# What You Need to Know about the New Energy Standard for Commercial Buildings: Standard 90.1-2019

U.S. Department of Energy Building Energy Codes Program
Energy Codes Commentator Webinar Series
AIA Provider #: I014 AIA Course #: 90.1-2019JAN20
ICC Provider Course #22737
January 23, 2020

# 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 40 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 2016 edition, Standard 90.1-2019 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 the whole building performance paths, Energy Cost Budget and Appendix G and new commissioning requirements. 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:*
  - The main changes to ASHRAE Standard 90.1-2019 from 90.1-2016
  - The new Commissioning requirements in 90.1-2019
  - The implications of the lighting requirements changes
  - The changes related to the performance compliance method

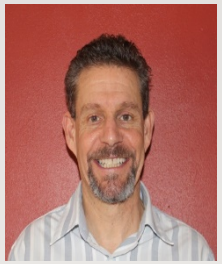
# Our Speakers Today:

Drake Erbe, SSPC 90.1 Chair

Len Sciarra, Chair, 90.1
Envelope Subcommittee

Jeff Boldt, Chair, 90.1
Mechanical Subcommittee

Michael Myer, Member, 90.1
Lighting Subcommittee



Michael Rosenberg, Member, 90.1
ECB  Subcommittee

Reid Hart, 90.1
Mechanical Consultant; Chair, 90.1
Cx working group,  2014-2019

# OVERVIEW

**Drake H. Erbe**

**Chair, SSPC 90.1**

# OBJECTIVES

- It is the overall goal of each version of Standard 90.1 to create a consensus standard that saves energy and is technically feasible and cost effective.
- It is also the goal to continue to improve clarity, understanding and compliance of the standard
- Continued viability and relevance is also a goal and requires thinking strategically as well as delivering a standard every 3 years

# RESULTS

- *More than 100 addenda were processed by the committee and 88 approved by the ASHRAE and IES Boards of Directors and are included in this edition.*
- *This version of the standard has had changes that affect all sections for standardization and are below:*
  - *Submittal documentation requirements have been outlined clearly most notably in Section 5 Envelope*
  - *Compliance paths are clarified especially for additions and alterations in Section 4 Administration and Enforcement*
  - *Throughout the standard unused definitions and references were removed*
  - *There are multiple clarifications and attention to definitions throughout the standard for ease of use and application*

# RESULTS (CONT.)

- One additional result for all sections should be highlighted and will be further explained in the presentation. Commissioning has been greatly enhanced in Section 4 with further requirements in each section. Also, an informative appendix has been added with additional guidance and information on this important inclusion into the standard.
- On viability and strategic direction, two initiatives have already started and have been out for Public Review
  - A very focused effort on widening Title, Purpose and Scope to include "site"
  - The inclusion of renewables into the standard

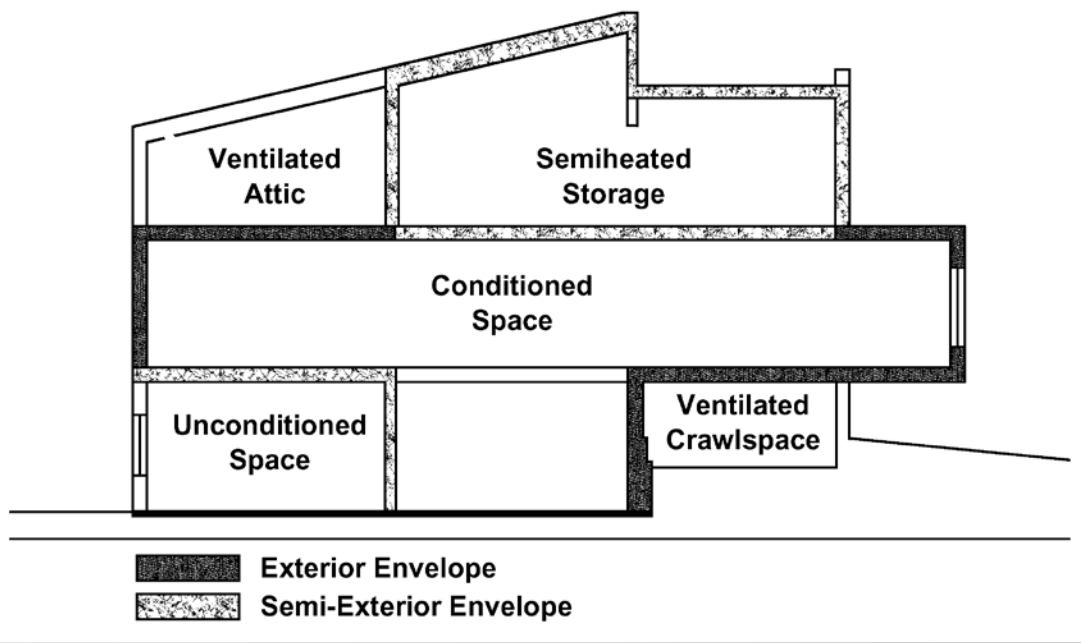
# OVERVIEW OF ENVELOPE CHANGES

**Leonard Sciarra, AIA**

**SSPC 90.1 Envelope Subcommittee Chair**

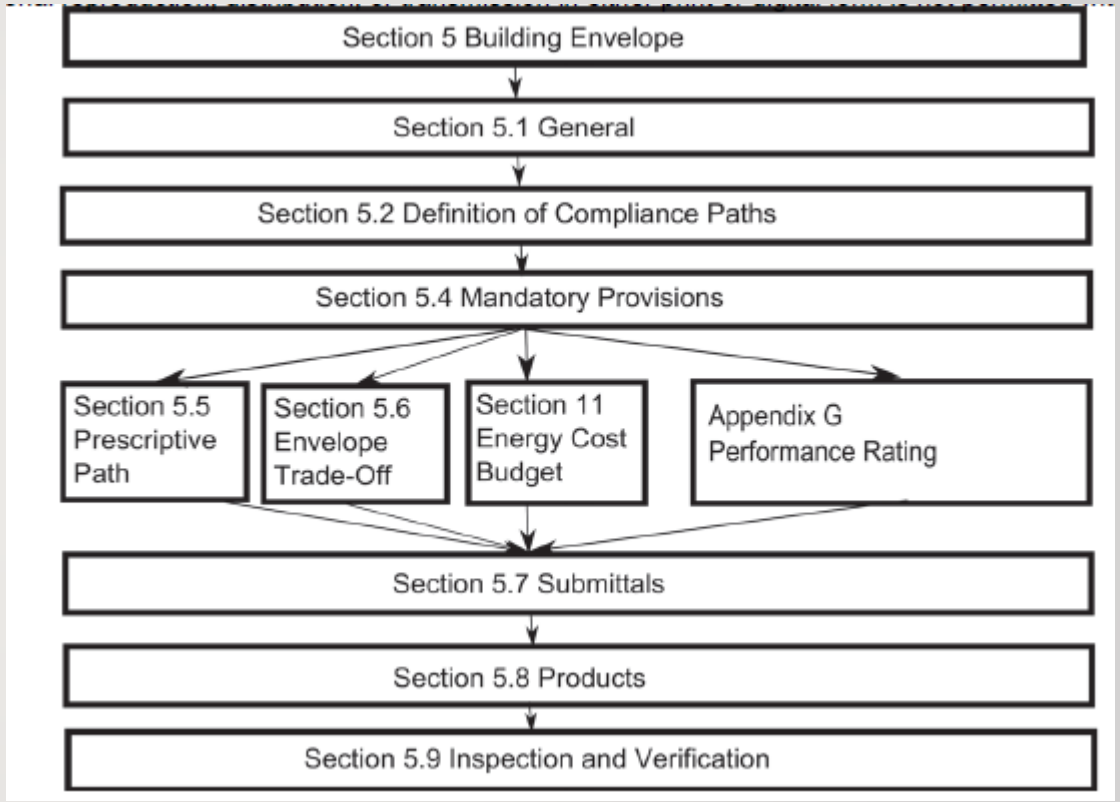
# OVERVIEW

- Clean up type changes
  - References
  - Definitions
- Criteria changes
- Text re-arrangement type changes

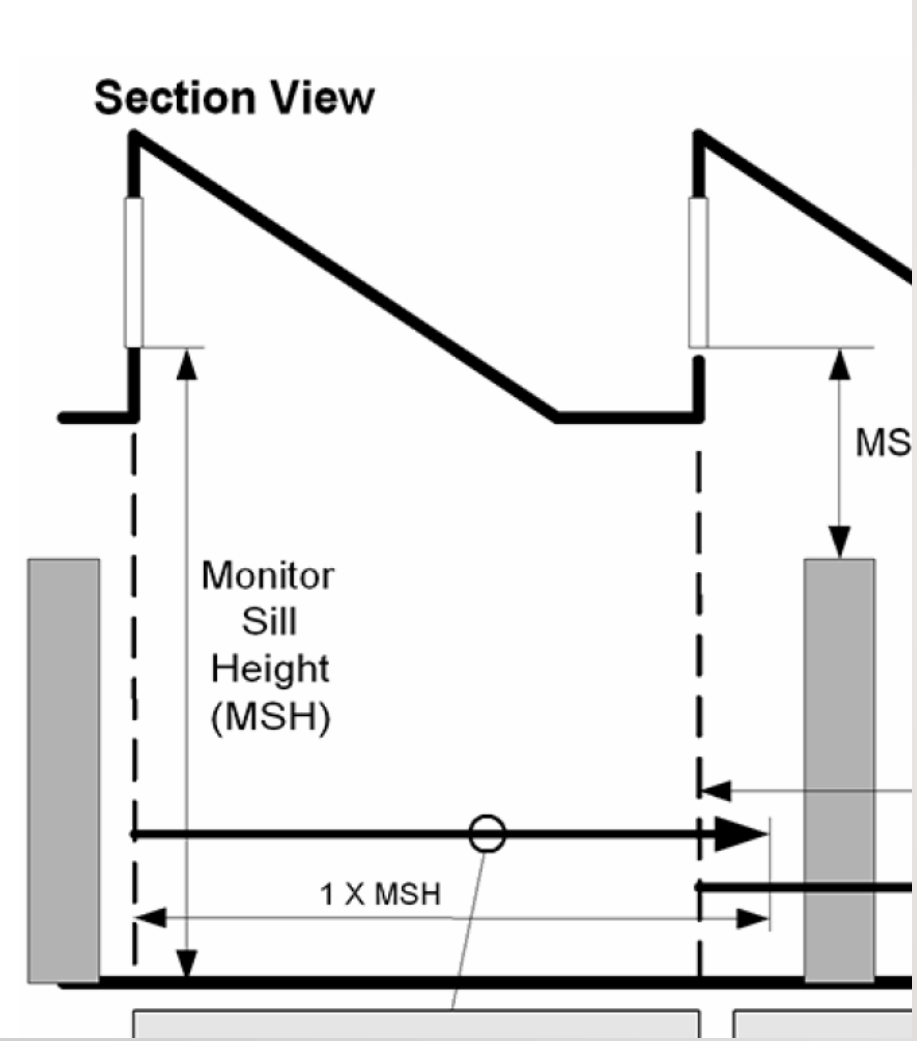


# COMPLIANCE

- 4 Compliance options still remain
- Notice reinforcement of compliance with 5.7, 5.8, & 5.9



# REFERENCES & DEFINITIONS




- Cool Roof Rating Standard from
  - CRRC -1 TO CRRC S100
- Added clarification in the definitions for ‘operable’ rooftop monitors
- Clarifications to the Definition of ‘door’ to help sort out confusion with revolving doors, garage doors, sectional garage doors, non-swinging doors, and glass doors.

# CRITERIA CHANGES

| *Fenestration* | Assembly Max. U | Assembly Max. *SHGC* | Assembly Min. *VT/SHGC* |
|---|---|---|---|
| *Vertical Fenestration*, 0% to 40% of *Wall* | | | |
| *Fixed* | 0.50 | 0.23 | 1.10 (for all types) |
| *Operable* | 0.62 | 0.21 | |
| *Entrance door* | 0.83 | 0.21 | |

| *Fenestration* | Assembly Max. U | Assembly Max. *SHGC* |
|---|---|---|
| *Vertical Fenestration*, 0% to 40% of *Wall* | | (for all frame |
| *Nonmetal framing*, all | 0.25 | 0.45 |
| *Metal framing, fixed* | 0.29 | |
| *Metal framing, operable* | 0.35 | |
| *Metal framing, entrance door* | 0.68 | |

- Fenestration
  - Fenestration is now based on type not on Material

# CRITERIA CHANGES

| Changes for Metal Framing - fixed | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **SHGC** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **2016** | 0.22 | 0.25 | 0.25 | 0.25 | 0.36 | 0.38 | 0.40 | 0.45 | 0.45 |
| **2019** | 0.22 | 0.23 | 0.25 | 0.25 | 0.36 | 0.36 | 0.38 | 0.40 | 0.40 |

| Changes for Metal Framing - fixed | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **U-factor** | **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **2016** | 0.50 | 0.57 | 0.54 | 0.45 | 0.38 | 0.38 | 0.36 | 0.33 | 0.29 |
| **2019** | 0.50 | 0.50 | 0.45 | 0.42 | 0.36 | 0.36 | 0.34 | 0.29 | 0.26 |

Example of stringency improvements – *note this will depend on the frame material*

# CRITERIA CHANGES

- Air Curtains
  - Now allowed for some building entrances
  - ANSI/AMCA 220
  - Jet Velocity of 6.6 ft/s
  - Angle to door < 20 deg
  - Commissioned
  - Automatic controls

**5.4.3.-43.3 Vestibule envelope.** The exterior surfaces of both conditioned vestibules and unconditioned vestibules shall comply with the *continuous air barrier* requirements.

**Exceptions to 5.4.3.3**

1. *Doors* not intended to be used as a *building entrance.*
2. *Doors* opening directly from a *dwelling unit.*
3. *Building entrances* in *buildings* located in Climate Zone 1 or 2.
4. *Doors* opening into *semiheated spaces*.
5. Enclosed elevator lobbies for *building entrances* directly from parking garages.
6. *Building entrances* in *buildings* that are located in Climate Zone 3, where the *building* is less than four stories above *grade*, and less than 10,000 ft² (1000 m²) in *gross conditioned floor area.*
7. *Building entrances* in *buildings* that are located in Climate Zones 0, 4, 5, 6, 7, or 8 and the *building* is ~~are~~ less than 1000 ft² (100 m²) in *gross conditioned floor area.*
8. *Doors* that open directly from a *space* that is less than 3000 ft² (300 m²) in area and is separate from the *building entrance.*
9. Self-closing doors in buildings in Climate Zones 0, 3, and 4 that have an air curtain complying with Section 10.4.5.
10. Self-closing doors in buildings 15 stories or less in Climate Zones 5 thru 8 that have an air curtain complying with Section 10.4.5.

