ASHRAE 90.1-2022 Transition from 90.1-2013

Sam Harvey, PE, CHD

90.1 Title Change

90.1-2013

Energy Standard for Buildings Except Low-Rise Residential Buildings

90.1-2022

Energy Standard for **Sites** and Buildings Except Low-Rise Residential Buildings

Takes on-site lighting or renewable energy systems into account as part of the standard, even if not attached to the building

3. Definitions, Abbreviations, and Acronyms

New

- Air Leakage
- Best Efficiency Point (BEP)
- Building Service
- Building Service Equipment
- Ceiling Fan
- Ceiling Fan Energy Index (CFEI)
- Chi-Factor
- Clear-Field Thermal Bridge
- Combined Energy Efficiency Ration (CEER)
- Commissioning
- Commissioning Provider
- Driver
- Direct-Expansion Dedicated Outdoor Air System Units (DX-DOAS)
- East-oriented
- Energy Recovery Ratio, Series (SERR)
- Energy Recovery, Series
- Enthalpy Recovery Ratio
- Existing Site
- Exterior Wall
- Fan Array
- Fan, Embedded
- Fan Energy Index (FEI)
- Fan Nameplate Electrical Input Power
- Functional Performance Testing (FPT)
- Greenhouse
- Heat Recovery Coefficient of Performance (COP_{HR})
- High-End Trim
- IEC Design H Motor
- IEC Design N Motor
- Indoor Grow
- Indoor Pool Dehumidifier
- Integrated Seasonal Coefficient of Performance (ISCOP)
- Integrated Seasonal Moisture Removal Efficiency (ISMRE)
- Lighting, Horticultural
- Lumen Maintenance
- Moisture Removal Efficiency (MRE)
- NEMA Design A Motor
- NEMA Design B Motor
- NEMA Design C Motor
- Networked Guest Room Control System
- North-oriented
- Occupied-Standby Mode
- Off-Mode Power Consumption ($P_{W, OFF}$)
- On-Site Electricity Generation Systems
- Parking Garage Daylight Transition Zone
- Parking Garage Section
- Pump Energy Index, Constant Load (PEI_{CL})
- Pump Energy Index, Variable Load (PEI_{VL})
- Pump Energy Rating, Constant Load (PER_{CL})
- PER_{STD}
- Pump Energy Rating, Variable Load (PER_{VL})
- Photosynthetic Photon Efficacy (PPE)
- Process Application
- Property
- Psi-Factor
- Pump (and subdefinitions)
- Regulated Energy Use
- Renewable Energy Resources
- Residential Associated HVAC Zone
- Sensible Energy Recovery Ratio
- Sidelighting Effective Aperture
- Standby Power Mode Consumption ($P_{W,SB}$)
- Structure
- Thermal Bridge
- Toplighting
- Total System Performance Ratio (TSPR)
- Trim Compressor
- TSPR Reference Building Design
- Unregulated Energy Use
- Verification and Testing Provider (V&T Provider)
- West-oriented

Section 4

Administration and Enforcement

4. Administration and Enforcement

4.2.1.1 now allows compliance via

- Prescriptive Path
- Energy Cost Budget Method (ECB, Section 12)
- Normative Appendix G

When using Normative Appendix G, the Performance Cost Index (PCI) of new *buildings*, *additions* to *existing buildings*, and/or *alterations* to *existing buildings* shall be less than or equal to the Performance Cost Index Target (PCI_t) when calculated in accordance with the following:

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

where

PCI	=	Performance Cost Index calculated in accordance with Section G1.2.2
BBUEC	=	baseline *building* unregulated *energy* cost, the portion of the annual *energy* cost of a *baseline building design* that is due to *unregulated energy use*
BPF	=	*building* performance factor from Table 4.2.1.1. For *building* area types not listed in Table 4.2.1.1, use "All others." Where a *building* has multiple *building* area types, the required BPF shall be equal to the area-weighted average of the *building* area types based on their *gross floor area*. Where a project includes an *existing building* and an *addition*, the required BPF shall be equal to the area-weighted average, based on the *gross floor area*, of the *existing building* BPF determined as described in Section 4.2.1.3 and the *addition* BPF from Table 4.2.1.1.
BBREC	=	baseline *building* regulated *energy* cost, the portion of the annual *energy* cost of a *baseline building design* that is due to *regulated energy use*
PRE	=	$PBP_{nre} - PBP_{pre}$
PBP	=	*proposed building performance*, including the reduced, annual *purchased energy* cost associated with all *on-site renewable energy* generation *systems*
PBP_{nre}	=	*proposed building performance* without any credit for reduced annual *energy* costs from *on-site renewable energy* generation *systems*
PBP_{pre}	=	*proposed building performance*, excluding any renewable *energy system* in the *proposed design* and including an *on-site renewable energy system* that meets but does not exceed the requirements of Section 10.5.1.1 modeled following the requirements for a *budget building design* in Table 12.5.1, row 15
BBP	=	*baseline building performance*

Regulated *energy* cost shall be calculated by multiplying the total *energy* cost by the ratio of *regulated energy use* to total *energy* use for each *fuel* type. Unregulated *energy* cost shall be calculated by subtracting regulated *energy* cost from total *energy* cost.

Table 4.2.1.1 Building Performance Factor (BPF)

Building Area Type	0A	0B	1A	1B	2A	2B	3A
Multifamily	0.69	0.68	0.71	0.70	0.72	0.72	0.71
Healthcare/hospital	0.69	0.69	0.70	0.68	0.67	0.65	0.65
Hotel/motel	0.66	0.66	0.69	0.65	0.65	0.64	0.64
Office	0.54	0.54	0.53	0.52	0.52	0.52	0.50
Restaurant	0.62	0.59	0.57	0.57	0.57	0.53	0.57
Retail	0.51	0.49	0.48	0.48	0.44	0.43	0.43
School	0.52	0.57	0.57	0.56	0.52	0.53	0.52
Warehouse	0.26	0.26	0.22	0.25	0.21	0.22	0.25
All others	0.62	0.60	0.62	0.59	0.55	0.51	0.53

4.2.4 Inspections

- Materially expanded to require explicit documentation from multiple disciplines
- Accounts for the added Section 11 – Additional Efficiency Requirements
  - 4.2.4.1 Fenestration Inspections
  - 4.2.4.2 Opaque Assembly Thermal Insulation Inspections
  - 4.2.4.3 Continuous Air-Barrier Inspections
  - 4.2.4.4 Operable Fenestration and Door Inspections
  - 4.2.4.5 Loading-Dock Weatherseals Inspections
  - 4.2.4.6 Other Inspections *(e.g. mech, elec, plumbing, lighting)*

4.2.5 Verification, Testing, and Commissioning

- 90.1-2022 explicitly states that "systems, controls, and the building envelope" must comply with verification/testing sections

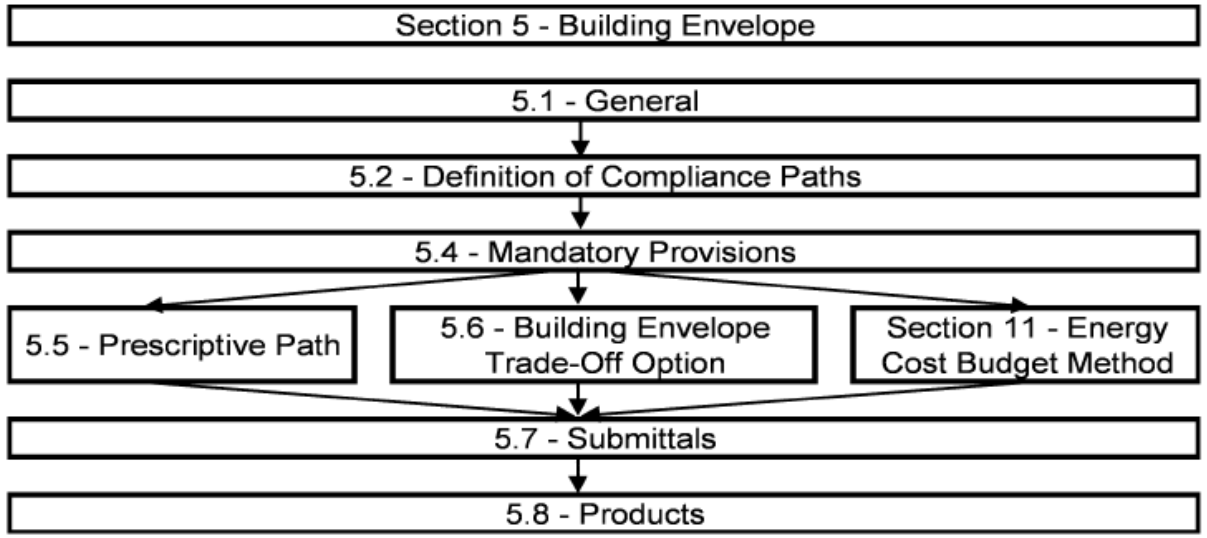
- Functional Performance Testing (FPT) is now a code requirement. Compliance now includes **proof of operation**.

