HVAC Compliance

HVAC Compliance

Service Water Heating Compliance

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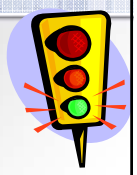
24 July – Pittsburgh

1

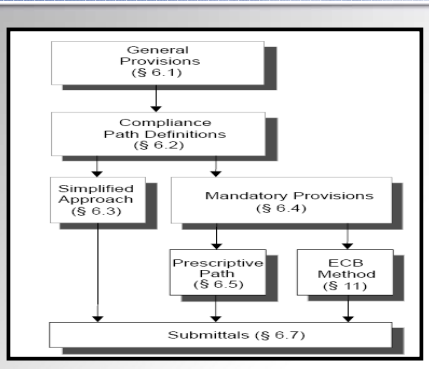
Complying with ASHRAE/IESNA Standard 90.1-2004 HVAC/Mechanical



Learning Objectives

1. Attendee will identify mechanical system requirements of Standard 90.1
2. Attendee will become familiar with 90.1 Standard mechanical code compliance requirements
3. Attendee will identify decisions most likely to increase building energy efficiency

6.2 HVAC Section



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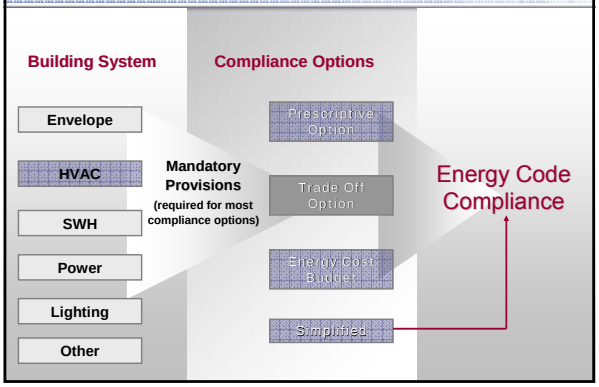
HVAC Compliance



Forms

- Modifiable electronic forms are included with the CD distributed with the Users Manual. These are also available for download from the ASHRAE website (www.ASHRAE.org)
- At the top of the page, under **Technology and Standards**, use the drop down menu to go to **Standards, Forms and Procedures**
- Scroll down to **Compliance Forms** (near the bottom of the page). These are presented in PDF format.

5

Code Compliance

- IECC
- COMcheck - www.energycodes.gov

6

HVAC Alterations

- New equipment shall meet the minimum efficiency requirements
- New cooling systems installed to serve previously uncooled spaces shall comply with this section
- Alterations to existing cooling systems shall not decrease economizer capacity (unless economizer tradeoff is used)
- New and replacement duct work shall comply with applicable requirements
- New and replacement piping shall comply with applicable requirements

Section 6.1.1.3	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

HVAC Alterations

- Alterations to the building HVAC system shall comply with the requirements of Section 6
  - Exceptions that are allowed:
    - For equipment being modified or repaired, but not replaced, provided such modifications will not result in an increase in the annual energy consumption
    - Where a replacement or alteration of equipment requires extensive revisions to other systems and such replacement or altered equipment is a like-for-like replacement
    - For refrigerant change of existing equipment
    - For the relocation of existing equipment
    - For ducts and pipes where there is insufficient space or access to meet these requirements

Section 6.1.1.3	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

HVAC Compliance Paths

- Section 6.2
- You have to follow Sections 6.1, 6.7, and 6.8, and then you can follow either

  Section 6.3

  OR

  Sections 6.4 and 6.5

- Alternatively, you can follow Section 11 (ECB), in which case Section 6.4 is mandatory

9

Simplified Approach Option

- Limited to…
  - Buildings with 1 or 2 stories
  - Buildings < 25,000 ft^2
  - Each HVAC system in the building meets the following requirements
- Requirements
  - Single-zone systems
  - Air-cooled or evaporatively cooled only

10

Section 6.3	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Simplified Approach Option *(cont'd)*

- The system shall have an economizer, unless the economizer Trade-off Option is used
  - Limited to unitary systems
  - Requires higher minimum cooling efficiency (EER)
  - Trade-off EER by
    - System size
    - Climate zone

Table 6.3.2

11

Section 6.3	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Climate Criteria

