1.1 and in the tables 6.8.1-1 to 6.8.1-16

Table	Name	Change
6.8.1-1	Electrically Operated Unitary Air Conditioners and Condensing Units	**Effective Dates**
6.8.1-2	Electrically Operated Unitary and Applied Heat Pumps	**Effective Dates**
6.8.1-3	Water-Chilling Packages—Minimum Efficiency Requirements	**Effective Dates**
6.8.1-4	Electrically Operated Packaged Terminal Air Conditioners, Packaged Terminal Heat Pumps, Single-Package Vertical Air Conditioners, Single-Package Vertical Heat Pumps, Room Air Conditioners, and Room Air Conditioner Heat Pumps	No change
6.8.1-5	Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters	No change
6.8.1-6	Gas- and Oil-Fired Boilers	No change
6.8.1-7	Performance Requirements for Heat Rejection Equipment	**Higher levels**
6.8.1-8	Heat Transfer Equipment	No change

New Equipment Efficiency Requirements

continued

Table	Name	Change
6.8.1-9	Electrically Operated Variable-Refrigerant-Flow Air Conditioners	**New levels effective 1/1/2017**
6.8.1-10	Electrically Operated Variable-Refrigerant-Flow and Applied Heat Pumps	**New levels effective 1/1/2017 & 1//2018**
6.8.1-11	Air Conditioners and Condensing Units Serving Computer Rooms	**New categories and levels**
6.8.1-12	Commercial Refrigerator and Freezers	No change
6.8.1-13	Commercial Refrigeration	No change
6.8.1-14	Vapor Compression Based Indoor Pool Dehumidifiers	**New Table**
6.8.1-15	Electrically Operated DX-DOAS Units, Single-Package and Remote Condenser, without Energy Recovery	**New Table**
6.8.1-16	Electrically Operated DX-DOAS Units, Single Package and Remote Condenser, with Energy Recovery	**New Table**

Table 6.8.1-1 & 2 – Unitary Equipment

- These tables define the minimum efficiency requirements for Electrically Operated Unitary Air Conditioners and Condensing Units in table 6.8.1-1 and heat pumps in table 6.8.1-2
- In ASHRAE 90.1-2013 the IEER values were increased with an effective date of 1/1/2016, but the EER levels remained the same
- DOE under the rules of EPACT must rule on these changes and they have conducted a study and a final rule has been released after an ASRAC negotiated ruling for the federally covered products from 65,000 Btu/h to 760,000 Btu/h
  - Under federal law DOE can only have one metric and as part of this rule they switched the efficiency metric from EER to IEER
  - The rule aligns with the ASHRAE 90.1 levels effective as early as 1/1/2016 but with a federal preemptive effective date of 1/1/2018
  - The rule also defined higher levels that will be effective 1/1/2023
- The efficiency level for <65,000 3 phase products also was increased the SEER and HSPF values an ASHRAE 90.1 effective date of 1/1/2015
- Again DOE was required to rule on this and agreed with the level, but the federal preemptive level will not go into effect until 1/1/2017

Note that as defined in EPACT federal requirements override and preempt any state or city implemented efficiency, but if the values are approved by DOE then states can implement the ASHRAE 90.1 requirements on **new construction**, but **not on replacement units**.

DOE: CML Packaged AC & HP, Furnaces

A/C & HP ≥ 65,000 TO 760,000 Btu/h, Gas Heat ≥ 225K Btu/h

January 1, 2018

Minimum Cooling Efficiency Standards for Air-Cooled Air Conditioners and Heat Pumps

Equipment Category	Rated Cooling capacity	Sub-Category	Heating Type	Minimum Energy Efficiency Standard
Small Commercial Split and Single Package Air-Conditioners and Heat Pumps (Air-Cooled)	≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 12.9
			All Other Types of Heating	IEER = 12.7
		HP	Electric Resistance Heating or No Heating	IEER = 12.2
			All Other Types of Heating	IEER = 12.0
Large Commercial Split and Single Package Air-Conditioners and Heat Pumps (Air-Cooled)	≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 12.4
			All Other Types of Heating	IEER = 12.2
		HP	Electric Resistance Heating or No Heating	IEER = 11.6
			All Other Types of Heating	IEER = 11.4
Very Large Commercial Split and Single Package Air-Conditioners and Heat Pumps (Air-Cooled)	≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 11.6
			All Other Types of Heating	IEER = 11.4
		HP	Electric Resistance Heating or No Heating	IEER = 10.6
			All Other Types of Heating	IEER = 10.4

Minimum Heating Efficiency Standards for Air-Cooled Heat Pumps

Equipment Category	Rated Cooling capacity	Heating type	Minimum Energy Efficiency Standard
Small Commercial Split and Single Package Heat Pumps (Air-Cooled)	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance Heating or No Heating	COP = 3.3
		All Other Types of Heating	
Large Commercial Split and Single Package Heat Pumps (Air-Cooled) (Air-Cooled)	≥135,000 Btu/h and <240,000 Btu/h	Resistance Heating or No Heating	COP = 3.2
		All Other Types of Heating	
Very Large Commercial Split and Single Package Heat Pumps (Air-Cooled)	≥240,000 Btu/h and <760,000 Btu/h	Resistance Heating or No Heating	COP = 3.2
		All Other Types of Heating	

January 1, 2023

Minimum Cooling Efficiency Standards for Air-Cooled Air Conditioners and Heat Pumps

Equipment Category	Rated Cooling capacity	Sub-Category	Heating Type	Minimum Energy Efficiency Standard
Small Commercial Split and Single Package Air-Conditioners and Heat Pumps (Air-Cooled)	≥65,000 Btu/h and <135,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 14.8
			All Other Types of Heating	IEER = 14.6
		HP	Electric Resistance Heating or No Heating	IEER = 14.1
			All Other Types of Heating	IEER = 13.9
Large Commercial Split and Single Package Air-Conditioners and Heat Pumps (Air-Cooled)	≥135,000 Btu/h and <240,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 14.2
			All Other Types of Heating	IEER = 14.0
		HP	Electric Resistance Heating or No Heating	IEER = 13.5
			All Other Types of Heating	IEER = 13.3
Very Large Commercial Split and Single Package Air-Conditioners and Heat Pumps (Air-Cooled)	≥240,000 Btu/h and <760,000 Btu/h	AC	Electric Resistance Heating or No Heating	IEER = 13.2
			All Other Types of Heating	IEER = 13.0
		HP	Electric Resistance Heating or No Heating	IEER = 12.5
			All Other Types of Heating	IEER = 12.3

Minimum Heating Efficiency Standards for Air-Cooled Heat Pumps

Equipment Category	Rated Cooling capacity	Heating type	Minimum Energy Efficiency Standard
Small Commercial Split and Single Package Heat Pumps (Air-Cooled)	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance Heating or No Heating	COP = 3.4
		All Other Types of Heating	
Large Commercial Split and Single Package Heat Pumps (Air-Cooled)	≥135,000 Btu/h and <240,000 Btu/h	Resistance Heating or No Heating	COP = 3.3
		All Other Types of Heating	
Very Large Commercial Split and Single Package Heat Pumps (Air-Cooled)	≥240,000 Btu/h and <760,000 Btu/h	Resistance Heating or No Heating	COP = 3.2
		All Other Types of Heating	

January 1, 2023 all gas-fired commercial warm air furnaces ≥ 225K BTU/h input capacity minimum thermal efficiency at the maximum rated capacity (rated maximum input) is 81%

Direct Final Rule & SNOPR issued January 15, 2016. SNOPR comment period ended May 4 with no negative comments. Consequently, the direct final rule will proceed to become DOE's regulation on May 16, 2016.

Table 6.8.1-3 Chillers

- In the 2013 standard the efficiency levels for chillers were revised
  - Changes to some of the capacity categories
  - Addition of path B for air cooled chillers
  - New levels for full load and part load with an effective date of 1/1/2015
- Because the effective date is now in the past (before 1/1/2015 levels were eliminated) there is an error in the table. The dates were removed but the effective 1/1/2015 values were not. This will be corrected with an Errata so the first two columns should be ignored as shown in the next slide.
- In addition to this the AHRI 550/590 (IP) standard and AHRI 551/591 (SI) standards have been revised and rating conditions were revised to a entering and leaving temperature instead of a temperature and a flow rate.
- The AHRI standard is now using different conditions for IP and SI so this is reflected in the ratings and a direct conversion of efficiency metrics can not be used. The reflect this IPLV values are now labeled IPLV.IP and IPLV.SI
- In addition to these change the Kadj equations used for centrifugal minimum efficiency adjustments has been changed in section 6.4.1.2.1. A new spreadsheet tool will be provided with the Users Manual to be released next year, but the tool will also be available on the AHRI website.

Table 6.8.1-3 Errata Change

These values are the old effective 1/1/2010 values and should be ignored

Equipment Type	Size Category	Units	Path A	Path B	Path A	Path B	Test Procedure[c]
Air-cooled chillers	<150 tons	*EER* (Btu/Wh)	≥9.562 FL	NA[d]	≥10.100 FL	≥9.700 FL	AHRI 550/590
			≥12.50 *IPLV*.IP		≥13.700 *IPLV*.IP	≥15.800 *IPLV*.IP	
	≥150 tons		≥9.562 FL		≥10.100 FL	≥9.700 FL	
			≥12.750 *IPLV*.IP		≥14.000 *IPLV*.IP	≥16.100 *IPLV*.IP	
Air-cooled without condenser, electrically operated	All capacities	*EER* (Btu/Wh)	Air-cooled chillers without condenser must be rated with matching condensers and comply with air-cooled chiller *efficiency* requirements				AHRI 550/590
Water-cooled, electrically operated positive displacement	<75 tons	*kW*/ton	≤0.780 FL	≤0.800 FL	≤0.750 FL	≤0.780 FL	AHRI 550/590
			≤0.630 *IPLV*.IP	≤0.600 *IPLV*.IP	≤0.600 *IPLV*.IP	≤0.500 *IPLV*.IP	
	≥75 tons and <150 tons		≤0.775 FL	≤0.790 FL	≤0.720 FL	≤0.750 FL	
			≤0.615 *IPLV*.IP	≤0.586 *IPLV*.IP	≤0.560 *IPLV*.IP	≤0.490 *IPLV*.IP	
	≥150 tons and <300 tons		≤0.680 FL	≤0.718 FL	≤0.660 FL	≤0.680 FL	
			≤0.580 *IPLV*.IP	≤0.540 *IPLV*.IP	≤0.540 *IPLV*.IP	≤0.440 *IPLV*.IP	
	≥300 tons and <600 tons		≤0.620 FL	≤0.639 FL	≤0.610 FL	≤0.625 FL	
			≤0.540 *IPLV*.IP	≤0.490 *IPLV*.IP	≤0.520 *IPLV*.IP	≤0.410 *IPLV*.IP	
	≥600 tons		≤0.620 FL	≤0.639 FL	≤0.560 FL	≤0.585 FL	
			≤0.540 *IPLV*.IP	≤0.490 *IPLV*.IP	≤0.500 *IPLV*.IP	≤0.380 *IPLV*.IP	
Water cooled, electrically operated centrifugal	<150 tons	*kW*/ton	≤0.634 FL	≤0.639 FL	≤0.610 FL	≤0.695 FL	AHRI 550/590
			≤0.596 *IPLV*.IP	≤0.450 *IPLV*.IP	≤0.550 *IPLV*.IP	≤0.440 *IPLV*.IP	
	≥150 tons and <300 tons		≤0.634 FL	≤0.639 FL	≤0.610 FL	≤0.635 FL	
			≤0.596 *IPLV*.IP	≤0.450 *IPLV*.IP	≤0.550 *IPLV*.IP	≤0.400 *IPLV*.IP	
	≥300 tons and <400 tons		≤0.576 FL	≤0.600 FL	≤0.560 FL	≤0.595 FL	
			≤0.549 *IPLV*.IP	≤0.400 *IPLV*.IP	≤0.520 *IPLV*.IP	≤0.390 *IPLV*.IP	
	≥400 tons and <600 tons		≤0.576 FL	≤0.600 FL	≤0.560 FL	≤0.585 FL	
			≤0.549 *IPLV*.IP	≤0.400 *IPLV*.IP	≤0.500 *IPLV*.IP	≤0.380 *IPLV*.IP	
	≥600 tons		≤0.570 FL	≤0.590 FL	≤0.560 FL	≤0.585 FL	
			≤0.539 *IPLV*.IP	≤0.400 *IPLV*.IP	≤0.500 *IPLV*.IP	≤0.380 *IPLV*.IP	

Table 6.8.1-7 Heat Rejection Equipment

- In table 6.8.1-7 the requirements for heat rejection equipment, which includes cooling towers and air cooled condensers, are defined.
- One change was made to the table to increase the efficiency requirement for Propeller or axial fan closed-circuit cooling towers from 14.0 gpm/hp to 16.1 gpm/hp

Table 6.8.1-7 Performance Requirements for Heat Rejection *Equipment*—Minimum *Efficiency* Requirements

Equipment Type	Total *System* Heat-Rejection Capacity at Rated Conditions	Subcategory or Rating Condition[h]	Performance Required[a,b,c,f,g]	Test Procedure[d,e]
Propeller or axial fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥40.2 gpm/hp	CTI ATC-105 and CTI STD-201 RS
Centrifugal fan open-circuit cooling towers	All	95°F entering water 85°F leaving water 75°F entering wb	≥20.0 gpm/hp	CTI ATC-105 and CTI STD-201 RS
Propeller or axial fan closed-circuit cooling towers	All	102°F entering water 90°F leaving water 75°F entering wb	≥16.1 gpm/hp	CTI ATC-105S and CTI STD-201 RS