Section 5

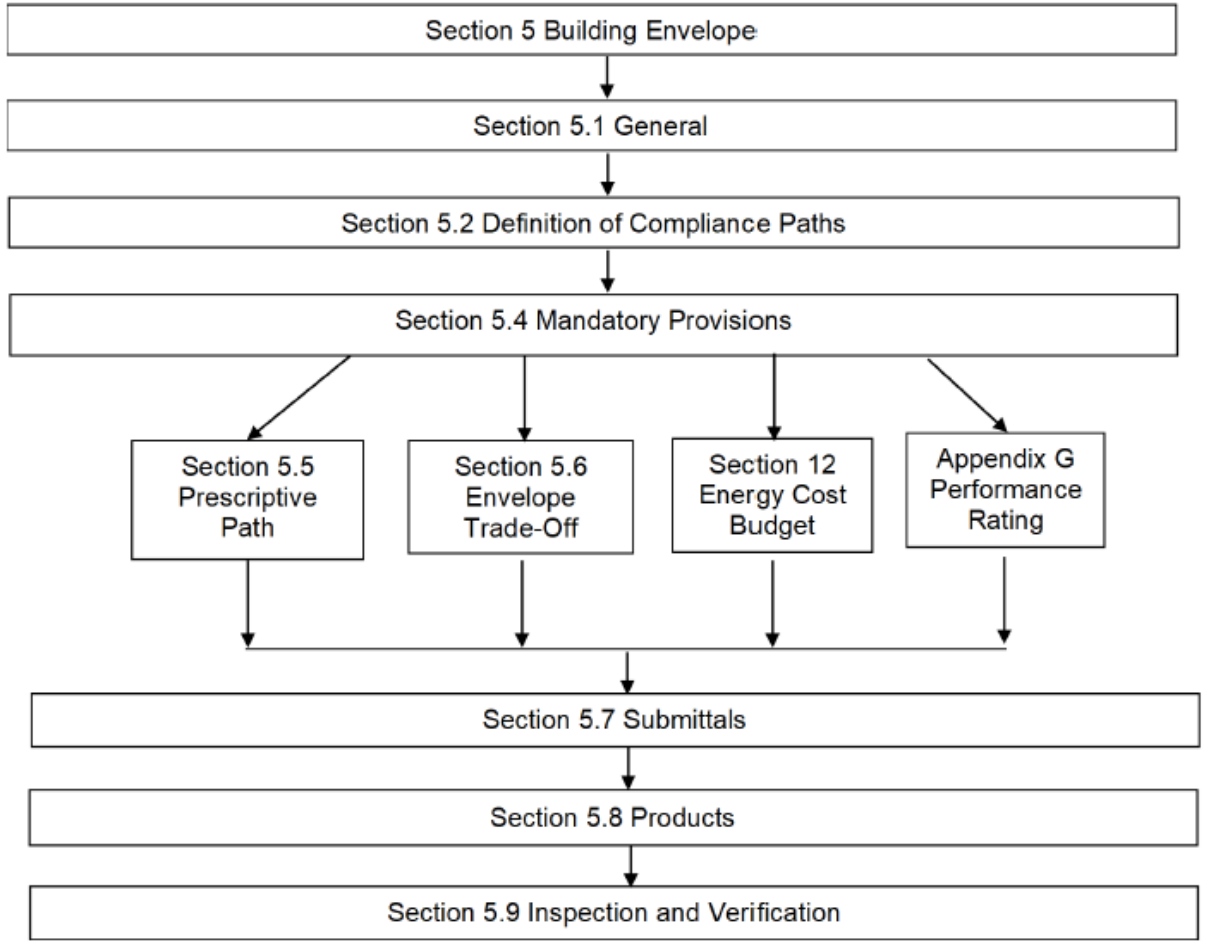
Building Envelope

5. Building Envelope

2013



2022

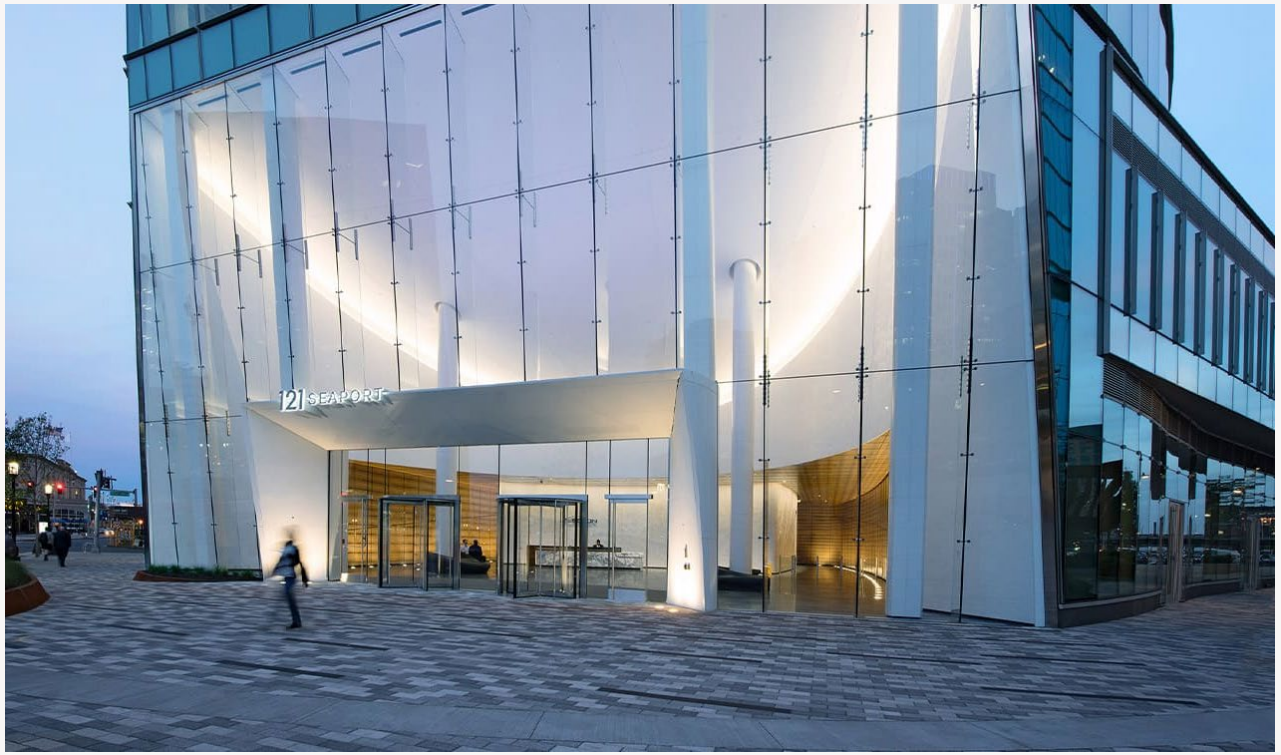


5.4.3 Air Leakage

- Expanded to add requirements to limit whole-building air leakage. Maximum 0.35 CFM/ft^2 at 75 Pa

- Vestibule size has a minimum mandate to limit leakage (7ft smaller buildings, 16ft for buildings 40k sqft and larger)

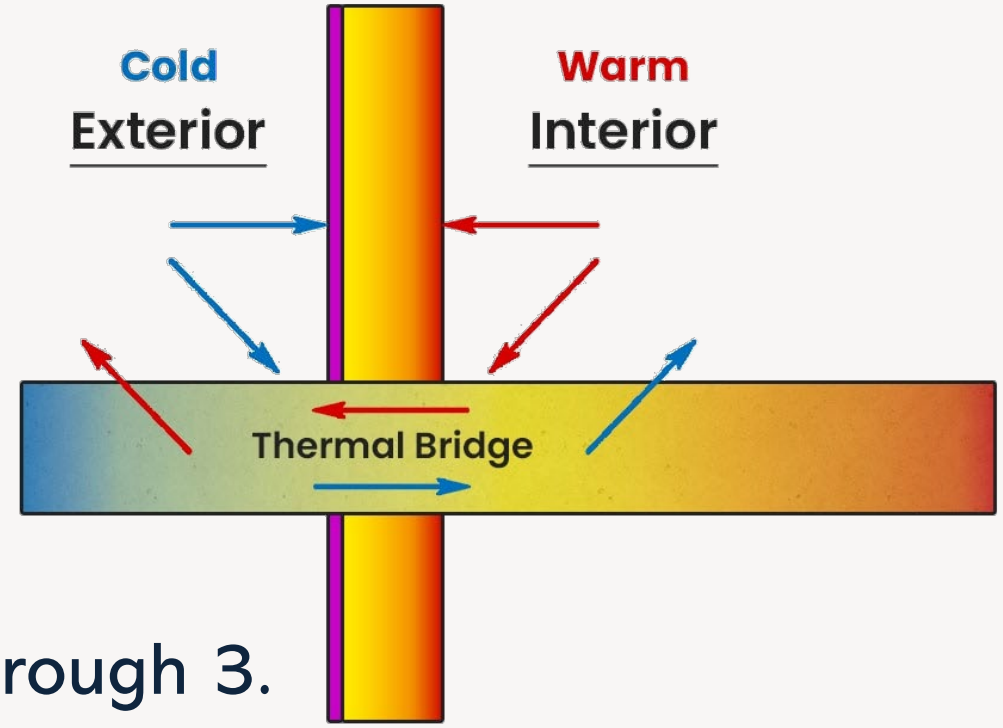
5.5 Building Envelope Prescriptive Path



- Mostly no changes to envelope prescriptive table for Climate Zone 2A/3A.
- Opaque doors have slightly more stringent U-factor requirements in 2022
- 5.5.1 thru 5.5.4 are mostly unchanged.

5.5.5 Thermal Bridging

- Nominal insulation values often overstated real performance because of heat bypassing through thermal bridges
- Includes extensive requirements for:
  - Roof Edges
  - Parapets
  - Floor Intersections
  - Exterior Cladding Support
  - Fenestration Intersections
- Exception included for Climate Zones 0 through 3.



5.7 Submittals

- Compliance documentation is now required to be submitted (2013 said “AHJ may require”)
- Permit application documents must include
  - R-values of insulation for each product
  - U-factor for each opaque door, fenestration product
  - Labeling of space conditioning categories (if partial conditioning is present)
  - Daylighting documentation
  - Continuous air barrier compliance with whole-building pressurization testing
- Record documents must be provided to building owner within 90 days, including O&Ms

5.8.3 Air Leakage

- Prescriptive table for maximum air leakage through fenestration and door products

Table 5.8.3.2 Maximum Air Leakage for Fenestration and Doors

Fenestration and Door Products	Maximum Air Leakage, cfm/ft^2	Minimum Test Pressure, psf	Test Methods
Glazed swinging *entrance doors*, glazed power-operating sliding *entrance doors*, glazed power-operated folding *entrance doors*, and revolving *doors*	1.0	1.57	AAMA/WDMA/CSA 101/I.S.2/A440, NFRC 400, or ASTM E283;
Curtainwall and storefront glazing	0.06	1.57	NRFC 400 or ASTM 283
Unit *skylights* having condensation weepage openings	0.3	1.57	AAMA/WDMA/CSA 101/I.S.2/A440 or NFRC 400
	OR		
	0.5	6.24	AAMA/WDMA/CSA 101/I.S.2/A440
Nonswinging doors intended for vehicular access and material transportation, with a minimum opening rate of 32 in./s	1.3	1.57	ANSI/DASMA 105, NFRC 400, or ASTM E283
Other *opaque nonswinging doors*, glazed *sectional garage doors*, and upward acting glazed *nonswinging*	0.4	1.57	ANSI/DASMA 105, NFRC 400, or ASTM E283
All other products	0.2	1.57	AAMA/WDMA/CSA 101/I.S.2/A440 or NFRC 400
	OR		
	0.3	6.24	AAMA/WDMA/CSA 101/I.S.2/A440

5.9 Verification, Testing, and Commissioning

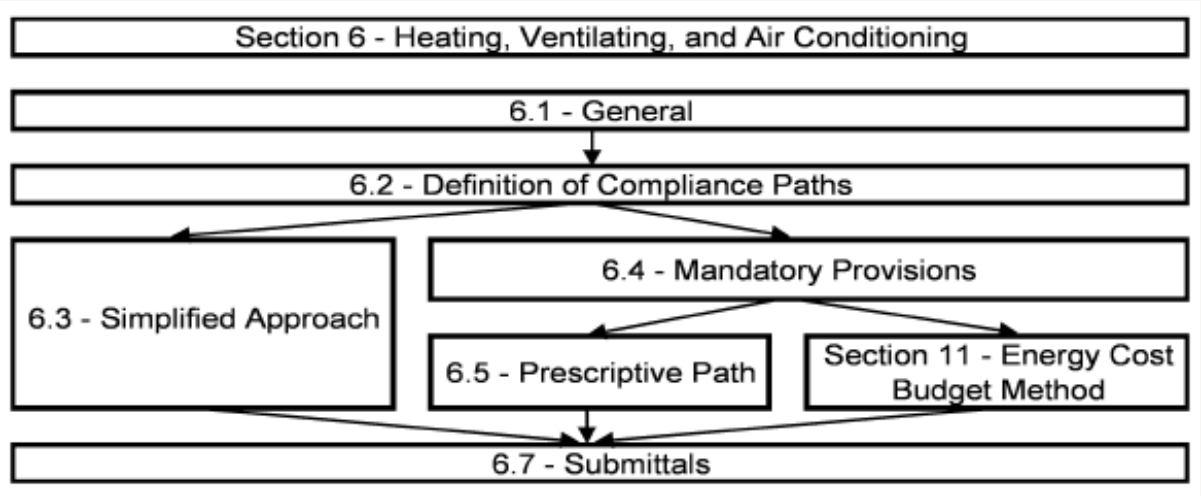
- The building envelope ***shall be verified in accordance with Section 4.2.5.1***
- The energy performance of the building envelope ***shall be commissioned in accordance with Section 4.2.5.2***

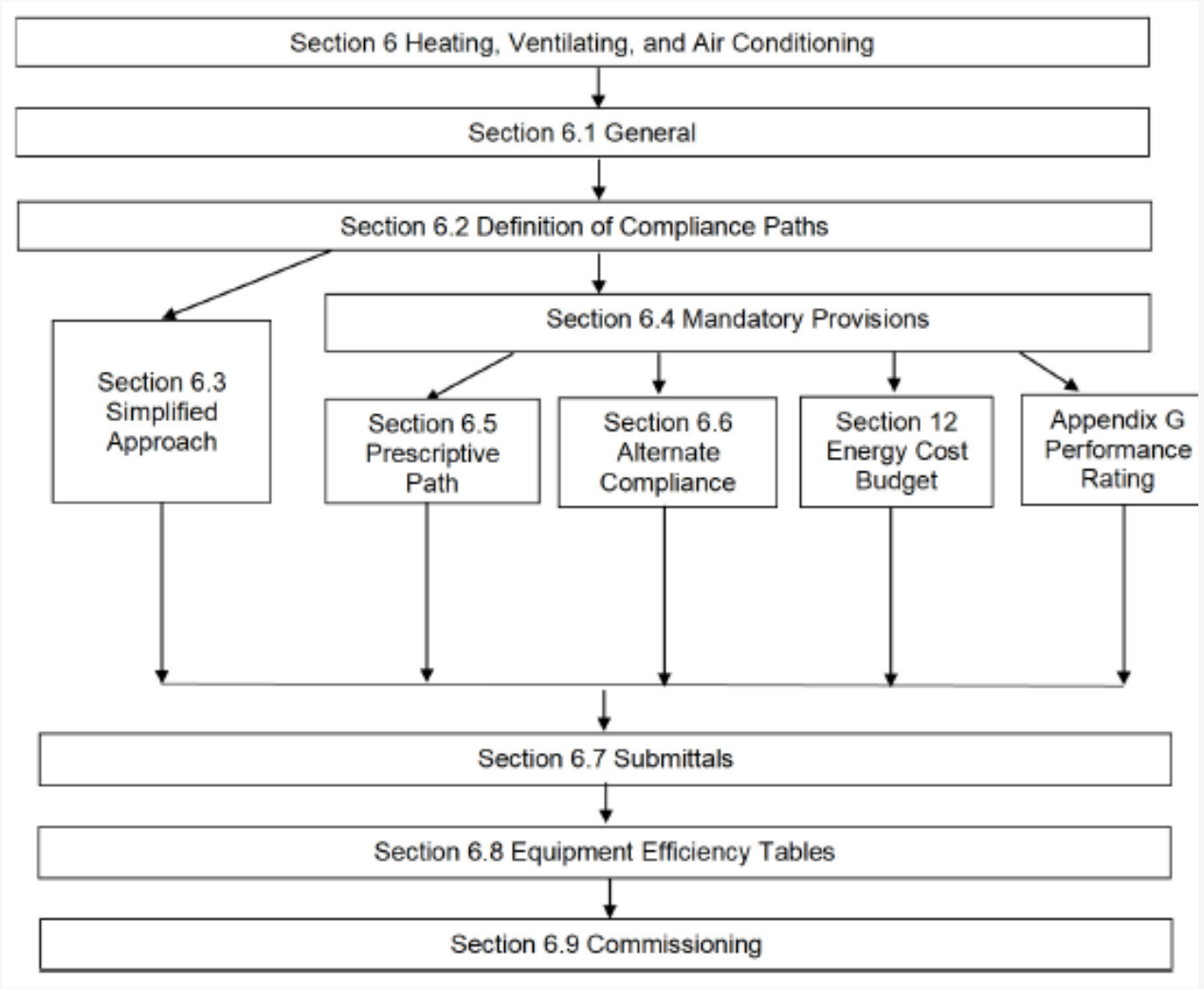
- Also allows for a 3rd-party V&T provider to review the continuous air barrier design and construction, in lieu of whole-building air leakage testing
  - (only allowed on buildings 10k ft^2 and larger)