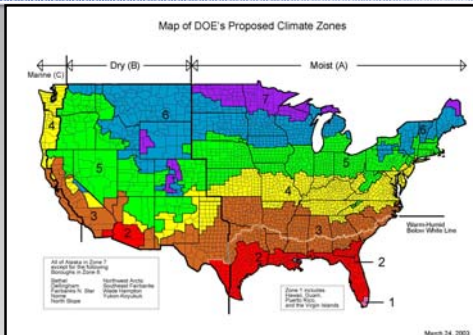


Figure B-1 Climate Zones

12

Simplified Approach Option *(cont'd)*

- Requirements
  - Manual changeover or dual set-point thermostat
  - Heat pump supplementary control
  - No reheat or simultaneous heating and cooling for humidity control
  - Time clocks (except hotel/motel guest rooms and systems requiring continuous operation
  - Pipe and ductwork insulated

13

Section	Mandatory Provisions				Prescriptive Option			
6.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Simplified Approach Option *(cont'd)*

- Requirements
  - Ducted system to be air balanced in accordance with industry accepted procedures
  - Interlocked thermostats to prevent simultaneous heating and cooling when separate heating and cooling systems are used
  - Non-manually operated dampers required on exhaust systems with capacity > 300 cfm unless continuous operation
  - Optimum start controls (design supply air capacity > 10,000 cfm)

14

Section	Mandatory Provisions				Prescriptive Option			
6.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

HVAC Mandatory Provisions

- Minimum Equipment Efficiency *(Section 6.4.1)*
- Load Calculations *(Section 6.4.2)*
- Controls *(Section 6.4.3)*
- HVAC System Construction and Insulation *(Section 6.4.4)*
- Completion Requirements *(Section 6.4.5)*

Section	Mandatory Provisions				Prescriptive Option			
6.4	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Equipment Covered

- Package air conditioners and condensing units
- Heat pumps (air, water, and ground source)
- Packaged terminal and room air conditioners
- Chillers including absorption chillers
- Furnaces and unit heaters
- Boilers
- Heat rejection equipment

16

Mechanical Equipment Efficiency

- Tables 6.8.1A – 6.8.1G
- Tables 6.8.1H-6.8.1J used for water cooled centrifugal chillers that operate at non-standard rating conditions
- Combination HVAC and water heating systems to meet all requirements for appropriate space heating or cooling category
- Gas-fired and oil-fired forced air furnaces with input ratings ≥ 225,000 Btu/h to have intermittent ignition or interrupted device and have either power venting or a flue damper
- All furnaces with input ratings ≥ 225,000 Btu/h, including electric furnaces, not located in conditioned space, to have jacket losses ≤ 0.75% of the input rating

17

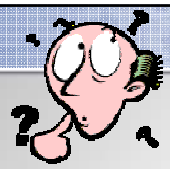
Section 6.4.1	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

HVAC Mandatory Section 6.8.1 Tables

- What are the efficiency requirements for a 25-ton unitary air-source heat pump?
- Use Table 6.8.1B
- 25 Tons X 12,000Btuh/ton = 300,000 Btuh
  - >240,000
- Cooling Mode 9.0 EER and 9.2IPLV both
- Heating Mode 3.1COP

18

Review Terms



- EER – *Energy Efficiency Ratio* – cooling cap. in **Btuh/Watts** input, with set conditions
- COP – *Coefficient of Performance* –**Watts** (cooling or Heating)/**Watts** (input), *consistent units* with set conditions
- SEER – *Seasonal Energy Efficiency Ratio* –total cooling output per year in **Btuh/Watts** input per year, with set conditions
- IPLV – *Integrated Part Load Value* – calculated at standard rating conditions
- NPLV – *Non-Standard Part Load Value*- calculated at non IPLV conditions

19

IPLV and NPLV

- IPLV & NPLV
  - = 0.01A+0.42B+0.45C+0.12D
  - Where
    - A= COP or EER at 100% @ 85 deg F ECWT
    - B= COP or EER at 75% @ 75 deg F ECWT
    - C= COP or EER at 50% @ 65 deg F ECWT
    - D= COP or EER at 25% @ 65 deg F ECWT

Weighted at design full load - 1% of time.