Also note in section 6.5.5.2 there are new requirements for cooling tower fan control

Table 6.8.1-9 &10 – VRF Equipment

- New higher IEER values were defined for air cooled cooling only and heat pump Variable Refrigerant Flow (VRF) equipment with an effective date of 1/1/2017
- EER values were not changed.
- The IEER, EER and heating COP levels for water source heat pump VRF's were also changed and go into effect on 1/1/2018

Table 6.8.1-10 Electrically Operated Variable-Refrigerant-Flow and Applied Heat Pumps—Minimum *Efficiency* Requirements

Equipment Type	Size Category	Heating Section Type	Subcategory or Rating Condition	Minimum *Efficiency*	Test Procedure
VRF air cooled (cooling mode)	<65,000 Btu/h	All	*VRF* multisplit *system*	13.0 *SEER* 11.0 *EER* 12.9 *IEER* (before 1/1/2017) 14.6 *IEER* (as of 1/1/2017)	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	*Electric resistance* (or none)			
			VRF multisplit *system* with heat recovery	10.8 *EER* 12.7 *IEER* (before 1/1/2017) 14.4 *IEER* (as of 1/1/2017)	

See standard for additional product categories

Table 6.8.1-11 Computer Room Units

- Table 6.8.1-11 was totally revised to add 3 classification of computer units to reflect the trend in the industry to higher computer room operating temperatures
  - Class 1 – 75 F DB/52 F WB
  - Class 2 – 85 F DB/52 F WB
  - Class 3 – 95 F DB/52 F WB
- New COP_C values were then defined for the various products and new categories
- This goes along with revisions to the AHRI 1360 rating standard

Table 6.8.1-11 Air Conditioners and *Condensing Units* Serving *Computer Rooms*—Minimum *Efficiency* Requirements

Equipment Type	Net Sensible Cooling Capacity	Standard Model	Minimum Net Sensible COP_C Return Air Dry-Bulb Temperature/Dew-Point Temperature			Test Procedure
			Class 1	Class 2	Class 3	
			75°F/52°F	85°F/52°F	95°F/52°F	
Air cooled	<65,000 Btu/h	Downflow unit		2.30		AHRI 1360
		Upflow unit—ducted		2.10		
		Upflow unit—nonducted	2.09			
		Horizontal-flow unit			2.45	
	≥65,000 and <240,000 Btu/h	Downflow unit		2.20		
		Upflow unit—ducted		2.05		
		Upflow unit—nonducted	1.99			
		Horizontal-flow unit			2.35	
	≥240,000 Btu/h	Downflow unit		2.00		
		Upflow unit—ducted		1.85		
		Upflow unit—nonducted	1.79			
		Horizontal-flow unit			2.15	

Table 6.8.1-14 Indoor Pool Dehumidifiers

- This is a brand new efficiency table and prior to this there were no efficiency requirements for pool dehumidifiers
- AHRI has developed a new standard for these products called AHRI 920 and this table now defines the minimum efficiency requirements
- A new metric is used call MRE
  - ***Moisture Removal Efficiency (MRE).*** A ratio of the Moisture Removal Capacity expressed in kg/h to the total power input in kW at any given set of Rating Conditions expressed in kg of moisture/kWh. So a unit shown can remove 3.5 kg of moisture per 1 kWh of electricity used.

Table 6.8.1-14 Vapor Compression Based *Indoor Pool Dehumidifiers*—Minimum *Efficiency* Requirements

Equipment Type	Subcategory or Rating Condition	Minimum *Efficiency*	Test Procedure
Single package indoor[a] (with or without economizer)	Rating Conditions: A, B, or C	3.5 *MRE*	AHRI 910
Single package indoor water-cooled (with or without economizer)		3.5 *MRE*	
Single package indoor air-cooled (with or without economizer)		3.5 *MRE*	
Split *system* indoor air-cooled (with or without economizer)		3.5 *MRE*	

a. Units without air-cooled condenser.

Table 6.8.1-15 & 16 DX-DOAS Equipment

- Table 6.8.1-15 covers efficiency requirements for DX-DOAS Equipment based on the new AHRI 920 standard
- This is a new table and prior to this there were no efficiency requirements for DOAS equipment
- Similar to the Pool Dehumidifiers this table uses a new metric base on moisture removal and this metric is an annual part load metric similar to IEER and IPLV
  - ***Integrated Seasonal Moisture Removal Efficiency*** **(ISMRE).** This seasonal efficiency number is a combined value based on the formula listed in AHRI Standard 920 of the four (4) dehumidification Moisture Removal Efficiency (MRE) ratings required for DX-DOAS Units expressed in lb. of moisture/kWh
- There are two table with table 15 covering units without energy recovery and table 16 covering units with energy recovery

Table 6.8.1-15 Electrically Operated *DX-DOAS Units*, Single-Package and Remote Condenser, without *Energy* Recovery—Minimum *Efficiency* Requirements

Equipment Type	Subcategory or Rating Condition	Minimum *Efficiency*	Test Procedure
Air cooled (dehumidification mode)		4.0 *ISMRE*	AHRI 920
Air source heat pumps (dehumidification mode)		4.0 *ISMRE*	AHRI 920
Water cooled (dehumidification mode)	Cooling tower condenser water	4.9 *ISMRE*	AHRI 920
	Chilled Water	6.0 *ISMRE*	
Air source heat pump (heating mode)		2.7 *ISCOP*	AHRI 920
Water source heat pump (dehumidification mode)	Ground source, closed loop	4.8 *ISMRE*	AHRI 920
	Ground-water source	5.0 *ISMRE*	
	Water source	4.0 *ISMRE*	
Water source heat pump (heating mode)	Ground source, closed loop	2.0 *ISCOP*	AHRI 920
	Ground-water source	3.2 *ISCOP*	
	Water source	3.5 *ISCOP*	

Control of HVAC in Hotel/Motel Guest Rooms

New requirements were added for hotel and motel guest room control

Hotels and motels with greater than 50 guest rooms shall be provided with automatic controls for the HVAC equipment serving each guest room capable of and configured according to the requirements in the following requirements;

Guest Room HVAV Setpoint Control - Within 30 minutes of all occupants leaving the guest room, HVAC set points shall be automatically raised by at least 4°F from the occupant set point in the cooling mode and automatically lowered by at least 4°F from the occupant set point in the heating mode. When the guest room is unrented and unoccupied, HVAC set points shall be automatically reset to 80°F or higher in the cooling mode and to 60°F or lower in the heating mode. Unrented and unoccupied guest rooms shall be determined by either of the following:

a. The guest room has been continuously unoccupied for up to 16 hours.
b. A networked guest room control system indicates the guest room is unrented and the guest room is unoccupied for no more than 30 minutes.

Guest Room Ventilation Control - Within 30 minutes of all occupants leaving the guest room, ventilation and exhaust fans shall automatically be turned off, or isolation devices serving each guest room shall automatically shut off the supply of outdoor air to the guest room and shut off exhaust air from the guest room.

Captive key cards are permitted to be used for compliance

There are some exceptions so see the standard for further details

Chilled Water Plant Monitoring

Chilled Water Plant Monitoring

- A new section was added for large chilled water plant monitoring.

- For electric-motor-driven chilled-water plants in new buildings, or for new plants in existing buildings, measurement devices shall be installed and shall measure the electric energy use and efficiency of the chilled-water plant for;

  a. water-cooled chilled-water plants larger than 1500 tons peak cooling capacity for Climate Zones 5 through 8, 3C, and 4C, and larger than 1000 tons peak cooling capacity for all other zones; and

  b. air-cooled chilled-water plants larger than 860 tons peak cooling capacity for Climate Zones 5 through 8, 3C, and 4C, and larger than 570 tons peak cooling capacity for all other zones.

- The efficiency shall be calculated in kW/ton of cooling operating capacity

Miscellaneous Controls Requirements

Control Setpoint Configuration Requirements

- In many of the controls requirements it was stated that controls must be capable of some configuration. This has been changed to not only require that they are capable but they shall be configured to the defined requirement.

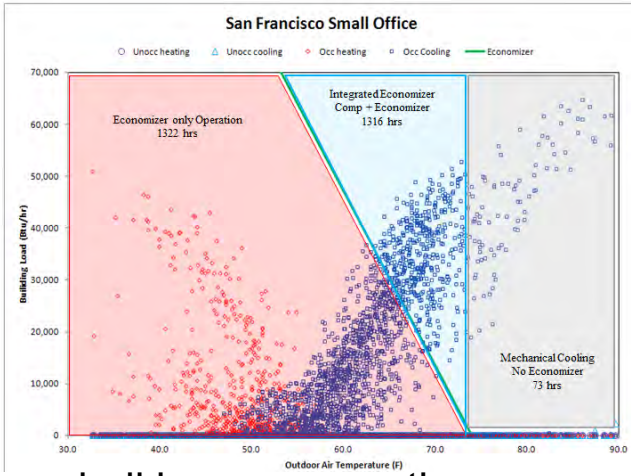
  Example in 6.4.3.4 Ventilation outdoor air and exhaust/relief dampers shall be capable of and **configured to** automatically…..

Chilled and Hot Water Temperature Reset Control

- 6.5.4.4 Chilled and Hot Water Temperature Reset Control – A new requirement has been added to water temperature reset where DDC is used to control valves, the set point shall be reset based on valve positions until one valve is nearly wide open or setpoint limits of the system equipment or application have been reached. There are some exceptions.

Economizer Control Diagnostics

- Air cooled economizers are a very effective way to improve efficiency by using outside air to free cool the space during cooling operation and when the ambient temperature are below the space temperature
- Air-cooled direct-expansion cooling units listed in Tables 6.8.1-1 and 6.8.1-2, where an air economizer is installed in accordance with Section 6.5.1, shall include a fault detection and diagnostics (FDD) system complying with the following:



- The outdoor air, supply air, and return temperature sensors shall be permanently installed to monitor system operation and the control shall include a means to display values
- The economizer control shall system status indication for the following;
  - Free cooling available
  - Economizer enabled
  - Compressor enabled
  - Heating enabled
  - Mixed-air low-limit cycle active
- The control system shall be capable of and configured to display the following faults
  - Air temperature sensor failure/fault
  - Not economizing when the unit should be economizing
  - Economizing when the unit should not be economizing
  - Damper not modulating
  - Excess *outdoor air*

Return and Relief Fan Control

An important part of effective use of an air economizer is building exhaust control during the economizer operation.

A new requirement has been added to section 6.5.3.2 for Fan Control

6.5.3.2.4 Return and Relief Fan Control

Return and relief fans used to meet Section 6.5.1.1.5 shall comply with all of the following:

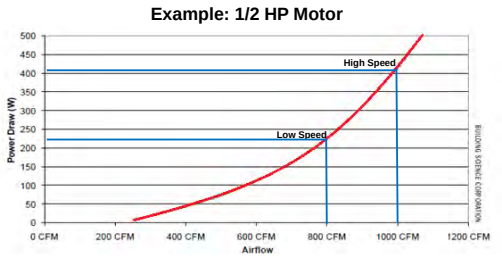
a. Relief air rate shall be controlled to maintain building pressure either directly, or indirectly through differential supply-return airflow tracking. Systems with constant speed or multispeed supply fans shall also be allowed to control the relief system based on outdoor air damper position.
b. Fans shall have variable-speed control or other devices that will result in total return/relief fan system demand of no more than 30% of total design power at 50% of total design fan flow.

Exceptions to 6.5.3.2.4

1. Return or relief fans with total motor size less than or equal to 0.5 hp.
2. Staged relief fans with a minimum of four stages.

Supply Fan Control

In the 2013 standard requirements were added for supply fan control



Each cooling system listed in Table 6.5.3.2.1 shall be designed to vary the supply fan airflow as a function of load and shall comply with the following requirements:

a. DX and chilled-water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have a minimum of two stages of fan control. Low or minimum speed shall not exceed 66% of full speed. At low or minimum speed, the fan system shall draw no more than 40% of the fan power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.

b. b. All other units, including DX cooling units and chilled-water units that control the space temperature by modulating the airflow to the space, shall have modulating fan control. Minimum speed shall not exceed 50% of full speed. At minimum speed, the fan system

Cooling System Type	Fan Motor Size, hp	Mechanical Cooling Capacity, Btu/h	Effective Date
DX cooling	Any	≥110,000	
		≥75,000	1/1/2014
		≥65,000	1/1/2016
Chilled-water and evaporative cooling	≥5	Any	
	≥1/4	Any	1/1/2014

The effective dates are now in the past so a DX units ≥65,000 Btu/h and chilled water units greater than ¼ hp require a minimum of 2 stages of fan control

Parallel-Flow Fan-Power VAV Terminal Control

A new requirement was added for parallel flow fan powered VAV terminals

6.5.3.4 Parallel-flow fan-powered VAV air terminals shall have automatic controls configured to

a. turn off the terminal fan except when space heating is required or if required for ventilation;

b. turn on the terminal fan as the first stage of heating before the heating coil is activated; and

c. during heating for warmup or setback temperature control, either
   1. operate the terminal fan and heating coil without primary air or
   2. reverse the terminal damper logic and provide heating from the central air handler through primary air.