Section 6

Heating, Ventilating, and Air Conditioning

6.1 General

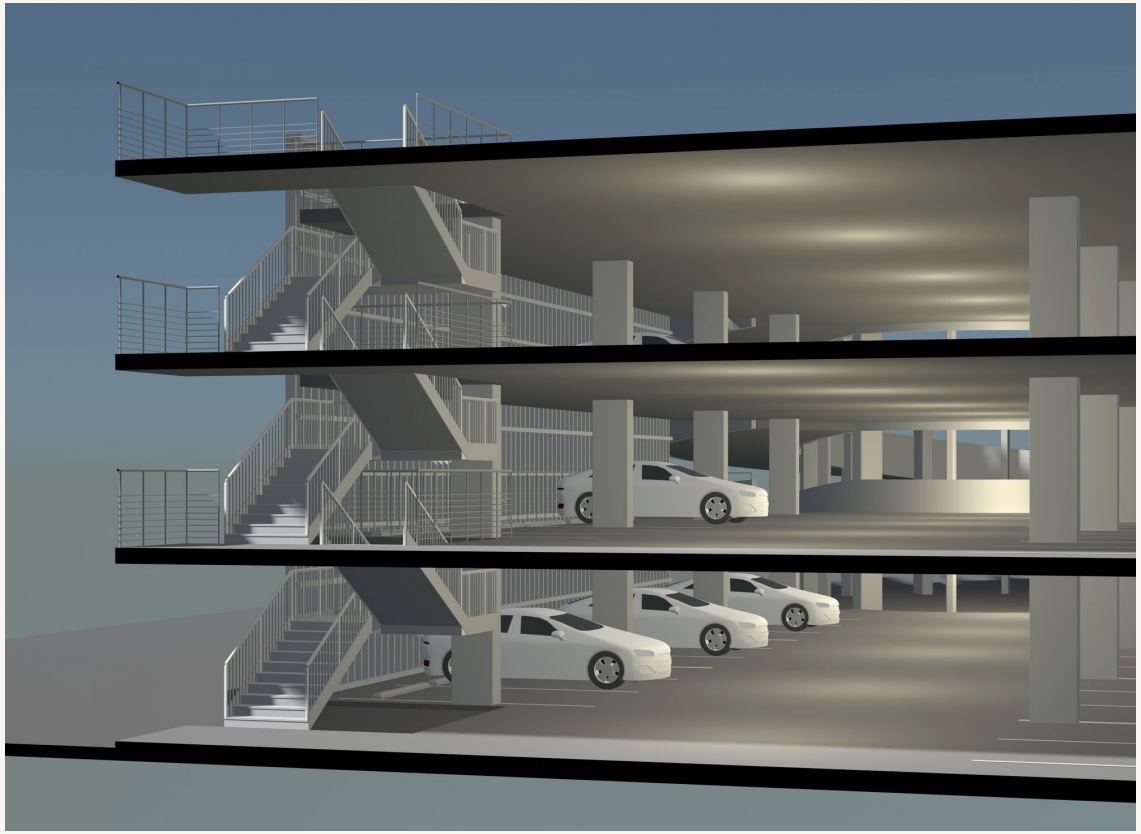

Section 6 - Heating, Ventilating, and Air Conditioning
6.1 - General
6.2 - Definition of Compliance Paths
6.3 - Simplified Approach
6.4 - Mandatory Provisions
6.5 - Prescriptive Path
Section 11 - Energy Cost Budget Method
6.7 - Submittals


Section 6 Heating, Ventilating, and Air Conditioning
Section 6.1 General
Section 6.2 Definition of Compliance Paths
Section 6.3 Simplified Approach
Section 6.4 Mandatory Provisions
Section 6.5 Prescriptive Path
Section 6.6 Alternate Compliance
Section 12 Energy Cost Budget
Appendix G Performance Rating
Section 6.7 Submittals
Section 6.8 Equipment Efficiency Tables
Section 6.9 Commissioning

6.4.3.4.5 Parking Garage Ventilation Systems

- Separate ventilation systems and control systems required for each *parking garage section*
- *Parking Garage Section:* A part of a parking garage where airflow is restricted from other parts of the garage by solid walls

- Intended to prevent situations where one section's sensors control the entire garage's fans



6.4.3.8 Demand Control Ventilation

- In 2013, required for spaces > 500ft^2 with occupancy ≥ 25 people per 1000ft^2
- In 2022, there is an occupancy- and density-based table per climate zone → :

Table 6.4.3.8 Demand Control Ventilation (DCV) Floor Area Thresholds

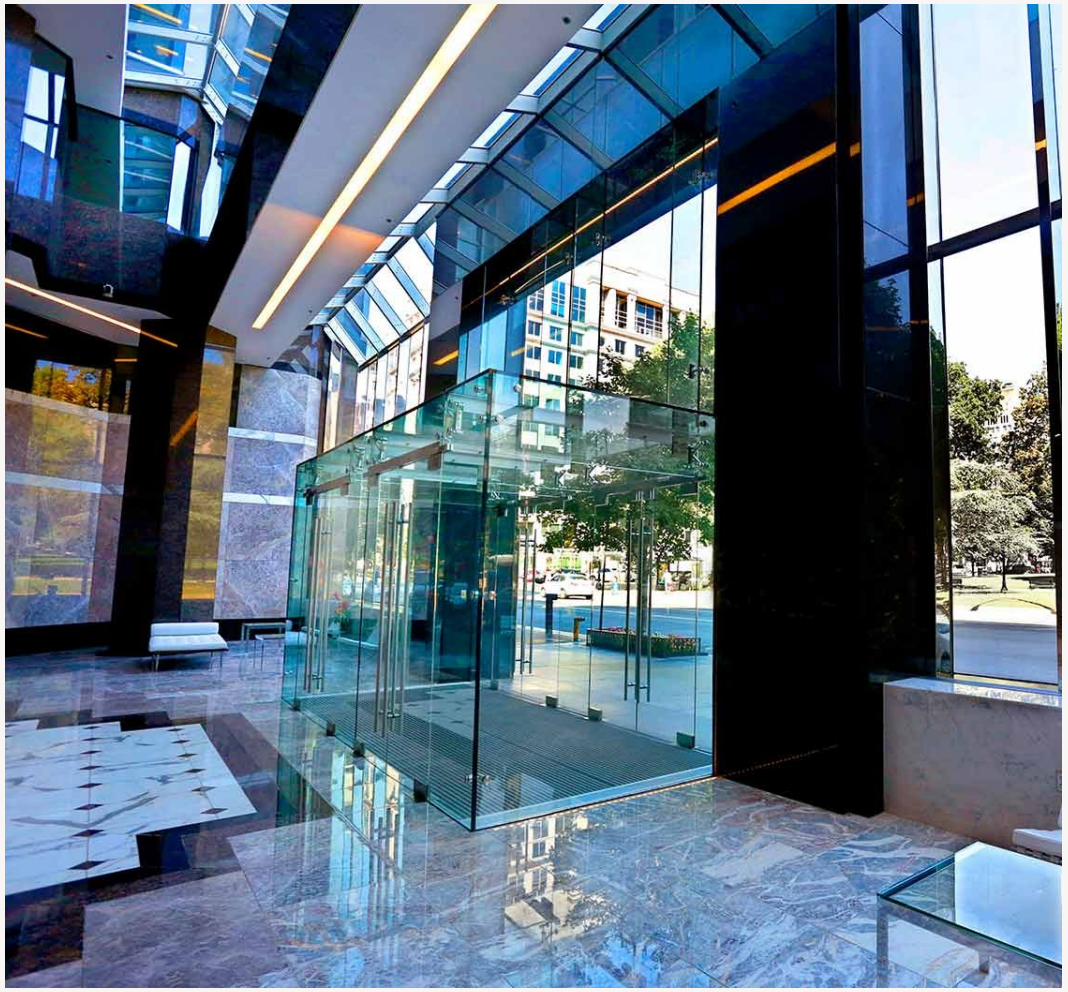
	Occupant Outdoor Airflow Component (cfm/1000 ft^2) [a]					
	100 to 199	200 to 399	≥400	100 to 199	200 to 399	≥400
	Minimum Space Floor Area in ft^2 where DCV Is Required					
Climate Zone	Areas without Exhaust Air Energy Recovery			Areas with Exhaust Air Energy Recovery [b]		
7, 8	400	200	150	800	400	250
5A, 6A, 6B	600	250	150	1400	900	400
0A, 0B, 1B, 3A, 4A, 5B, 5C	800	400	250	2000	1000	500
2A, 2B, 4C	1100	600	300	2300	1100	600
3B, 4B	1500	700	400	5200	2350	1250
1A	2400	1100	600	5800	2600	1400
3C	7000	3000	1700	12,000	6000	3000

a. Occupant outdoor airflow component in cfm per 1000 ft^2 shall be calculated as the product of default occupant density and outdoor airflow rate per occupant (R_p) as shown in ASHRAE Standard 62.1, Table 6.2.2.1.
b. Where exhaust air energy recovery is required by Section 6.5.6.1.