20

IPLV/NPLV Formula

$$\text{IPLV/NPLV} = \frac{1}{(.01/A) + (.42/B) + (.45/C) + (.12/D)}$$

A = KW/Ton @ 100% Load @ 85.0 °F ECWT or 95.0 °F EDB
B = KW/Ton @ 75% Load @ 75.0 °F ECWT or 80.0 °F EDB
C = KW/Ton @ 50% Load @ 65.0 °F ECWT or 65.0 °F EDB
D = KW/Ton @ 25% Load @ 65.0 °F ECWT or 55.0 °F EDB

21

HVAC Mandatory Section
Table 6.8.1 Equipment Efficiency

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency*	Test Procedure *	
Air Conditioners, Air Cooled	<65,000 Btu/hr	All	Split System	10.0 SEER (before 1/23/2006) 12.0 SEER (as of 1/23/2006)		
			Single Package	9.7 SEER (before 1/23/2006) 12.0 SEER (as of 1/23/2006)		
Through-the-Wall, Air Cooled	< 30,000 Btu/h[c]	All	Split System	10.0 SEER (before 1/23/2006) 10.9 SEER (as of 1/23/2006) 12 SEER (as of 1/23/2010)	ARI 210/240	
			Single Package	9.7 SEER (before 1/23/2006) 10.6 SEER (as of 1/23/ 2006) 12.0 SEER (as of 1/23/2010)		

(Formerly Table 6.2.1A)

22

HVAC Mandatory Section
Table 6.8.1H "Non-Standard" Chiller Efficiencies

Centrifugal Chillers < 150 tons

COP_{nfl} = 5.00; $IPLV_{nfl}$ = 5.25

Leaving Chilled Water Temperature (°F)	Entering Condenser Water Temperature (°F)	LIFT* (°F)	Condenser Flow Rate: 2 gpm/ton		2.5 gpm/ton		3 gpm/ton		4 gpm/ton		5 gpm/ton		6 gpm/ton	
			FL COP	NPLV *	FL COP	NPLV *	FL COP	NPLV *	FL COP	NPLV *	FL COP	NPLV *	FL COP	NPLV *
40	75	35	5.11	5.35	5.33	5.58	5.48	5.73	5.67	5.93	5.79	6.06	5.88	6.15
40	80	40	4.62	4.83	4.82	5.14	5.09	5.32	5.27	5.52	5.38	5.63	5.45	5.70
40	85	45	3.84	4.01	4.32	4.52	4.58	4.79	4.84	5.06	4.98	5.20	5.06	5.29
41	75	34	5.19	5.43	5.41	5.66	5.56	5.81	5.75	6.02	5.89	6.16	5.99	6.26
41	80	39	4.70	4.90	5.01	5.24	5.17	5.41	5.35	5.60	5.46	5.71	5.53	5.78
41	85	44	4.02	4.21	4.46	4.67	4.70	4.91	4.94	5.17	5.06	5.30	5.14	5.38
42	75	33	5.27	5.51	5.49	5.74	5.64	5.90	5.85	6.12	6.00	6.27	6.11	6.39
42	80	38	4.84	5.06	5.10	5.33	5.25	5.49	5.43	5.67	5.53	5.79	5.61	5.87
42	85	43	4.19	4.38	4.59	4.80	4.81	5.03	5.03	5.26	5.15	5.38	5.22	5.46
43	75	32	5.35	5.59	5.57	5.82	5.72	5.98	5.95	6.23	6.11	6.39	6.23	6.52
43	80	37	4.94	5.16	5.18	5.42	5.32	5.57	5.50	5.76	5.62	5.87	5.70	5.96
43	85	42	4.35	4.55	4.71	4.93	4.91	5.13	5.12	5.35	5.23	5.47	5.30	5.54

23

(Formerly Tables 6.2.1H thru M)

HVAC Mandatory Section
6.8.1 Tables

- An air-cooled split system computer-room air conditioner serves a large telephone switching equipment room. What efficiency requirements must be met?
- None
  - equipment not listed in tables
  - Per scope-section 2.3 The Provisions of this standard do not apply to (c) equipment and portions of building systems that use energy primarily to provide for industrial, manufacturing, or commercial processes.

24

Load Calculations

- Determined in accordance with generally accepted engineering standards and handbooks acceptable to the adopting authority

25

Section 6.4.2 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Controls

- Zone Thermostatic controls
  - Required for each zone
  - Dead Band controls
  - Thermostats must have a 5°F dead band
  - Exceptions
    - Thermostats that require manual changeover between heating and cooling modes
    - Special occupancy or applications where wide temperature ranges aren't acceptable (e.g., retirement homes) and approved by adopting authority
    - NOTE: data center exception removed with addendum h
  - Set Point Overlap Restrictions

26

Section 6.4.3.1 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Controls

- Set Point Overlap Restriction
  - If limit switches, mechanical stops, or software programming for DDC systems are used
    - means will be provided to prevent the heating set point from exceeding the cooling set point minus any applicable proportional band