Hydronic Variable Flow Systems

- The requirements for hydronic variable flow system in section 6,5,4,2 was modified to clarify that it applies to both heating and cooling pumping systems
- The requirements used to be based on a requirement for variable flow with motors larger than 10 HP and this has not been changed to require variable flow on systems with more than 3 control valves and with motor HP or combined motor horsepower for parallel systems exceeds the values shown table 6.5.4.2
- The requires also require turndown to 25% flow or the limits of required flow for heat and cooling
- There are some exceptions for primary pumps, electric heat heating systems, when there are freeze protection issues and for heat recovery runaround loops

Table 6.5.4.2 Pump Flow *Control* Requirements

Chilled-Water Pumps in These Climate Zones	Heating Water Pumps in These Climate Zones	Motor *Nameplate Horsepower*
0A, 0B, 1A, 1B, 2B	NR	≥2 hp
2A, 3B	NR	≥3 hp
3A, 3C, 4A, 4B	7, 8	≥5 hp
4C, 5A, 5B, 5C, 6A, 6B	3C, 5A, 5C, 6A, 6B	≥7.5 hp
	4A, 4C, 5B	≥10 hp
7, 8	4B	≥15 hp
	2A, 2B, 3A, 3B	≥25 hp
	1B	≥100 hp
	0A, 0B, 1A	≥200 hp

Chilled Water Coil Selection

In a new section 6.5.4.7 requirements have been added for chilled water coil selection

Chilled-water cooling coils shall be selected to provide a 15°F or higher temperature difference between leaving and entering water temperatures and a minimum of 57°F leaving water temperature at design conditions.

Exceptions to 6.5.4.7

1. Chilled-water cooling coils that have an air-side pressure drop exceeding 0.70 in. of water when rated at 500 fpm face velocity and dry conditions (no condensation).
2. Individual fan-cooling units with a design supply airflow rate 5000 cfm and less.
3. Constant-air-volume systems.
4. Coils selected at the maximum temperature difference allowed by the chiller.
5. Passive coils (no mechanically supplied airflow).
6. Coils with design entering chilled-water temperatures of 50°F and higher.
7. Coils with design entering air dry-bulb temperatures of 65°F and lower.

Exhaust Air Energy Recovery

- A new definition was added for energy recovery efficiency
  - ***enthalpy recovery ratio:*** change in the enthalpy of the *outdoor air* supply divided by the difference between the *outdoor air* and entering exhaust air enthalpy, expressed as a percentage
  - ***sensible energy recovery ratio***: change in the dry-bulb temperature of the outdoor air supply divided by the difference between the outdoor air and entering exhaust air dry-bulb temperatures, expressed as a percentage.

- The require is still 50% but the required thresholds have change to account for availability of small energy recovery products.

- Some the exemptions for toxic, flammable, point and corrosive fumes and for commercial kitchen hoods were eliminated.

- A clarification on the exemption for exhaust airflow rates below 75% was added to added

Revised Exhaust Air Energy Recovery Tables

Table 6.5.6.1-1 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Less than 8000 Hours per Year

Climate Zone	% *Outdoor Air* at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥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	NR	NR	NR	NR
0B, 1B, 2B,5C	NR	NR	NR	NR	≥26000	≥12000	≥5000	≥4000
6B	≥28,000	≥26,500	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
0A, 1A, 2A, 3A, 4A, 5A, 6A	≥26,000	≥16,000	≥5500	≥4500	≥3500	≥2000	≥1000	≥120
7,8	≥4500	≥4000	≥2500	≥1000	≥140	≥120	≥100	≥80

NR—Not required

Table 6.5.6.1-2 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Greater than or Equal to 8000 Hours per Year

Climate Zone	% *Outdoor Air* at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
	Design Supply Fan Airflow Rate, cfm							
3C	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B, 3B, 4C, 5C	NR	≥19,500	≥9000	≥5000	≥4000	≥3000	≥1500	≥120
0A, 1A, 2A, 3A, 4B, 5B	≥2500	≥2000	≥1000	≥500	≥140	≥120	≥100	≥80
4A, 5A, 6A, 6B, 7, 8	≥200	≥130	≥100	≥80	≥70	≥60	≥50	≥40

NR—Not required

Transfer Air

The requirements for exhaust systems and transfer air in 6.5.7.1 were revised

6.5.7.1 Transfer Air - Conditioned supply air delivered to any space with mechanical exhaust shall not exceed the greater of

a. the supply flow required to meet the space heating or cooling load;

b. the ventilation rate required by the authority having jurisdiction, the facility Environmental Health and Safety department, or ASHRAE Standard 62.1; or

c. the mechanical exhaust flow minus the available transfer air from conditioned spaces or return air plenums on the same floor, not in different smoke or fire compartments, and that at their closest point are within 15 ft. of each other. Available transfer air is that portion of outdoor ventilation air that

    1. is not required to satisfy other exhaust needs,
    2. is not required to maintain pressurization of other spaces, and
    3. is transferable according to applicable codes and standards and to the class of air recirculation limitations in ASHRAE Standard 62.1.

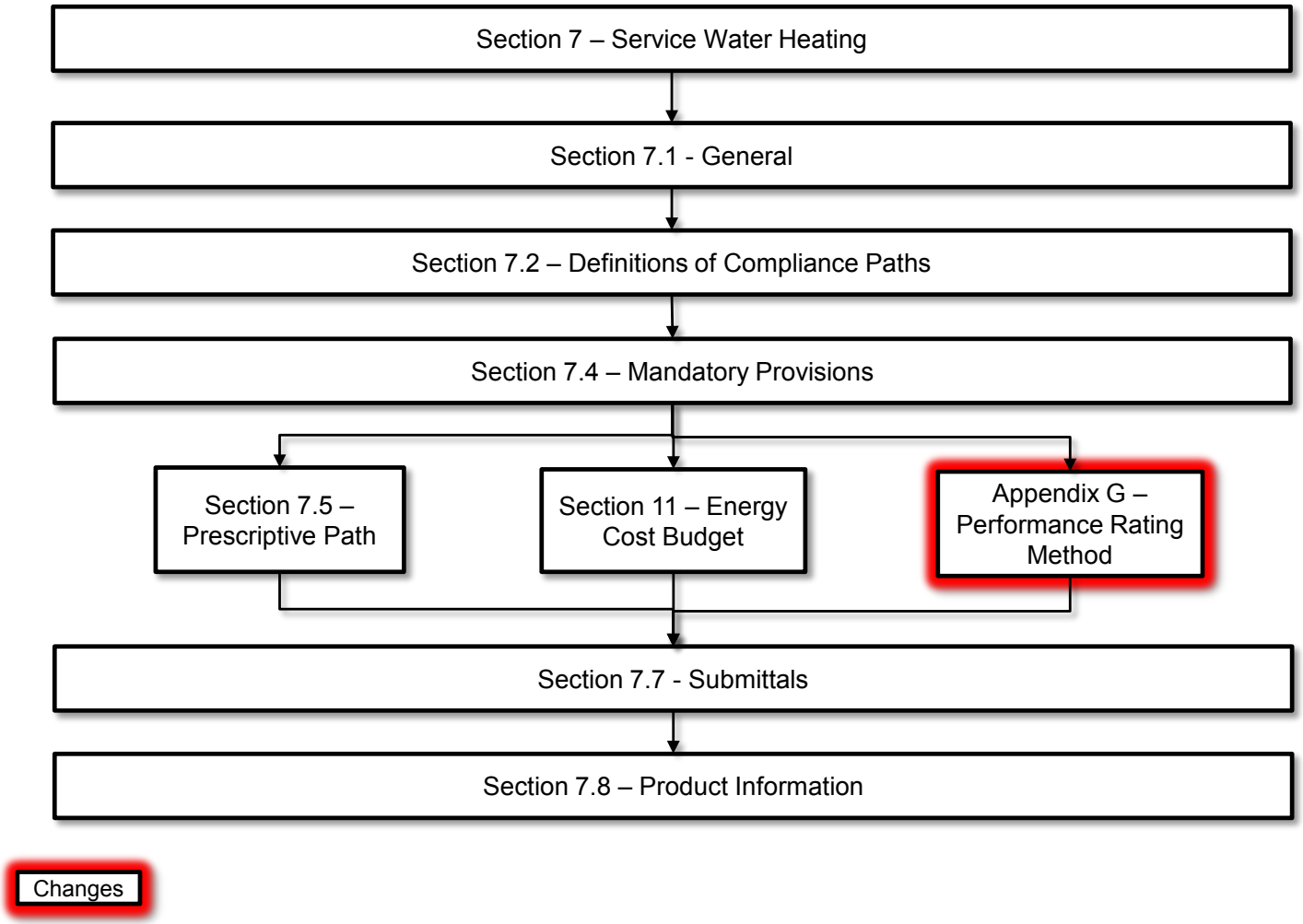
Exceptions to 6.5.7.1

1. Biosafety level classified laboratories 3 or higher.
2. Vivarium spaces.
3. Spaces that are required by applicable codes and standards to be maintained at positive pressure relative to adjacent spaces. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy.
4. Spaces where the demand for transfer air may exceed the available transfer airflow rate and where the spaces have a required negative pressure relationship. For spaces taking this exception, any transferable air that is not directly transferred shall be made available to the associated air-handling unit and shall be used whenever economizer or other options do not save more energy.

Section 7 – Service Water Heating

Section 7 Compliance Flowchart

Similar to section 6 the compliance flowchart as revised to clarify the compliance paths for service water heating



Service Water Heating Changes

- In section 7.4.3 covering Service hot water piping insulation a new requirement was added to require The first 8 ft. of branch *piping* connecting to recirculated, heat-traced, or impedance heated *piping to be insulated.*

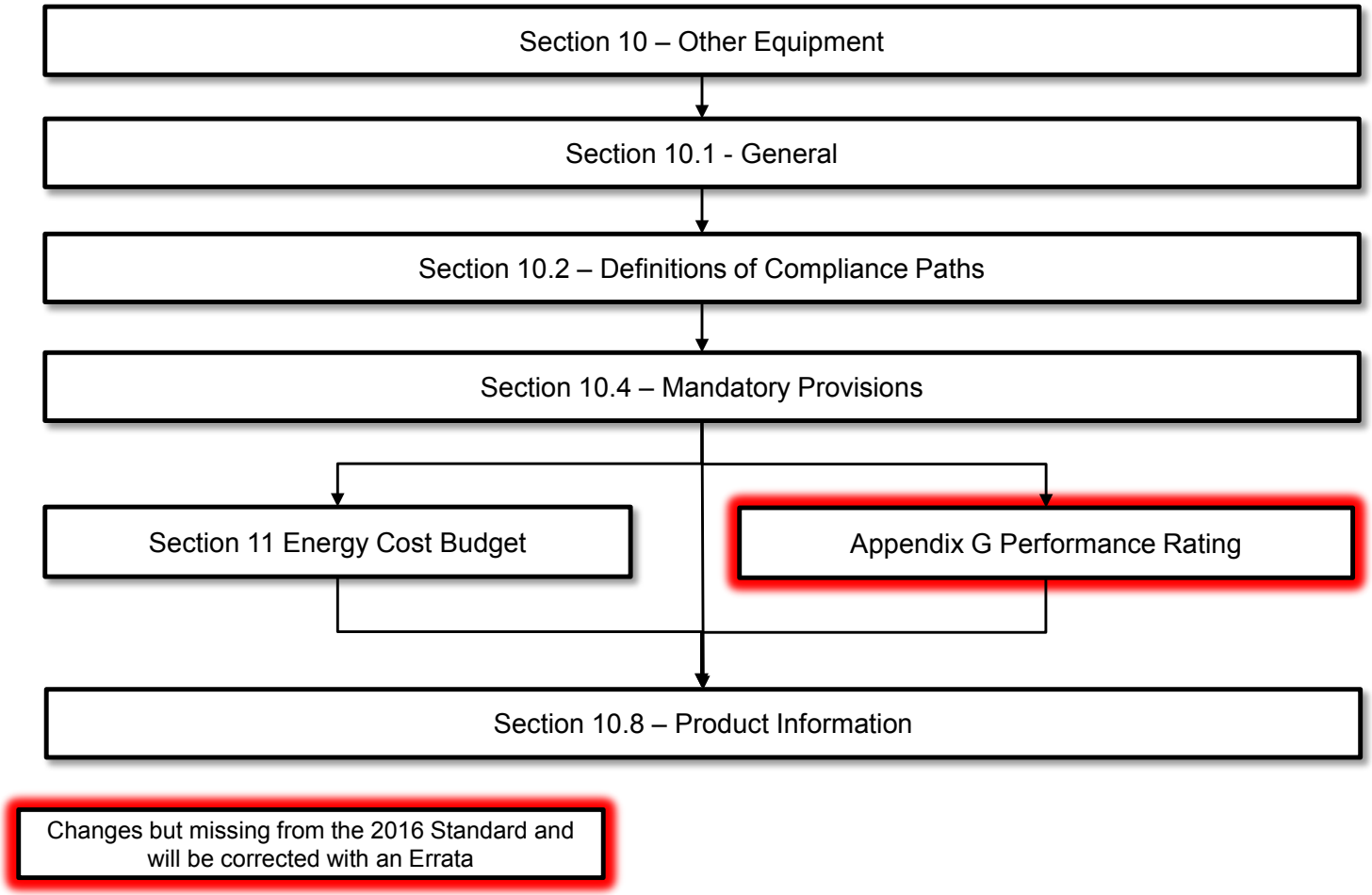
- In table 7.8 which defines the minimum efficiency for water heating equipment the requirements for the following products were moved to an Informative Appendix and referenced to the U.S. Department of Energy requirements and applicable test procedures found in the Code of Federal Regulations 10 CFR Part 430.