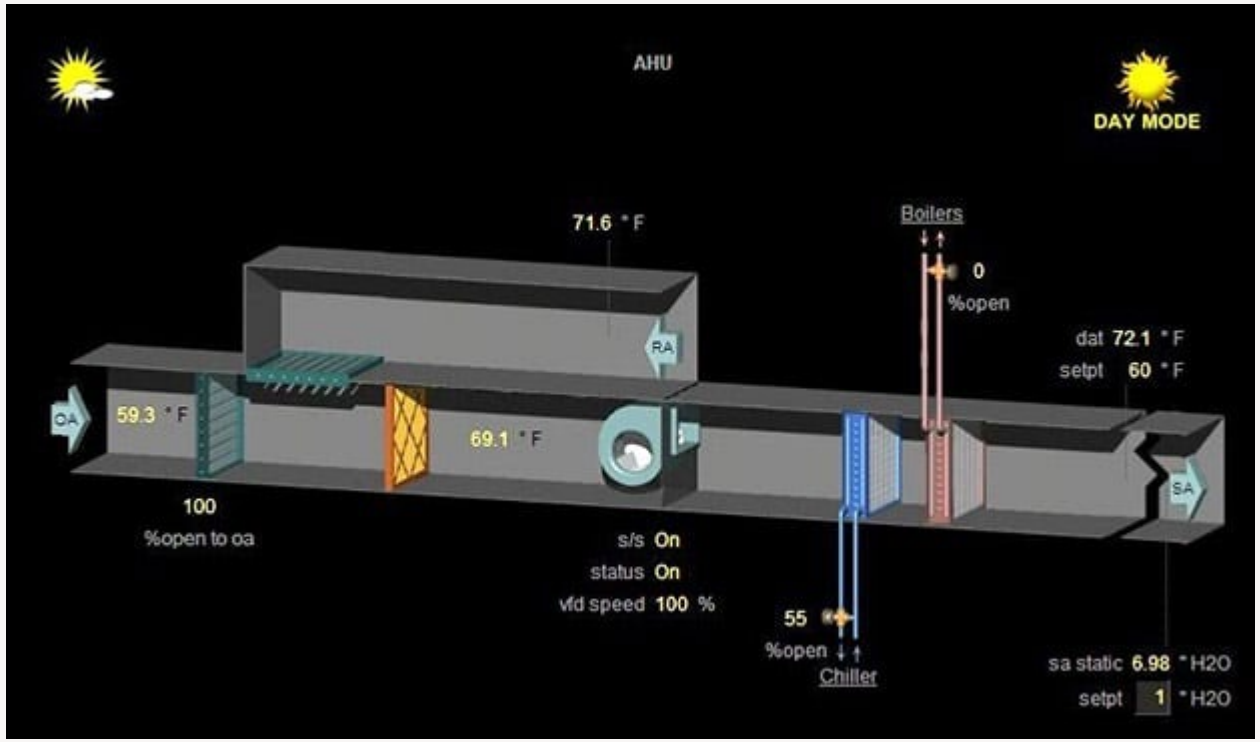
6.4.3.9 Heated or Cooled Vestibules

- Heating systems for vestibules shall heat to a maximum of 60F
- Cooling systems for vestibules shall cool to a minimum of 85F (previously no mention of cooling)

- Applies to air curtains with integral heating/cooling
- Does not require heating/cooling to be installed



6.4.3.10 DDC Control Requirements



- 2013 incorporated a Table on when DDC is required for buildings
- 2022 does not change that table, but now mandates what the DDC system should be capable of and configured for
- Now requires the DDC system to be capable of trending and graphically displaying input/output points

6.4.3.11 Chilled-Water Plant Monitoring

- Required for water-cooled chilled-water plants larger than 1000 Tons (CZ 3A)
- Required for air-cooled chilled-water plants larger than 570 Tons (CZ 3A)
- Measurement devices must be installed to track electric energy use and efficiency of the chilled-water plant in kW/ton
- Trended every 15 minutes and graphically displayed to include hourly, daily, monthly, and annual day. Collected for a minimum of 36 months.

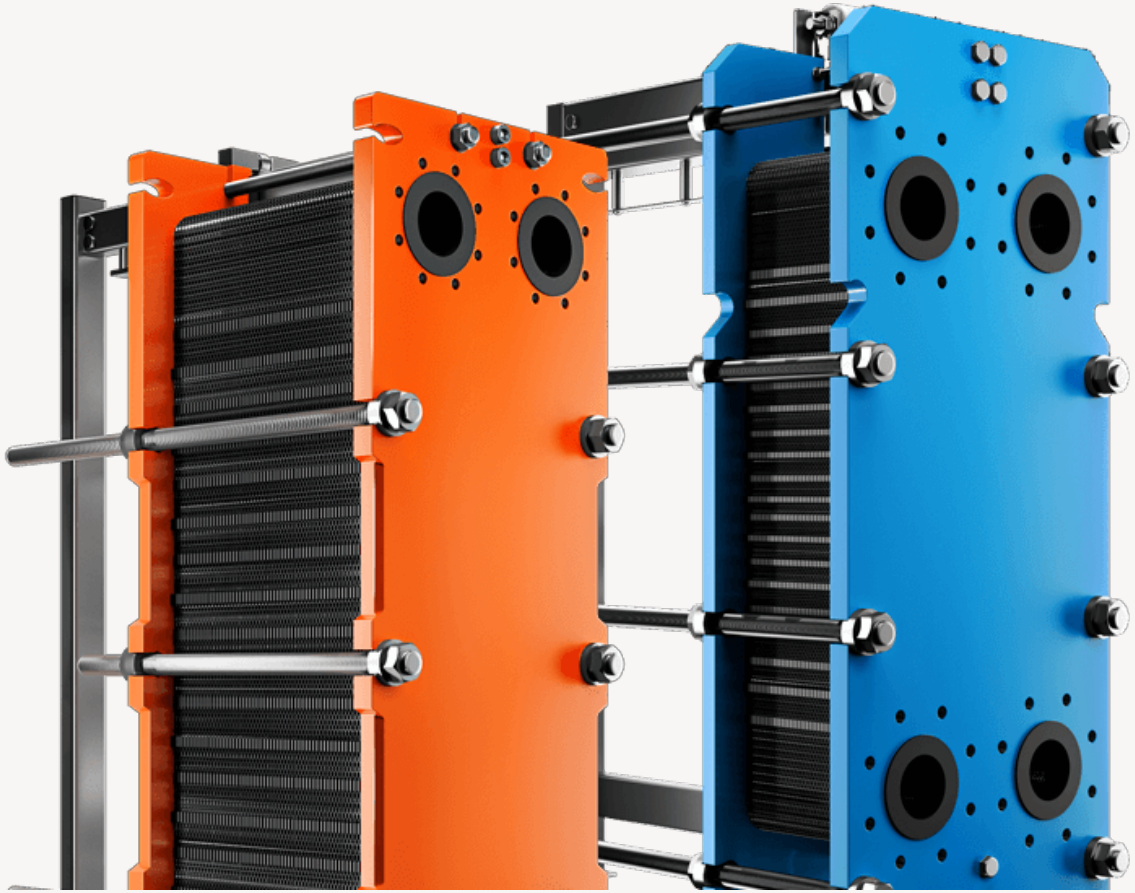
6.4.3.12 Economizer Fault Detection and Diagnostics (FDD)

- Requires air economizers to be equipped with fault detection and diagnostics (FDD) to ensure continuous operation
- Studies showed a high percentage of economizers were non-functional in the field
- Present in IECC 2015 already

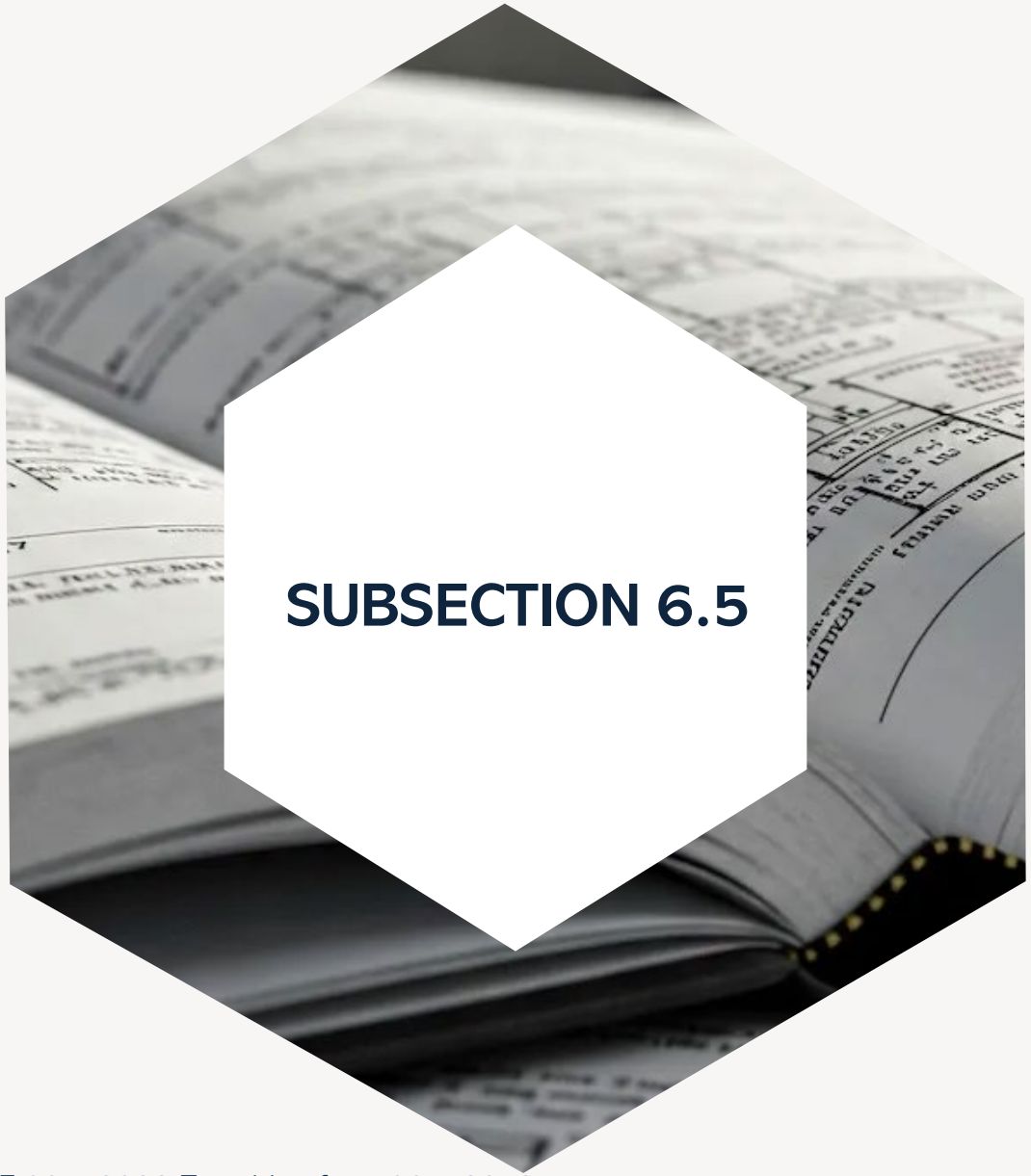
6.4.5 Walk-In Coolers and Freezers

- (k) Condenser Fan Motors: less than 1 hp must now be ECM, PSC, or 3-phase motor
- (l) Defrost Termination Control: walk-in freezers shall incorporate temperature-based defrost termination control (instead of time-based)
- (m) Door and Refrigeration System Efficiency: new efficiency Tables 6.8.1-18 thru 20 now cover Walk-In Cooler Doors, Walk-In Freezer Doors, and Walk-In Freezer Refrigeration Systems

6.4.7 Liquid-to-Liquid Heat Exchangers



- Plate-type liquid-to-liquid heat exchangers shall be rated in accordance with AHRI 400
- 2013 mentioned them offhand as a stray reference in 6.4.1.4 (Verification)



6.5 Prescriptive Compliance Path

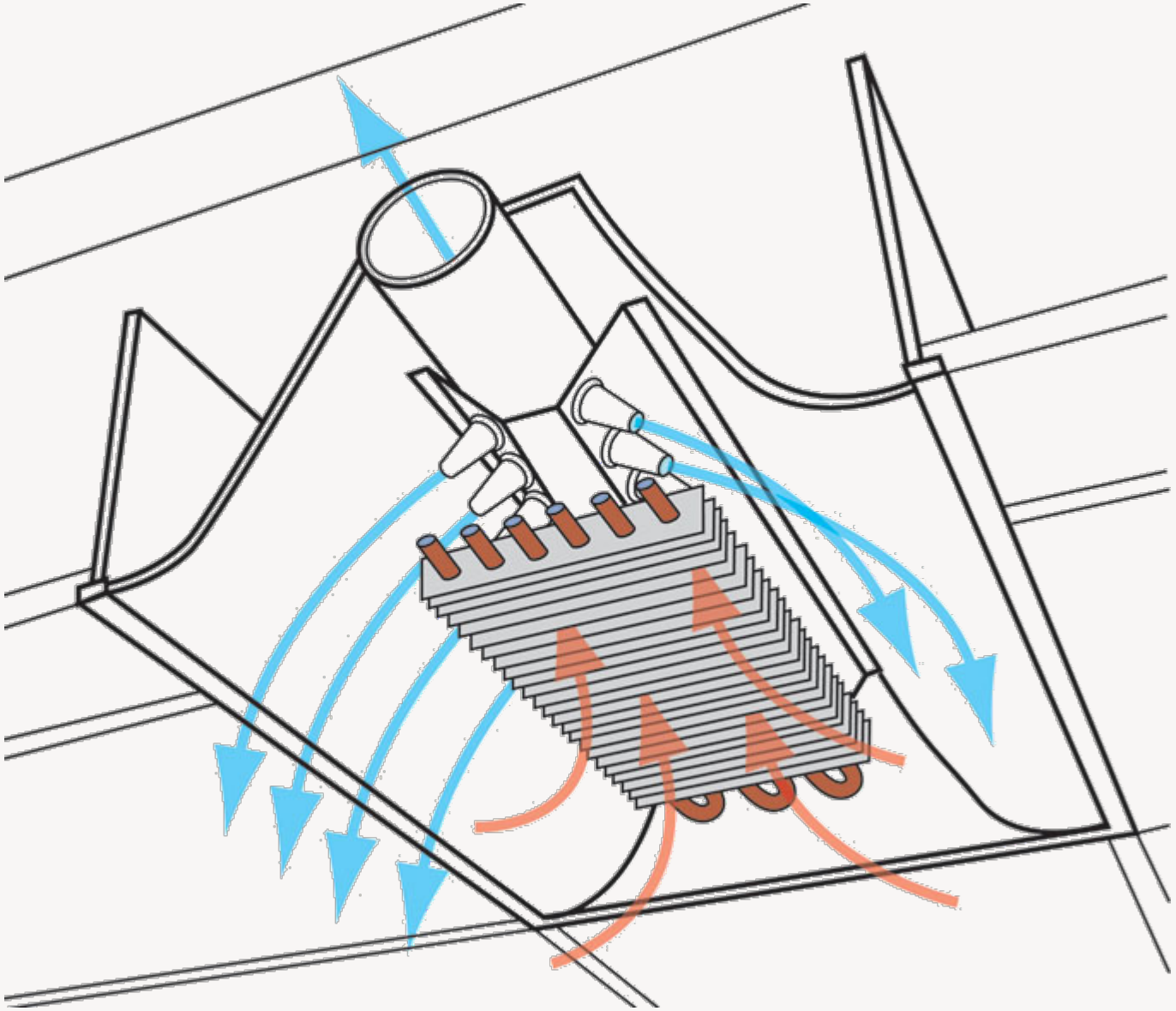
6.5.1 Economizers

- 2013: “Each cooling system that has a fan shall include either an air or water economizer…”
- 2022: “Each cooling system shall include either an air economizer or fluid economizer…”