# TEXT RE-ARRANGEMENTS

- Air Leakage
  - Whole Building testing to 0.40 cfm/ft$^2$ is the criteria with exceptions:
    - Portions of buildings
    - Allowance for up to 0.60 cfm/ft$^2$
    - Compliance by inspection and verification
      - Material and Assembly compliance
  - 5.7-submittals
  - 5.8-products
  - 5.9-verification testing and compliance

- Air Leakage
  - Materials – 0.004 cfm/ft$^2$
  - Assemblies – 0.04 cfm/ft$^2$
  - Buildings – 0.40 cfm/ft$^2$
    - With exception up to 0.06 cfm/ft$^2$

# TEXT RE-ARRANGEMENTS

- 5.9 Verification. Testing, Commissioning, and Inspections
  - 5.9.1 – verification
  - 5.9.2 – commissioning
  - 5.9.3 – inspections

Section expanded and reformatted to coordinate with overall commissioning requirements

# OVERVIEW OF MECHANICAL CHANGES

**Jeff G. Boldt, IMEG Corp.**

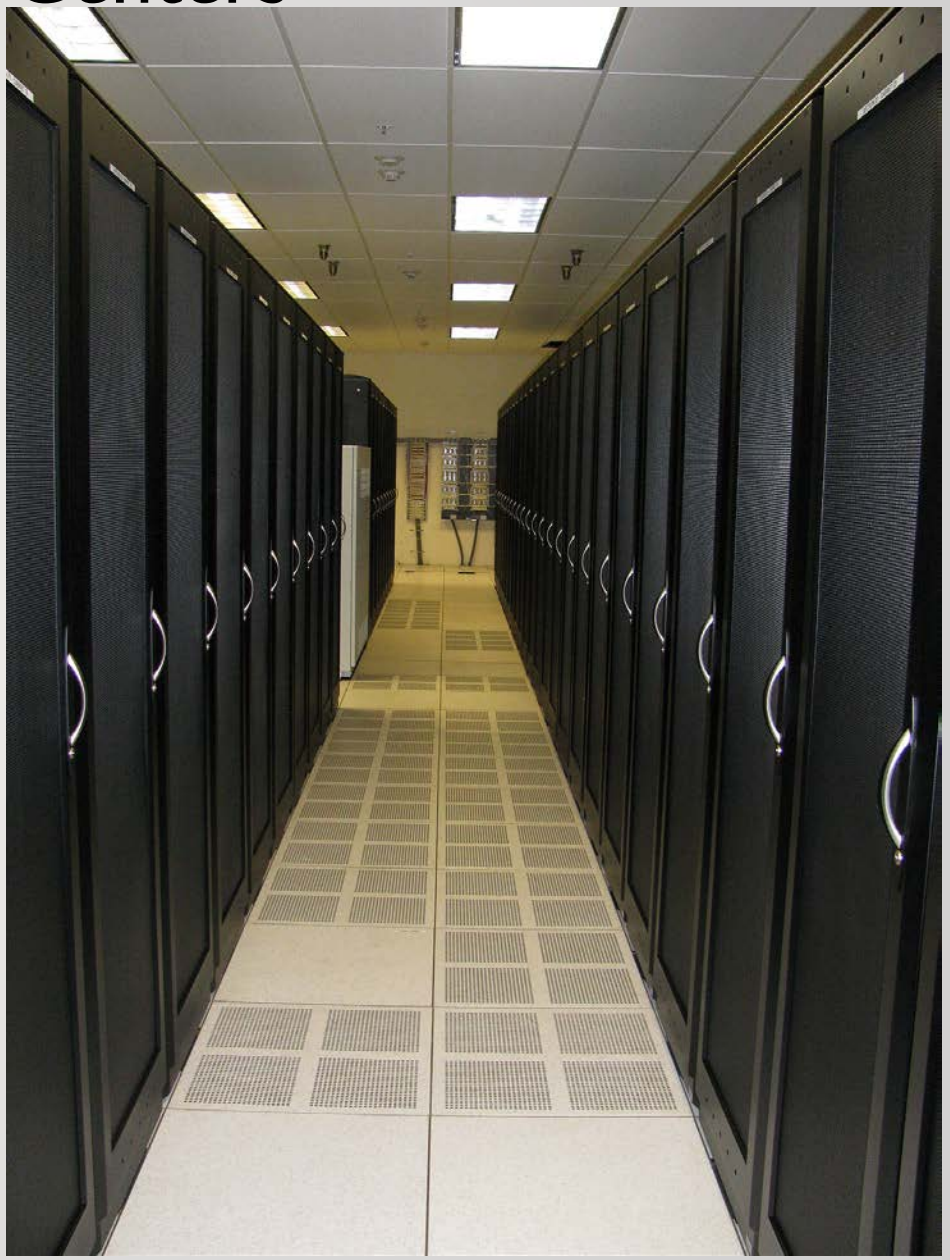
**SSPC 90.1 Mechanical Subcommittee Chair**

# Mechanical - Acknowledgements

- Thanks to the entire 90.1 committee and especially the Mechanical Subcommittee which reviewed this on very short notice.
  - Yes, we discuss saving energy at dinner!
- Some images are courtesy of AMCA, 2050 Partners, Big Ass Fans, American Aldes, Trane, Grundfos, & Multistack

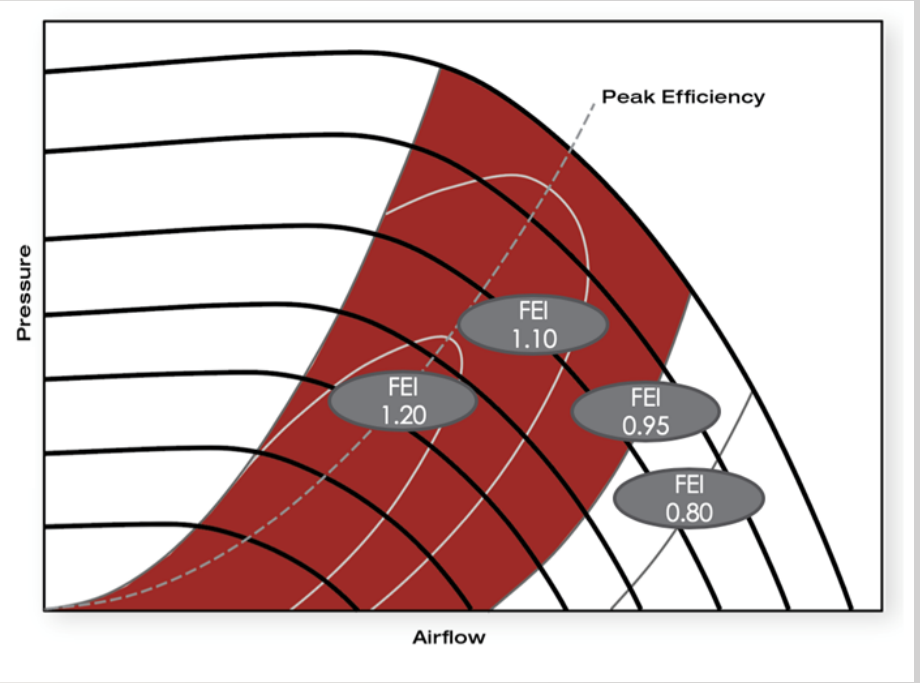
# Mechanical – Computer Rooms & Data Centers

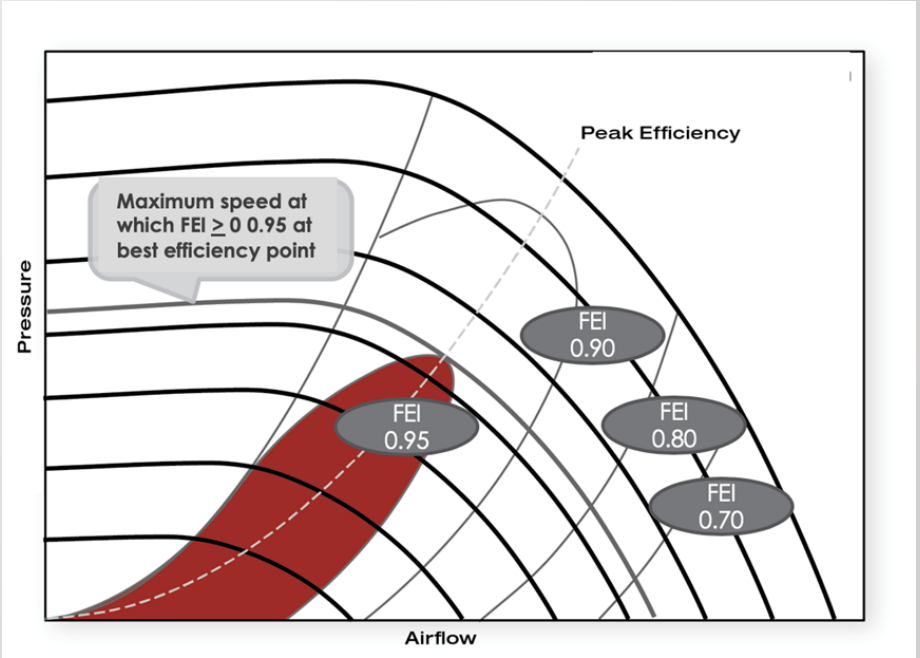
- New requirements to allow the option of using ANSI/ASHRAE Standard 90.4-2019, Energy Standard for Data Centers, instead of ASHRAE Standard 90.1 in computer rooms that have an IT equipment load larger than 10 kW
  - Took years to work out wording
  - Definition of computer room
  - Essentially big data centers follow 90.4
    - 90.4 has more electrical efficiency requirements
    - Smaller data rooms in a building follow 90.1
  - Computer Room = > 20 W/sf and ≥ 10 kW of comp load and/or IT equipment



# Mechanical – Fan Energy Index (FEI)

- Replaced Fan Efficiency Grade (FEG) efficiency metric with Fan Energy Index (FEI)
- FEG mainly requires good fan peak efficiency
- Does not concentrate as much on good selections
- FEI mainly requires good fan selections
  - Basically kW input must be below a calculated value AT THE SCHEDULED OPERATING POINT
  - So the fan must be fairly good too
  - Manufacturers selection software should tell you "Compliant with FEI" or NOT or just not list non-compliant products
- Requires some larger fans, esp. return fans
- Exceptions for embedded fans, safety fans, ceiling fans, fans outside scope of AMCA 208
  - No exception for PRVs
- Power threshold lowered from 5 HP to 1 HP




Images courtesy of AMCA

# Mechanical - FEI

- FEI is a true wire-to-air method
- Requirement:
  - Constant speed – FEI ≥ 1.0
  - VAV – FEI ≥ 0.95

$$FEI = \frac{\text{Reference Fan Electrical Input Power}}{\text{Fan Electrical Input Power}}$$

Images courtesy of AMCA

# Equipment Efficiency Tables

- MANY tables were updated

- Added pump definitions, requirements, and efficiency tables to the standard for the first time
  - Match DOE PEIs
  - Requires PEI ≤ 1.0
- PEI for pumps = similar to FEG = confusing
  - Also, lower numbers are better in FEI

Image courtesy of Grundfos

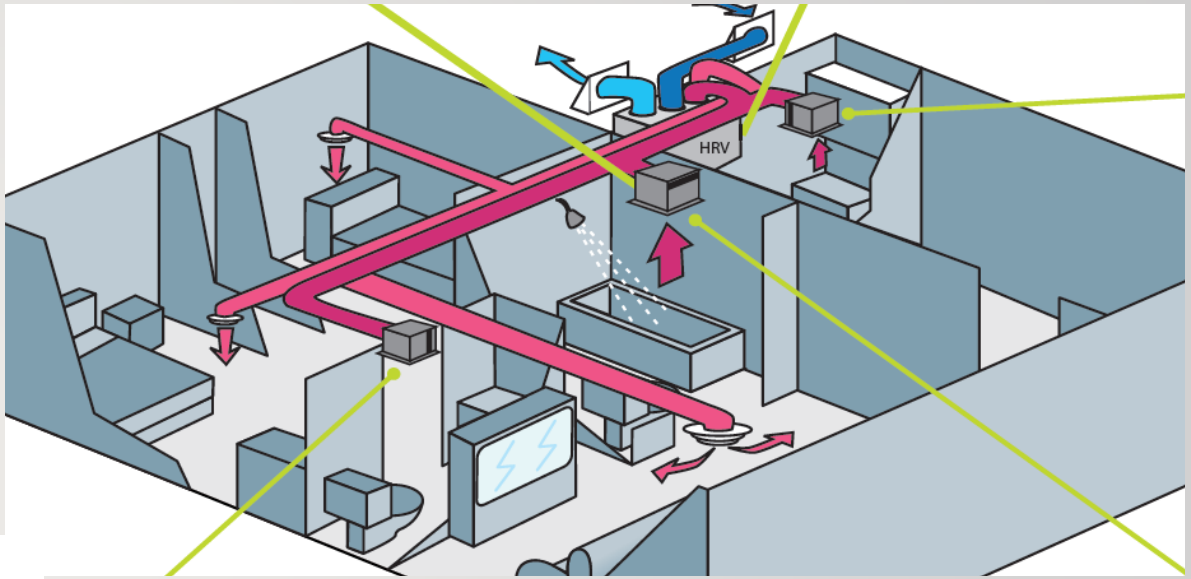
# Mechanical – Ceiling Fans

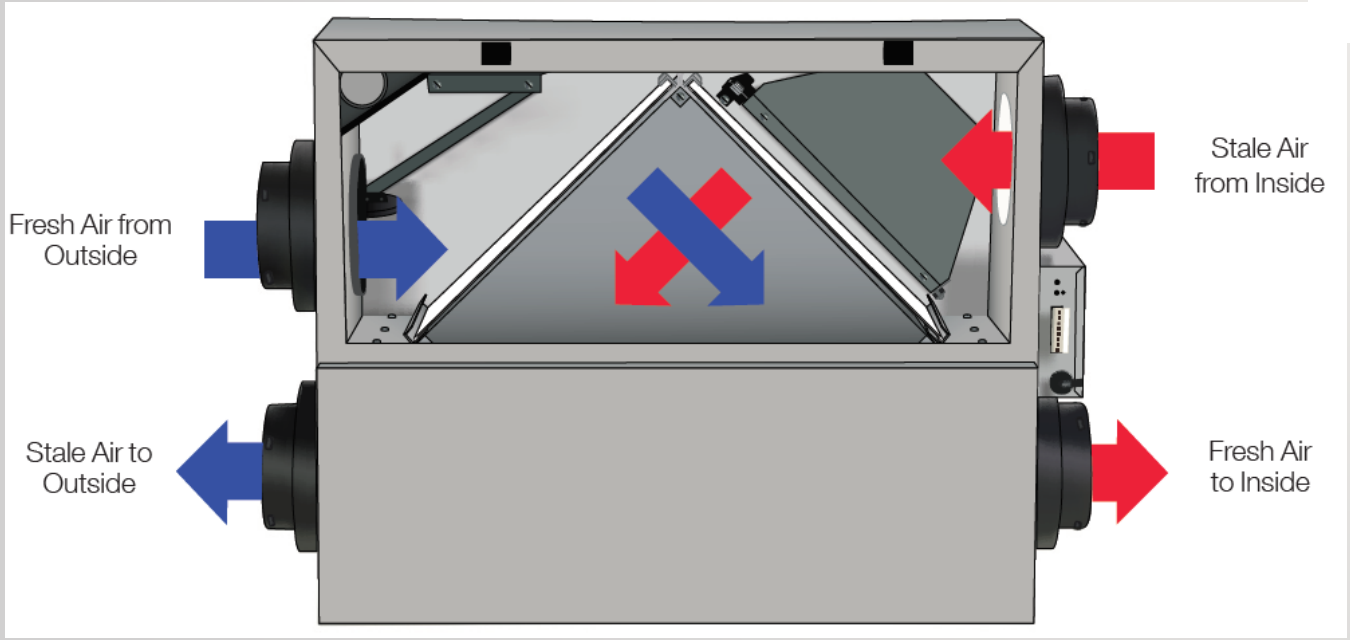
- New requirements for reporting fan power for large diameter (≥84.5”) ceiling fans
  - Rated per DOE 10 CFR 430 Appendix U or AMCA 230
  - Must report
    - Blade tip diameter
    - Rated airflow and power at max speed
- Smaller ceiling fans are covered in the Energy Star program

Image courtesy of Big Ass Fans

# Mechanical – ERVs for *Nontransient* Dwelling Units

- New energy recovery requirements for *nontransient* dwelling units (apartments & condos)
  - Enthalpy recovery ≥50% at cooling & 60% at heating design conditions
    - Unless one of the modes is not required
  - Exceptions based on size and CZs



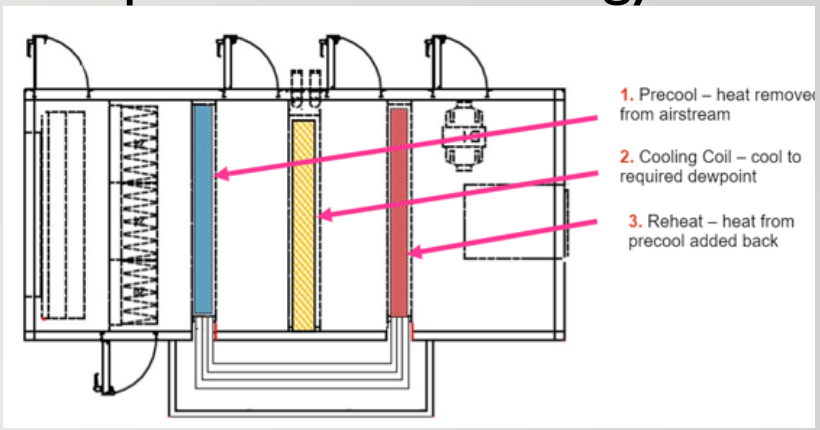

Images courtesy of American Aldes

# Updates to Exceptions to Exhaust Air Energy Recovery Requirements

- The language "energy recovery in series with the coil" was replaced with a definition of "series energy recovery."
  - Added a performance requirement for series energy recovery.
  - Now limited to climate zones 0-4

Parts of the addendum were not included in the first printing of ASHRAE 90.1 (I-P). This will be corrected through the errata process.