  - Electric table top water heaters with a storage capacity ≥ 20 gal
  - Electric water heaters < 12 kW and with a storage capacity ≥ 20 gal
  - Heat pump water heaters with ≤ 24 amps power and ≤ 250 volts power supply
  - Gas storage water heaters < 75,000 Btu/h and > 20 gallons
  - Oil storage water heaters < 105,000 Btu/h and > 20 gallons

Section 10 – Other Equipment

Section 10 Compliance Flowchart

- Similar to section 6 and 7 the compliance flowchart as revised to clarify the compliance paths for other equipment



Electric Motor Requiremen

The requirements for electric motors in section 10.4 were rev ased on the DOE 10 CFR 431 requirements

Electric motors manufactured alone or as a component other piece of *equipment* with a *rated motor power* of 1 hp or more, and less than or equal to ~~200~~, 500 hp* shall comply with the requirements shown in Table 10.8-1 for *NEMA Design A motors*, *NEMA Design B motors*, and *IEC Design N motors*, and Table 10.8-2 for *NEMA Design C motors* and *IEC Design H motors*.

General purpose *small electric motors* with an *rated motor power* of 0.25 hp or more, and less than or equal to 3 hp, shall have a minimum average full-load *efficiency* that is not less than as shown in Table 10.8-3 for polyphase *small electric motors* and Table 10.8-4 for capacitor-start capacitor-run *small electric motors* and capacitor-start induction-run *small electric motors*.

Fire pump electric motors shall have a minimum nominal full-load *efficiency* that is not less than that shown in Table 10.8-5

.

Exception to 10.4.1

The standards in this section do not apply to the following exempt electric motors:

1. Air-over electric motors.
2. Component sets of an electric motor.
3. Liquid-cooled electric motors.
4. Submersible electric motors.
5. Inverter-only electric motors.

*200 hp is error and will be corrected by an Errata

NEMA Design A Motor Efficiency Requirements

Table 10.8-1 Minimum Nominal Full-Load *Efficiency* for NEMA Design A, NEMA Design B, and *IEC Design N Motors* (Excluding Fire Pump Electric Motors) at 60 Hz[a,b]

Motor Horsepower, hp (kW)	Nominal Full-Load *Efficiency*, %							
	2-Pole		4-Pole		6-Pole		8-Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open	Enclosed	Open
1 (0.75)	77.0	77.0	85.5	85.5	82.5	82.5	75.5	75.5
1.5 (1.1)	84.0	84.0	86.5	86.5	87.5	86.5	78.5	77.0
2 (1.5)	85.5	85.5	86.5	86.5	88.5	87.5	84.0	86.5
3 (2.2)	86.5	85.5	89.5	89.5	89.5	88.5	85.5	87.5
5 (3.7)	88.5	86.5	89.5	89.5	89.5	89.5	86.5	88.5
7.5 (5.5)	89.5	88.5	91.7	91.0	91.0	90.2	86.5	89.5
10 (7.5)	90.2	89.5	91.7	91.7	91.0	91.7	89.5	90.2
15 (11)	91.0	90.2	92.4	93.0	91.7	91.7	89.5	90.2
20 (15)	91.0	91.0	93.0	93.0	91.7	92.4	90.2	91.0
25 (18.5)	91.7	91.7	93.6	93.6	93.0	93.0	90.2	91.0
30 (22)	91.7	91.7	93.6	94.1	93.0	93.6	91.7	91.7
40 (30)	92.4	92.4	94.1	94.1	94.1	94.1	91.7	91.7
50 (37)	93.0	93.0	94.5	94.5	94.1	94.1	92.4	92.4
60 (45)	93.6	93.6	95.0	95.0	94.5	94.5	92.4	93.0
75 (55)	93.6	93.6	95.4	95.0	94.5	94.5	93.6	94.1
100 (75)	94.1	93.6	95.4	95.4	95.0	95.0	93.6	94.1
125 (90)	95.0	94.1	95.4	95.4	95.0	95.0	94.1	94.1
150 (110)	95.0	94.1	95.8	95.8	95.8	95.4	94.1	94.1
200 (150)	95.4	95.0	96.2	95.8	95.8	95.4	94.5	94.1
250 (186)	95.8	95.0	96.2	95.8	95.8	95.8	95.0	95.0
300 (224)	95.8	95.4	96.2	95.8	95.8	95.8		
350 (261)	95.8	95.4	96.2	95.8	95.8	95.8		
400 (298)	95.8	95.8	96.2	95.8				
450 (336)	95.8	96.2	96.2	96.2				
500 (373)	95.8	96.2	96.2	96.2				

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.

b. For purposes of determining the required minimum nominal full-load *efficiency* of an electric motor that has a horsepower or *kilowatt* rating between two horsepower or two *kilowatt* ratings listed in this table, each such motor shall be deemed to have a listed horsepower or *kilowatt* rating, determined as follows:

1. A horsepower at or above the midpoint between the two consecutive horsepowers shall be rounded up to the higher of the two horsepowers.
2. A horsepower below the midpoint between the two consecutive horsepowers shall be rounded down to the lower of the two horsepowers.
3. A *kilowatt* rating shall be directly converted from *kilowatts* to horsepower using the formula 1 *kilowatt* = (1/0.746) horsepower. The conversion should be calculated to three significant decimal places, and the resulting horsepower shall be rounded in accordance with paragraph (1) or (2), whichever applies.

NEMA Design C & IEC H Motor Efficiency Requirements

Table 10.8-2 Minimum Nominal Full-Load *Efficiency* for NEMA Design C and *IEC Design H Motors* at 60 Hz[a,b]

Motor Horsepower, hp (kW)	Nominal Full-Load *Efficiency*, %					
	4-Pole		6-Pole		8-Pole	
	Enclosed	Open	Enclosed	Open	Enclosed	Open
1 (0.75)	85.5	85.5	82.5	82.5	75.5	75.5
1.5 (1.1)	86.5	86.5	87.5	86.5	78.5	77.0
2 (1.5)	86.5	86.5	88.5	87.5	84.0	86.5
3 (2.2)	89.5	89.5	89.5	88.5	85.5	87.5
5 (3.7)	89.5	89.5	89.5	89.5	86.5	88.5
7.5 (5.5)	91.7	91.0	91.0	90.2	86.5	89.5
10 (7.5)	91.7	91.7	91.0	91.7	89.5	90.2
15 (11)	92.4	93.0	91.7	91.7	89.5	90.2
20 (15)	93.0	93.0	91.7	92.4	90.2	91.0
25 (18.5)	93.6	93.6	93.0	93.0	90.2	91.0
30 (22)	93.6	94.1	93.0	93.6	91.7	91.7
40 (30)	94.1	94.1	94.1	94.1	91.7	91.7
50 (37)	94.5	94.5	94.1	94.1	92.4	92.4
60 (45)	95.0	95.0	94.5	94.5	92.4	93.0
75 (55)	95.4	95.0	94.5	94.5	93.6	94.1
100 (75)	95.4	95.4	95.0	95.0	93.6	94.1
125 (90)	95.4	95.4	95.0	95.0	94.1	94.1
150 (110)	95.8	95.8	95.8	95.4	94.1	94.1
200 (150)	96.2	95.8	95.8	95.4	94.5	94.1

a. Nominal efficiencies shall be established in accordance with DOE 10 CFR 431.

b. For purposes of determining the required minimum nominal full-load *efficiency* of an electric motor that has a horsepower or *kilowatt* rating between two horsepower or two *kilowatt* ratings listed in this table, each such motor shall be deemed to have a listed horsepower or *kilowatt* rating, determined as follows:

1. A horsepower at or above the midpoint between the two consecutive horsepowers shall be rounded up to the higher of the two horsepowers.
2. A horsepower below the midpoint between the two consecutive horsepowers shall be rounded down to the lower of the two horsepowers.
3. A *kilowatt* rating shall be directly converted from *kilowatts* to horsepower using the formula 1 *kilowatt* = (1/0.746) horsepower. The conversion should be calculated to three significant decimal places, and the resulting horsepower shall be rounded in accordance with paragraph (1) or (2), whichever applies.

Small Motor Efficiency Requirements

Table 10.8-3 Minimum Average Full-Load *Efficiency* for Polyphase Small Electric Motors[a]

	Full-Load *Efficiency*, %		
	Open Motors		
Number of Poles ⇒	2	4	6
Synchronous Speed (RPM) ⇒	3600	1800	1200
Motor Size, hp			
0.25	65.6	69.5	67.5
0.33	69.5	73.4	71.4
0.50	73.4	78.2	75.3
0.75	76.8	81.1	81.7
1	77.0	83.5	82.5
1.5	84.0	86.5	83.8
2	85.5	86.5	N/A
3	85.5	86.9	N/A

a. Average full-load efficiencies shall be established in accordance with 10 CFR 431.

Table 10.8-4 Minimum Average Full-Load *Efficiency* for Capacitor-Start Capacitor-Run and Capacitor-Start Induction-Run Small Electric Motors[a]

	Full-Load *Efficiency*, %		
	Open Motors		
Number of Poles ⇒	2	4	6
Synchronous Speed (RPM) ⇒	3600	1800	1200
Motor Size, hp			
0.25	66.6	68.5	62.2
0.33	70.5	72.4	66.6
0.50	72.4	76.2	76.2
0.75	76.2	81.8	80.2
1	80.4	82.6	81.1
1.5	81.5	83.8	N/A
2	82.9	84.5	N/A
3	84.1	N/A	N/A

a. Average full-load efficiencies shall be established in accordance with 10 CFR 431.

Design Documentation for Elevators

In section 10.4.3.4 new requirements were added for design documentation of elevator

10.4.3.4 Design Documents

Design documents shall list the following for new elevators:

a. Usage category as defined in ISO 25745-2 between 1 and 6.

b. Energy efficiency classes A through G per ISO 25745-2, Table 7.

Intent is to set the stage for future addition of elevator efficiency requirements

ISO 25745-2015 - Energy performance of lifts, escalators and moving walks

Lighting and Power Requirements

Eric Richman
Chair, 90.1 Lighting Subcommittee

Interior Lighting Power Density (LPD) Limits

Interior Power Density limits (LPD) were revised for 90.1-2016 primarily because of improved efficacy of LED lighting. All space type models used for LPD development were reviewed and where applicable, LED technology was included as part of the technology mix.

Space-by-Space LPDs – Most were reduced from previous 90.1-2013 levels with an average reduction of 26% but a few went up based on revised design criteria and current practice for that space type

Building area LPDs – Almost all were reduced as much as 34% with an overall average reduction across all building types of 12% from the 90.1-2013 allowances.

Where Do LPD Values Come From?

- Space type LPDs
  - For 90.1 - Developed within the ASHRAE/IESNA 90.1 Lighting subcommittee with Illuminating Engineering Society (IES) committee support.
  - Generated from building space type models with design and lighting technology inputs
- Whole building LPDs
  - Developed from detailed room data for commercial buildings and the space type LPDs
  - Weighted average for building type

Energy Code LPDs and LED Lighting

- Energy codes **do** limit the installed lighting power for interior and exterior (LPD) but…….
- Energy codes (including 90.1) **do not** specify or require the use of specific lighting technologies.

However….

- 90.1-2016 does include partial or complete LED efficacy in many space type models in recognition of:
  - Proven LED efficacy and energy savings capability
  - Continued reduced cost of LEDs
  - Product maturity and reasonable applicability
- It is very likely that the future 90.1-2019 standard will include additional LED technology further reducing some space type and building LPD values.

Retail Display and Decorative Allowances

Additional allowances for retail display lighting were reduced ~ 25% to reflect LED technology

Additional Lighting Power Allowance:

1000 watts

+ (Retail Area 1 × 0.45 W/ft^2)

+ (Retail Area 2 × 0.45 W/ft^2)

+ (Retail Area 3 × 1.05 W/ft^2)

+ (Retail Area 4 × 1.88 W/ft^2)

Allowances for decorative lighting were also reduced ~ 25% from 1.0 W/ft^2 to 0.75 W/ft^2 to reflect LED technology

Exterior Lighting Power Density (LPD) Limits

Exterior Power Density limits (LPD) were reduced for 90.1-2016 based on improved efficacy of LED lighting that is currently effectively applied in exterior environments.

All area, linear, and application limits were reduced an average of 30% reflecting efficacy data collected on current efficient LED products.

Interior Lighting Controls – Review

Interior control requirements in 90.1-2016 are applied by space type (with exemptions)

Each space is <u>required to have</u> or is <u>limited by</u> one or more control functions:

- Local on/off control
- Manual on restriction
- Partial automatic on (occupancy/timer based)
- Partial automatic off (occupancy/timer based)
- Automatic full off (occupancy/timer based)
- Bi-level control available to occupant
- Scheduled automatic shutoff
- Daylight control (continuous dimming or multi-step) – sidelighting or toplighting as appropriate

90.1 Tabular Format for Controls (partial list)

- The requirements table shows LPD limit and applicable control functions by space type
- Each control function is separately defined in the text

Informative Note: This table is divided into two sections; this first section covers space types that can be commonly found in multiple building types. The second part of this table covers space types that are typically found in a single building type.			The control functions below shall be implemented in accordance with the descriptions found in the referenced paragraphs within Section 9.4.1.1. For each space type: (1) All REQs shall be implemented. (2) At least one ADD1 (when present) shall be implemented. (3) At least one ADD2 (when present) shall be implemented.								
			Local Control (See Section 9.4.1.1[a])	Restricted to Manual ON (See Section 9.4.1.1[b])	Restricted to Partial Automatic ON (See Section 9.4.1.1[c]	Bilevel Lighting Control (See Section 9.4.1.1[d])	Automatic Daylight Responsive Controls for Sidelighting (See Section	Automatic Daylight Responsive Controls for Toplighting (See Section	Automatic Partial OFF (See Section 9.4.1.1[g] [Full Off complie	Automatic Full OFF (See Section 9.4.1.1[h])	Scheduled Shutoff (See Section 9.4.1.1[i])
Common Space Types[1]	LPD	RCR	a	b	c	d	e	f	g	h	i
Atrium											
<20 ft in height	0.03/ft total	NA	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
≥20 ft and ≤40 ft in height	0.03/ft total	NA	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
>40 ft in height	0.40 + 0.02/ft total height	NA	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Audience Seating Area											
Auditorium	0.63	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Convention center	0.82	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Gymnasium	0.65	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Motion picture theater	1.14	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Penitentiary	0.28	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Performing arts theater	2.03	8	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Religious building	1.53	4	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Sports arena	0.43	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
All other audience seating areas	0.43	4	REQ	ADD1	ADD1		REQ	REQ		ADD2	ADD2
Banking Activity Area	0.86	6	REQ	ADD1	ADD1	REQ	REQ	REQ		ADD2	ADD2
Breakroom (See Lounge/Breakroom)											
Classroom/Lecture Hall/Training Room											

Partial Auto-On Restriction – Revision

- An exception was added to the requirement for manual on OR partial auto on to accommodate advanced lighting controls for added energy savings.
- Lighting in open-plan office spaces will be allowed to turn on automatically to more than 50% (i.e. full auto-on)
- The exception limits control zones to 600 square feet to preserve savings.