Climate Zone	Cooling Capacity for which an Economizer is Required	Application
0A, 0B, 1A, 1B	No economizer requirement	All
2A, 2B, **3A**, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	≥33,000 Btu/h	Fan-cooling units located outside the building
	≥54,000 Btu/h	All other fan-cooling-unit locations

6.5.1, Exception (2)

- Chilled-water cooling systems without a fan or that use induced airflow, where the total capacity of these systems is less than 1,000,000 Btu/h



6.5.1.1 Airside Economizers

6.5.1.1.5 Relief of Excess Outdoor Air

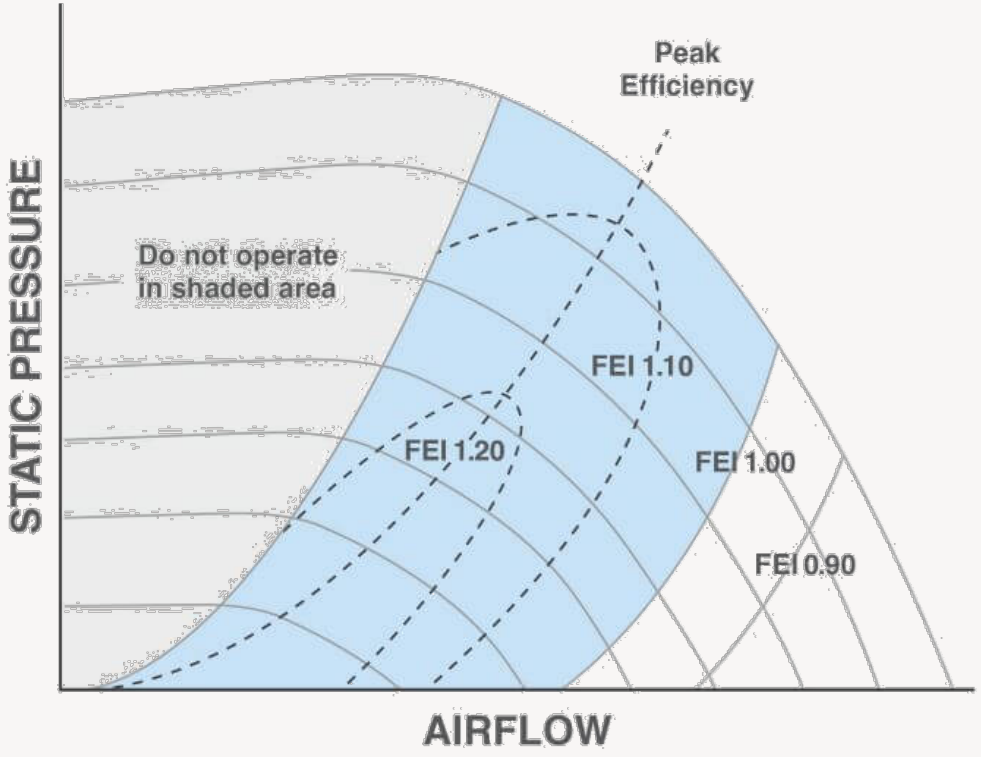
- 2013: “Systems shall provide a means to relieve excess outdoor air during air economizer operation to prevent overpressurizing the building.”
- 2022: Specifies two options for relief
  - 1) Return or relief fan(s) controlled to maintain building pressure
  - 2) Barometric or motorized damper relief path with a total pressure drop at design relief flow rate less than 0.10 in. of water from the occupied space to the outdoors. Design flow rate shall be the design supply airflow rate minus any other continuous exhausts in the building.

6.5.2.6 Ventilation Air Heating Control

- Limits DOAS or other ventilation systems to only heat to 60F maximum when majority of the building is in cooling mode

6.5.3 Air System Design and Control

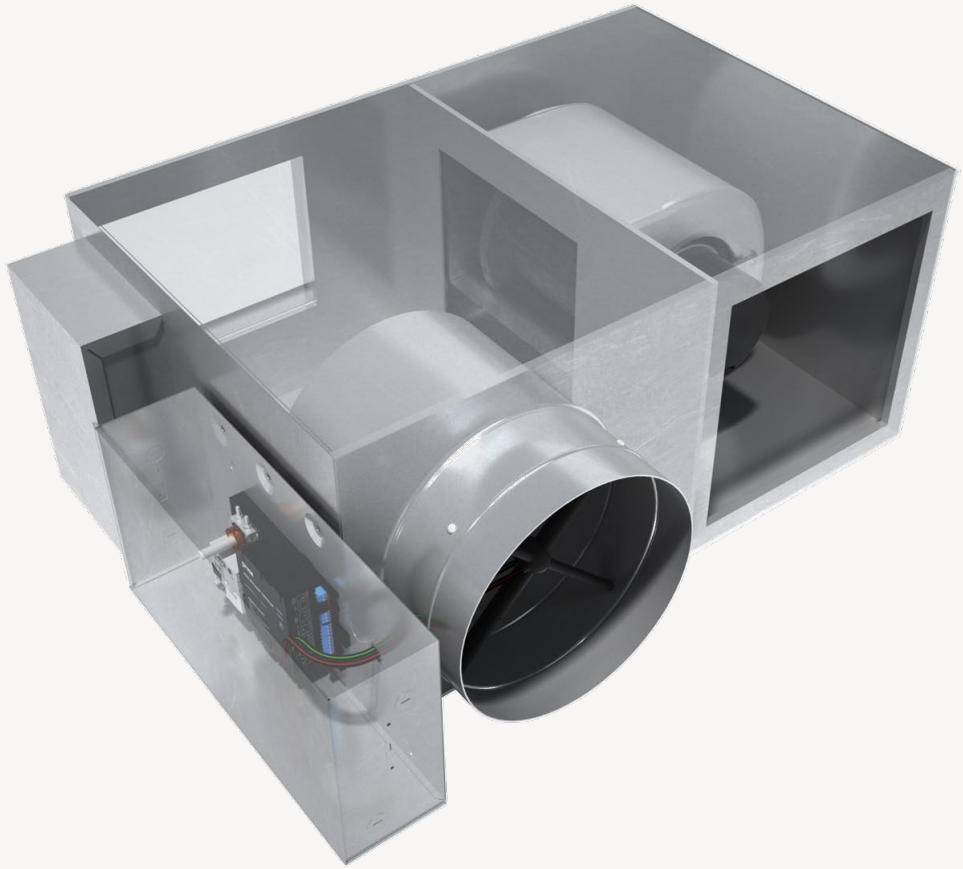
6.5.3.1.3 Fan Efficiency



- 2013: Required an FEG rating of 67 or higher based on AMCA 205
  - Fan Efficiency Grade (FEG) only measured peak aerodynamic efficiency with no consideration of motor efficiency or drive losses
- 2022: Requires an FEI rating of 1.00 or higher based on AMCA 208
  - Fan Energy Index (FEI) is a ratio of the fan's actual power consumption to a reference baseline power, incorporating motor and drive losses. FEI > 1.0 means the fan uses less energy than the reference baseline at the design point.

6.5.3.4 Parallel-Flow Fan-Powered VAV Air Terminal Control

- New section added to specify standard logic for FPUs/PIUs.
- Prohibits fan from constantly running during cooling and ventilation-only operation, and specifies the fan is meant to be the first heating stage before the heating coil energizes.



6.5.3.5 Supply Air Temperature Reset Controls

- 2013: Allowed supply air temp to reset based on humidity. Had a blanket exception for SAT reset for Climate Zones 2A/3A.
- 2022: Disallows SAT based on RH for all “A” climate zones. No blanket exception for Climate Zones 2A/3A **(Supply Air Temp reset is now *required* for our market)**

- Exceptions:
  - Systems in Climate Zone 3A with less than 3000 cfm of design outdoor air (30T+)
  - Systems in Climate Zone 2A with less than 10,000 cfm of design outdoor air (100T+)

6.5.3.5.1 Dehumidification Control Interaction

- “In Climate Zones 0A, 1A, 2A, and 3A, the system design shall allow SAT reset while dehumidification is provided. When dehumidification control is active, air economizers shall be locked out.”

- Since the previous section removes the blanket SAT reset exemption for hot-humid climates, it must also specify how to do SAT reset without compromising dehumidification.

6.5.3.7 Low Power Fans

Table 6.5.3.7 Minimum Fan Efficacy for Low-Power Fans

System Type	Minimum Fan Efficacy [a, b], cfm/W	Test Method and Rating Conditions
HRV [c], ERV [d], or other system with exhaust air *energy* recovery	1.2	CAN/CSA 439-18
Transfer fans; in-line [e] supply or exhaust fan	3.8	ASHRAE Standard 51
Other exhaust fan, <90 cfm	2.8	
Other exhaust fan, ≥90 cfm and ≤200 cfm	3.5	
Other exhaust fan, >200 cfm	4.0	

a. Fan efficacy is the volumetric fan airflow rate divided by total fan motor electrical input power at a specified static pressure difference.
b. Fans shall be tested in accordance with the referenced test method. Fan efficacy shall be reported in the product listing or shall be derived from the fan motor electrical input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV or ERV, balanced, and in-line fans shall be determined at a static pressure difference not less than 0.2 in. of water for each airstream. Fan efficacy for other ducted fan systems shall be determined at a static pressure difference not less than 0.1 in. of water.
c. A heat recovery ventilator (HRV) is a mechanically powered ventilating device with separate intake and exhaust airstreams and a heat exchanger to transfer a portion of the sensible energy, heat, from one airstream to the other.
d. An energy recovery ventilator (ERV) is a mechanically powered ventilating device with separate intake and exhaust airstreams and a heat exchanger to transfer a portion of the total energy, heat and moisture, from one airstream to the other.
e. An in-line fan is an exhaust or supply fan installed with ductwork on both the fan inlet and outlet.