Examples of Series Energy Recovery




Wrap-around Heat Pipes

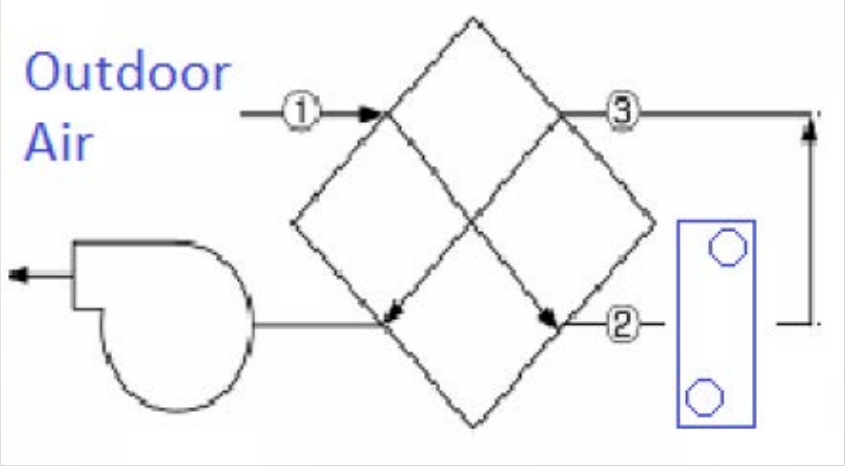



Plate Heat Exchanger

# Mechanical – Occupied Standby

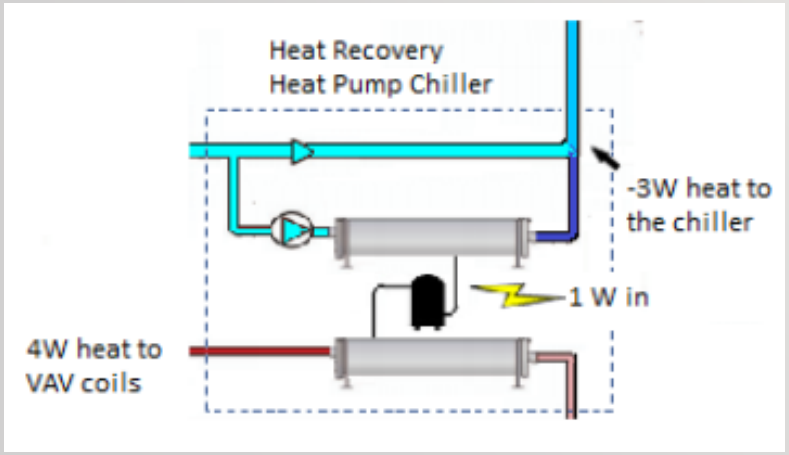
- Occupied-Standby Mode (6.5.3.8)
  - Definition: When a zone is scheduled to be occupied, and an occupant sensor indicates no occupants are within the zone
  - Tied to 9.4.1.1 lighting controls
  - Became important after Standard 62.1 (IAQ) allowed zero ventilation in unoccupied zones, even if scheduled occupied
  - Allows airflow only when zones are outside of their of temperature limits

# Mechanical – ER Chillers for Hospitals

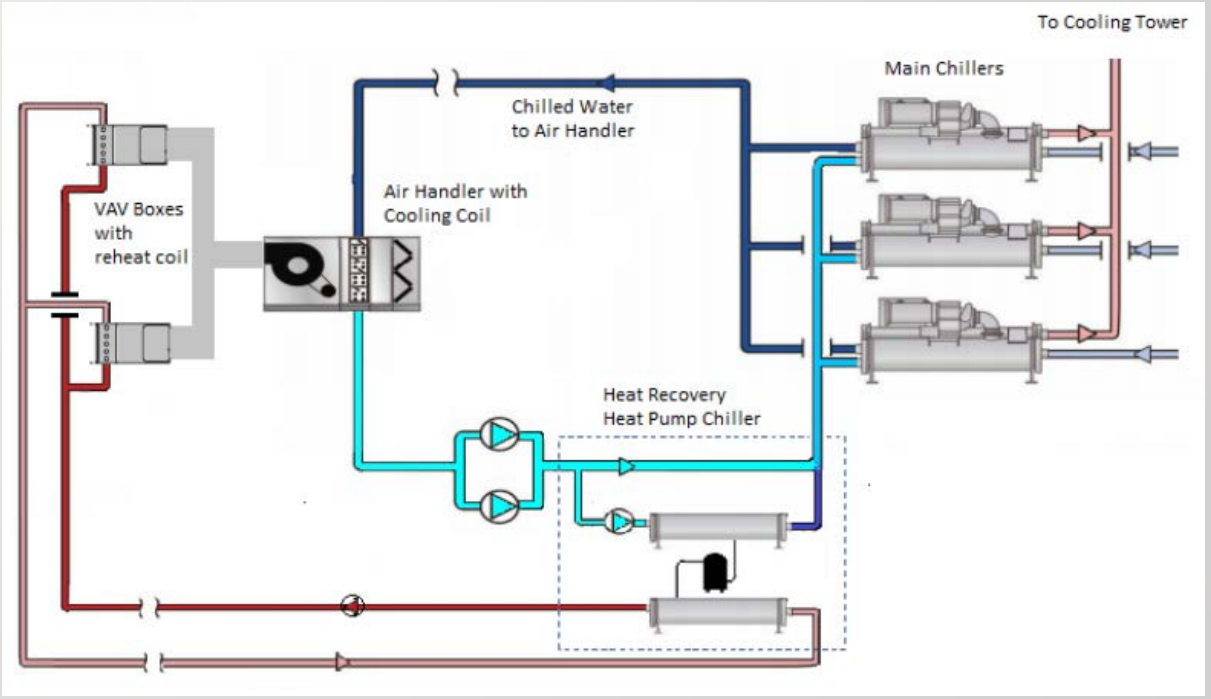
- Energy Recovery Chillers for Hospitals
  - Limited to:
    - Acute Inpatient
    - 24 hr operation
    - Chilled water capacity at design conditions >300 tons
    - Has simultaneous heat and cooling above 60F
  - Exceptions:
    - ≥60% of reheat energy from on-site renewables or site recovered energy
    - Climate Zones 5C, 6B, 7, & 8
  - Capacity of ≥7% of design capacity at design conditions (I.e. not standby chillers)

Image courtesy of Trane

Image courtesy of Multistack




Images courtesy of 2050 Partners



# Updated Many Tables to Match Latest DOE Efficiencies

- New equipment efficiency requirement tables and changes to efficiency requirements in existing tables to match DOE requirements

**Table 6.8.1-5 Warm-Air Furnaces and Combination Warm-Air Furnaces/Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters—Minimum *Efficiency* Requirements**

| *Equipment* Type | Size Category (Input) | Subcategory or Rating Condition | Minimum *Efficiency* | Test Procedure[a] |
|---|---|---|---|---|
| Warm-air furnace, gas fired for application outside the U.S. [g] | <225,000 Btu/h | Maximum capacity[c] | 80% *AFUE* (nonweatherized) or 81% *AFUE* (weatherized) or 80% $E_t$ [b,d] | 10 CFR 430 Appendix N or Section 2.39, Thermal *Efficiency*, ANSI Z21.47 |
| Warm-air furnace, gas fired | ≥225,000 Btu/h | Maximum capacity[c] | 80% $E_t$ [b,d] before 1/1/2023 81% $E_t$ [d] after 1/1/2023 | Section 2.39, Thermal *Efficiency*, ANSI Z21.47 |
| Warm-air furnace, oil fired for application outside the U.S. [g] | <225,000 Btu/h | Maximum capacity[c] | 83% *AFUE* (nonweatherized) or 78% *AFUE* (weatherized) or 80% $E_t$ [b,d] | 10 CFR 430 Appendix N or Section 42, Combustion, UL 727 |
| Warm-air furnace, oil fired | ≥225,000 Btu/h | Maximum capacity[c] | 80% $E_t$ [d] before 1/1/2023 82% $E_t$ [d] after 1/1/2023 | Section 42, Combustion, UL 727 |
| Electric furnaces for applications outside the U.S. [g] | <225,000 Btu/h | All | 96% *AFUE* | 10 CFR 430 Appendix N |
| Warm-air duct furnaces, gas fired | All capacities | Maximum capacity[c] | 80% $E_c$ [c] | Section 2.10, *Efficiency*, ANSI Z83.8 |
| Warm-air unit heaters, gas fired | All capacities | Maximum capacity[c] | 80% $E_c$ [e,f] | Section 2.10, *Efficiency*, ANSI Z83.8 |
| Warm-air unit heaters, oil fired | All capacities | Maximum capacity[c] | 80% $E_c$ [e,f] | Section 40, Combustion, UL 731 |

a. Section 12 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.
b. Combination units (i.e., furnaces contained within the same cabinet as an air conditioner) not covered by 10 CFR 430 (i.e., three-phase power or with cooling capacity greater than or equal to 65,000 Btu/h) may comply with either rating. All other units greater than 225,000 Btu/h sold in the U.S. must meet the *AFUE* standards for consumer products and test using USDOE's *AFUE* test procedure at 10 CFR 430, Subpart B, Appendix N.
c. Compliance of multiple firing rate units shall be at the maximum firing rate.
d. $E_t$ = thermal *efficiency*. Units must also include an interrupted or intermittent ignition device (IID), have jacket losses not exceeding 0.75% of the input rating, and have either power venting or a *flue damper*. A *vent damper* is an acceptable alternative to a *flue damper* for those furnaces where combustion air is drawn from the *conditioned space*.
e. $E_c$ = combustion *efficiency* (100% less flue losses). See test procedure for detailed discussion.
f. Units must also include an interrupted or intermittent ignition device (IID) and have either power venting or an automatic flue damper.
g. For U.S. applications of federal covered greater than 225,000 Btu/h products, see Informative Appendix F, Table F-4.

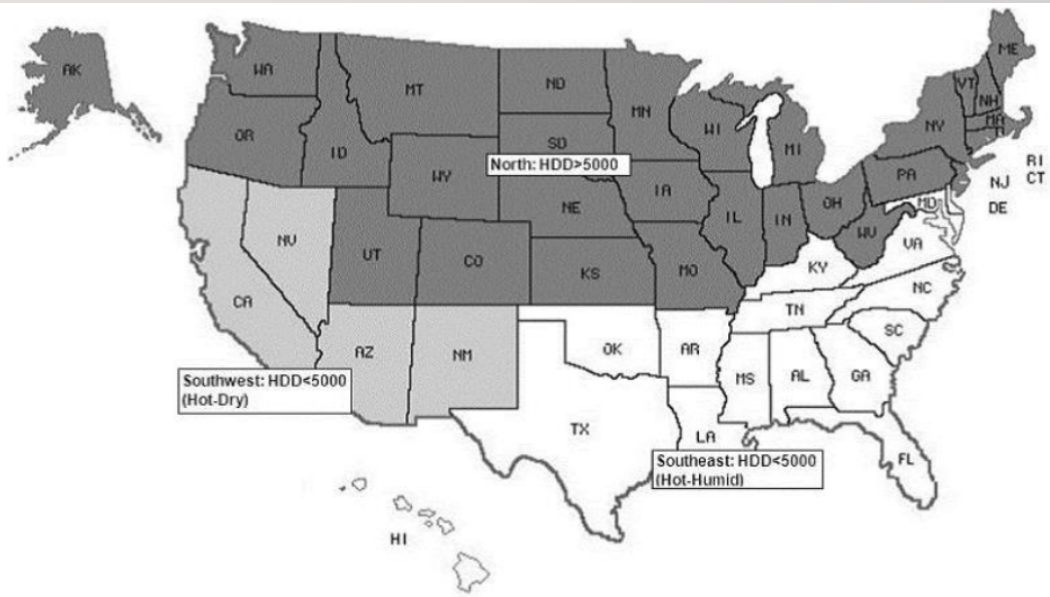



**Figure F-1 Map of the regions for the analysis of central air conditioners and heat pumps.**
(Source: *Federal Register* 76 FR 37431, June 7, 2018)

**Table F-1 Minimum *Efficiency* Requirements for Single-Phase Central Air Conditioners and Heat Pumps for Sale in the U.S**

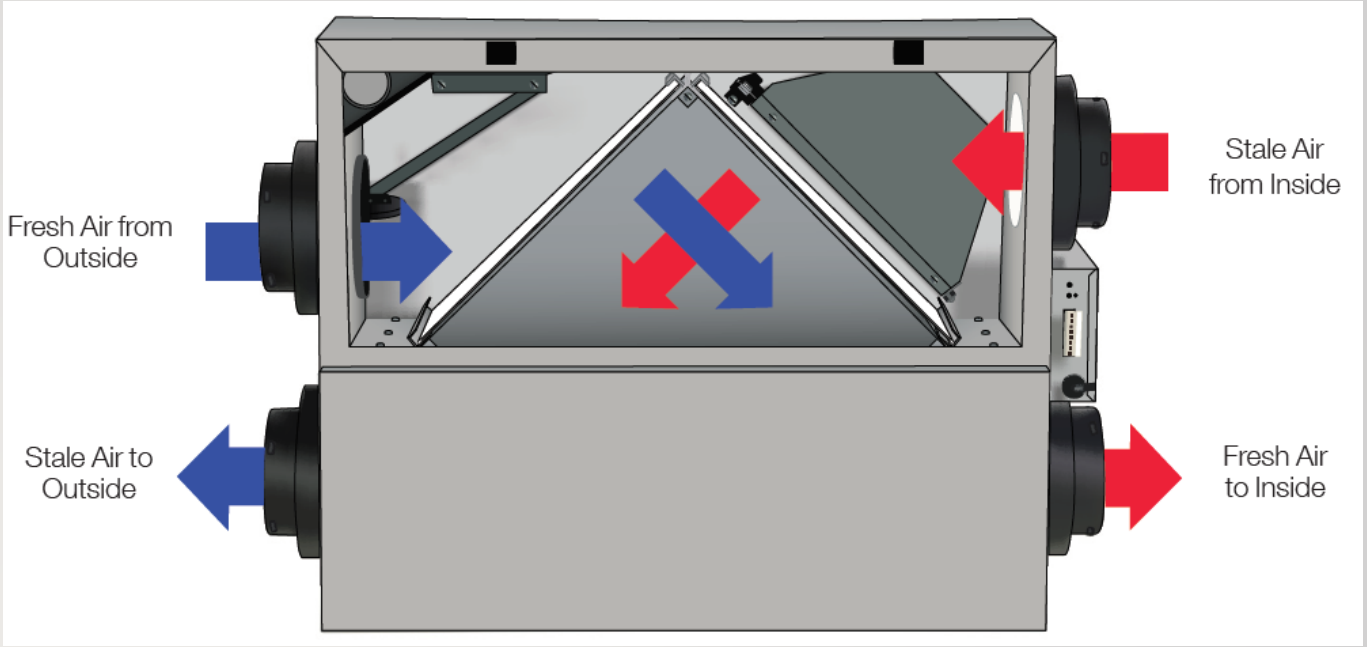
| Product Class | Capacity Range | National Standards | Southeastern Region Standards[a] | Southwestern Region Standards[b] | Test Procedure[f] |
|---|---|---|---|---|---|
| **Central Air Conditioners and Heat Pumps[c]** | | | | | |
| Split-system air conditioners for U.S. applications | <45,000 Btu/h *single phase* | before 1/1/2023 *SEER* = 13.0 $P_{W,OFF} \leq$ 30 W after 1/1/2023 *SEER2* = 13.4 $P_{W,OFF} \leq$ 30 W | before 1/1/2023 *SEER* = 14.0 $P_{W,OFF} \leq$ 30 W after 1/1/2023 *SEER2* = 14.3 $P_{W,OFF} \leq$ 30 W | before 1/1/2023 *SEER* = 14.0 *EER* = 12.2 $P_{W,OFF} \leq$ 30 W after 1/1/2023 *SEER2* = 14.3 *EER2* = 11.7/9.8 [d] $P_{W,OFF} \leq$ 30 W | AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023 |
| Split-system air conditioners | ≥45,000 Btu/h and <65,000 Btu/h *single phase* | before 1/1/2023 *SEER* = 13.0 $P_{W,OFF} \leq$ 30 W after 1/1/2023 *SEER2* = 13.4 $P_{W,OFF} \leq$ 30 W | before 1/1/2023 *SEER* = 14.0 $P_{W,OFF} \leq$ 30 W after 1/1/2023 *SEER2* = 13.8 $P_{W,OFF} \leq$ 30 W | before 1/1/2023 *SEER* = 14.0 *EER* = 11.7[d] $P_{W,OFF} \leq$ 30 W after 1/1/2023 *SEER2* = 13.8 *EER2* = 11.2/9.8[e] $P_{W,OFF} \leq$ 30 W | AHRI 210/240-2017 before 1/1/2023 AHRI 210/240-2023 after 1/1/2023 |

# Miscellaneous

- Removed 10 unused definitions
- Revised test conditions for pool dehumidifiers (AHRI 910) for MRE
- Air barrier and leakage testing
  - Not mechanical – but very important to HVAC engineers!
  - Two major guesses in HVAC load calcs:
    - Infiltration
    - Internal Heat Gains (RP-1742 = 0.34-1.53 W/SF)
- Clarified much wording, e.g. humidification & dehumidification

# Miscellaneous 2

- Added indoor pool dehumidifier energy recovery:
  - 50% EA sensible recovery, or
  - Condenser pool heating, or
  - 50% EA enthalpy recovery
- Air Curtains
  - NOT MECHANICAL – but affects MEs
  - What should HVAC engineers figure for lobby infiltration loads?
- Motor selection
  - Simplified
  - Made more tolerant of motors not rated in BHP