Exterior Lighting Control – Revision

- Requirements to reduce lighting power by 30% during periods of unoccupancy or after business hours in exterior applications AND parking garages has been increased to 50%.

New Specific Parking Lighting Control

New requirements for parking areas with shorter poles (24 ft or less) and lights greater than 78 W:

- Lights must automatically reduce power of each luminaire by at least 50% when no activity is detected in the area for 15 minutes or less.
- Limited to 1500 W of lighting controlled together

New Dwelling Unit Lighting Control

New requirement for Dwelling unit lighting

- Dwelling units (apartment, condo, living space, etc.) must be built so that at least 75 percent of the permanently installed lighting fixtures utilize lamps with an efficacy of at least 55 lm/W, or have a total luminaire (fixture) efficacy of at least 45 lm/W.
  - **Exception:** Lighting that is controlled with dimmers or automatic control devices.
- Applies to 4 story above grade multi-family (3 story and below not in scope of 90.1)
- Other common spaces in the building must follow standard 90.1 Requirements.

Alterations Requirements – Revision

Lighting alterations (retrofits) section revised to add interior and exterior controls

- **Interior** retrofits must now also comply with occupancy and scheduled full and partial shutoff and bi-level switching where specified.
- **Exterior** retrofits must now also comply with astronomical control and/or scheduled shutoff control where specified for each application.

Alterations Requirements – More Revision

- Application threshold changed to 20% of lighting load before requirements are applied. This acknowledges the added controls savings and practicality of applying controls in retrofits.
- Lamp plus ballast retrofits and one-for-one fixture replacements need only comply with LPD limits.

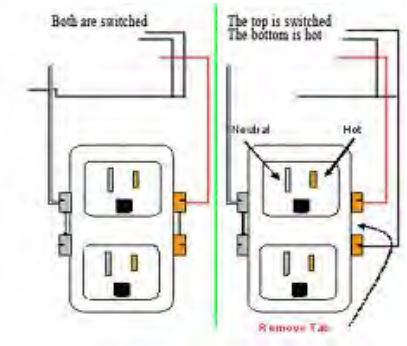
Power Requirements – Revision

- Low Voltage Dry Transformer efficiency
  - Values were revised to meet federal efficiency minimums
- Voltage Drop for efficiency
  - Value combined/changed to maximum 5% of design load for combined feeder plus branch circuits

Receptacle (wall plug) Control – Review

A portion of receptacles (wall plugs) in a space must have automatic shutoff control

- Applies to 50% of 125 volt, 15 and 20 Amp receptacles in:
  - Private offices and Conference rooms
  - Print/copy rooms and Break rooms
  - Individual workstations and classrooms
- Applies to 25% of branch circuits for modular furniture
- Requires automatic control using: time-of-day schedule, occupancy sensor, or other automatic occupancy control
- Exceptions for safety/security or required 24 hour use
- Controlled receptacles must be marked and uniformly distributed
- **Plug-in type devices do not comply**



Appendix G – Performance Rating Method

A New Path for Compliance with ASHRAE Standard 90.1-2016

Michael Rosenberg
Pacific Northwest National Laboratory

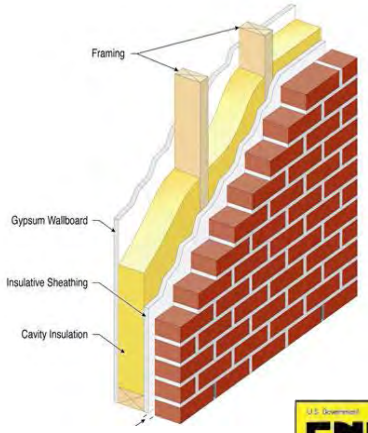
Background

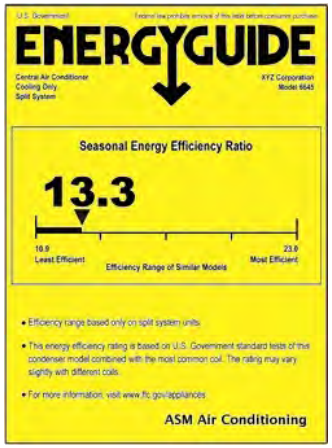
Performance Paths in Standard 90.1 Through 2013

Compliance with Standard 90.1

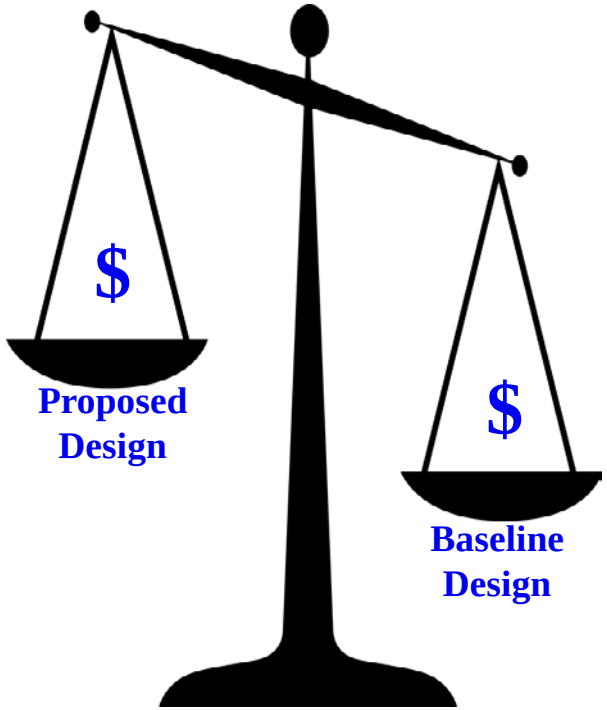
Through 2013 Standard 90.1 Includes Two Paths for Compliance:

Prescriptive





Performance – Energy Cost Budget (ECB)



EDSL Tas DesignBuilder EnergyGauge CoolTool Carrier HAP AUTODESK GREEN BUILDING STUDIO TRNSYS17 IC3 DOE-2 eQUEST ekotrope APOGEE INTERACTIVE REM/Design REM/Rate EnergyInsights™ INTEGRATED ENVIRONMENTAL SOLUTIONS

Appendix G – Performance Rating Method

- Appendix G – Performance Rating Method (PRM)
  - Performance path similar to Energy Cost Budget, but more flexible
  - Not for code compliance (prior to 2016)
  - Used for beyond code programs
    - LEED
    - ASHRAE Standard 189.1
    - International Green Construction Code (IgCC)
    - EPACT Tax Credits
    - Federal Energy Management Program (FEMP)

ECB – Dependent Baseline

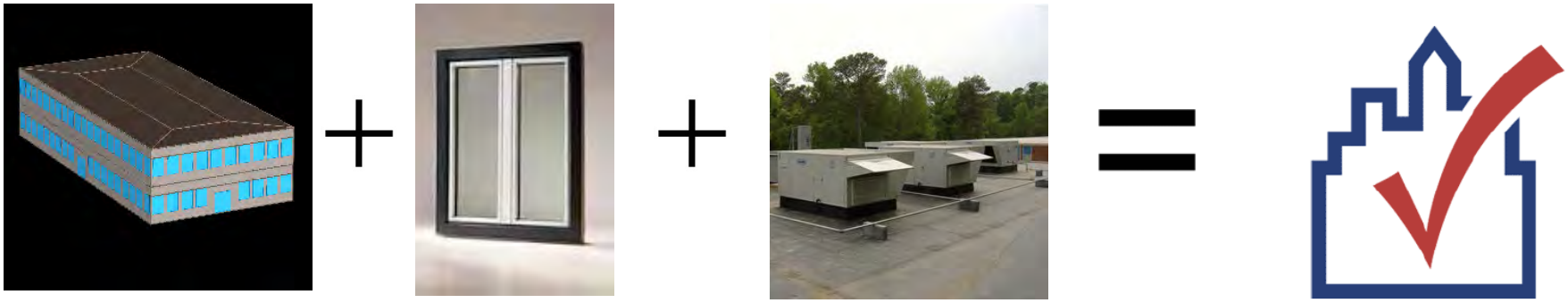
- Current Performance Path (**ECB**) Baseline is **Dependent** on the Proposed Design
  - Baseline matches the proposed design in most ways, except backed down to prescriptive limits

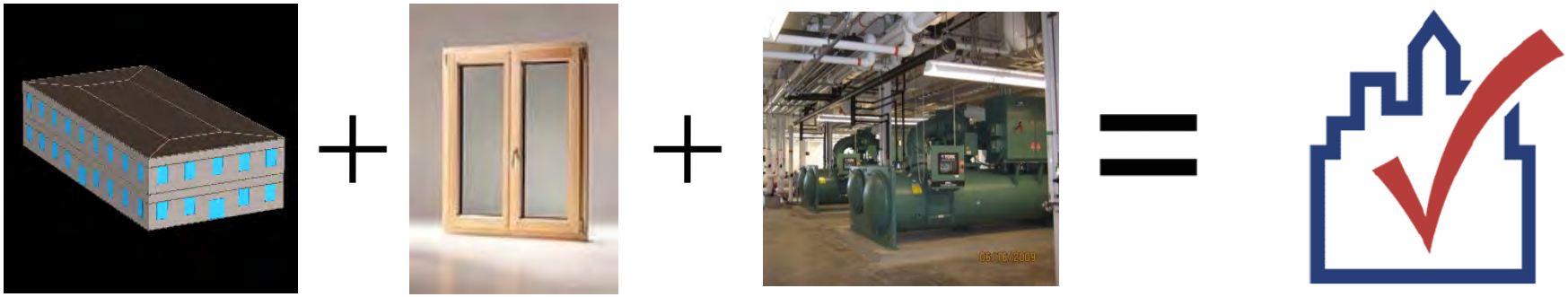
	Baseline Modeling Assumption
Design Parameter	**Energy Cost Budget**
Window Area	Matches proposed design (up to 40%)
HVAC System Type	Matches proposed design
HVAC System Sizing	Matches proposed design
Orientation	Matches proposed design
Fan power	Matches proposed design (up to limit)
Air Tightness	Matches proposed design
Use of Thermal Mass	Matches proposed design

ECB – Dependent Baseline

ECB compliance path does not prescribe energy use

- Multitude of prescriptive options – with it's baseline
- Each combination chosen results in very different energy use