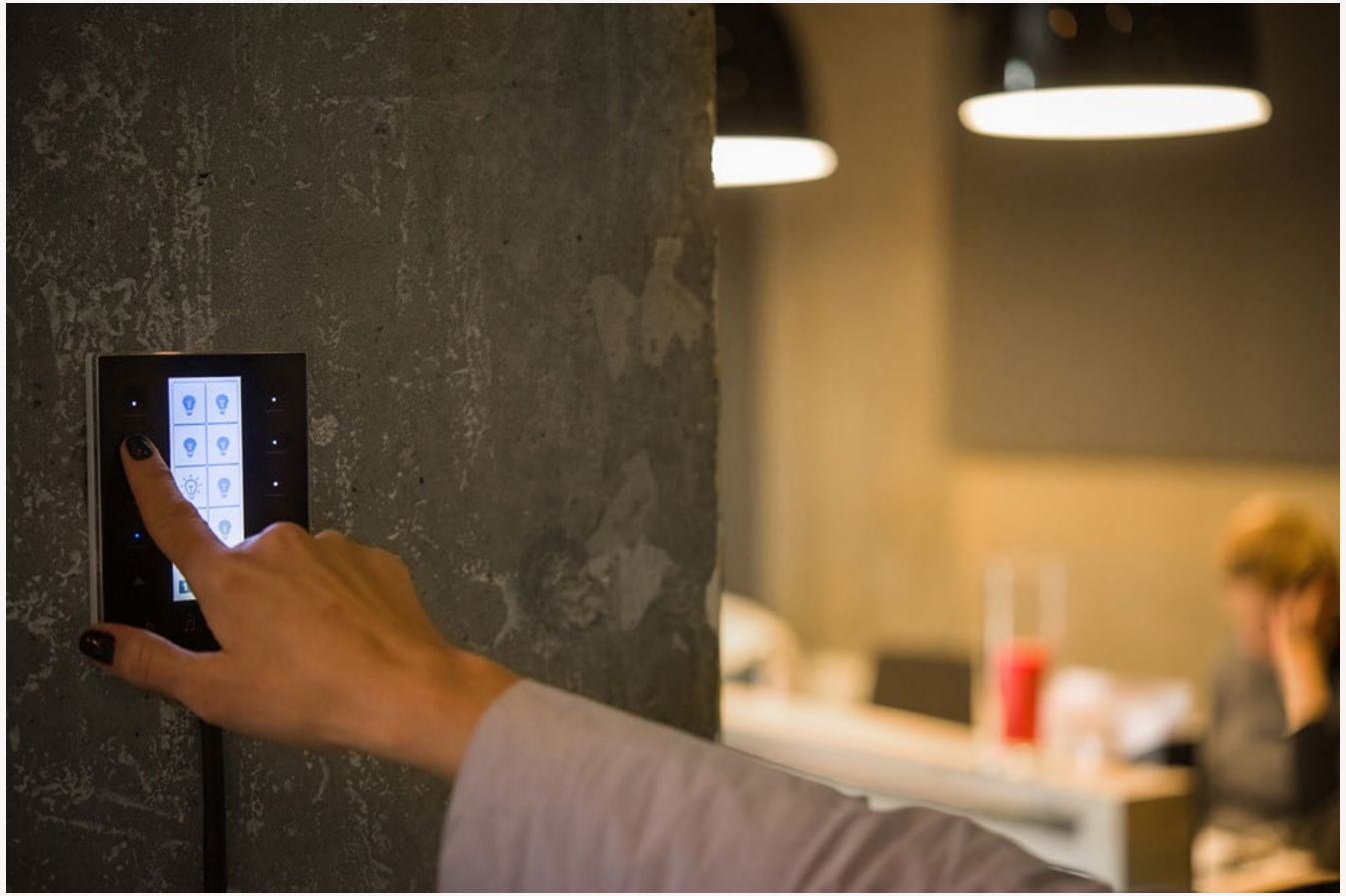
- 2013: Fans below 1/12 hp entirely unregulated.
- 2022: Fans with less than 180W input power, or horsepower less than 1/12 hp must now meet minimum fan efficacy (cfm/W) in Table 6.5.3.7

6.5.3.8 Ventilation Design

- 2013: Not present, sizing was implicit in Standard 62.1 compliance.
- 2022: Now requires the outdoor air rate be in compliance with Standard 62.1, 62.2, or 170.

- Also limits the design outdoor air to 135% of the required minimum outdoor air rate. Over-ventilation can be a significant energy waste in commercial buildings.

6.5.3.9 Occupied-Standby Zone Controls



- Zones serving rooms with automatic OFF lighting controls (per Section 9.4.1.1) where Standard 62.1 permits ventilation to be reduced to zero in occupied-standby mode shall do so with 5 minutes.

6.5.4.7 Chilled-Water Coil Selection

- Requires chilled-water cooling coils to provide a 15°F or higher temperature difference between leaving and entering water temperatures
- Requires a minimum of 57°F leaving water temperature at design conditions

- Aims to solve for low-dT syndrome, and reduce pump flow rates.
- Seven exceptions present to acknowledge situations where a 15°F delta-T is genuinely impractical.

6.5.4.8 Buildings with High-Capacity Space-Heating Gas Boiler Systems

- New buildings with gas hot-water boiler systems for space heating with a total system input of ≥1,000,000 Btu/h and ≤10,000,000 Btu/h shall have a thermal efficiency E_t of 90% or higher
- Coils and heat exchangers shall be sized to have boiler return temperature of 120°F or less.

6.5.6.1.1 Nontransient Dwelling Units

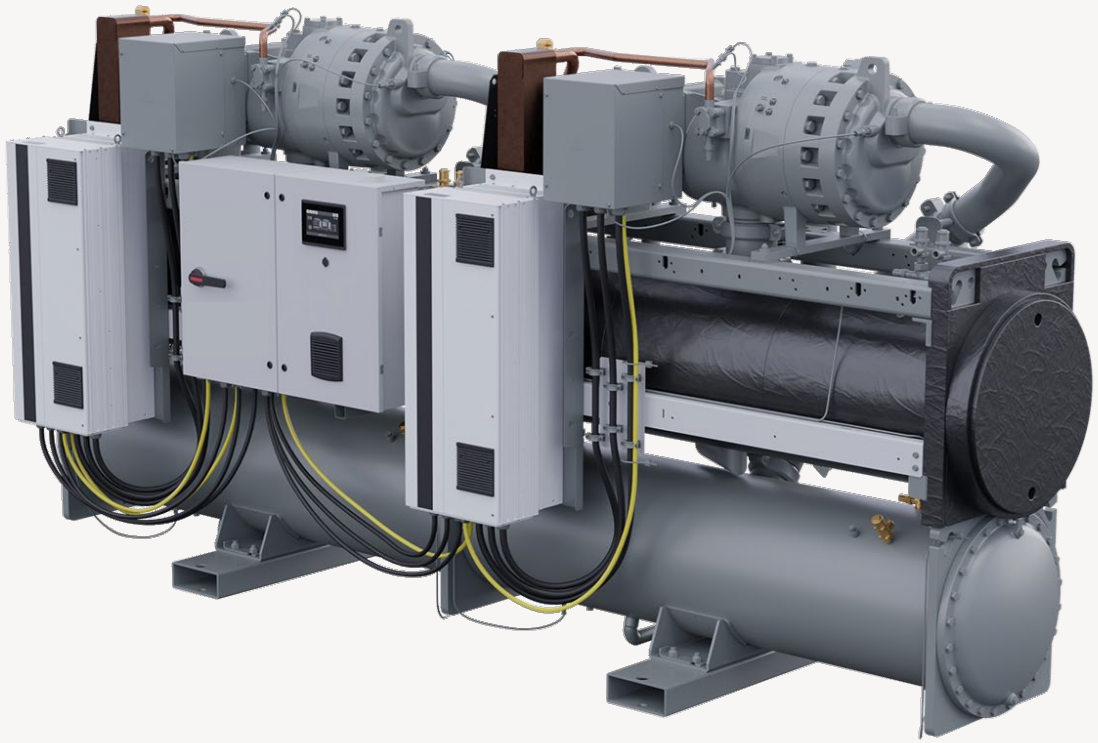
- All nontransient dwelling units (i.e. multifamily) shall be provided with outdoor air energy recovery ventilation systems.

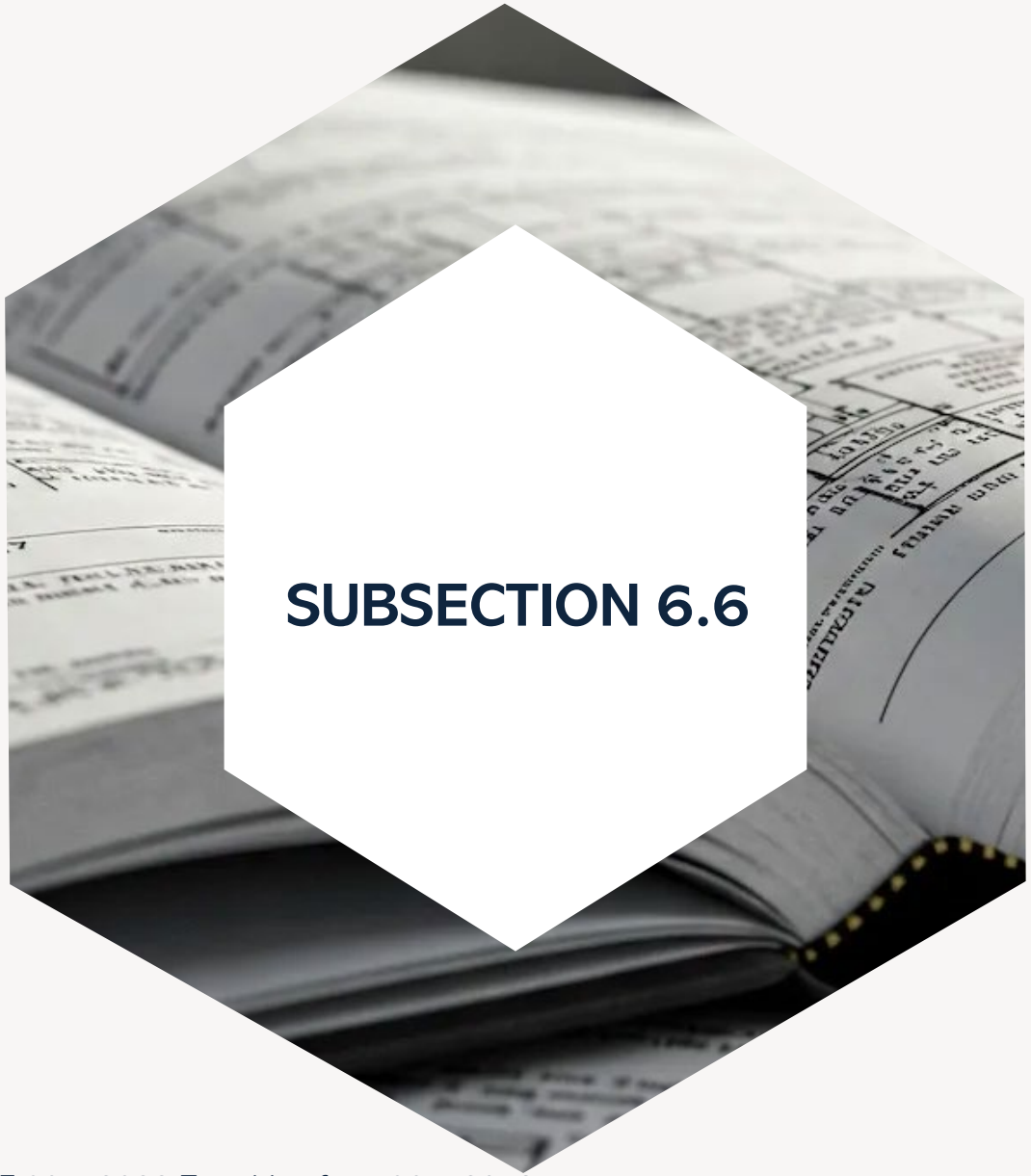
- Enthalpy Recovery Ratio must be 50% or higher
- Sensible Energy Recovery Ratio must be 60% or higher