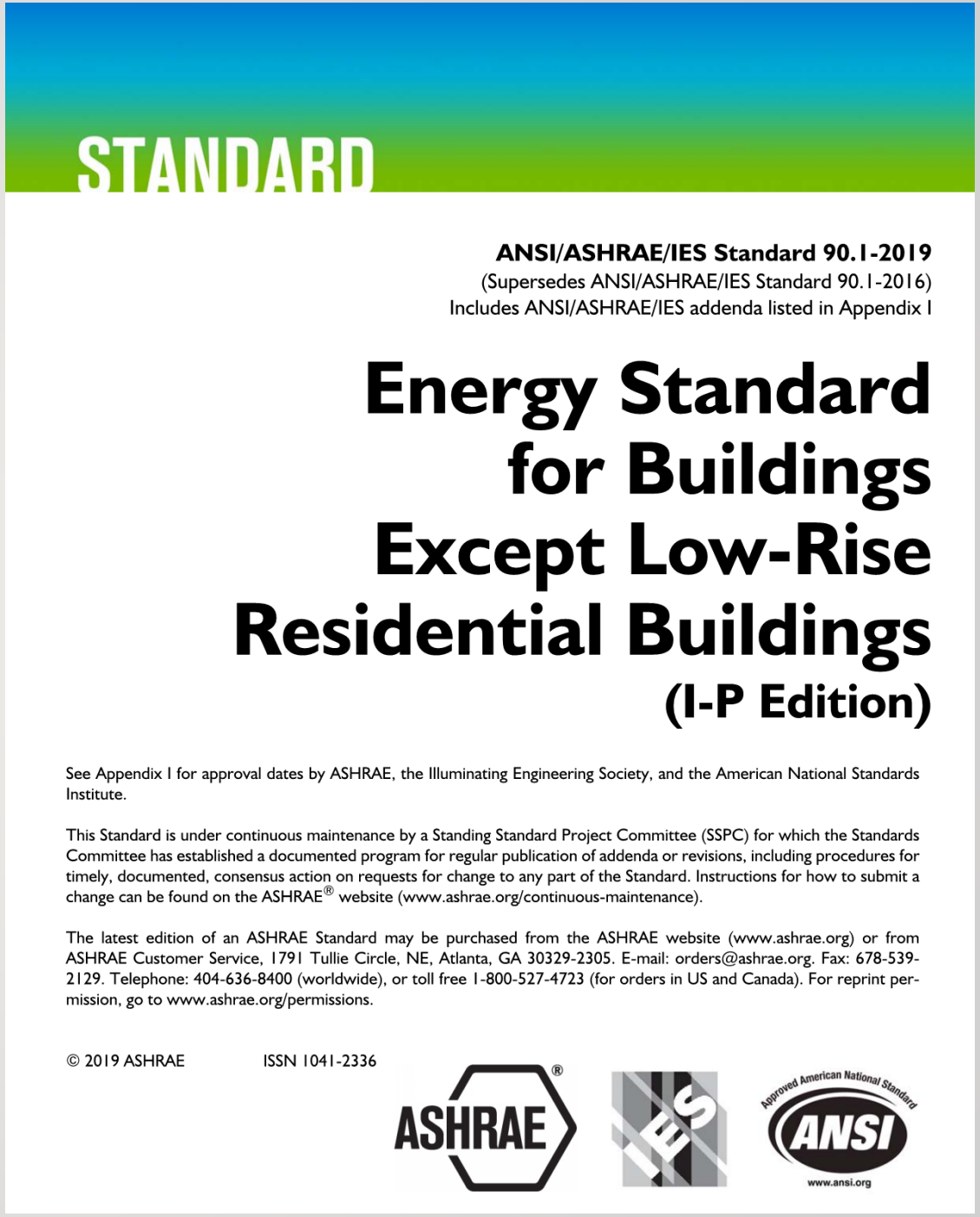
# Miscellaneous 3

- Starting to incorporate Guideline 36 recommendations, especially in reheat limitations and fan speed vs. SAT reset sequences

# Suggestions – Ideas

- We want to hear your ideas to conserve more energy economically!
- Please send me or anyone on the committee your ideas.
- Stop in at a meeting, or attend our monthly web-meetings. All are welcome.
- Test out whether you are a future 90.1 committee member!

- Thank You



STANDARD

**ANSI/ASHRAE/IES Standard 90.1-2019**
(Supersedes ANSI/ASHRAE/IES Standard 90.1-2016)
Includes ANSI/ASHRAE/IES addenda listed in Appendix I

# Energy Standard for Buildings Except Low-Rise Residential Buildings
## (I-P Edition)

See Appendix I for approval dates by ASHRAE, the Illuminating Engineering Society, and the American National Standards Institute.

This Standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the Standard. Instructions for how to submit a change can be found on the ASHRAE® website (www.ashrae.org/continuous-maintenance).

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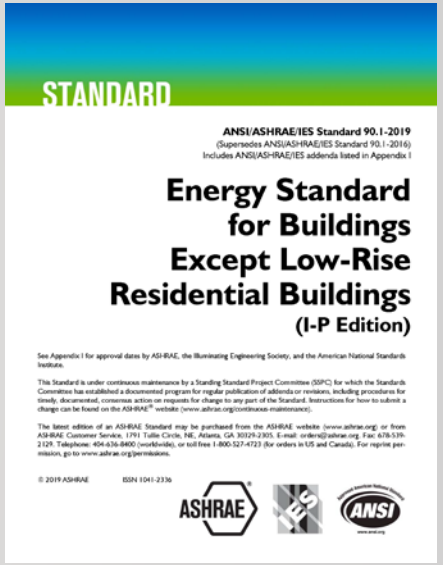
# LIGHTING UPDATES

**Michael Myer, PNNL**

**Member, Lighting Subcommittee**

# LIGHTING: SCOPE AND APPLICATION

- Lighting powered by a building's electrical service – can include lighting in buildings, mounted to buildings, and on building sites
- Nonresidential buildings greater than three stories, includes multi-family residential bldgs
- Applies to new construction and major renovation, tenant fit-outs of existing buildings, additions to buildings, and retrofits of existing lighting systems
- Prescribes limits for installed power (*in watts/sq. ft.*)
- Mandates functional requirements for lighting controls
- Requirements vary by application (e.g., office, retail sales area, warehouse, classroom, patient room, etc.)



# LIGHTING: COMPLIANCE

## Mandatory Provisions

### Prescribed Limits for Lighting Power

Building area method
Space-by-space method

### Lighting Control Requirements

Local control
Dimming control
Daylighting control
Automatic shut-off control
Parking garage control
Power reduction
Parking lot luminaire control

### Electric Power Requirements

Voltage drop
Automatic receptacle control
Metering. Monitoring, reporting

## Simplified method for lighting

# AGENDA: SUMMARY OF UPDATES

1) Updated Lighting Model for LPD calculations
2) Updated LPD allowances in Sections NEW [9.5.1, 9.6.1]
3) New Simplified lighting method for select buildings up to 25,000 sq. ft. [9.3]
4) Updated Interior and exterior lighting wattage [9.1.4]
5) Updated Parking garage lighting control requirements [9.4.1.2]
6) Updated Special applications lighting and controls [9.4.1.2]
7) Updated Daylighting control requirements [9.4.1.1]
8) Updated Daylighting zones [3.2, 9.4.1.1(e)]
9) Updated Daylighting for sidelighting requirements [9.4.1.1(e)]
10) Updated LPDs for non-typical exterior areas [9.4.2]

# 1. LIGHTING: 90.1-2019 LIGHTING MODEL

- 90.1 lighting methodology used to develop LPAs was evaluated and the model reconstructed
- Now more representative of real-world conditions
- Updated IES recommendations, room cavity ratios, light loss factors, and efficacy values
- Additional surface reflectance categories added
- Features a 100% LED baseline

# 2. INTERIOR LIGHTING POWER ALLOWANCES SPACE BY SPACE METHOD

- Average LPD reduction from 2016: **5%**
- Space-by-space values are primary
- Building area method LPDs values flow from the space-by-space

**Space-by-Space Method – Lighting Power Densities (w/sq. ft.)**

| Space Type | 90.1 2016 | 90.1 2019 |
|---|---|---|
| Office, open plan | 0.81 | 0.61 |
| Guest room | 0.77 | 0.41 |
| Lobby, hotel | 1.06 | 0.51 |
| Parking area, interior | 0.14 | 0.15 |
| Retail sales Area | 1.22 | 1.05 |
| Classroom/lecture/training | 0.92 | 0.71 |
| Warehouse, med. To bulky items | 0.35 | 0.33 |


**Addendum BB**

# 2. INTERIOR LIGHTING POWER ALLOWANCES BUILDING AREA METHOD

- Average LPD reduction from 2016: 5%
- BAM values flow from the space-by-space values

**Building Area Method – Lighting Power Densities (w/sq. ft.)**

| Building Type | 90.1 2016 | → | 90.1 2019 |
|---|---|---|---|
| Office | 0.79 | → | 0.64 |
| Hotel/Motel | 0.75 | → | 0.56 |
| Manufacturing Facility | 0.90 | → | 0.82 |
| Parking Garage | 0.15 | → | 0.18 |
| Retail | 1.06 | → | 0.84 |
| School/University | 0.81 | → | 0.72 |
| Warehouse | 0.48 | → | 0.45 |

**Addendum CG**

# 3. NEW COMPLIANCE METHOD FOR LIGHTING IN SIMPLE BUILDINGS

- Intended for contractors who design or renovate office, school, and retail buildings up to 25,000 sq. ft.
- Single interior and exterior LPD targets that cover the entire building, LPAs are lower than other methods
- Requires occupancy sensor lighting control in most spaces with some exemption where life safety concerns apply
- All power from all lights must be counted towards the Interior Lighting Power Allowance ILPA **No Exemptions**

**Addendum BG**

# 3. NEW COMPLIANCE METHOD FOR LIGHTING IN SIMPLE BUILDINGS

**Table 9.3.1-3 Simplified Building Method for School *Buildings***

| Interior *Space* Type | Interior Lighting Power Allowance | *Controls* [a] |
|---|---|---|
| All *spaces* in school *buildings* other than parking garages, stairwells, and corridors | 0.70 W/ft$^2$ | All lighting shall be *automatically* controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied. (**Exception:** Lighting load not exceeding 0.02 W/ft$^2$ multiplied by the gross lighted area of the *building* shall be permitted to operate at all times.)<br>Each *space* shall have a *manual control* device that allows the occupant to reduce lighting power by a minimum of 50% and to turn the lighting off. |
| Classrooms, offices *spaces*, conference rooms, meeting rooms, library, storage rooms, and break rooms | 0.70 W/ft$^2$ | These *spaces* shall also be controlled by *manual-ON occupant sensors*. |
| Gymnasiums and cafeterias | 0.70 W/ft$^2$ | These *spaces* shall also be controlled by *occupant sensors*. |
| Restrooms | 0.70 W/ft$^2$ | These *spaces* shall also be controlled by *occupant sensors*. |
| Stairwells and corridors in school *buildings* and parking garages | 0.70 W/ft$^2$ | These *spaces* shall also be controlled by *occupant sensors* that reduce the lighting power by a minimum of 50% when no activity is detected for not longer than 20 minutes and be controlled to turn off when the *building* is either unoccupied or scheduled to be unoccupied. |
| Parking garages | 0.13 W/ft$^2$ | All lighting shall be *automatically* controlled to turn off during garage nonoperating hours. Lighting shall also be controlled by *occupant sensors*. *Controls* shall reduce the power by a minimum of 50% when no activity is detected for not longer than 20 minutes. No device shall control more than 3600 ft$^2$. |

a. All lights in the space shall be controlled.

**Addendum BG**

# 3. NEW COMPLIANCE METHOD FOR LIGHTING IN SIMPLE BUILDINGS

**Table 9.3.2 Simplified Building Method for *Building* Exteriors**

| Exterior Area Type | *Exterior Lighting Power Allowance*[a,b] | *Controls*[c] |
|---|---|---|
| Base allowance | 200 W | *Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours. |
| Façade lighting and special feature areas, walkways, plazas | 0.10 W/ft$^2$ | *Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours. |
| Landscape | 0.04 W/ft$^2$ | *Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours. |
| Entry doors | 14 W/linear foot | *Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours. |
| Stairs and ramps | 0.7 W/ft$^2$ | No additional *controls* required. |
| Parking lots and drives | 0.05 W/ft$^2$ | *Luminaires* mounted 25 ft or less above grade shall be controlled to reduce the power by at least 50% when no activity is detected for not longer than 15 minutes. |
| All other areas not listed | 0.20 W/ft$^2$ | *Luminaires* shall be turned off or the power reduced by a minimum of 75% during nonoperating hours. |

a. To calculate the exterior allowance, multiply the *space* or area square footage by the allowed W/ft$^2$ and sum the exterior allowances and the base allowance. Façade lighting shall be calculated separately by multiplying the façade area by the allowed W/ft$^2$. Façade allowance shall not be traded with other exterior areas or between separate *façade areas*.
b. For *buildings* in Lighting Zone 2, as defined in Table 9.4.2-1, decrease exterior allowances by 20%. For *buildings* in Lighting Zone 4, as defined in Table 9.4.2-1, increase exterior allowances by 25%.
c. All exterior lighting shall be automatically controlled by either a photocell or an astronomical time switch to shut off the lighting when daylight is available.

**Addendum BG**

# 4. INTERIOR AND EXTERIOR LIGHTING WATTAGE

- Replaced *luminaire* with *lighting equipment*
- Changed the term *ballast* to be *ballast/driver*
- Section now clearly split into 5 categories:
  1. Line voltage lighting equipment
  2. Line voltage lighting equipment with remote ballast/driver
  3. Track/plug-in busway
  4. Low-voltage track
  5. DC low voltage lighting systems with flexible cabling for plug-in connection of lighting equipment and remote power supply (e.g., PoE lighting)

NEW

- Wattage of a DC low voltage lighting system that employs flexible cabling for plug-in connection of the lighting equipment and a remote power supply shall be the labeled maximum wattage of the system power supply
- For systems that also provide power to equipment other than lighting, the wattage shall be the labeled maximum wattage of the system power supply reduced by the wattage of the non-lighting equipment connected to the system

**Addendum AH**

# 5. PARKING GARAGE LIGHTING CONTROL REQUIREMENTS

- Increased the stringency of setback in parking garages – % reduction & time period
- Updated control requirements for transition lighting
- Continuous daylight dimming down to 50% required for luminaires within 20 ft. of wall openings

NEW

- **NEW** exemptions for permanent architectural screens or architectural elements that obstruct more than 50% of the opening and where the top of and existing adjacent structures or natural objects is at least twice as high above the openings as its horizontal distance from the opening.

**Parking Garages**

| | 90.1 2016 | 90.1 2019 |
|---|---|---|
| **Time** | 20 | 10 |
| **Reduction** | 30% | 50% |

**Addendum CV**

# 6. SPECIAL APPLICATIONS LIGHTING AND CONTROLS

- Clarified the lighting control requirements for lighting applications not specifically covered in Table 9.6.1 and aligned them to the mandatory control provisions in 9.4.1

| Item # | Equipment/Application | In Addition to and controlled Separately from *General Lighting* | Required Controls |
|---|---|---|---|
| 1 | Lighting that is integral to *equipment*, medical *equipment* or instrumentation and is installed by its *manufacturer.* | YES | No control requirements |
| 2 | Lighting specifically designed for use only during medical or dental procedures | YES | 9.4.1.1(a) - Local control |
| 8 | Lighting integral to both open and glass-enclosed refrigerator and freezer cases. | YES | 9.4.1.1(h) - Automatic full OFF or 9.4.1.1(i) - Scheduled shutoff |
| 9 | Casino gaming areas. | NO | |
| 10 | Lighting in retail display windows, provided the display area is enclosed by ceiling-height partitions. | YES | 9.4.1.1(a) - Local control and 9.4.1.1(i) - Scheduled shutoff |

**Addendum AQ**



# 7. DAYLIGHTING CONTROL REQUIREMENTS

NEW

- **NEW:** Continuous daylight dimming required for all spaces
  - Step dimming (control points) eliminated from requirements
- Calibration for automatic daylight responsive controls for sidelighting no longer requires the physical presence of a person at the sensor while processing
- Low setting for the photocontrol to reduce electric lighting power in response to available daylight using continuous dimming set to '20% or less or off'
- When an *automatic* partial OFF control has reduced the lighting power to the unoccupied setpoint, the daylight responsive control shall adjust the electric light in response to available daylight, but it shall not allow the lighting power to be above the unoccupied setpoint

***continuous dimming***: a lighting control strategy that varies the light output of a *lighting system* over a continuous range from full light output to a minimum light output in imperceptible steps without flickering.