27

Section 6.4.3.2 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Controls

- Off-Hour controls *(Section 6.4.3.3)*
  - automatic shutdown
  - setback controls
  - optimum start controls
  - shutoff damper controls
  - zone isolation
- Exceptions, HVAC systems
  - with heating/cooling capacity < 15,000 Btu/h
  - serving hotel/motel guestrooms
  - intended to operate continuously

28

Section	Mandatory Provisions				Prescriptive Option			
6.4.3.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Automatic Shutdown

- Controls to operate on different time schedules for seven different day-types per week and retain programming and time setting during loss of power for at least 10 hrs
- Each control to have
  - Occupant sensor, **OR**
  - Manually-operated timer with maximum two hour duration, **OR**
  - Interlock to security system

29

Section	Mandatory Provisions				Prescriptive Option			
6.4.3.3.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Setback Controls

- For heating systems in climate zones 2-8, the heating set point must be adjustable down to ≤ 55°F
- For cooling systems in zones 1b, 2b, and 3b, cooling set point must be adjustable up to ≥ 90°F to prevent high space humidity levels
- Exception
  - Radiant floor and ceiling heating systems

30

Section	Mandatory Provisions				Prescriptive Option			
6.4.3.3.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Optimum Start Controls

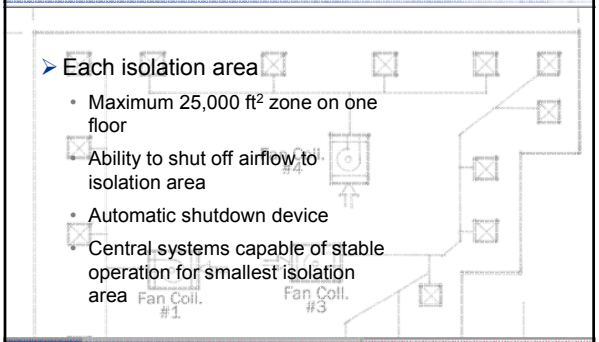
- Individual heating and cooling air distribution systems with
  - Total design supply air capacity > 10,000 cfm
  - Served by one or more supply fans
- Control algorithm to at least be a function of
  - Difference between space temperature and occupied setpoint and amount of time prior to scheduled occupancy

31

Section 6.4.3.3.3	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

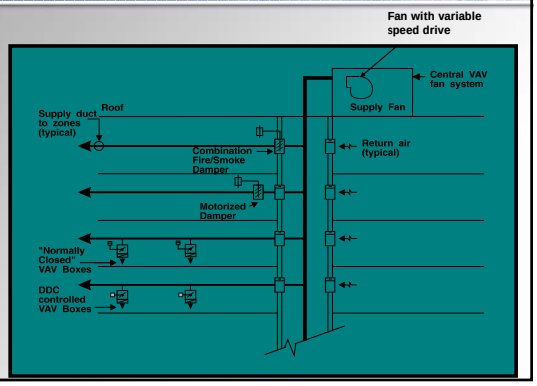
Zone Isolation

- Each isolation area
  - Maximum 25,000 ft^2 zone on one floor
  - Ability to shut off airflow to isolation area
  - Automatic shutdown device
  - Central systems capable of stable operation for smallest isolation area



Section 6.4.3.3.4	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Isolation Area Example



Controls *(cont'd)*

- Ventilation System Controls *(Section 6.4.3.4)*
  - Stair and Shaft Vent dampers
  - Gravity Hoods, Vents, and Ventilator Dampers
- Heat Pump Auxiliary Heat Control *(Section 6.4.3.5)*

34

Section 6.4.3 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Stair and Shaft Vents

- Motorized dampers
  - Can be automatically closed during normal building operation
  - Interlocked to open as required by fire and smoke detection systems

35

Section 6.4.3.4.1 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Gravity Hoods, Vents, and Ventilators

- Motorized dampers to automatically shut when spaces served are not in use
- Exceptions
  - Gravity dampers okay in buildings
    - < 3 stories in height
    - Of any height in climate zones 1 – 3
  - Ventilation systems serving unconditioned spaces

36

Section 6.4.3.4.2 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Shutoff Damper Controls

- Motorized dampers for outdoor air supply and exhaust systems
- Ventilation outside air dampers to be capable of automatically shutting off during
  - Preoccupancy building warm up, cool down, and setback