6.5.6.3 Heat Recovery for Space Conditioning

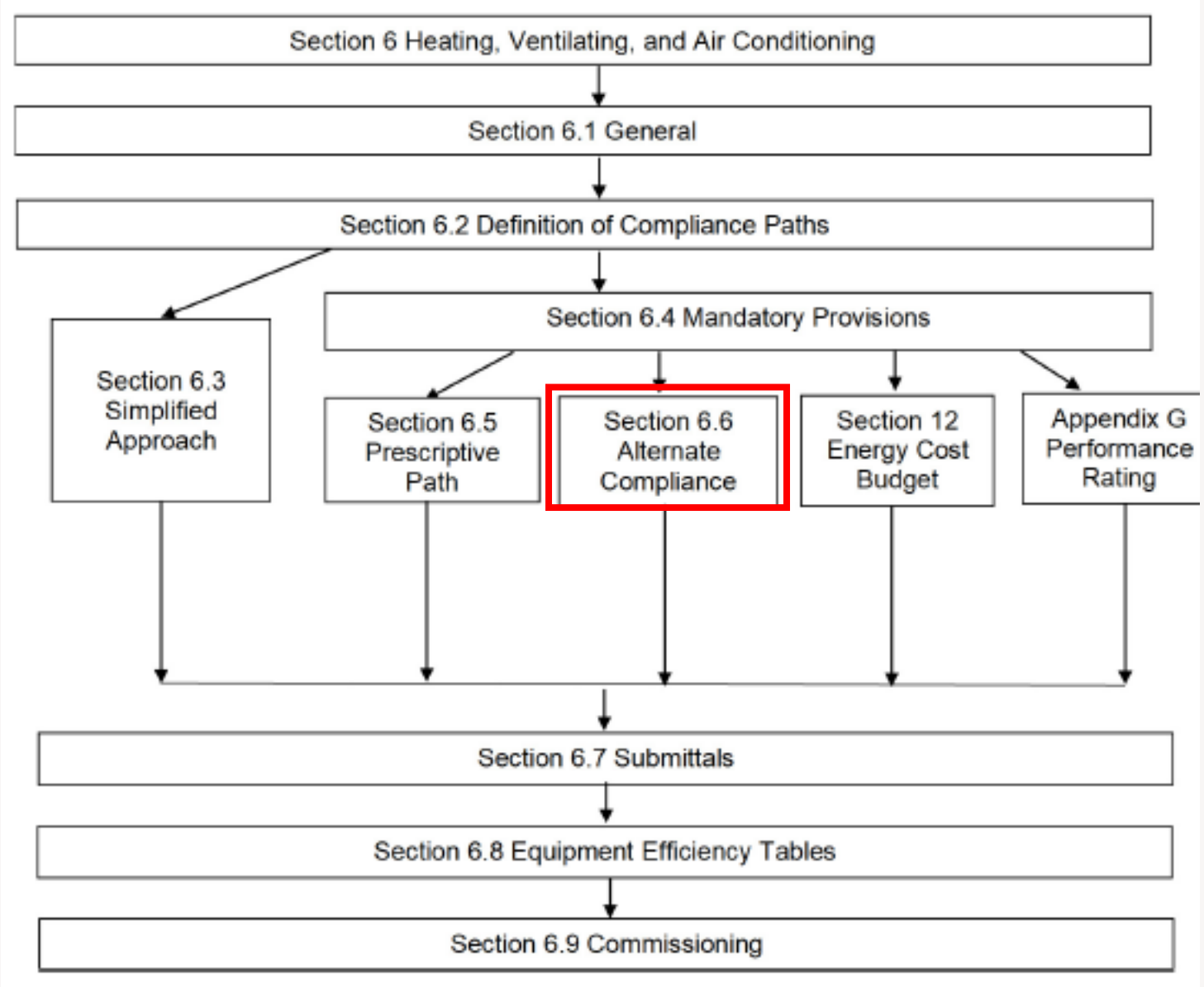
- A heat pump / heat recovery chiller must be provided if all are true:
  - A) The building is an acute inpatient hospital
  - B) Total ChW capacity exceeds 3,600,000 Btu/h of cooling
  - C) Simultaneous heating and cooling occurs above 60°F outdoor air temperature

- Must be at least 7% of the total design chilled-water capacity of the hospital





6.6 Alternative Compliance Path


Section 6 Heating, Ventilating, and Air Conditioning
Section 6.1 General
Section 6.2 Definition of Compliance Paths
Section 6.3 Simplified Approach
Section 6.4 Mandatory Provisions
Section 6.5 Prescriptive Path
Section 6.6 Alternate Compliance
Section 12 Energy Cost Budget
Appendix G Performance Rating
Section 6.7 Submittals
Section 6.8 Equipment Efficiency Tables
Section 6.9 Commissioning

6.6.1 Computer Room Systems Path

- 2013: Compliance based on PUE (Power Usage Effectiveness) in Table 6.6.1 within 90.1
- 2022: Entirely replaced with a single cross-reference to ASHRAE 90.4, the dedicated data center energy standard.

6.6.2 Mechanical System Performance Path

- Entirely new performance-based compliance path for HVAC systems in offices, retail, hotels, multifamily, and schools.
- Total System Performance Ratio (TSPR), calculated per the new Normative Appendix L

$$TSPRp \geq \frac{TSPRr}{MPF}$$

Where:

- TSPRp = proposed design TSPR
- TSPRr = reference building TSPR (meeting all Section 6.5 Prescriptive requirements)
- MPF = Mechanical Performance Factor from Table 6.6.2.2 (varies by climate zone and building type, ranges roughly from 0.46 to 0.72 for CZ 3A)

6.8 Minimum Efficiency Tables

- Existing tables remain mostly unchanged; updated to include DOE regulations
- New tables added:
  - 6.8.1-13 Electrically Operated DX-DOAS Units without Energy Recovery
  - 6.8.1-14 Electrically Operated DX-DOAS Units with Energy Recovery
  - 6.8.1-15 Electrically Operated Water-Source Heat Pumps
  - 6.8.1-16 Heat Pump and Heat Recovery Water-Chilling Packages
  - 6.8.1-17 Ceiling-Mounted Computer-Room Air Conditioners
  - 6.8.1-18 Walk-In Cooler and Freezer Display Doors
  - 6.8.1-19 Walk-In Cooler and Freezer Nondisplay Doors
  - 6.8.1-20 Walk-In Cooler and Freezer Refrigeration Systems
  - 6.8.1-21 Ceiling Fans

6.8.2 Duct Insulation

- R-values increased across the board
- 2013 two tables now consolidated into a single Table 6.8.2

Table 6.8.2 Minimum Duct Insulation R-Value[a]

Climate Zone	Duct Location: Exterior [b]	Duct Location: Unconditioned Space and Buried Ducts	Duct Location: Indirectly Conditioned Space [c,d]
Supply and Return Ducts for Heating and Cooling			
0 to 4	R-8	R-6	R-1.9
5 to 8	R-12	R-6	R-1.9
Supply and Return Ducts for Heating Only			
0 to 1	None	None	None
2 to 4	R-6	R-6	R-1.9
5 to 8	R-12	R-6	R-1.9
Supply and Return Ducts for Cooling Only			
0 to 6	R-8	R-6	R-1.9
7 to 8	R-1.9	R-1.9	R-1.9

a. Insulation *R-values*, measured in $h \cdot ft^2 \cdot °F/Btu$, are for the insulation as installed and do not include film resistance. The required minimum thicknesses do not consider water vapor transmission and possible surface condensation. Where portions of the *building envelope* are used as a *plenum* enclosure, *building envelope* insulation shall be as required by the most restrictive condition of Section 6.4.4.1 or Section 5, depending on whether the *plenum* is located in the *roof*, *wall*, or *floor*. Insulation resistance measured on a horizontal plane in accordance with ASTM C518 at a *mean temperature* of 75°F at the installed thickness.

b. Includes attics above insulated ceilings, parking garages and crawl *spaces*.

c. Includes return air *plenums* with or without exposed *roofs* above.

d. Return ducts in this duct location do not require insulation.

6.9 Verification, Testing, and Commissioning

- HVAC control system shall be tested in accordance with Section 4.2.5.1
- Mechanical systems shall be commissioned in accordance with Section 4.2.5.2

Section 7

Service Water Heating

7.4 Performance Requirements

- “Efficiency tables” for water-heating equipment.
- EF (Energy Factor) has been replaced throughout the table by UEF (Uniform Energy Factor)
- UEF is a more rigorous metric tested at four draw patterns to represent real-world usage.

7.4.4 Service Water-Heating Controls

- New *Informative Note* pointing to ASHRAE Standard 188 "Legionellosis: Risk Management for Building Water Systems", which was published after 2013.

7.9 Verification, Testing, and Commissioning

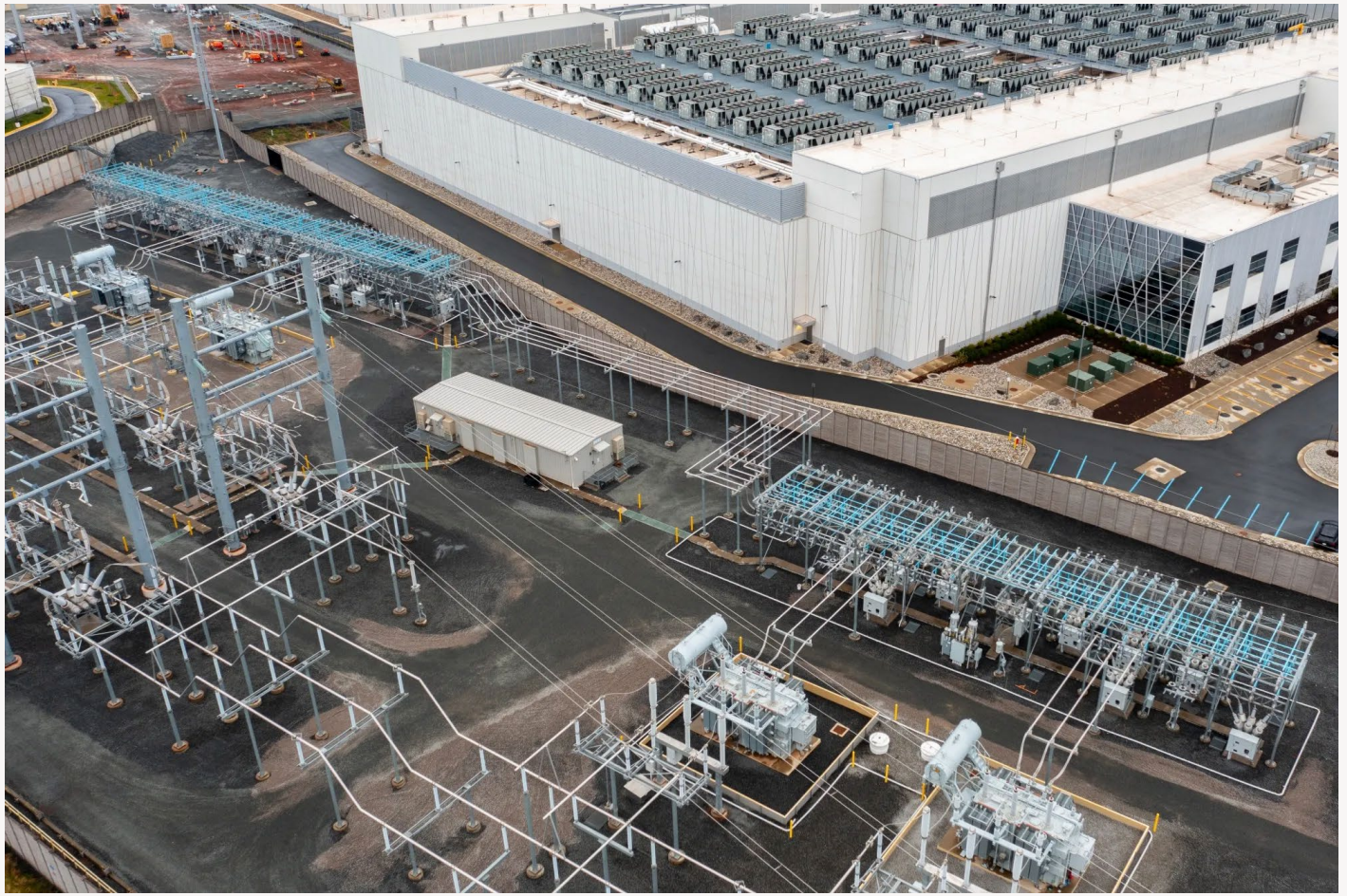
- Service hot-water controls shall be verified and tested…
- Energy performance of the service water heating systems shall be commissioned in accordance with Section 4.2.5.2

Section 8

Power

8.6 Alternative Compliance Path

- In parallel to past sections, pushes data center / data rooms with IT load greater than 10kW to utilize ASHRAE 90.4 as the Energy Standard



8.9 Verification, Testing, and Commissioning

- Electrical energy monitoring systems shall be verified and tested in accordance with Section 4.2.5.1
- Electrical systems shall be commissioned in accordance with Section 4.2.5.2

Section 9

Lighting

9.4.2 Exterior Lighting Power

- Exterior lighting power allowance table is completely rewritten in 2022. All values are reduced.