**Addendum CW**

# 8. DAYLIGHTING ZONES

NEW

- **NEW:** Added definition for daylight area under skylights in multi-story space
- Added two figures for clarity
- Added an exemption for primary sidelighted areas adjacent to vertical fenestration that have external projections and no *vertical fenestration* above the external projection and *projection factor* >1.0 for *north-oriented* projections or where the external projection has a *projection factor* > 1.5 for all other orientations

***daylight area under skylights in multistory spaces:*** the *daylight area under skylights in multi-story spaces* shall include *floor* areas directly beneath the skylight and portions of the uppermost *floor* adjacent to the multistory space that meet the criteria for a *daylight area under skylights,* where CH is the ceiling height of the uppermost *floor*

**Addendum CH**

# 9. DAYLIGHTING FOR SIDELIGHTING REQUIREMENTS

- Modified the sidelighting requirements to clarify that the setback distance is a horizontal measurement
- Added natural objects as obstructions in addition to existing adjacent structures
- Removed an error that inadvertently set an exact measurement for an obstruction (instead of saying at least twice as high above the windows as its horizontal distance away from the windows)

**Addendum CY**



# 9. SELECTING LPDs FOR NON-TYPICAL EXTERIOR AREAS

- Clarified how to select an LPD for an exterior area not *already* listed in Table 9.4.2-2 by moving the language from 9.4.2 to a new explanatory row at the end of Table 9.4.2-2
- Interior LPDs from Table 9.6.1 are referenced and an appropriate reduction is applied to recognize the reduced power and illumination needs in exterior applications.

| | | | | | |
|---|---|---|---|---|---|
| For areas that are not listed in this Table or are not comparable to areas listed in this Table, use the comparable interior *space* type from Table 9.6.1 as modified by the factors in this row | No allowance | 65% of the *interior lighting power allowance* value | 65% of the *interior lighting power allowance* value | 80% of the *interior lighting power allowance* value | 100% of the *interior lighting power allowance* value |

**Addendum T**

# Overview of Whole Building Performance Changes

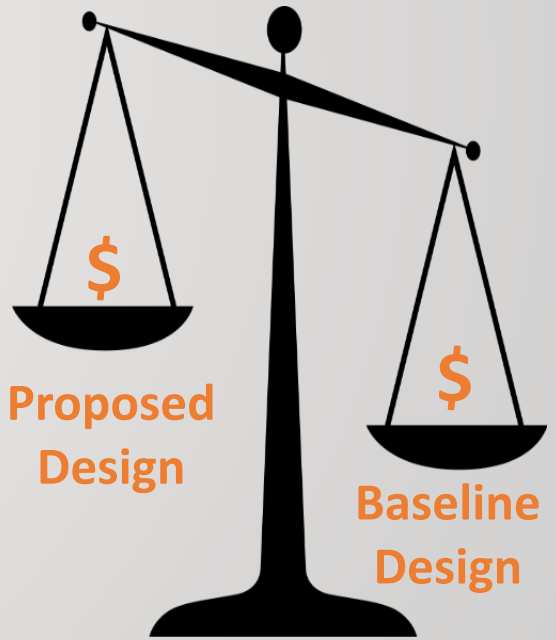
**Michael Rosenberg, Pacific Northwest National Laboratory**

**SSPC 90.1 Energy Cost Budget Subcommittee**

# WHOLE BUILDING PERFORMANCE REFRESHER

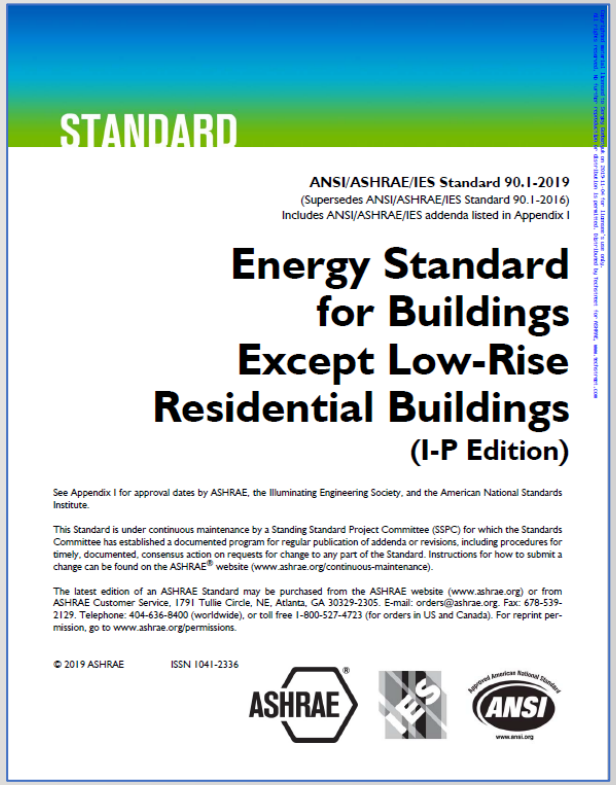
- Standard 90.1 Includes Two Whole Building Performance Path Options
  - Both compare the energy cost of a proposed building design to a baseline

1. Energy Cost Budget (ECB), Section 11
   - Baseline systems and components are same as proposed building, but at minimum, current prescriptive efficiency (**dependent baseline**)
2. Performance Rating Method (PRM), Appendix G
   - Baseline systems and components based on the architectural program and location of a building (**independent baseline**)
   - Baseline set at efficiency ~ equal to 2004 standard with proposed design required to exceed the baseline (**stable baseline**)



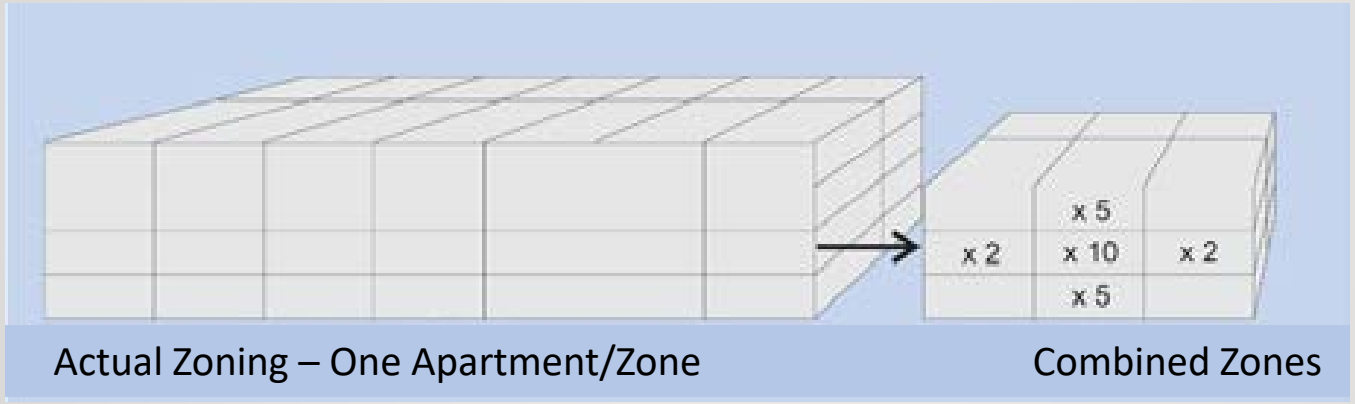
# HIGH LEVEL SUMMARY OF CHANGES

- 23 Addenda Impacting ECB and Appendix G Incorporated in 2019
  - Section 11
    - Changes to align with Appendix G where appropriate
    - Add clarifications
    - Update baseline for consistency with prescriptive requirements
  - Appendix G
    - Clean up oversites and inconsistencies
    - Tighten definition of baseline
    - Support consistent modeling and automation



# WHAT'S NEW IN 2019 – APPENDIX G

- **Addendum F** – HVAC Efficiency for Combined Zones
  - Where thermal zones are combined into a single thermal block for model simplification, baseline equipment efficiency determined by individual zone size

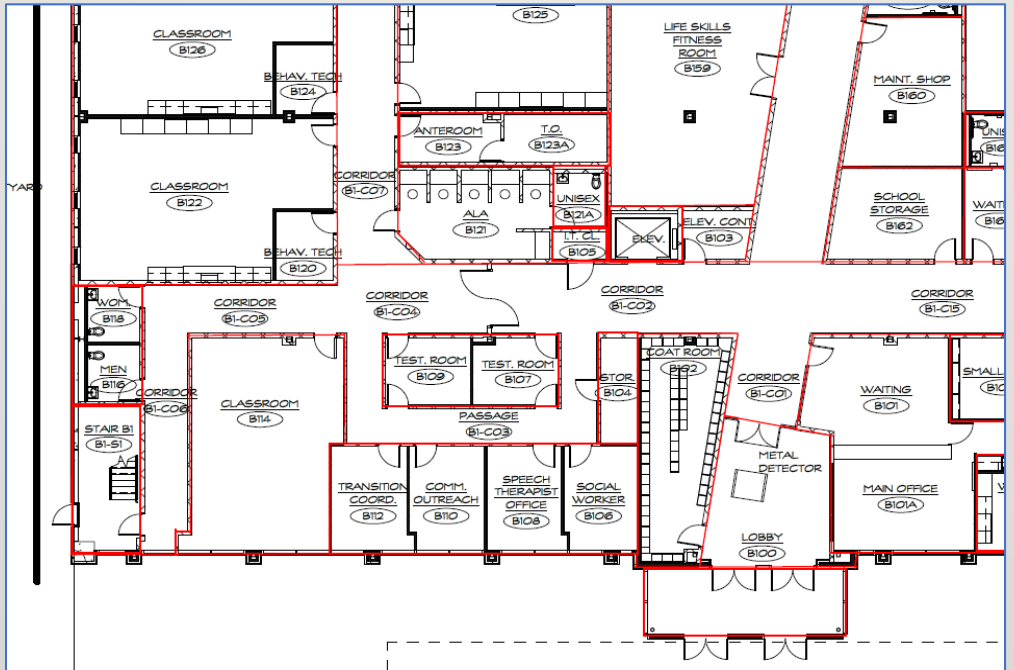



**Thermal Blocks for Apartment Building**

*equipment capacity for efficiency = equip capacity of thermal block/# zones*

# WHAT'S NEW IN 2019 – APPENDIX G

- **Addendum AL** – Thermal Zones and Spaces
  - Adds a requirement that thermal zones to be combined into a thermal block only if peak internal loads differ by less than 10 Btu/h-ft$^2$ from average of other zones
  - Replaces references to "spaces" with "*HVAC zones*" when describing requirements for fan system operation
  - Requires that space classification use the lighting Space-By-Space table (Table 9.6.1) instead of Building Area table (Table 9.5.1) unless space type is not known (ex., prior to tenant buildout)



# WHAT'S NEW IN 2019 – APPENDIX G

- **Addendum D** – Future Building Components
  - Not-yet-designed components (such as future tenant buildouts) are modeled to comply with current prescriptive requirement
    - Future commitments not rewarded or penalized
- **Addendum E** – Service Water Heating
  - Specifies that piping losses should not be modeled
  - Clarifies that when a proposed design includes a combined space and water heating systems, the baseline uses two separate systems

# WHAT'S NEW IN 2019 – APPENDIX G

- **Addendum L** – Fan Power for Systems 12 and 13
  - Fixes an oversite where baseline fan power was not prescribed for systems 12 and 13 (single zone, constant volume with hot water and electric heat respectively)

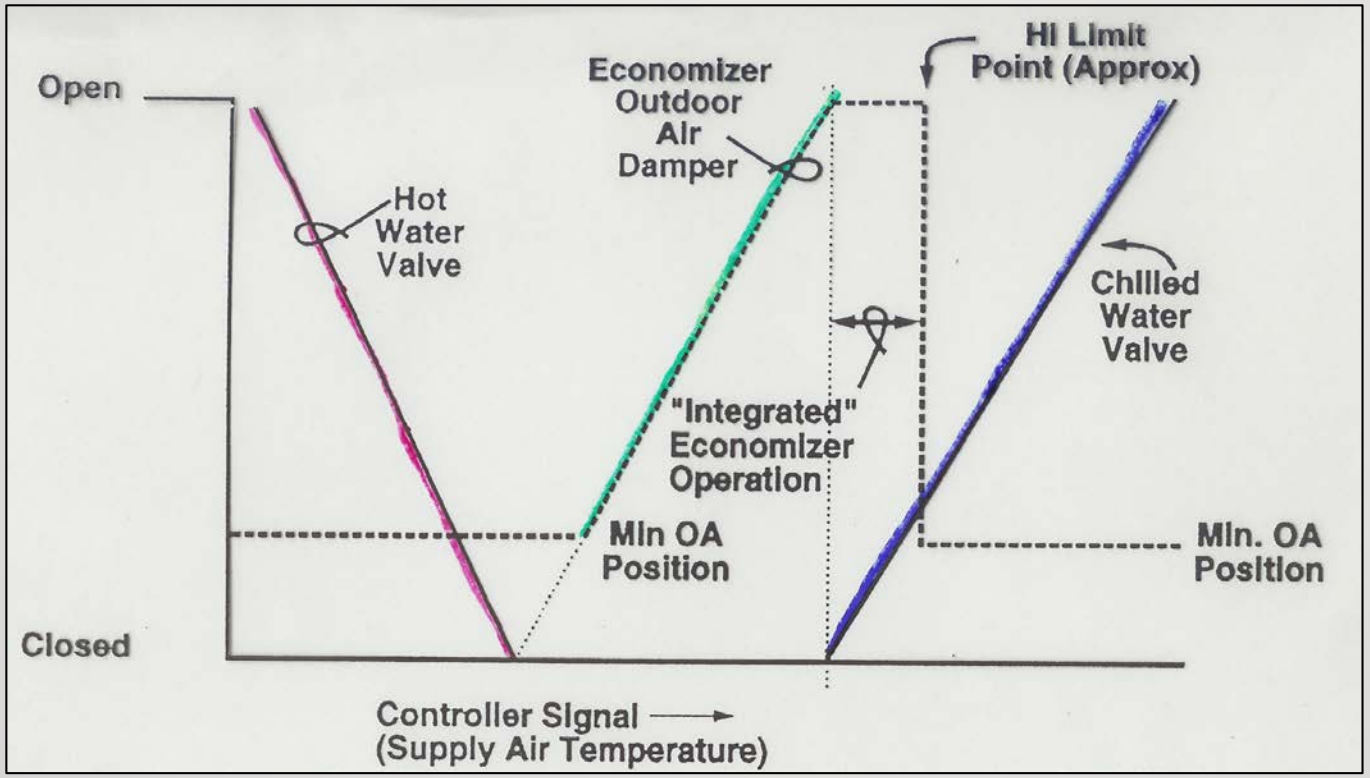
Table G3.1.2.9 Baseline *Fan Brake Horsepower*

| Baseline Fan Motor Brake Horsepower | | |
|---|---|---|
| Constant-Volume *Systems* 3, ~~to~~ 4, 12, and 13 | Variable-Volume *Systems* 5 to 8 | Variable-Volume *System* 11 |
| $CFM_S \times 0.00094 + A$ | $CFM_S \times 0.0013 + A$ | $CFM_S \times 0.00062 + A$ |

- **Addendum M** – Infiltration Modeling
  - Specifies that infiltration in proposed building model is set at 0.6 cfm/ft$^2$ if prescriptive air barrier requirements met
  - Sets baseline infiltration at 1.0 cfm/ft$^2$

# WHAT'S NEW IN 2019 – APPENDIX G

- **Addendum R** – Integrated Economizers
  - Clarifies that baseline economizers must be simulated as integrated with mechanical cooling




**Typical Integrated Economizer Control**

# WHAT'S NEW IN 2019 – APPENDIX G

- **Addendum Y** – Baseline Sizing Runs
  1. Clarifies that baseline system oversizing applies only to heating and cooling coil capacities, not airflow
  2. Specifies that baseline central plant capacities are sized based on coincident loads
  3. Specified that design day runs must use *heating design temperature (99.6% DB)* and *cooling design temperature (1% DB &WB)*
  4. Specifies internal gains used in sizing runs
     - Heating – values equal to lowest annual hourly value
     - Cooling – values equal to highest annual hourly value (except for residential occupancies which use the most frequent value)

# WHAT'S NEW IN 2019 – APPENDIX G

- **Addendum S** – Renewable Energy Tradeoffs
  - Limits the amount of renewable energy available for tradeoff to 5% of the baseline energy cost
    - Only applies when Appendix G is used for minimum compliance

*If renewable energy contribution >5% of BBP*

$$PCI + [(PBP_{nre} - PBP)/BBP] - 0.05 < PCI_t$$

where

PBP = proposed building energy cost

BBP = baseline building energy cost

PCI = Performance Cost Index (proposed energy cost/baseline energy cost)

$PCI_t$ = Performance Cost Index target (PCI required for minimum compliance)

$PBP_{nre}$ = Proposed energy cost without any credit for renewable energy

# WHAT'S NEW IN 2019 – APPENDIX G

- **Addendum AG** – Receptacle Control Power Credit
  - Provides a methodology for receiving credit for installing automatic receptacle controls when not required
- **Addendum AK** – Default Baseline SHGC and Visible Transmittance (VT) for fenestration
  - Provides default SHGC and VT values in Table G3.4.1-8 instead of sending modeler to Appendix C

**Table G3.4-6 *Performance Rating Method Building Envelope* Requirements for Climate Zone 6 (A,B)**

| Fenestration | Assembly Max. U | Assembly Max. *SHGC* | Visible Transmittance | Assembly Max. U | Assembly Max. *SHGC* | Visible Transmittance | Assembly Max. U | Assembly Max. *SHGC* | Visible Transmittance |
|---|---|---|---|---|---|---|---|---|---|
| Vertical Glazing, % of *Wall* | | | | | | | | | |
| 0% to 10.0% | $U_{all}$-0.57 | $SHGC_{all}$-0.49 | $VT_{all}$-0.54 | $U_{all}$-0.57 | $SHGC_{all}$-0.49 | $VT_{all}$-0.54 | $U_{all}$-1.22 | $SHGC_{all}$-0.40 | $VT_{all}$-0.44 |
| 10.1% to 20.0% | $U_{all}$-0.57 | $SHGC_{all}$-0.39 | $VT_{all}$-0.43 | $U_{all}$-0.57 | $SHGC_{all}$-0.39 | $VT_{all}$-0.43 | $U_{all}$-1.22 | $SHGC_{all}$-0.40 | $VT_{all}$-0.44 |
| 20.1% to 30.0% | $U_{all}$-0.57 | $SHGC_{all}$-0.39 | $VT_{all}$-0.43 | $U_{all}$-0.57 | $SHGC_{all}$-0.39 | $VT_{all}$-0.43 | $U_{all}$-1.22 | $SHGC_{all}$-0.40 | $VT_{all}$-0.44 |
| 30.1% to 40.0% | $U_{all}$-0.57 | $SHGC_{all}$-0.39 | $VT_{all}$-0.43 | $U_{all}$-0.57 | $SHGC_{all}$-0.39 | $VT_{all}$-0.43 | $U_{all}$-1.22 | $SHGC_{all}$-0.40 | $VT_{all}$-0.44 |

# WHAT'S NEW IN 2019 – APPENDIX G

- **Addenda BT & CI** – Updates Building Performance Factors (BPFs)
  - BPFs used to set performance targets for compliance using Appendix G

$$PCI_t = [BBUEC + (BPF \times BBREC)]/BBP$$

  - Represents the energy cost of Standard 90.1-2019/energy cost of Standard 90.1-2004
  - Needs to be updated with each new edition of 90.1