(Except when ventilation reduces energy costs or when ventilation must be supplied to meet code requirements)

37

Section 6.4.3.4.3	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Shutoff Damper Controls

- Exceptions:
  - Gravity dampers okay in buildings
    - < 3 stories in height
    - Of any height in climate zones 1-3
  - Gravity dampers are acceptable in systems with design outside air intake or exhaust capacity ≤ 300 cfm
- Table 6.4.3.3.4 provides maximum leakage rates for outdoor air supply and exhaust dampers

38

Section 6.4.3.4.3	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Heat Pump Auxiliary Heat Control

- Controls to prevent supplementary heat when heat pump can handle the load
- Exception
  - Heat pumps
    - With minimum efficiency regulated by NAECA
    - With HSPF rating meeting Table 6.8.1B

(Includes all usage of internal electric resistance heating)

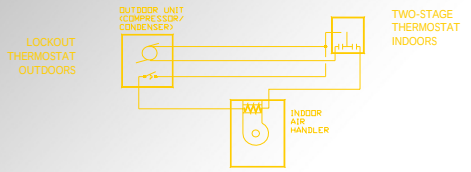
39

Section 6.4.3.5	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

HVAC Mandatory Section
6.4.3.4 Heat Pump Auxiliary Heat Control

Example

- Two common compliance options
  - Special "smart" heat pump thermostat (preferential rate control)
  - Two-stage thermostat with outdoor air lockout wired to lock out auxiliary heat when >45°F or so



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HVAC Mandatory Section
Heat Pump Auxiliary Heat Control

- Will a simple two-stage thermostat, wired to bring on the auxiliary heat as the second stage, meet the requirements of 6.4.3.4?
- No, because it will still cause auxiliary heat to be brought on during warm-up even when outdoor temperatures are mild and the heat pump has adequate capacity by itself.

41

Controls *(cont'd)*

- Humidifier Preheat Controls *(Section 6.4.3.6)*
- Humidification and Dehumidification Controls *(Section 6.4.3.7)*
- Freeze Protection and Ice Melting Systems Controls *(Section 6.4.3.8)*
- Ventilation Controls for High-Occupancy Areas *(Section 6.4.3.9)*

42

Section 6.4.3	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Humidifier Preheat

- Automatic valve to shut off preheat when humidification isn't required

43

Section 6.4.3.6 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Humidification and Dehumidification

- Provide means to prevent simultaneous operation of humidification and dehumidification equipment
  - Limit switches, mechanical stops, or software programming (DDC systems)
- Exceptions
  - Zones served by desiccant systems, used with direct evaporative cooling in series
  - Systems serving zones where specific humidity levels are required and approved by jurisdiction
    - Computer rooms, museums, and hospitals

44

Section 6.4.3.7 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Freeze Protection and Snow/Ice

- Automatic controls for
  - Freeze protection systems
    - outside air temperatures > 40°F or when conditions of protected fluid will prevent freezing
  - Snow- and ice-melting systems
    - pavement temperature > 50°F and no precipitation is falling and outdoor temperature > 40°F

Section 6.4.3.8 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Ventilation Controls for High-Occupancy Areas

- Automatic controls for reduction of outdoor air for systems with >3000 cfm outdoor air design capacity and greater than 100 person/1000 sf
  - Exception for systems with heat recovery

46

Section 6.4.3.9 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

HVAC Mandatory Section
6.4.3.8 Demand Controlled Ventilation

- Automatic control to reduce outdoor air to spaces with >100 people/1000 ft^2 design occupant density, > 3000 cfm design outdoor air rate
- DCV required>500 ft^2 **and** >40 people/1000 ft^2 design occupant density **and** either an air side economizer, modulating damper or > 3000 cfm design outdoor air rate
- Exceptions for energy recovery, multiple-zones without central control, outdoor air or net supply less than 1,200 CFM

47

Addendum v

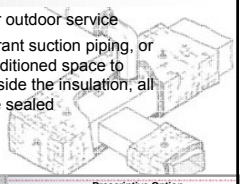
HVAC System Construction and Insulation

- Insulation installed in accordance with industry accepted standards
- Insulation protection
- Duct and plenum insulation
- Duct sealing
- Duct leakage testing
- Piping insulation

Section 6.4.4 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

General

- Insulation installed in accordance with industry accepted standards
- Insulation
  - Protected from damage due to sunlight, moisture, equipment maintenance, and wind
  - Exposed to weather to be suitable for outdoor service
  - Covering chilled water piping, refrigerant suction piping, or cooling ducts located outside the conditioned space to include a vapor retardant located outside the insulation, all penetrations and joints of which to be sealed