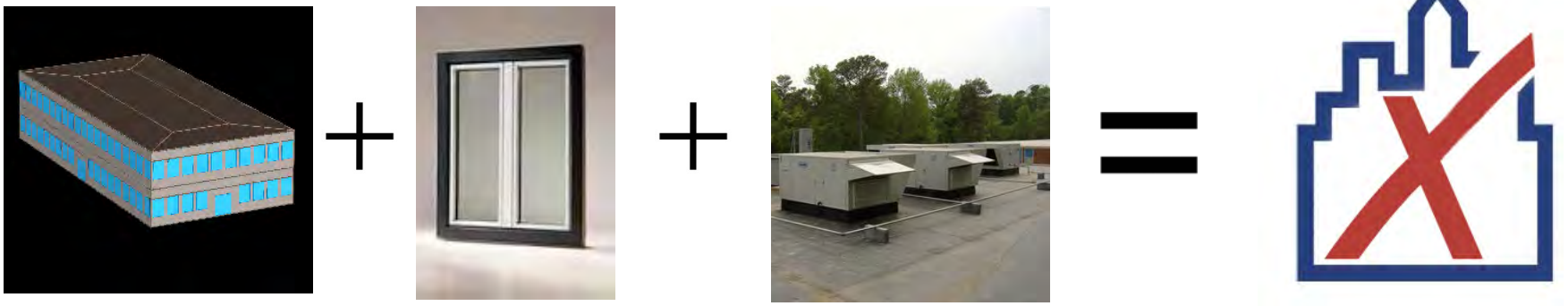


Appendix G – Independent Baseline

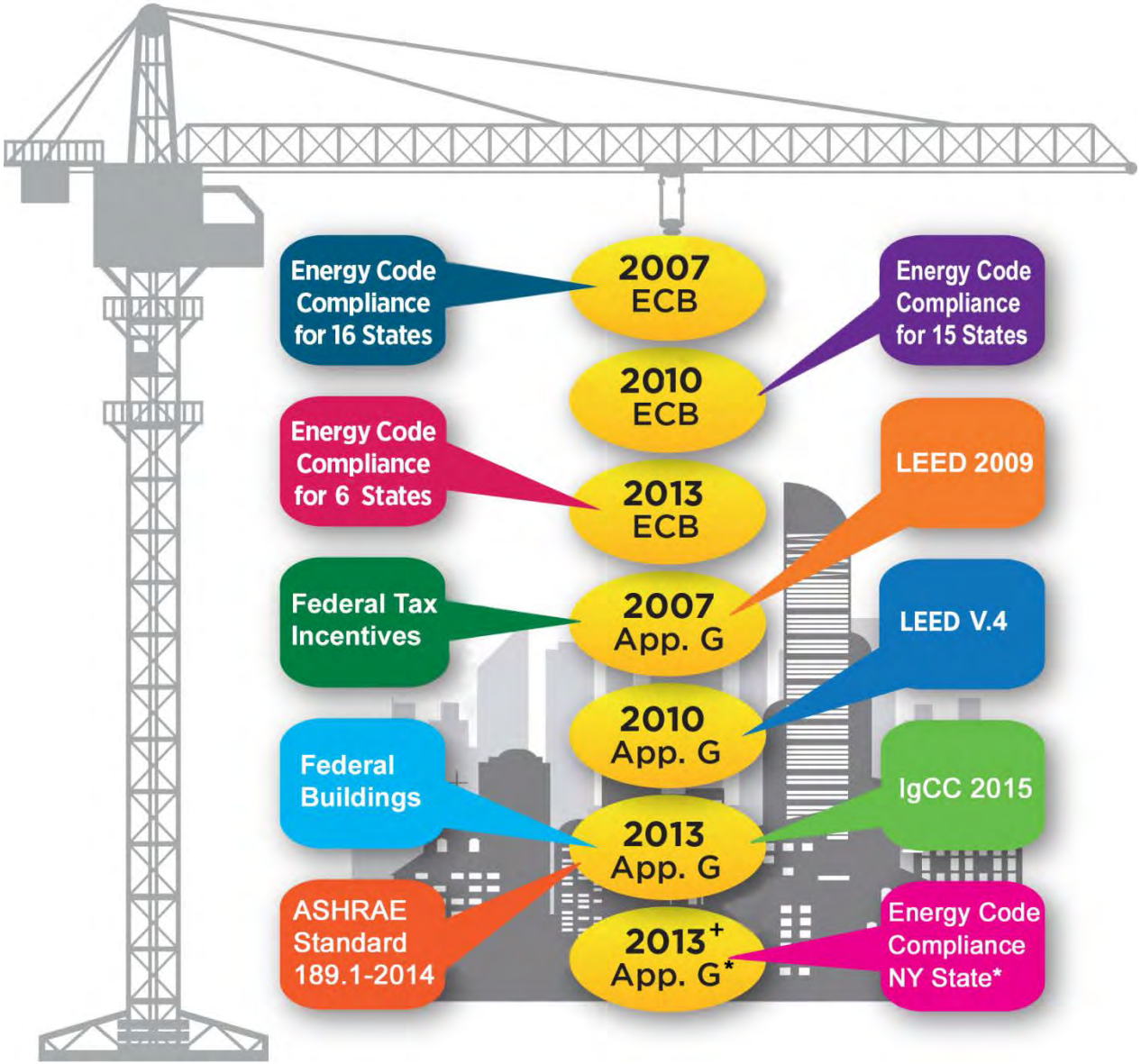
- **Appendix G** Baseline is more **Independent** of the Proposed Design
  - Design parameters set at standard practice - allows more credit for good design choices

	Baseline Modeling Assumption	
Design Parameter	**Energy Cost Budget**	**Appendix G**
Window Area	Matches proposed design (up to 40%)	Set at standard practice based on building type
HVAC System Type	Matches proposed design	Set at standard practice based on building type and climate zone
HVAC System Sizing	Matches proposed design	Set at standard practice
Orientation	Matches proposed design	Neutral (average of 4 rotations)
Fan power	Matches proposed design (up to limit)	Set at standard practice
Air Tightness	Matches proposed design	Set at standard practice
Use of Thermal Mass	Matches proposed design	Set at standard practice

Appendix G – Independent Baseline

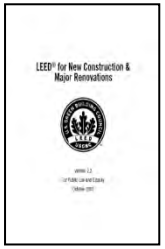


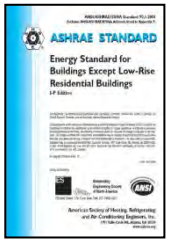
Multiple Performance Rulesets for Codes and Beyond Code Programs

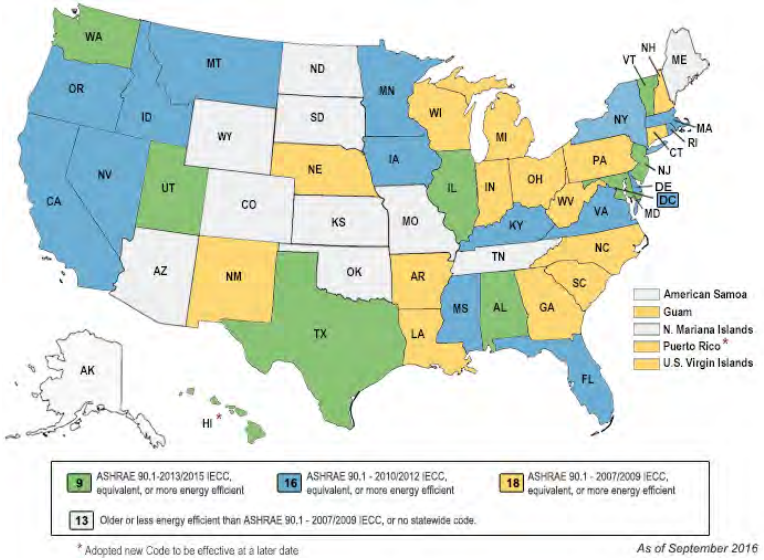


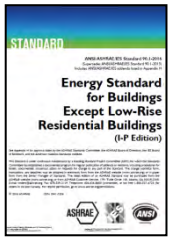
Multiple Performance Rulesets for Codes and Beyond Code Programs

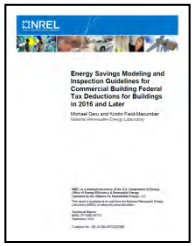
- Each program and code requires different rules
  - One project could require 3 different baseline models:
    - Compliance, LEED, incentives
  - Confusing, expensive, difficult to master
  - Limited software to properly implement performance path
    - Market share is diluted
    - Not financially attractive for a software developer







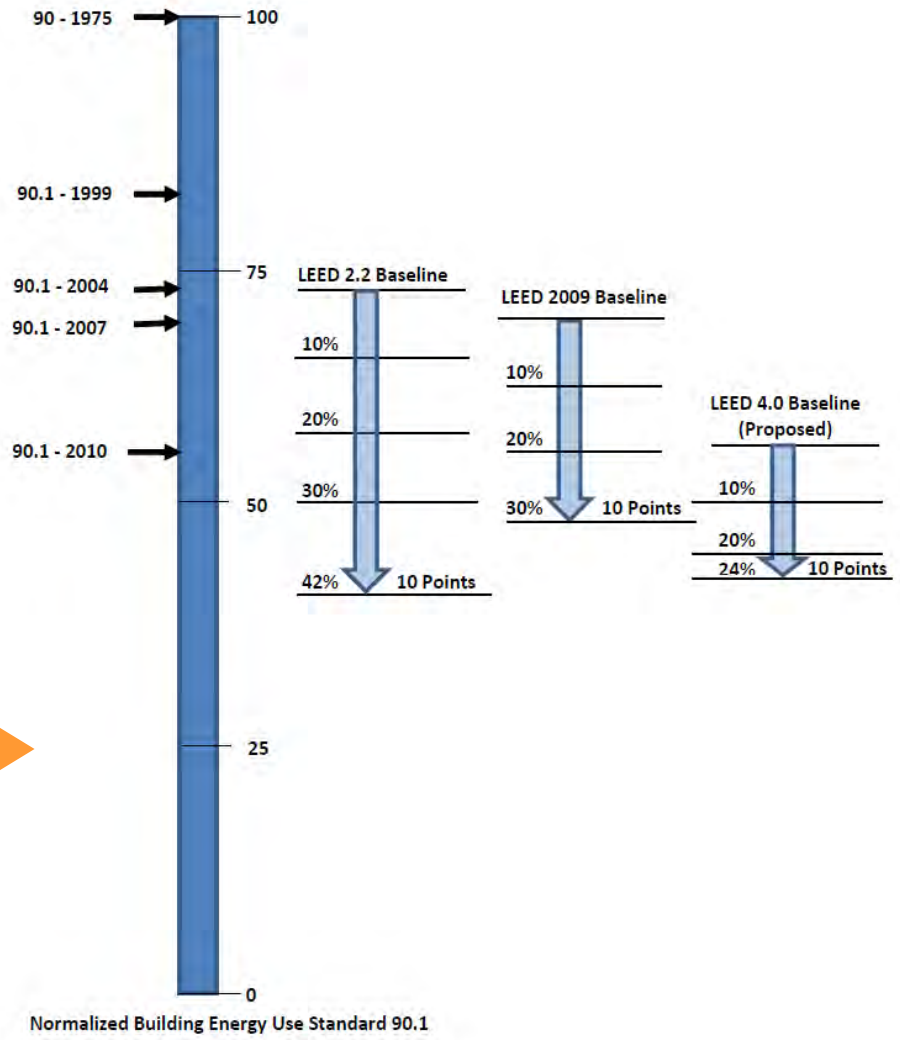




Baseline is a Moving Target

- Baseline stringency changes with each new version of the Standard
  - Comparisons between buildings using different versions of the standard are very difficult
  - Which is better, 40% below 2004 or 30% below 2007?

Moving Baseline



Summary through 90.1-2013

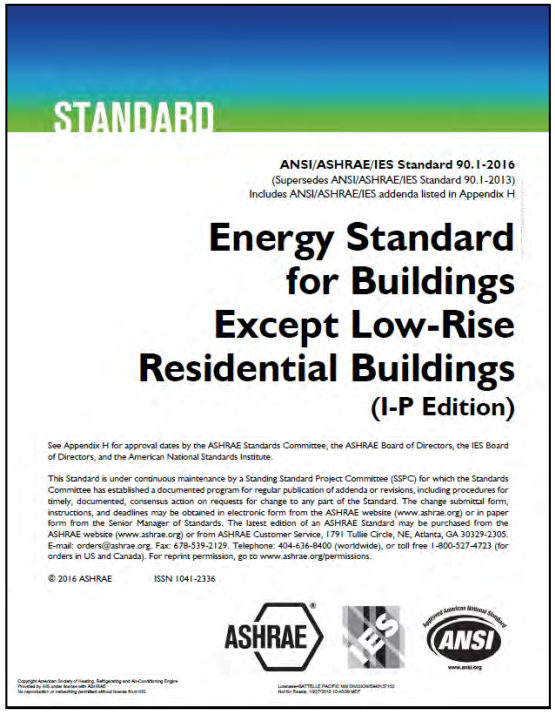
- Two paths for compliance – prescriptive and ECB
- 2nd performance path – Appendix G PRM for “beyond code programs”
- ECB baseline is dependent on proposed design – limited credits available
- Appendix G is more independent – increased credit for good design choice
- For both – baseline changes with new prescriptive requirements
  - Limited software
  - Difficult to learn and QC multiple performance paths
  - Expensive

The Future

Performance Paths in Standard 90.1 Beginning 2016

Addendum BM – Third Compliance Path

- New Compliance Path for 2016
  1. Prescriptive
  2. Energy Cost Budget
  3. **Appendix G**



4.2 Compliance

4.2.1 Compliance Paths

4.2.1.1 New Buildings

New buildings shall comply with either the provisions of

a. Section 5, "Building Envelope"; Section 6, Heating, Ventilating, and Air Conditioning"; Section 7, "Service Water Heating"; Section 8, "Power"; Section 9, "Lighting"; and Section 10, "Other Equipment," or

b. Section 11, "Energy Cost Budget Method," or

c. **Appendix G, "Performance Rating Method."**

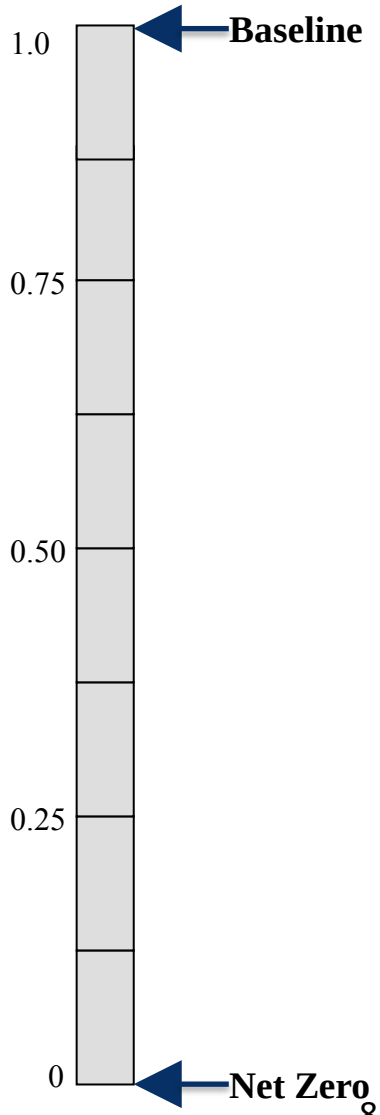
Addendum BM – Third Compliance Path

- Requires a Performance Cost Index (PCI) specific to building type and climate zone

$$Performance\ Cost\ Index\ (PCI) = \frac{Proposed\ Building\ Performance}{Baseline\ Building\ Performance}$$