**Table 4.2.1.1 *Building* Performance Factor (BPF)**

| *Building* Area Type | Climate Zone | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0A and 1A | 0B and 1B | 2A | 2B | 3A | 3B | 3C | 4A | 4B | 4C | 5A | 5B | 5C | 6A | 6B | 7 | 8 |
| Multifamily | 0.68 | 0.70 | 0.66 | 0.66 | 0.69 | 0.68 | 0.59 | 0.74 | 0.76 | 0.74 | 0.70 | 0.73 | 0.75 | 0.68 | 0.71 | 0.68 | 0.72 |
| Healthcare/ hospital | 0.60 | 0.60 | 0.58 | 0.54 | 0.56 | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.57 | 0.52 | 0.54 | 0.57 | 0.52 | 0.57 | 0.57 |
| Hotel/motel | 0.55 | 0.53 | 0.53 | 0.52 | 0.53 | 0.54 | 0.54 | 0.53 | 0.53 | 0.52 | 0.50 | 0.51 | 0.51 | 0.50 | 0.51 | 0.50 | 0.50 |
| Office | 0.52 | 0.57 | 0.50 | 0.56 | 0.53 | 0.56 | 0.48 | 0.51 | 0.52 | 0.49 | 0.51 | 0.51 | 0.49 | 0.52 | 0.51 | 0.49 | 0.51 |
| Restaurant | 0.63 | 0.64 | 0.60 | 0.60 | 0.60 | 0.61 | 0.58 | 0.62 | 0.57 | 0.61 | 0.63 | 0.60 | 0.64 | 0.65 | 0.62 | 0.67 | 0.70 |
| Retail | 0.51 | 0.54 | 0.49 | 0.55 | 0.51 | 0.55 | 0.53 | 0.51 | 0.55 | 0.54 | 0.50 | 0.54 | 0.55 | 0.50 | 0.51 | 0.48 | 0.50 |
| School | 0.39 | 0.47 | 0.38 | 0.43 | 0.38 | 0.42 | 0.40 | 0.37 | 0.40 | 0.38 | 0.36 | 0.40 | 0.36 | 0.36 | 0.37 | 0.36 | 0.37 |
| Warehouse | 0.38 | 0.42 | 0.40 | 0.42 | 0.43 | 0.44 | 0.43 | 0.44 | 0.43 | 0.46 | 0.49 | 0.47 | 0.48 | 0.54 | 0.51 | 0.57 | 0.57 |
| All others | 0.56 | 0.57 | 0.50 | 0.52 | 0.50 | 0.54 | 0.53 | 0.53 | 0.52 | 0.54 | 0.51 | 0.51 | 0.50 | 0.50 | 0.50 | 0.50 | 0.46 |

# WHAT'S NEW IN 2019 – APPENDIX G

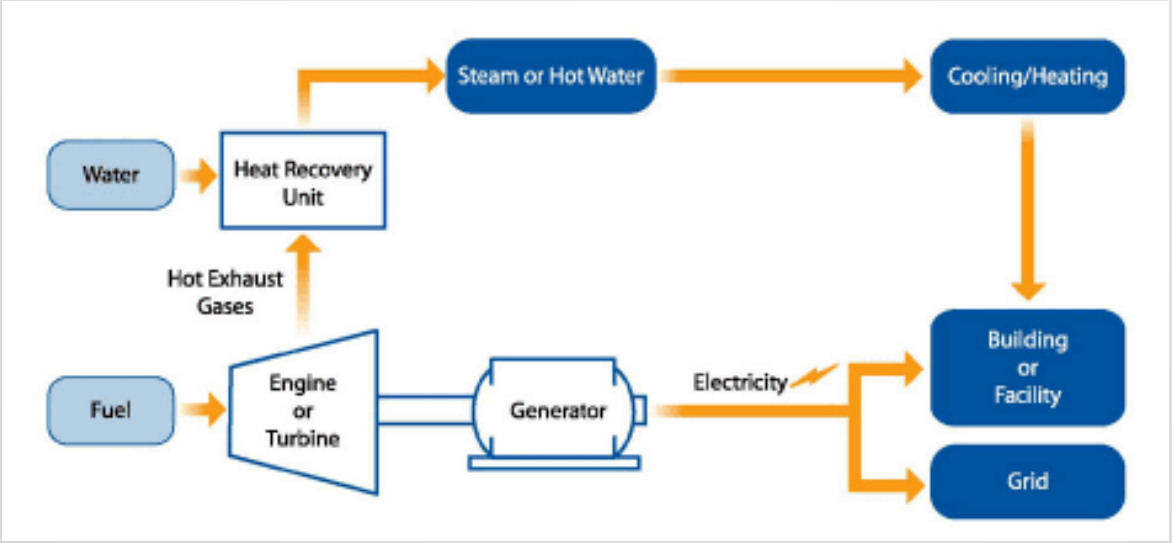
- **Addendum AZ** – Refrigeration System Modeling
  - Specifies that proposed building refrigeration systems rated in accordance with AHRI 1200 should be modeled with the rated energy use
- **Addendum BA** – Unspecified Baseline Values
  - Establishes how baseline is determined when allowed to differ from proposed design, but is unspecified (SWH loads, cooking equipment, laboratory equipment, etc.)
    1. According to requirements in Sections 5-10
    2. In accordance with other codes or standards applicable to the building (plumbing code, ventilation code, OHSA, etc.)

# WHAT'S NEW IN 2019 – APPENDIX G

- **Addenda AR & BU** – Minor Table and Language Cleanup
  - Adds "Performance Rating Method" to table titles in Appendix G, etc.
  - Removes redundant footnotes (Tables 4.2.1.1, G3.1.1-1, G3.4.x)
  - Removes leftover baseline references to proposed heating source
  - Changes "spaces" to "zones" in several instances
  - Changes "process loads" to "internal gains"
  - Fixes section headings that included incorrect system numbers

# WHAT'S NEW IN 2019 – Appendix G & ECB

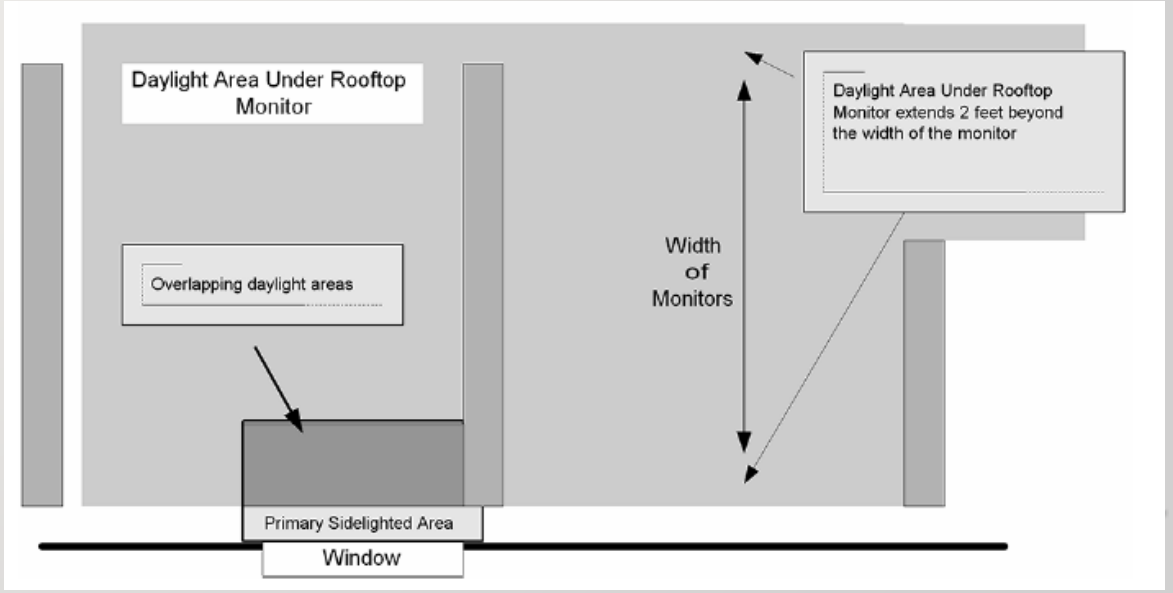
- **Addendum AT** – Recharging and Refueling Vehicles
  - Energy for recharging or refueling vehicles used off-site are not counted when calculating proposed building energy cost
- **Addendum BK** – On-site Electricity Generation (OSEG)
  - Typically generators, CHP, or fuel cells
  - If proposed design includes OSEG, baseline includes same generation system, but no recovered heat.



# WHAT'S NEW IN 2019 – APP G & ECB

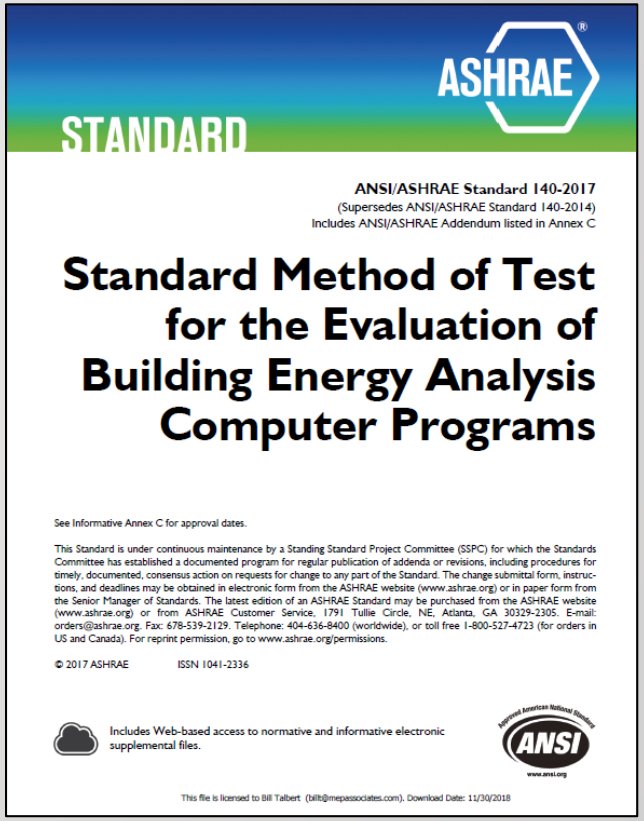
- **Addendum CJ** – Various Lighting Changes
  - ECB
    1. For dwelling units, guestrooms and other spaces with plug-in lighting not shown on plans, baseline LPD = proposed LPD
    2. Sets baseline LPD for dwelling units at 0.6 W/ft2
    3. For existing lighting systems and spaces without lighting designs (future buildout), baseline LPD = proposed LPD
    4. Requires that daylighting calculations treat primary sidelit, secondary sidelit, and toplit areas separately

  - Appendix G
    1. For dwelling units, guestrooms and other spaces with plug-in lighting not shown on plans, proposed LPD = 0.6 W/ft2 or as designed, whichever is greater. Expect fixtures with higher efficacy can be demonstrated through calculations
    2. Sets baseline LPD for dwelling units at 1.07 W/ft2



# WHAT'S NEW IN 2019 – APP G & ECB

- **Addendum BI** – Testing to ASHRAE Standard 140
  - Simulation tools previously been required to test in accordance with Standard 140
  - Now must also:
    - Post results on a public website alongside results from reference software.
    - Complete Standard 140 reports for results falling outside reference values
    - Applicant provide link with model submittal
    - Still no pass/fail criteria provided



# WHAT'S NEW IN 2019 – APP G & ECB

- **Addendum Z** – Baseline Packaged Equipment Efficiency Calculation ($COP_{no\ fan}$)
  - **In ECB** the formula cooling capacity (Q) is capped at 63 Tons.

    *For example*: $COP_{nfcooling} = 7.84E\text{-}8 \times EER \times Q + 0.338 \times EER$
  - In **Appendix G** formula is no longer needed – instead, $COP_{no\ fan}$ for all applicable equipment is listed in Tables G3.5.1 and G3.5.2.

    *For example*:

**Table G3.5.1** ***Performance Rating Method*** **Air Conditioners (efficiency ratings excluding supply fan power)**

| ***Equipment*** **Type** | **Size Category** | **Heating Section Type** | **Subcategory or Rating Condition** | ***Efficiency*** |
|---|---|---|---|---|
| Air conditioners, air-cooled | <65,000 Btu/h | All | Single-package | 3.0 $COP_{nfcooling}$ |
| | ≥65,000 Btu/h and <135,000 Btu/h | | Split-*system* and single-package | 3.5 $COP_{nfcooling}$ |
| | ≥135,000 Btu/h and <240,000 Btu/h | | | 3.4 $COP_{nfcooling}$ |
| | ≥240,000 Btu/h and <760,000 Btu/h | | | 3.5 $COP_{nfcooling}$ |
| | ≥760,000 Btu/h | | | 3.6 $COP_{nfcooling}$ |

# WHAT'S NEW IN 2019 – Appendix G & ECB

- **Addendum S** – Renewable Energy Tradeoffs
  - Allows credit for renewable energy generated on site even if the building owner does not own the system provided that:
    - The owner has signed a lease agreement for a minimum of 15 years
    - The owner has signed an agreement to purchase the renewable energy for a minimum of 15 years

# WHAT'S NEW IN 2019 – ECB

- **Addendum CL** – Many changes to ECB to Align with Appendix G
  - Updates simulation program definition to engine and GUI
  - Requires 8760 hour simulation (from 1400)
  - Updates documentation and submittal requirements
  - Requires weather files include solar radiation, wind speed and direction
  - Adds requirements for exceptional calculations
  - Adds equipment sizing rules for cases when HVAC zones are combined into thermal blocks
  - Allows credit for demand control ventilation
  - Sets requirements for baseline system airflow (fan) sizing
  - Sets requirements for fan, temperature, and humidity setpoint schedules
  - Specifies that piping losses shall not be modeled
  - Various other language cleanups for consistency

# Commissioning Comes to Standard 90.1

**Reid Hart, PE**

**Pacific Northwest National Laboratories**

**SSPC 90.1 Mechanical Consultant**

**Chair of 90.1 Cx working group, 2014-2019**

# COMMISSIONING COMES TO STANDARD 90.1

- Why Commissioning in 90.1
  - New construction savings benefits
  - Improves specific 90.1 compliance
- Requirement Overview
  - Verification and functional performance testing
  - Commissioning required items
  - Informative Appendix H

# Why Commissioning?

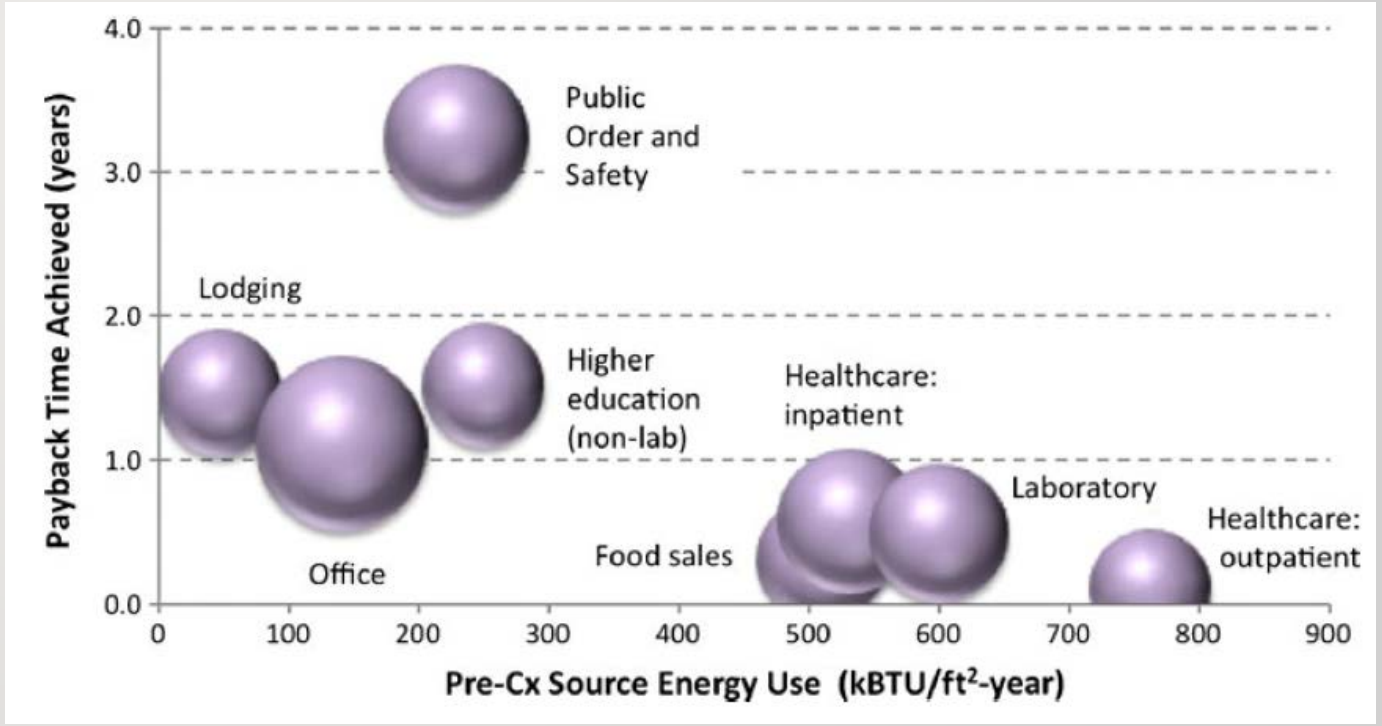
# WHY COMMISSIONING (Cx)?