Section 6.4.4.1.1	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Duct and Plenum Insulation

- All supply and return ducts and plenums to be insulated per Tables 6.8.2A and 6.8.2B
- Exceptions
  - Factory-installed plenums, casings, or ductwork furnished as part of HVAC equipment
  - Ducts located in heated, semi-heated, or cooled spaces
  - For runouts < 10 ft in length to air terminals or air outlets, the R-value need not exceed R-3.5
  - Backs of air outlets and outlet plenums exposed to unconditioned or indirectly conditioned spaces with face areas > 5 ft^2 need not exceed R-2; those ≤ 5 ft^2 need not be insulated

50

Section 6.4.4.1.2	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

HVAC Mandatory Section 6.4.4.1.2 Duct Insulation

- Does the Exhaust Ductwork in the example building need to be insulated?
- Exhaust ductwork is not covered in Tables 6.8.2A and 6.8.2B
  - Exhaust Ductwork need not be insulated
  - What about the duct between the outside wall louver and the shutoff damper?

51

Piping Insulation

- Table 6.8.3
- Exceptions
  - Factory-installed
  - Piping conveying fluids
    - design operating temperature range between 60°F-105°F, inclusive
    - that haven't been heated or cooled through the use of nonrenewable energy or where heat gain or heat loss will not increase energy usage
  - Hot water piping between shut off valve and coil, not > 4 ft in length, when located in conditioned spaces
  - Pipe unions in heating systems (steam, steam condensate, and hot water)

52

Section 6.4.4.1.3 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

HVAC Mandatory Section 6.4.4.1.3 Piping Insulation

- A chilled water system is designed for a chilled water supply temperature of 44^0F with a 16^0F range. Is insulation required on the return piping?
- No, the return piping **design** temperature is 60^0F. This is a minimum code, watch out for part load conditions.

53

Duct Sealing

- Table 6.4.4.2A
- Requirements of 6.4.4.2
- Based on standard industry practice and definitions

Table 6.4.4.2A
Minimum Duct Seal Level

Duct Location	Duct Type: Supply ≤2 in. w.c.†	Supply >2 in. w.c.†	Exhaust	Return
Outdoors	A	A	C	A
Unconditioned Spaces	B	A	C	B
Conditioned Spaces**	C	B	B	C

* See Table 6.2.4.3B definition of Seal Level.
† Duct design static pressure classification.
** Includes indirectly conditioned spaces such as return air plenums.

54

Section 6.4.4.2 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Duct Leakage Tests

- Designed > 3 in. w.c.
  - Leak tested
  - Representative sections ≥ 25% of the total installed duct area shall be tested
  - Ratings > 3 in. w.c. to be identified on drawings
  - Maximum permitted duct leakage
    - $L_{max} = C_L P^{0.65}$

Where L_{max} = maximum permitted leakage in cfm/100 ft^2 duct surface area

55

Section	Mandatory Provisions				Prescriptive Option			
6.4.4.2.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Completion Requirements

Refers to Section 6.7 for Submittal and Completion Requirements including

- Record drawings and O&M Manuals
- Balancing
  - Balancing report required for buildings > 5,000 ft^2
  - Balanced to minimize throttling losses then:
    - For fans >1 HP, adjust speed
    - For pumps >10 HP, adjust speed or trim impellers
- Control elements calibrated, adjusted
- Commissioning
  - Detailed commissioning instructions required for buildings > 50,000 ft^2

Section	Mandatory Provisions				Prescriptive Option			
6.4.5	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

HVAC Prescriptive Path

- Economizers *(Section 6.5.1)*
- Simultaneous Heating and Cooling Limitation *(Section 6.5.2)*
- Air System Design and Control *(Section 6.5.3)*
- Hydronic System Design and Control (*Section 6.5.4)*
- Heat Rejection Equipment *(Section 6.5.5)*
- Energy Recovery *(Section 6.5.6)*
- Exhaust Hoods *(Section 6.5.7)*
- Radiant Heating Systems *(Section 6.5.8)*
- Hot Gas Bypass Limitation *(Section 6.5.9)*

57

Section	Mandatory Provisions				Prescriptive Option			
6.5	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Economizers