  - Performance Cost Index of 1.0 = baseline building
  - Performance Cost Index of 0.0 = zero net energy
  - For compliance, PCI < PCI_t
  - PCI_t specific for building type, climate zone, and proportion of regulated loads : unregulated load

$$PCI_t = \frac{(BBUEC + (BPF \cdot BBREC))}{BBP}$$



Addendum BM – Third Compliance Path

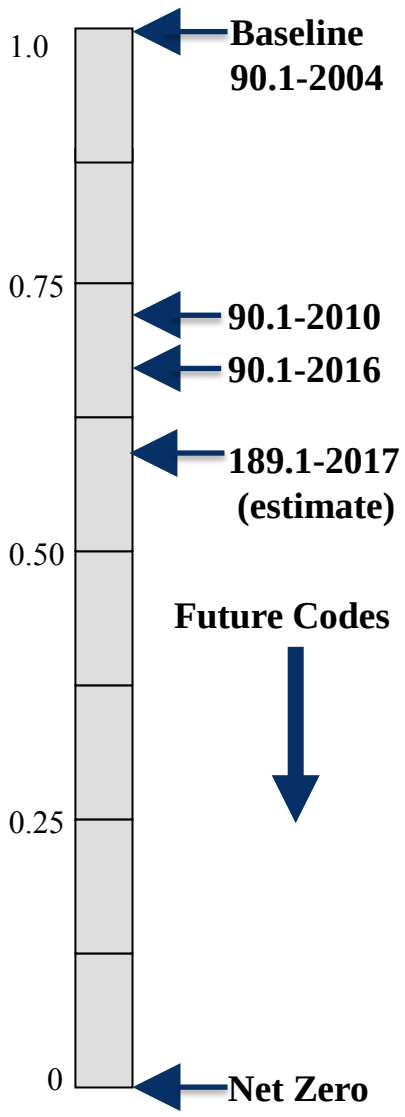
- Building type and climate zone adjustment by Building Performance Factor

Table 4.2.1.1 *Building* Performance Factor (BPF)

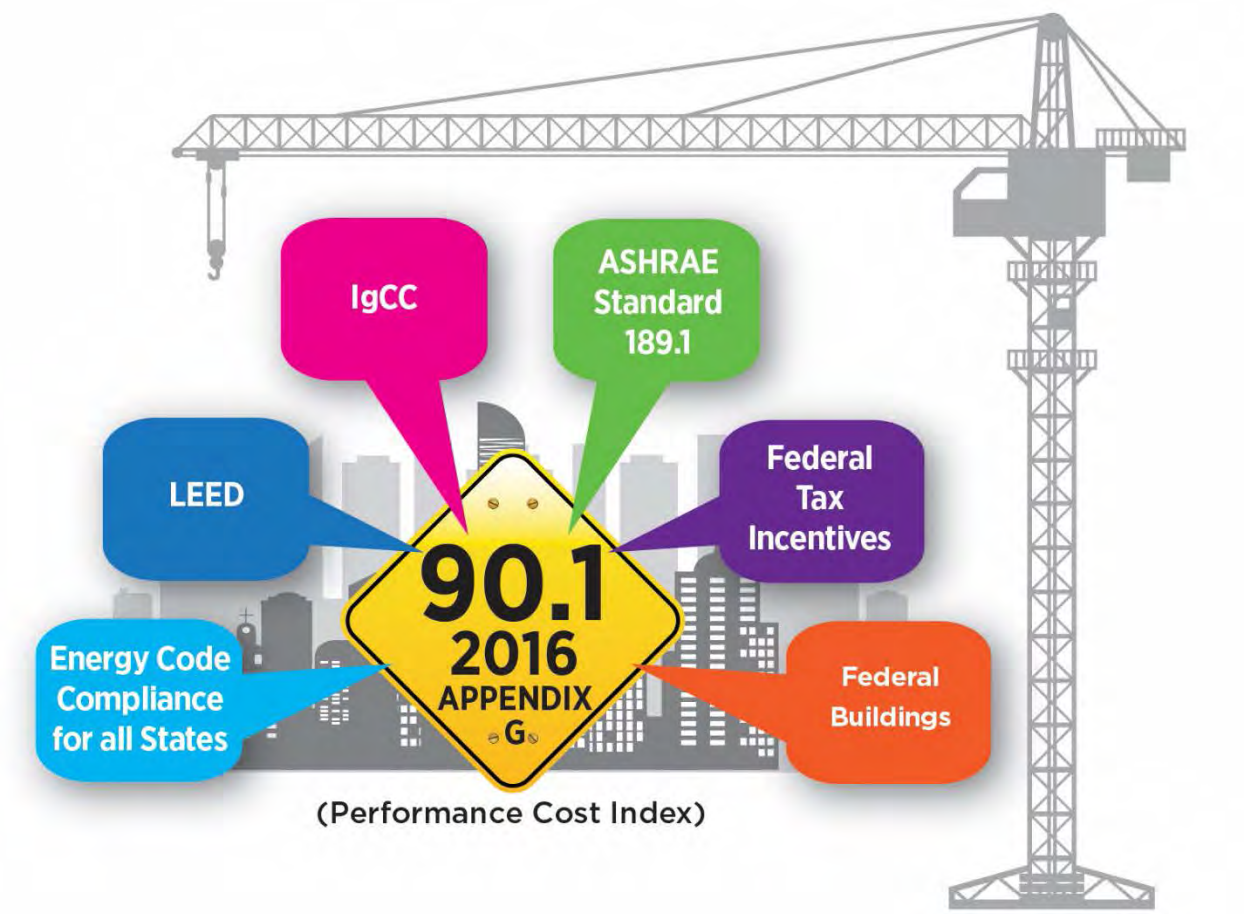
Building Area Type[a]	Climate Zone																
	0A and 1A	0B and 1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Multifamily	0.73	0.73	0.71	0.69	0.74	0.73	0.68	0.78	0.81	0.81	0.76	0.80	0.81	0.76	0.79	0.74	0.80
Healthcare/ hospital	0.64	0.56	0.60	0.56	0.60	0.56	0.54	0.57	0.53	0.55	0.59	0.52	0.55	0.57	0.52	0.56	0.56
Hotel/motel	0.64	0.65	0.62	0.60	0.63	0.65	0.64	0.62	0.64	0.62	0.60	0.61	0.60	0.59	0.61	0.57	0.58
Office	0.58	0.62	0.57	0.62	0.60	0.64	0.54	0.58	0.60	0.58	0.60	0.61	0.58	0.61	0.61	0.57	0.61
Restaurant	0.62	0.62	0.58	0.61	0.60	0.60	0.61	0.58	0.55	0.60	0.62	0.58	0.60	0.63	0.60	0.65	0.68
Retail	0.52	0.58	0.53	0.58	0.54	0.62	0.60	0.55	0.60	0.60	0.55	0.59	0.61	0.55	0.58	0.53	0.53
School	0.46	0.53	0.47	0.53	0.49	0.52	0.50	0.49	0.50	0.49	0.50	0.50	0.50	0.49	0.50	0.47	0.51
Warehouse	0.51	0.52	0.56	0.58	0.57	0.59	0.63	0.58	0.60	0.63	0.60	0.61	0.65	0.66	0.66	0.67	0.67
All others	0.62	0.61	0.55	0.57	0.56	0.61	0.59	0.58	0.57	0.61	0.57	0.57	0.61	0.56	0.56	0.53	0.52

Addendum BM – Appendix G - Fixed Baseline

- Appendix G - Fixed Baseline
- Baseline set ~ 90.1-2004
  - Intent is that the stringency of the baseline doesn't change
  - PCI target changes with each version of a code
  - Beyond code programs can choose a PCI to meet their needs



Addendum BM – Appendix G – One Ruleset for Many Purposes



- Create a larger market for automated software
- Same model used for multiple purposes
- Simpler, cheaper, more likely to be accurate

Fixed Baseline Example – LEED V.4 Pilot Credit

LEED BD+C: New Construction | v4-LEEDv4

Alternative Performance Rating Method

Whole-Building Energy Simulation

"Demonstrate a minimum reduction of 5% for new construction or 3% for major renovations in the proposed building Performance Cost Index (PCI) below the Performance Cost Index Target (PCI_t) calculated in accordance with Section 4.2.1.1 of ANSI/ASHRAE/IESNA Standard 90.1-2016, Appendix G, except with Table 1 below replacing Table 4.2.1.1"

Table 1 – Building Performance Factors (BPFs)

Rating System Adaptation	Building Performance Factor (BPF)
New Construction (Except High-Rise Residential)	0.72
Retail (Incl. Restaurant)	0.72
School	0.65
Healthcare	0.69
Hospitality	0.76
Warehouse	0.70
Homes Mid-Rise & NC High-Rise Residential	0.89

Addendum BM Summary

- 2016 Version of Appendix G with Addendum bm offers these benefits:
  - A new third option for compliance for increased flexibility
  - Saves time and money dedicated to energy modeling by allowing a single modeling approach to be used for multiple functions
  - Encourages the creation of tools that automate the simulation process as the market is increased
  - Provides credit for good design practices that were previously not recognized for code compliance

What Else is New in Appendix G for 2016?

Addendum k directs the modeler to use the **default assemblies** in Appendix A for baseline opaque envelope assemblies.

Opaque Assemblies. Opaque assemblies used for new buildings, existing buildings, or additions shall conform with ~~the following common, lightweight assembly types~~ assemblies detailed in Appendix A and shall match the appropriate assembly maximum U-factors in Tables 5.5-1 through 5.5-8:

Example: Exterior Walls CZ 5 – U-factor 0.055

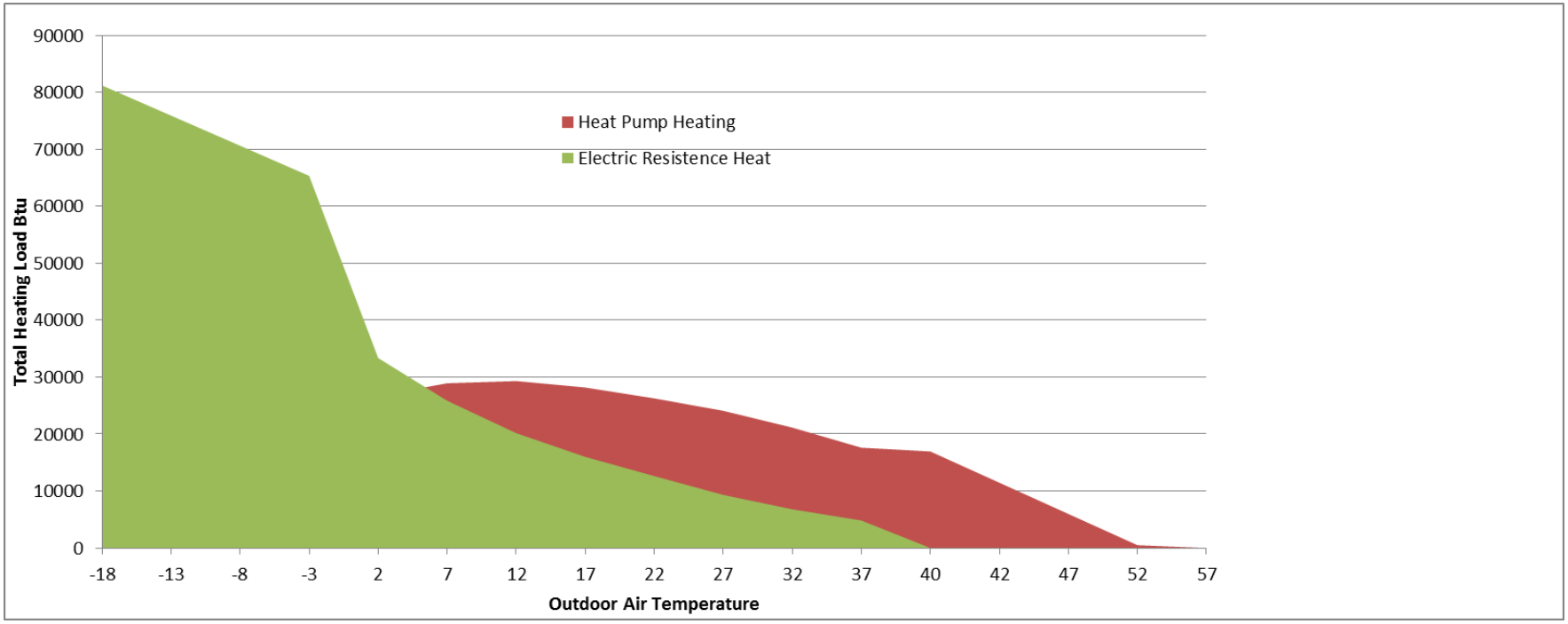
Table A3.3.3.1 Assembly *U-Factors* for Steel-Frame *Walls*

Framing Type and Spacing Width (Actual Depth)	Cavity Insulation *R-Value*: Rated (Effective Installed [see Table A9.2-2])	Overall *U-Factor* for Entire Base *Wall* Assembly	Overall *U-Factor* for Assembly of Base *Wall* Plus *Continuous Insulation* (Uninterrupted by Framing)																		
			Rated *R-Value* of *Continuous Insulation*																		
			R-1.00	R-2.00	R-3.00	R-4.00	R-5.00	R-6.00	R-7.00	R-8.00	R-9.00	R-10.00	R-11.00	R-12.00	R-13.00	R-14.00	R-15.00	R-20.00	R-25.00	R-30.00	R-35.00	R-40.00
Steel Framing at 16 in. on Center																					
3.5 in. depth	None (0.0)	0.352	0.260	0.207	0.171	0.146	0.128	0.113	0.102	0.092	0.084	0.078	0.072	0.067	0.063	0.059	0.056	0.044	0.036	0.030	0.026	0.023
	R-11 (5.5)	0.132	0.117	0.105	0.095	0.087	0.080	0.074	0.069	0.064	0.060	0.057	0.054	0.051	0.049	0.046	0.044	0.036	0.031	0.027	0.024	0.021
	R-13 (6.0)	0.124	0.111	0.100	0.091	0.083	0.077	0.071	0.066	0.062	0.059	0.055	0.052	0.050	0.048	0.045	0.043	0.036	0.030	0.026	0.023	0.021
	R-15 (6.4)	0.118	0.106	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057	0.054	0.051	0.049	0.047	0.045	0.043	0.035	0.030	0.026	0.023	0.021
6.0 in. depth	R-19 (7.1)	0.109	0.099	0.090	0.082	0.076	0.071	0.066	0.062	0.058	0.055	0.052	0.050	0.047	0.045	0.043	0.041	0.034	0.029	0.026	0.023	0.020
	R-21 (7.4)	0.106	0.096	0.087	0.080	0.074	0.069	0.065	0.061	0.057	0.054	0.051	0.049	0.047	0.045	0.043	0.041	0.034	0.029	0.025	0.022	0.020

What Else is New in Appendix G for 2016?