- We assume all the field assemblies and controls work: but do they?
- New building Cx saves 7% to 30% annual energy
  and median savings is 13% in new construction
- Cx cost effectiveness study:

Mills, Evan. 2011. Energy Efficiency. "Building commissioning: a golden opportunity for reducing energy costs and greenhouse gas emissions in the United States"

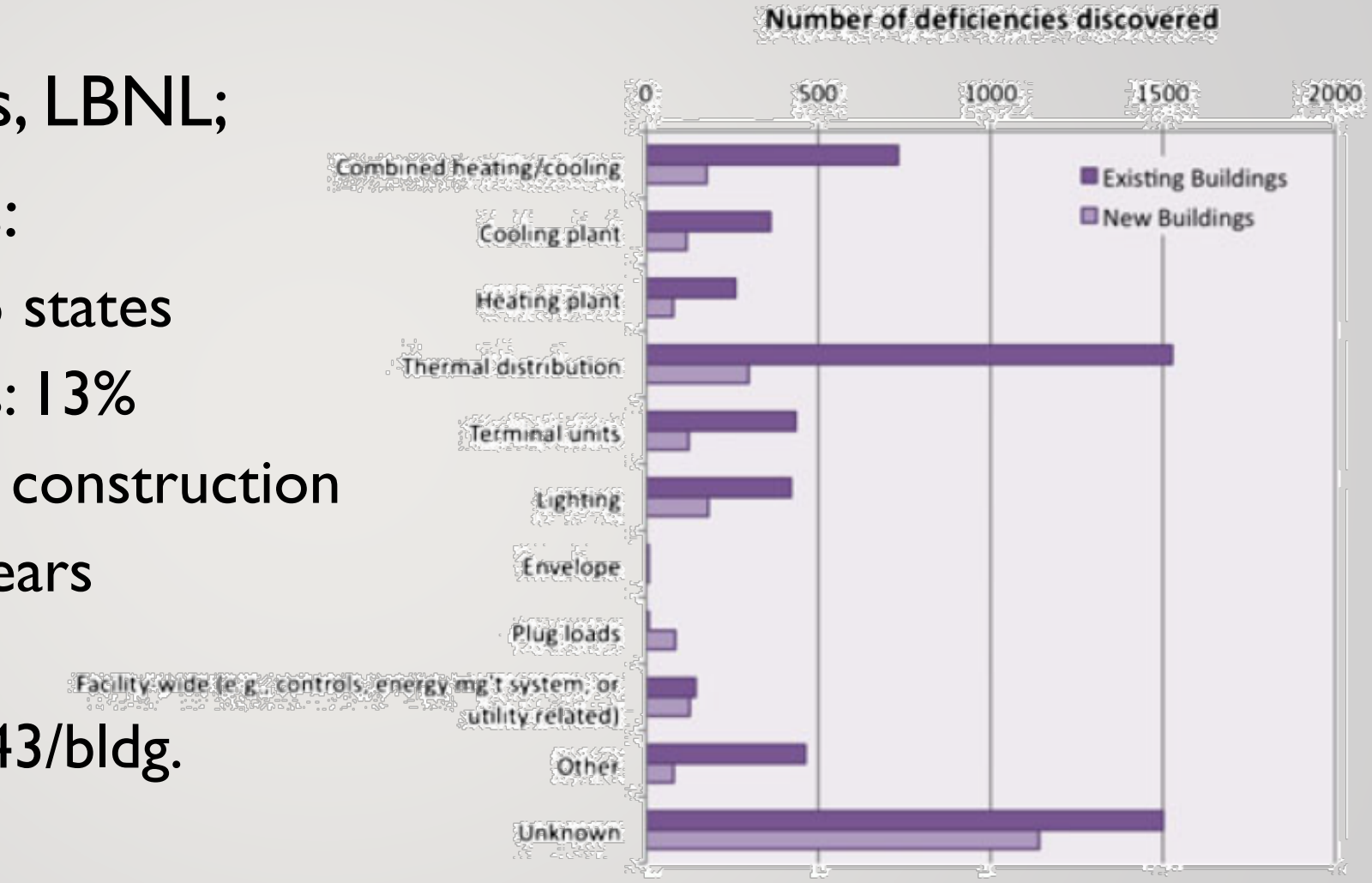
Results by building type

- Includes both new Cx & retro Cx
- Circle diameter proportional to percent energy cost savings (e.g.,"Office" = 22%)



# COMMISSIONING IS COST EFFECTIVE

- Cx study by Evan Mills, LBNL;
- New building Cx stats:
  - 82 new buildings in 15 states
  - Median energy savings: 13%
  - Cx Cost: 0.4% of new construction
  - Median payback: 4.2 years
  - 8.8 million sq. ft.
  - 3,528 deficiencies or 43/bldg.



# Cx COMPARED ACROSS STANDARDS/CODES

| ***Thresholds*** | **90.1-2016** | | **90.1-2019** (16-ai) | | **189.1-2017** (14-aq) | | **2015 IECC** |
|---|---|---|---|---|---|---|---|
| | FPT | Cx | FPT | Cx | FPT | Cx | Cx |
| **Building Size** | any | >50,000 sf only for Mech | any | >10,000 sf if not simple HVAC | any | >10,000 sf | NA |
| **Envelope, air barrier** | Verify All (5.9.2) | NR | Verify All | ** | NR | NR | NR |
| **Cooling load** | * | * | ** | ** | 15 tons | *** | 40 tons |
| **HVAC Controls** | All (6.7.2.4) | >50,000 sf building area | ** | ** | If above HVAC limits | *** | If above HVAC limits |
| **Ventilation airflow** | * | * | ** | ** | 10,000 cfm | *** | 480 MBH combined Mech & SHW heating |
| **Heating load** | * | * | ** | ** | 300 MBH | *** | |
| **Hot water load** | NR | NR | ** | ** | 50 MBH | *** | |
| **Lighting system controls** | All (9.4.3) | NR | ** | ** | 5kW total | *** | All (FPT only) |
| **Power receptacles** | NR | NR | ** | ** | NR | NR | NA |

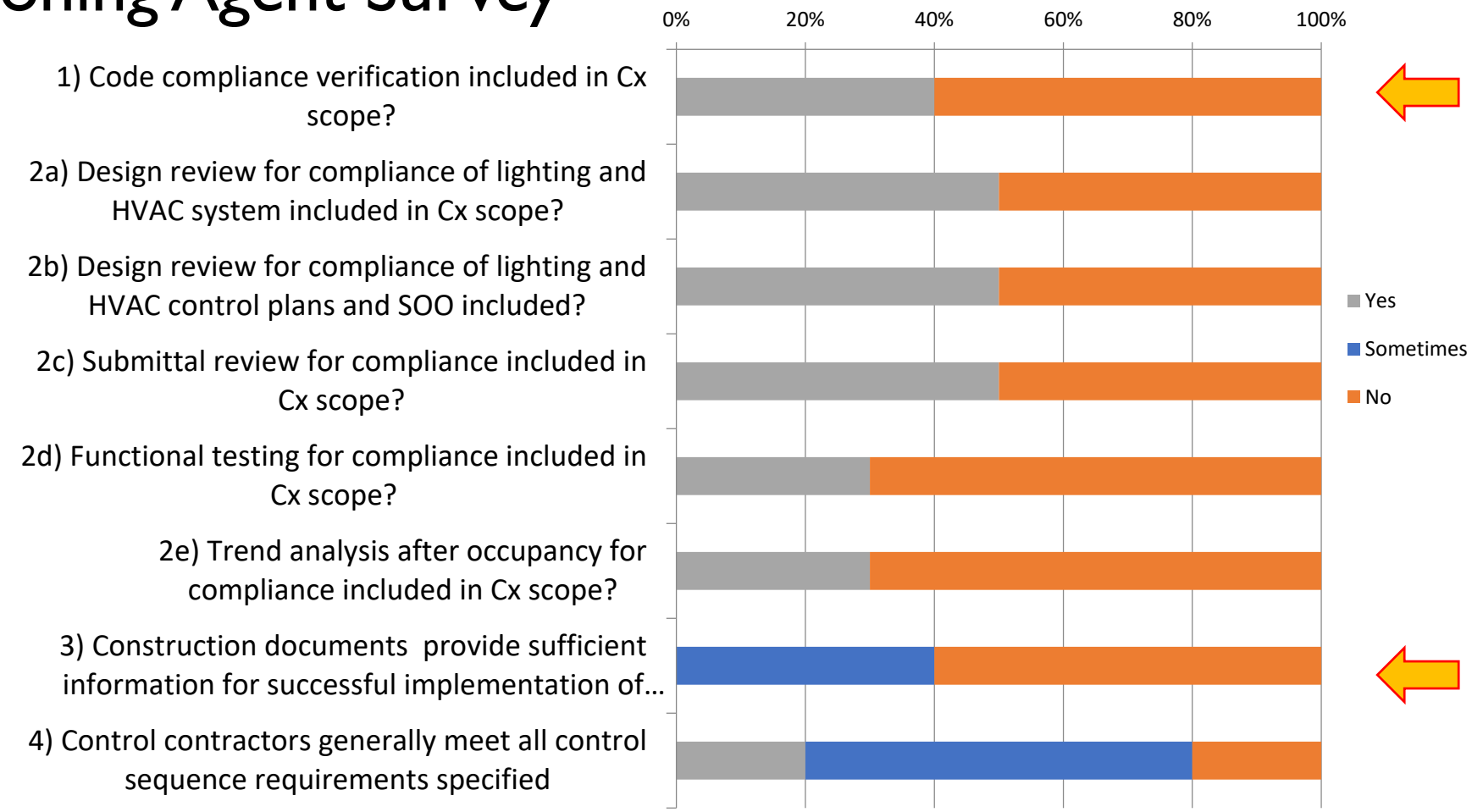
* Commissioning required for mechanical systems based on building size; basic functional testing required for all HVAC controls

** Verification & testing required for all systems. Currently required functional testing included under umbrella of commissioning effort for larger, more complex buildings.

*** Verification & testing required for systems based on size. Required functional testing included under umbrella of commissioning effort for larger, more complex buildings.

# WHY Cx OF EFFICIENCY REQUIREMENTS?:

## Commissioning Agent Survey



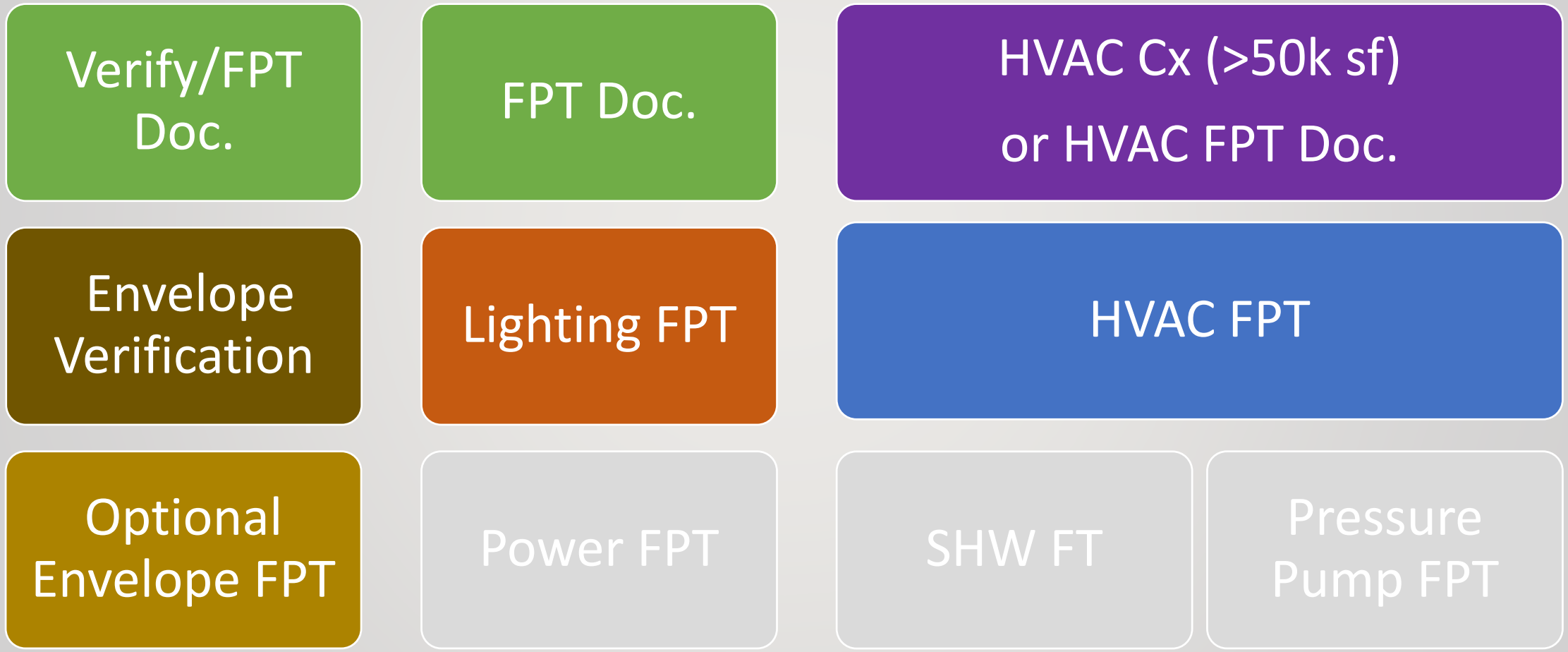

Based on survey of 10 commissioning agents.

# WHY Cx FOR 90.1 - CONCLUSION

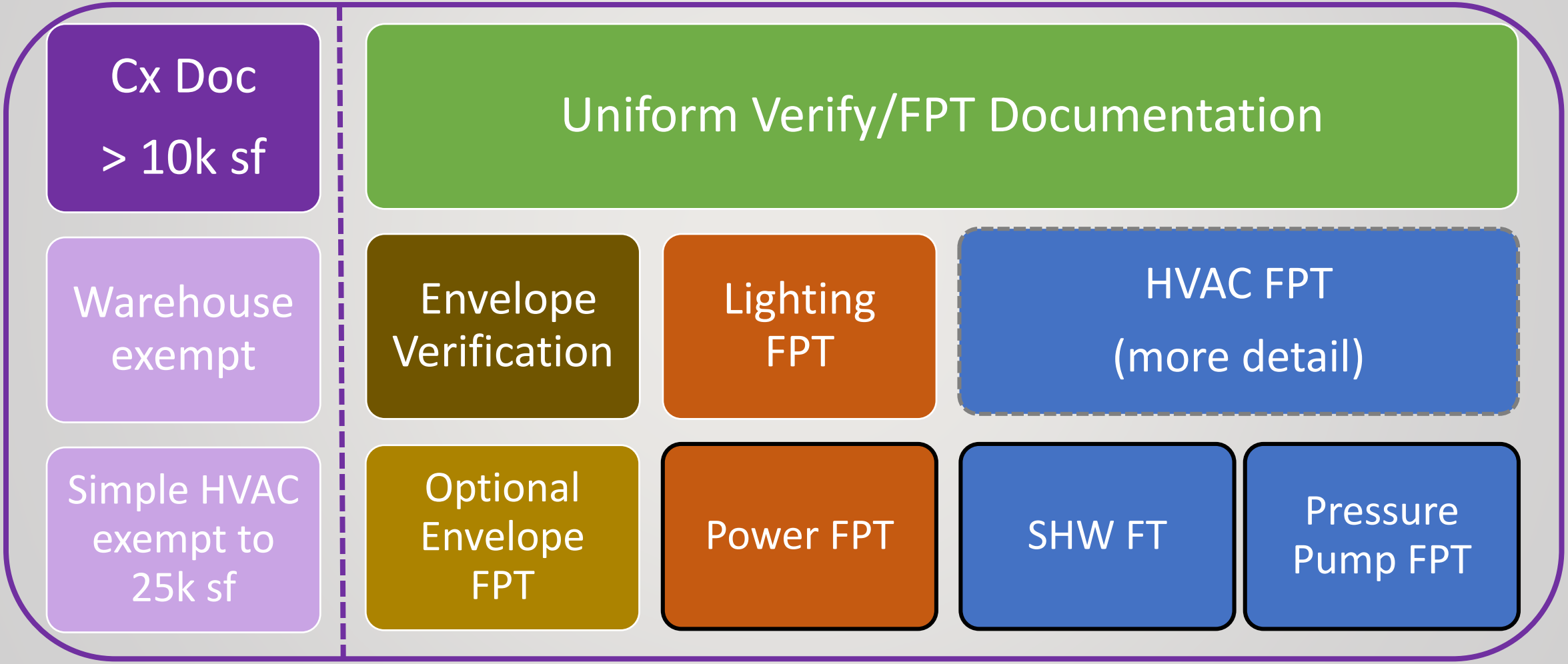
- ASHRAE Standard 202 defines process
  - Still up to Owner to define scope within process
  - Does not tell you what to do for specific areas, e.g. energy efficiency
- Guideline 0 & 1.1 (and others) provide guidance on specific tests for different items.
  - Does not tell you what to include in scope, e.g. energy efficiency
- 90.1 has very specific items related to energy efficiency
  - Defining a list of "what" to do bridges the gap
  - Making our documentation process consistent with standards works better with the industry
- Commissioning, Verification, and Testing now accepted
  - Required in base LEED
  - Required on federal projects
  - Found to be cost effective based on field studies the past two decades