- Climate and size dependent (Table 6.5.1)
- There are LOTS of exceptions
- Can use air economizers
  - 100% of design supply air
  - Sequenced with mechanical cooling equipment
  - High limit shutoff
  - Dampers
- Can use water economizers
  - 100% of expected system cooling load at 50°F DB, 45°F WB
  - Maximum pressure drop limitation

Section	Mandatory Provisions				Prescriptive Option			
6.5.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

HVAC Prescriptive Section 6.5.1 Economizers

- Economizers
  - Either Air- or Water- side
  - Climate dependent requirements based on DOE-2 analysis

59

Design Capacity

- System capable of modulating outside air and return air dampers to provide up to 100% of the design supply air quantity as outside air for cooling

60

Section	Mandatory Provisions				Prescriptive Option			
6.5.1.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Control Signal

- Economizer dampers capable of being sequenced with the mechanical cooling equipment and shall not be controlled by only mixed air temperature
- Exception
  - Systems controlled from space temperature (such as single-zone systems)

61

Section	Mandatory Provisions				Prescriptive Option			
6.5.1.1.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

High Limit Shutoff

- Automatically reduce outside air intake to minimum outdoor air quantify when outside air intake will no longer reduce cooling energy usage
- Control types for specific climates from Table 6.5.1.1.3A
- Settings from Table 6.5.1.1.3B

62

Section	Mandatory Provisions				Prescriptive Option			
6.5.1.1.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Dampers

- Return air and outside air dampers to meet the damper leakage specified in 6.4.3.3.4

63

Section	Mandatory Provisions				Prescriptive Option			
6.5.1.1.4	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

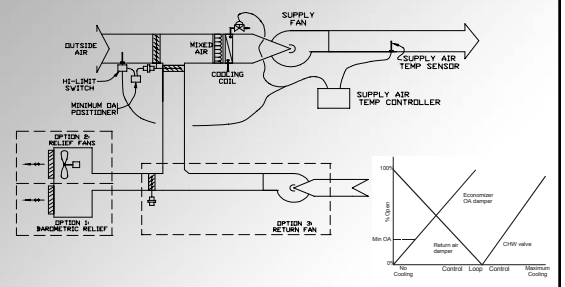
Relief of Excess Outside Air

- Means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building
- Outlet located to avoid recirculation into the building

64

Section 6.5.1.1.5 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Air Economizers



Design Capacity

Water-side economizer

- System capable of cooling supply air by indirect evaporation and providing up to 100% of expected system cooling load at outside air temperatures of 50°F dry bulb/45°F wet bulb and below
- Exception
  - You can also meet this requirement if your design can meet 100% of expected cooling load at 45°F dry bulb/40°F wet bulb

Section 6.5.1.2.1 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

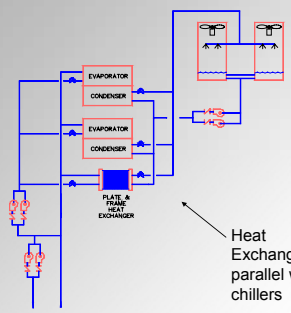
Maximum Pressure Drop

- Precooling coils and water-to-water heat exchangers to have either
  - Water-side pressure drop of < 15 ft of water **OR**
  - Create a secondary loop so the coil or heat exchanger pressure drop isn't seen by the circulating pumps when the system is in normal cooling mode

67

Section 6.5.1.2.2	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Water-side Economizers
6.5.1.3 Non-integrated Control



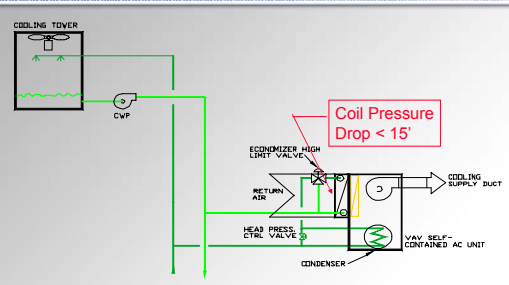
Heat Exchanger in parallel with chillers

This design is <u>not</u> allowed if integrated control is required.