Addendum z provides detail on the simulation of baseline building heat pumps, including how **auxiliary heat** is used in conjunction with heat-pump heating.

G3.1.3.1 Heat Pumps (Systems 2 and 4). Electric airsource heat pumps shall be modeled with electric auxiliary heat and an outdoor air thermostat. The systems shall be controlled ~~with multistage space thermostats and an outdoor air thermostat wired~~ to energize auxiliary heat only ~~on the last thermostat stage and~~ when the outdoor air temperature is less than 40°F (4°C). The air-source heat pump shall be modeled to continue to operate while auxiliary heat is energized.



What Else is New in Appendix G for 2016?

Addendum aa provides direction regarding when it is appropriate to model a **heating-only system** in Appendix G.

b. All conditioned spaces in the proposed design shall be simulated as being both heated and cooled even if no heating or cooling system is to be installed.

Exceptions: Spaces ~~using Baseline System types 9 and 10 not be simulated with mechanical cooling.~~ designed with heating only systems 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 not be modeled with mechanical cooling.

Addendum ad clarifies when baseline HVAC systems should be modeled with **preheat coils**.

G3.1.3.19 Preheat Coils (Systems 5 through 8). The baseline system shall be modeled with a preheat coil controlled to a fixed setpoint 20°F (11°C) less than the design room heating temperature setpoint.

What Else is New in Appendix G for 2016?

Addendum ek sets baseline efficiency requirements for **commercial refrigeration systems**.

Table G3.10.1 *Performance Rating Method* Commercial Refrigerators and Freezers

Equipment Type	Application	*Energy* Use Limits, kWh/day	Test Procedure
Refrigerator with solid *doors*	Holding temperature	0.125 × *V* + 2.76	AHRI 1200
Refrigerator with transparent *doors*		0.172 × *V* + 4.77	
Freezers with solid *doors*		0.398 × *V* + 2.28	
Freezers with transparent *doors*		0.94 × *V* + 5.10	
Refrigerators/freezers with solid *doors*		0.12 × *V* + 4.77	
Commercial refrigerators	Pulldown	0.181 × *V* + 5.01	

Note: V is the chiller or frozen compartment volume (ft^3) as defined in Association of Home Appliance Manufacturers Standard HRF-1.

Table G3.10.2 *Performance Rating Method* Commercial Refrigeration

Equipment Type					
Equipment Class[a]	Family Code	Operating Mode	Rating Temperature	*Energy* Use Limits,[b,c] kWh/day	Test Procedure
VOP.RC.M	Vertical open	Remote condensing	Medium temperature	1.01 × TDA + 4.07	AHRI 1200
SVO.RC.M	Semivertical open	Remote condensing	Medium temperature	1.01 × TDA + 3.18	
HZO.RC.M	Horizontal open	Remote condensing	Medium temperature	0.51 × TDA + 2.88	
VOP.RC.L	Vertical open	Remote condensing	Low temperature	2.84 × TDA + 6.85	
HZO.RC.L	Horizontal open	Remote condensing	Low temperature	0.68 × TDA + 6.88	
VCT.RC.M	Vertical transparent *door*	Remote condensing	Medium temperature	0.48 × TDA + 1.95	
VCT.RC.L	Vertical transparent *door*	Remote condensing	Low temperature	1.03 × TDA + 2.61	

What Else is New in Appendix G for 2016?

Addendum dw sets baseline efficiency requirements for **elevators**.

16. Elevators	
Where the *proposed design* includes elevators, the elevator motor, *ventilation* fan, and light load shall be included in the model. The cab *ventilation* fan and lights shall be modeled with the same schedule as the elevator motor.	Where the *proposed design* includes elevators, the *baseline building design* shall be modeled to include the elevator cab motor, *ventilation* fans, and lighting power. The elevator peak motor power shall be calculated as follows: bhp = (Weight of Car + Rated Load – Counterweight) × Speed of Car/(33,000 × $h_{mechanical}$) P_m = bhp × 746/h_{motor}

Table G3.9.2 *Performance Rating Method* Baseline Elevator Motor

Number of Stories (Including Basement)	Motor Type	Counterweight	Mechanical *Efficiency*	Motor Efficiency[a]
≤4	Hydraulic	None	58%	Table G3.9.3
>4	Traction	*Proposed design* counterweight, if not specified use weight of the car plus 40% of the rated load	64%	Table G3.9.1

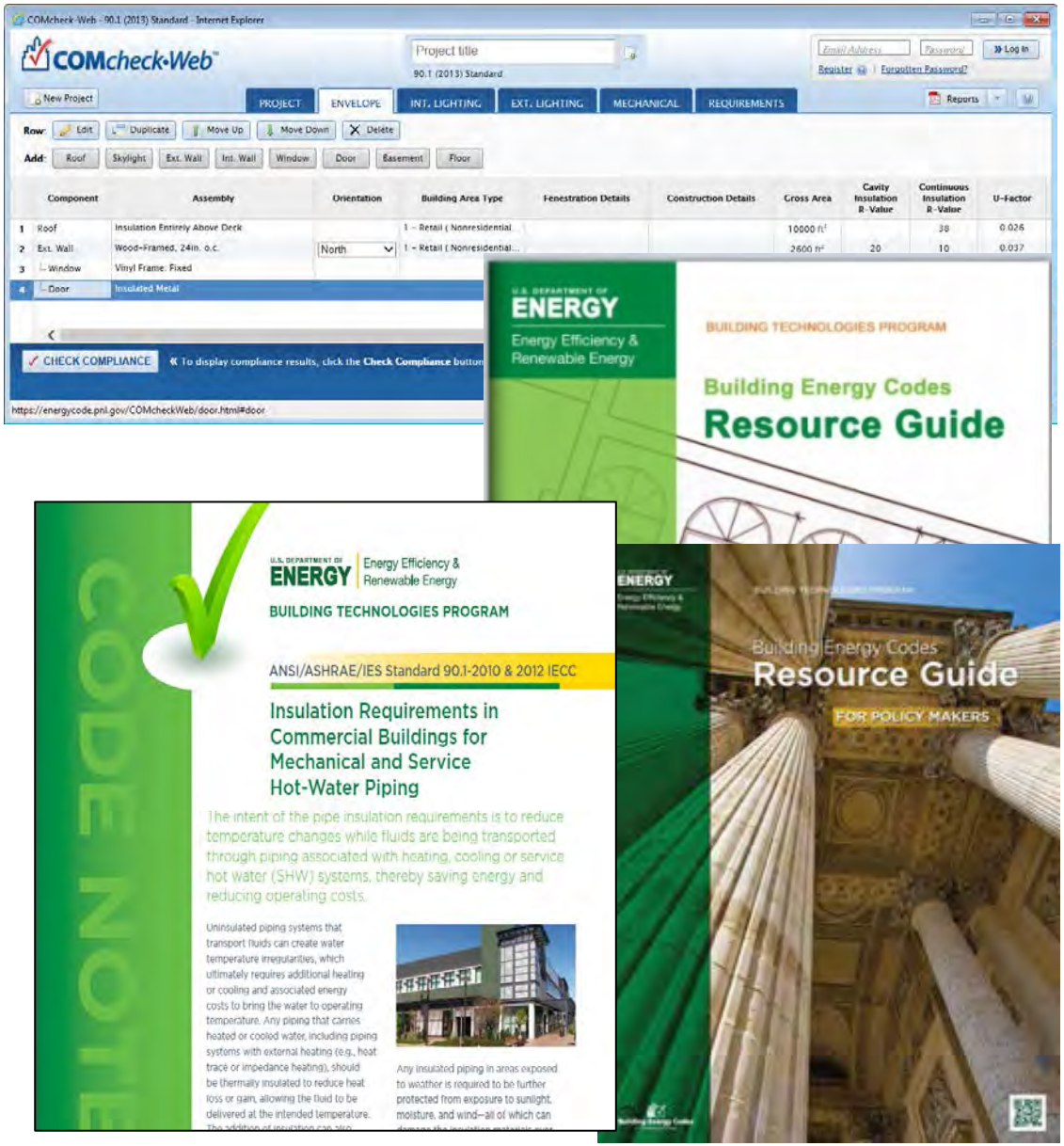
a. Use the *efficiency* for the next motor size greater than the calculated bhp.

Questions

Building Energy Codes Program Resources

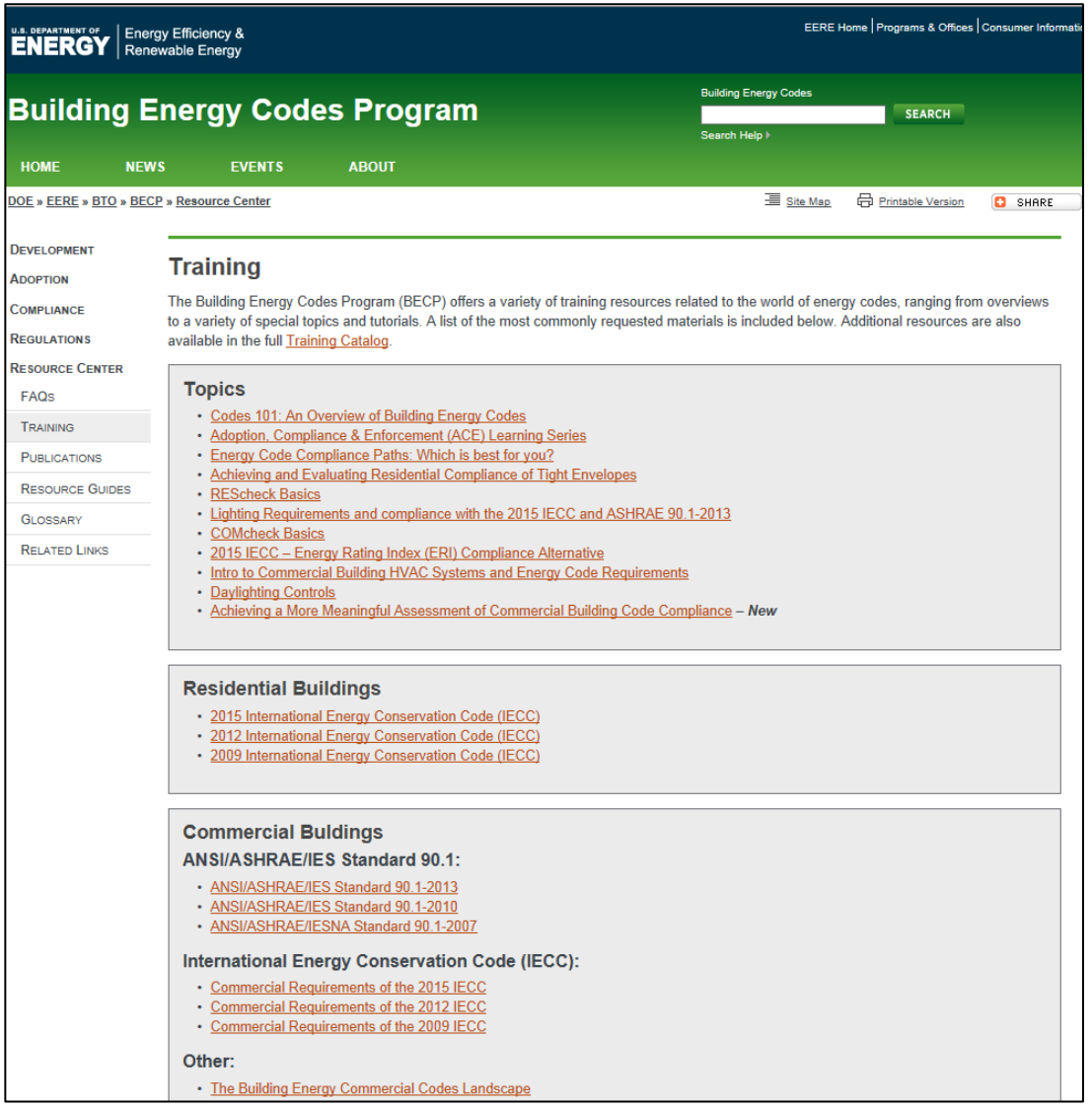
- Compliance software
- Technical support
- Code notes
- Publications
- Resource guides
- Training materials

www.energycodes.gov



Training Topic Ideas?

- Give us your topic ideas



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