# 90.1-2019 Testing and Commissioning Requirements

# 90.1-2016 VERIFICATION, TESTING & COMMISSIONING



# 90.1-2019 VERIFICATION, TESTING & Cx



# FUNCTIONAL PERFORMANCE TESTING (FPT)AND VERIFICATION IS A BASE REQUIREMENT

***FPT/V applies to all buildings in** both 2016 & 2019*

## 90.1-2016 FPT/V

- Envelope air barrier verification
  - Two options (5.9.2.2)
    - Air barrier pressurization testing
    - Design review & periodic field inspection
  - Separate documentation report (4.2.5)
- HVAC controls testing (6.7.2.4)
  - Controls tested
  - "Commissioning" if > 50,000 sq. ft.
- Lighting functional testing (9.4.3)
  - Specific testing procedures for:
    - Occupancy sensors
    - Time switches
    - Daylight controls
  - Provide "documentation"


## New 90.1-2019 FPT/V

- Cross-discipline consistent requirements
  - Verification & Testing (V&T) providers not involved in design or construction (4.2.5.1.1)
  - Clear & standard documentation (4.2.5.1.2)
  - All discipline (#) V&T moved to § #.9.1
- 7.9.1 Service hot-water controls testing
  - Temperature controls
  - Heat trace or recirculation pump controls
  - Pool time switch controls
- 8.9.1 Power system controls testing
  - Receptacle control
  - End use monitoring systems
- 10.9.1 Other system controls testing
  - Water pressure booster systems
  - Elevator light and fan standby mode
  - Whole building energy monitoring
- 11.2 & G1.2.1:V&T of high performance systems

# START WITH VERIFICATION & FPT FOR ALL BUILDINGS

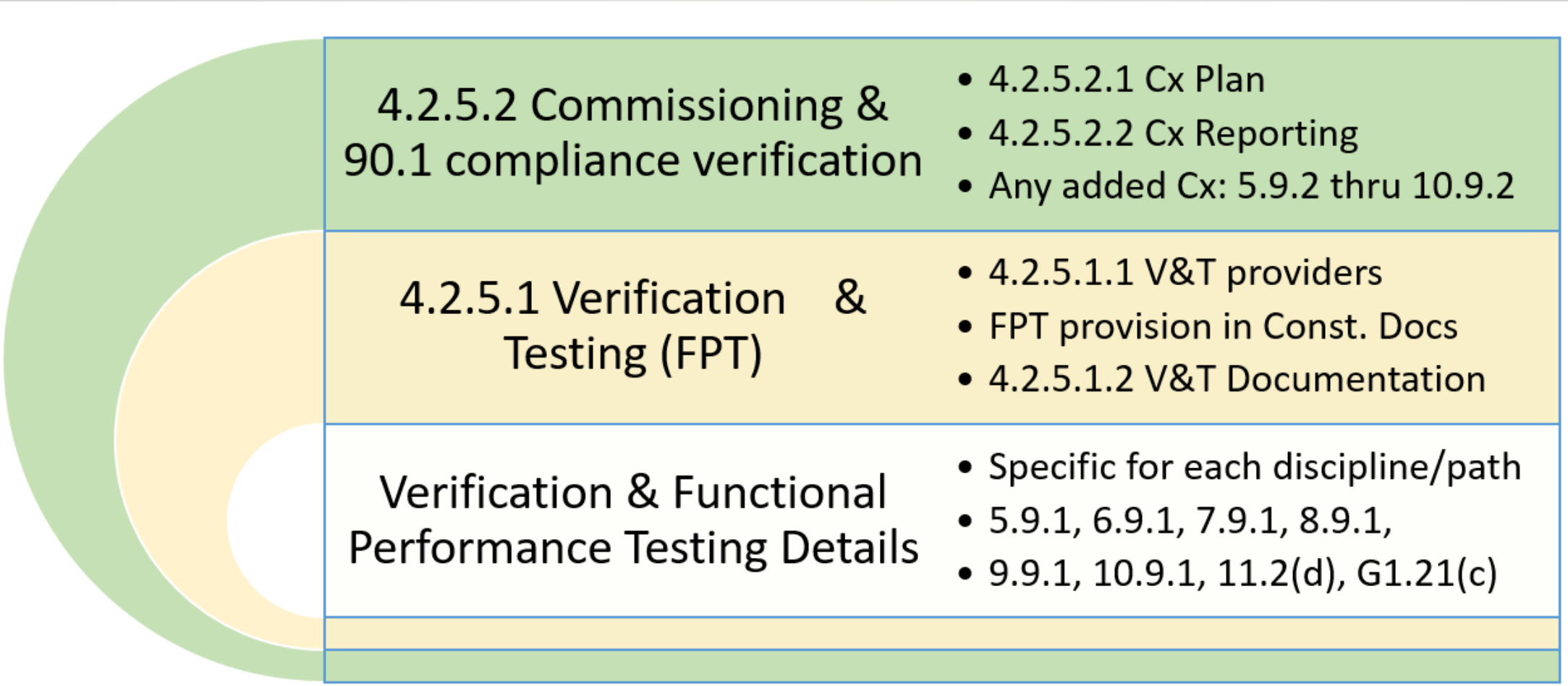
**Verification & Functional Performance Testing Details**

- Specific for each discipline/path
- 5.9.1, 6.9.1, 7.9.1, 8.9.1,
- 9.9.1, 10.9.1, 11.2(d), G1.21(c)

# ADD A WRAPPER OF CONSISTENT DOCUMENTATION

| | |
|---|---|
| 4.2.5.1 Verification & Testing (FPT) | • 4.2.5.1.1 V&T providers<br>• FPT provision in Const. Docs<br>• 4.2.5.1.2 V&T Documentation |
| Verification & Functional Performance Testing Details | • Specific for each discipline/path<br>• 5.9.1, 6.9.1, 7.9.1, 8.9.1,<br>• 9.9.1, 10.9.1, 11.2(d), G1.21(c) |

# INCLUDE VERIFICATION & FPT IN COMMISSIONING



# WHERE DO Cx REQUIREMENTS APPLY IN 90.1-2019

| | Simple buildings (<10k conditioned ft², warehouse, or Simple HVAC path < 25k ft²) | Complex Buildings < 50,000 ft² | All Buildings ≥ 50,000 ft² |
|---|---|---|---|
| % U.S. Floor area | ~27% | ~23% | ~50% |
| % U.S. Buildings | ~80% | ~14% | ~6% |
| Verification, FPT | Required | Required | Required |
| Pre- & Design phase Cx | NR | Required | Required |
| Construction Phase Cx | NR | Required | Required |

- 80% of US buildings are exempt from commissioning requirements
- Verification and functional performance testing (FPT) required throughout
- Pre & design phase Cx saves energy and cost by catching issues early
- 90.1 Cx requirements only apply to 90.1 standard requirements
- Verification that the design substantially meets 90.1 included

# WHAT IS COMMISSIONING IN 90.1-2019

Adopted in 90.1-2019 (Addendum ***ai***)

- Cx specifically includes <u>verification</u>; same as required for smaller or less complex buildings.
- Cx specifically includes verification that the building meets the 90.1 standard
- Cx plan and reporting required in accordance with Standard 202.
- Distinct verification and commissioning discipline sections #.9.1 & #.9.2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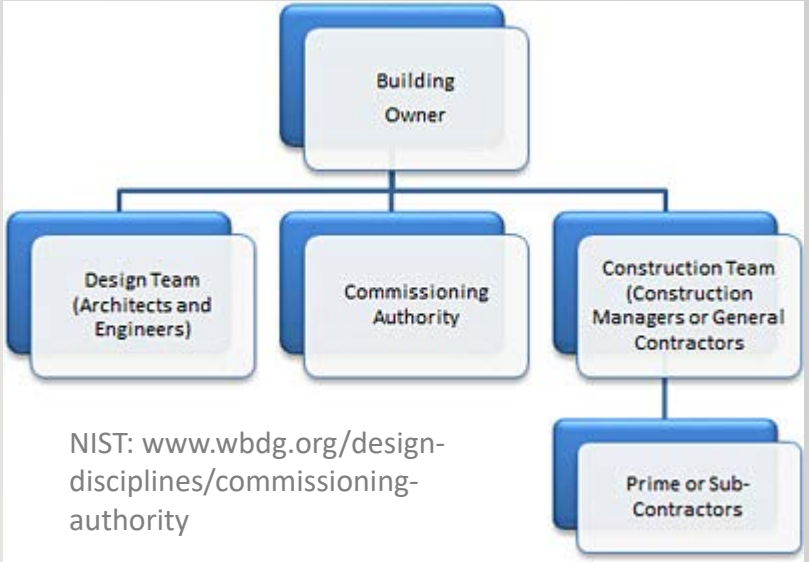
# Cx UPDATES IN 90.1-2019

Develop consistent approach across technical sections in 90.1

- Section on general functional testing and commissioning
  - Definitions, requirements and process for verification, testing & commissioning
- Coordinate the 90.1 commissioning requirements and format with Standards 189.1 and 202
- Design review included when Cx is required, based on T24 cost effectiveness
- Cx includes review of 90.1 compliance




NIST: www.wbdg.org/design-disciplines/commissioning-authority

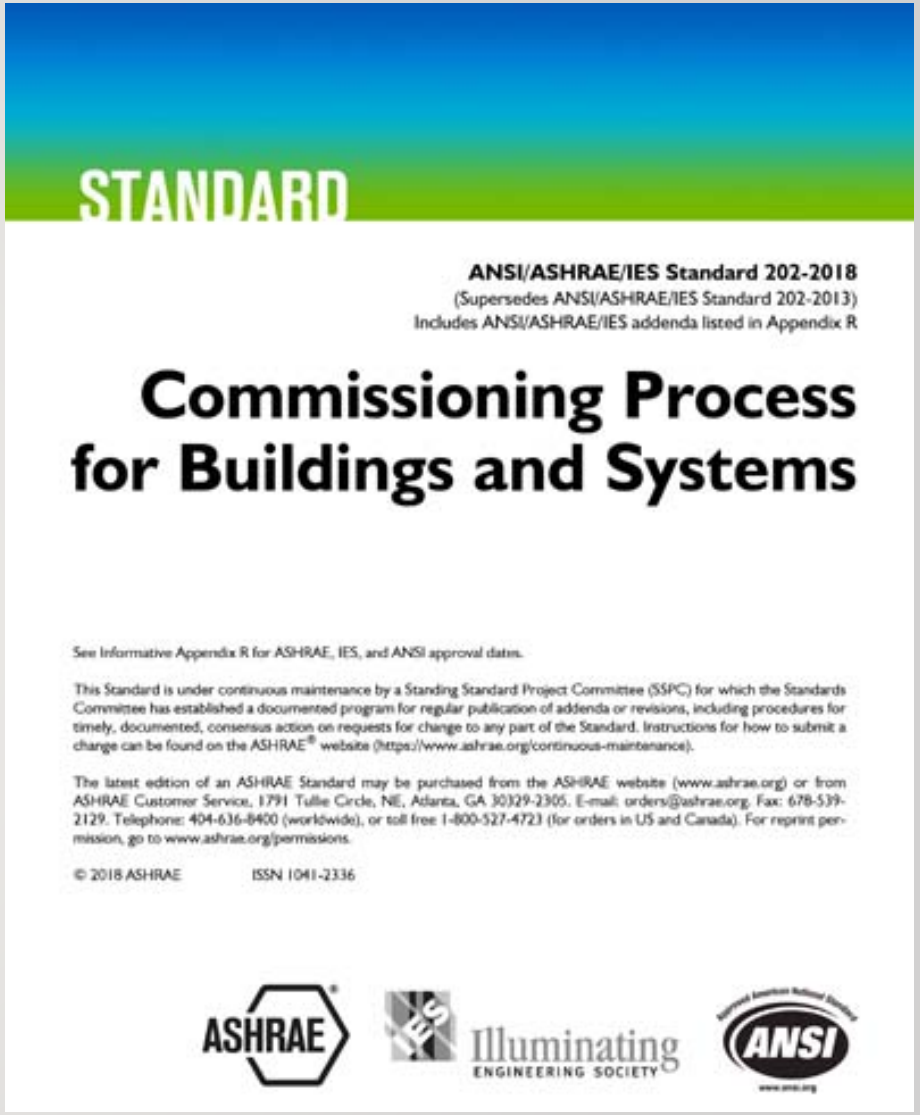
## Cx Documentation required in 90.1

- Commissioning Plan
- Cx design review report
- Verification & FPT reports
- Preliminary Cx report
- Final Cx report

# STANDARD 202 VS. 90.1

- The Standard 202 Commissioning Plan specifies a process and requires commissioned & verified or FPT items to be identified
- 202 does not specify what items should be included
- It is up to the owner what to include in the plan
- 90.1 calls for these items:
  - Specific verification items to be included—that are also required for non-commissioned buildings
  - A design review for compliance with 90.1 (note: this could be met with COMcheck or the checklist in the 90.1 user's manual in most cases)

In conclusion, beyond what 90.1 specifically calls for, it is up to the Owner what is to be commissioned.



# 90.1 DELIVERABLES VS. STANDARD 202 / GUIDELINE 0

**Table H-2 Typical Commissioning Process Activities, Deliverables**

| Item | Activity | Deliverable | 90.1 Section |
|---|---|---|---|
| 1 | Owner's Project Requirements (OPR) | OPR document | NR |
| 2 | Basis of Design (BoD) | BoD document | NR |
| 3 | *Commissioning* plan | *Commissioning* plan document | 4.2.5.2.2 |
| 4 | Contractor Cx requirements | *Cx* specifications | 4.2.5.1.1, 4.2.5.2.1, 6.9.2 |
| 5 | Design review, including Standard 90.1 compliance review | *Cx* design review report | 4.2.5.2, 4.2.5.2.2 |
| 6 | Submittal review | Submittal review report* | NR |
| 7 | *Commission* designated systems, inspections, *FPT* | Installation, inspection, functional test reports, performance test reports* | 4.2.5.1, 4.2.5.2 |
| 8 | Track identified issues to resolution | Issues and resolution log* | 4.2.5.1, 4.2.5.2 |
| 9 | Systems manual | Systems manual review | Review NR |
| 10 | Training | Training plan and reports* | NR |
| 11 | Preliminary Cx report | Preliminary Cx report | 4.2.5.1.2, 4.2.5.2.2 |
| 12 | Cx activities during occupancy | Additional information and updates to reports* | NR |
| 13 | Final Cx report | Final Cx Report | 4.2.5.2.2 |

* Noted interim or partial deliverables are typically included in the preliminary and final *commissioning* reports.
NR = Not required by Standard 90.1; Cx = commissioning.

# INFORMATIVE APPENDIX H

- Coordinates 90.1 Cx with standard Cx
- Itemizes things in 90.1 to commission
- Supports requirements of 202 without normative requirements
- Added Cx information adapted from 189.1 informative appendix
- Gives specific outline for deliverables
  - Based on guideline 0
  - Customized for 90.1
  - Includes Cx authority qualification recommendations

**Table H-3 Standard 90.1 Items to Verify *(Continued)***

| Subsection | Subsection Title | Standard 90.1 Items to Verify for Proper Operation or Inclusion |
|---|---|---|
| 6.5.1.1 | Air economizers | *Outdoor air* and return air damper control sequence properly configured. High-limit shutoff set properly. Damper leakage and relief air appropriate. Sensor accuracy and calibration. |
| 6.5.1.2 | Water economizers | Maximum pressure drop (precooling coils, water-to-water heat exchanger). Economizer control integration sequence with heating, mechanical cooling, and inside humidity. |
| 6.5.2.1 | Simultaneous heat/cool: zone controls | Zone box minimum position and operating sequence, *deadband*, and *set points* configured properly. |
| 6.5.2.2 | Simultaneous heat/cool: hydronic systems | Two-pipe changeover control *dead band* and hydronic heat-pump system controls configured properly. |
| 6.5.2.3/4 | Simultaneous heat/cool: dehumidification and humidification | Humidistatic controls configured properly if applicable. |
| 6.5.2.5 | Preheat coils | Control sequence configured properly. |
| 6.5.3.1 | Fan system power and efficiency | Fans are within power limits or meet efficiency requirements. |
| 6.5.3.2 | Fan control | Fans are equipped with variable-speed drives or multispeed control where required, and control sensors and sequence are properly implemented. VAV static pressure *set point* is reset. |
| 6.5.3.3 | Multiple-zone VAV system ventilation optimization control | Proper configuration of ventilation optimization controls for VAV systems. |
| 6.5.3.4 | Parallel-flow fan-powered VAV air-terminal control | Check for proper sequence control. |
| 6.5.3.5 | Supply air temperature reset controls | Proper operation of supply air reset controls for multiple zone systems. |
| 6.5.3.6 | Fractional horsepower fan motors | For smaller fans, ECM or equivalent efficiency motors have speed control. |

*Thanks for your interest!*

# Commissioning Comes to Standard 90.1


- **Reid Hart, PE**
- **Pacific Northwest National Laboratories**

**reid.hart@pnnl.gov**






# QUESTIONS

# THANK YOU!

- Building Energy Codes Program

www.energycodes.gov/training

- BECP help desk

https://www.energycodes.gov/HelpDesk