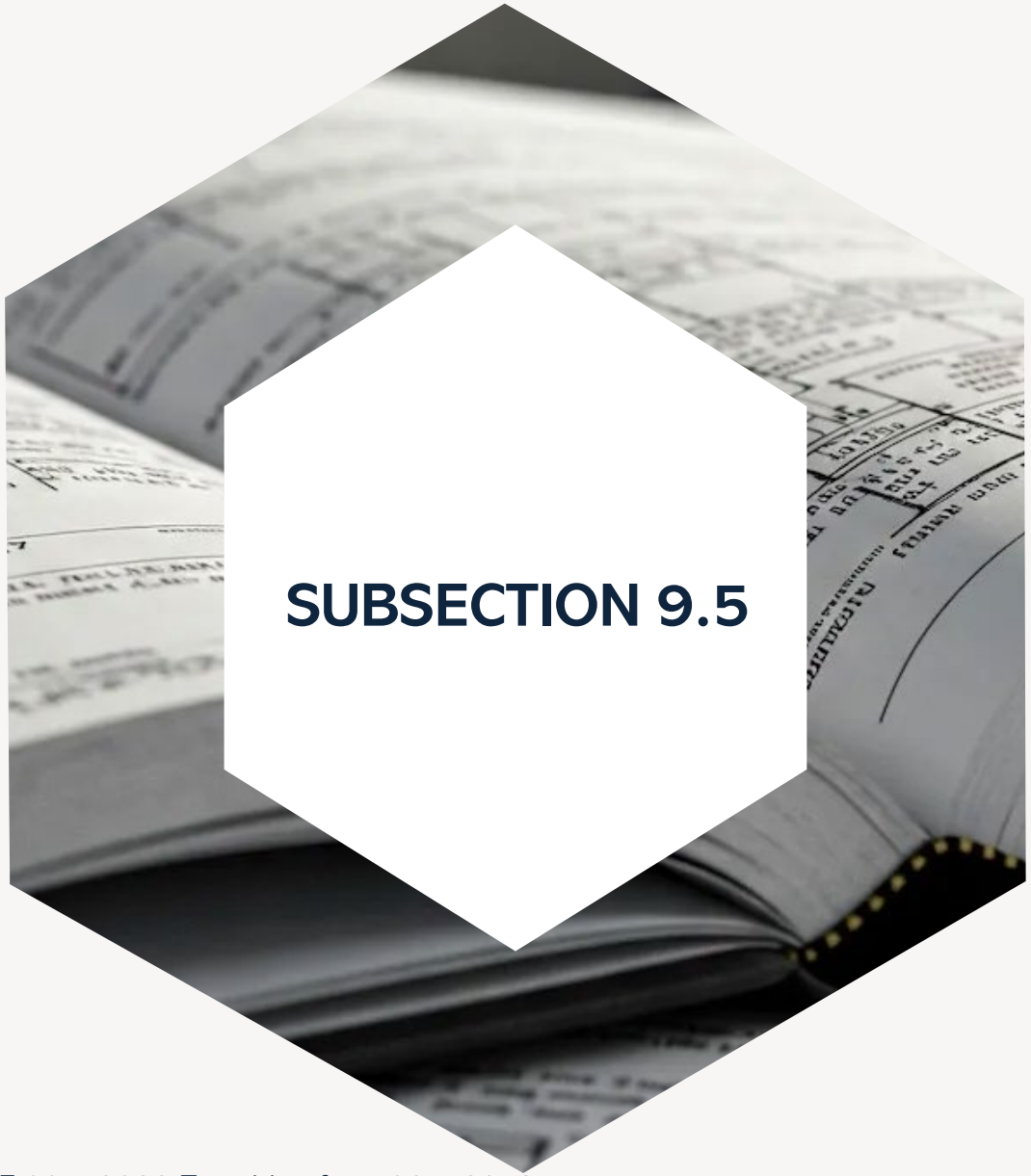
Application	2013 Zone 3	2022 Zone 3	Reduction
Uncovered parking	0.10 W/ft²	**0.037 W/ft²**	~63% reduction
Walkways < 10 ft	0.8 W/linear ft	**0.55 W/linear ft**	~31% reduction
Plaza areas	0.16 W/ft²	**0.070 W/ft²**	~56% reduction
Building façades	0.15 W/ft²	**0.140 W/ft²**	~7% reduction
ATMs	270 W + 90 W/additional	**90 W + 35 W/additional**	~67% reduction
Drive-through	400 W per DT	**132 W per DT**	~67% reduction
Parking near 24-hr retail	800 W per entry	**200 W per entry**	~75% reduction
Base site allowance (Zone 3)	1,300 W	**400 W**	~69% reduction

9.4.3 Dwelling Units

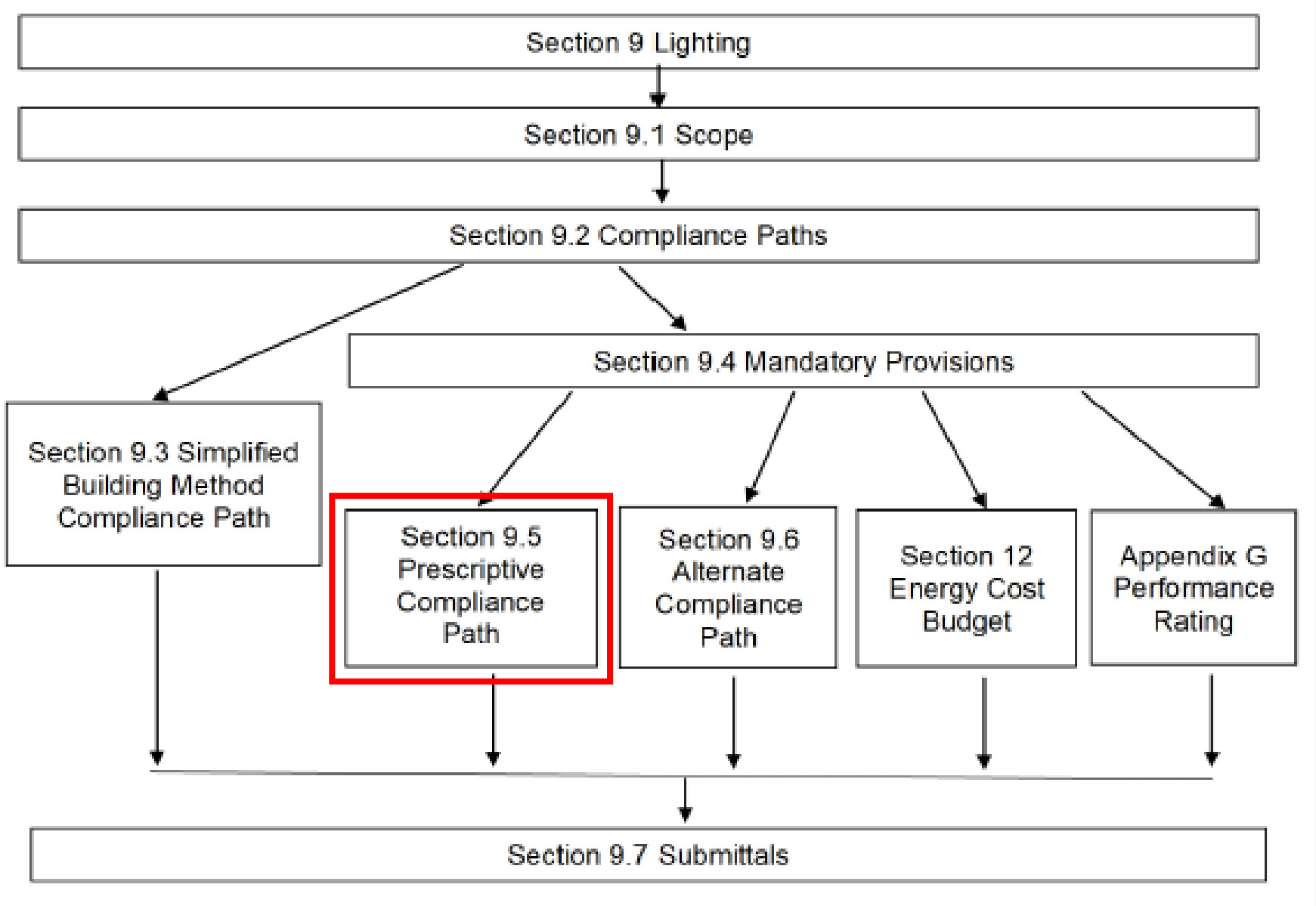
- Whole new section dedicated to dwelling unit lighting.
- Specifies 75% of lamps ≥75 lm/W or total luminaire efficacy ≥50 lm/W
- 50% of luminaires must be controlled with dimmers or auto-shutoff within 20 minutes of occupants leaving

9.4.4 Horticultural Lighting

- Addresses the need for lighting standards for greenhouses and indoor grow facilities



9.5 Prescriptive Compliance Path


Section 9 Lighting
Section 9.1 Scope
Section 9.2 Compliance Paths
Section 9.4 Mandatory Provisions
Section 9.3 Simplified Building Method Compliance Path
Section 9.5 Prescriptive Compliance Path
Section 9.6 Alternate Compliance Path
Section 12 Energy Cost Budget
Appendix G Performance Rating
Section 9.7 Submittals

9.5.1 Building Area Method

- Lighting Power Density requirements in Table 9.5.1 are reduced in every facility type across the board.
- Reductions on the order of 20-40% depending on building type.
- (previously called the Prescriptive Path)

9.5.2 Space-by-Space Method

- Previously was 9.6 Alternative Compliance Path, now rolled in as a co-equal prescriptive path.
- Utilizes tradeoffs via large tables
- 9.5.2.2.c addresses spaces for the purpose of videoconferencing, acknowledging the lighting requirements may exceed traditional LPDs in the prescriptive path, and allows compliance with ANSI/IES/AVIXA RP-38.

9.9 Verification, Testing, and Commissioning

- Lighting control devices and control systems shall be verified and tested in accordance with Section 4.2.5.1
- The energy performance of the lighting systems shall be commissioned in accordance with Section 4.2.5.2

Section 10

Other Equipment

10.4.3.4 Elevator Energy Use

- Now mandates a minimum efficiency for elevators according to ISO 25745-2

10.4.5 Air Curtains

- Now mandates performance testing according to AMCA 220 or ISO 27327-1
- Specifies minimum jet speed of 6.6 ft/s

10.4.6 Compressed Air Systems

- Whole new section with five sub-sections covering factory industrial-occupancy compressed air systems with total motor power ≥25 hp
- Addresses the famously-expensive losses of compressed air in industrial buildings by controlling leakage and piping sizes

10.4.8 Clean Water Pumps

- Previously clean water pump efficiency was unregulated in 90.1
- Must now meet Maximum PEI levels in Table 10.8.6

10.5 On-Site Renewable Energy

- "The building site shall have equipment for on-site renewable energy with a rated capacity of not less than **0.50 W/ft² or 1.7 Btu/ft²** multiplied by the sum of the gross conditioned floor area for all floors up to the three largest floors."

10.9 Verification, Testing, Commissioning, and Documentation

- Other applicable equipment shall be verified and tested in accordance with Section 4.2.5.1
- The energy performance of the other equipment systems shall be commissioned in accordance with Section 4.2.5.2

Section 11

Additional Efficiency Requirements

11.5 Prescriptive Compliance Path: *Energy Credits*

Credits required by Building Use Type:

Building Use Type	Climate Zone 3A
Multifamily	46
Health care	49
Hotel/motel	46
Office	50
Restaurant	50
Retail	50
Education	50
Warehouse	50
Other	30

The target of ~50 credits represents approximately 5% total building annual energy cost savings beyond base 90.1-2022 prescriptive compliance.

11.5.2 Credits Available

Category E: Envelope

- E01 Improved Envelope Performance

Category H: HVAC

- H01 HVAC System Performance
- H02 HVAC Heating Performance Improvement
- H03 HVAC Cooling Performance Improvement
- H04 Residential Space HVAC Control
- H05 Ground-Source Heat-Pump System
- H06 DOAS with Zone Fan Control
- H07 Improved HVAC Sequence of Operations

Category W: Service Water Heating

- W01 Heat Recovery for SHW Preheating
- W02 Heat-Pump Water Heater
- W03 Efficient Gas Water Heater
- W04 SHW Piping Insulation Increase
- W05 Point-of-Use Water Heater
- W06 Thermostatic Balancing Valves
- W07 Dwelling-Unit SHW Submeters
- W08 Right Sizing SHW Distribution
- W09 Shower Drain Heat Recovery

11.5.2 Credits Available (cont)

Category P: Power/Monitoring

- P01 Energy Monitoring

Category L: Lighting

- L01 Lighting System Performance
- L02 Continuous Dimming and High-End Trim
- L03 Occupancy Sensor Control Areas
- L04 Increased Daylighting Control Area
- L05 Lighting Control for Multifamily
- L06 Reduce Interior Lighting Power

Category R: Renewable Energy

- R01 On-Site Renewable Energy

Category Q: Equipment Efficiency

- Q01 Efficient Elevator Equipment
- Q02 Efficient Kitchen Equipment
- Q03 Fault Detection and Diagnostics System

Category G: Load Management

- G01 Lighting Load Management
- G02 HVAC Load Management
- G03 Automated Shading Load Management
- G04 Electric Energy Storage
- G05 HVAC Cooling Energy Storage
- G06 SHW Thermal Storage
- G07 Building Thermal Mass

Thank You