Climate Zones Exempt 1,2,3a,4a,5a,5b,6,7,8

68

Water-side Economizers
6.5.1.3 Integrated Control: Pre-Cooling Coil



69

Integrated Economizer Control

- Economizers must be integrated with mechanical cooling systems and be capable of providing partial cooling even when additional mechanical cooling is required
- Some exceptions to this

70

Section 6.5.1.3 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Economizer Heating System Impact

- Designed so economizer operation doesn't increase the building heating energy use during normal operation
- Exception
  - Economizers on VAV systems that cause zone level heating to increase due to a reduction in supply air temperature

71

Section 6.5.1.4 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Simultaneous Heating and Cooling Limitation

- Zone controls capable of operating in sequence the supply of heating and cooling energy to the zone to prevent reheating, recooling, mixing or simultaneously supplying air previously heated or cooled
- Hydronic system controls to prevent reheating or recooling of fluids

72

Section 6.5.2 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Simultaneous Heating and Cooling Limitation *(cont'd)*

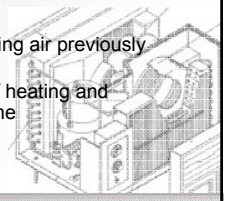
- Dehumidification controls
- Humidification controls

73

Section 6.5.2 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Zone Controls

- Capable of operating in sequence the supply of heating and cooling energy to the zone
- Controls prevent
  - Reheating
  - Recooling
  - Mixing or simultaneously supplying air previously heated or cooled
  - Other simultaneous operation of heating and cooling systems to the same zone



Section 6.5.2.1 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Zone Controls - Exceptions

- Zones for which volume of air that is reheated, recooled, or mixed is no greater than the larger of the following
  - Volume of outside air to meet 6.1.3 of ASHRAE 62 for the zone
  - 0.4 cfm/ft^2 of zone conditioned floor area
  - 30% of zone design peak supply
  - 300 cfm for zones whose peak flow rate totals no more than 10% of the total fan system flow rate
  - Any higher rate that can be demonstrated to jurisdiction to reduce overall system annual energy usage…
- Zones where special pressurization relationships, cross-contamination requirements, or code-required minimum circulation rates are such that the variable air volume systems are impractical

75

Section 6.5.2.1 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Hydronic System Controls

- Limit heating and cooling of fluids previously heated or cooled mechanically per 6.5.2.2.1 through 6.5.2.2.3

76

Section	Mandatory Provisions				Prescriptive Option			
6.5.2.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Three-Pipe System

- No common return system for both hot and chilled water

77

Section	Mandatory Provisions				Prescriptive Option			
6.5.2.2.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Two-Pipe Changeover System

- Common distribution system acceptable if
  - Deadband from one mode to another is ≥ 15°F outside air temperature
  - Controls to allow operation of ≥ 4 hours before changing over
  - Reset controls so heating and cooling supply temperatures at changeover point no more than 30°F apart

78

Section	Mandatory Provisions				Prescriptive Option			
6.5.2.2.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Hydronic (Water Loop) Heat Pump Systems

- Controls to provide heat pump water supply temperature deadband of at least 20°F between initiation of heat rejection and heat addition by central devices
- Cooling tower bypass or cooling tower isolation dampers
- A two-position valve at each hydronic heat pump for hydronic systems having a total pump system power > 10 hp
- Exception
  - If system loop temperature optimization controller is used, deadband < 20°F is allowed

79

Section	Mandatory Provisions				Prescriptive Option			
6.5.2.2.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Dehumidification

- Humidistatic controls to prevent
  - Reheating
  - Mixing of hot and cold air streams
  - Heating and cooling of same air stream

80

Section	Mandatory Provisions				Prescriptive Option			
6.5.2.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Dehumidification Exceptions

- Systems capable of reducing supply air flow to 50%, or to minimum ventilation
- Systems under 6.67 tons that can unload at least 50%
- Systems smaller than 3.3 tons
- Process applications
- 75% of reheat or recool energy is recovered or solar

81

Section	Mandatory Provisions				Prescriptive Option			
6.5.2.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Humidification

- Systems with hydronic cooling and humidification systems designed to maintain inside humidity at > 35°F dewpoint temperature shall use a water economizer if required by 6.5.1

82

Section 6.5.2.4 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Air System Design and Control

- HVAC systems with total fan system power > 5 hp to meet 6.5.3.1 through 6.5.3.2
  - Fan Power Limitation
  - VAV Fan Control
    - Part Load Fan Power Limitation
    - Static Pressure Sensor location
    - Set Point Reset

83

Section 6.5.3 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Fan Power Limitation

- Table 6.5.3.1
- Allowable fan system power may be adjusted if
  - Air systems require air treatment or filtering systems with pressure drops > 1 in. w.c. when filters are clean, or heat recovery coils or devices, or direct evaporative humidifiers/coolers, or other devices to serve process loads in the airstream
- If
  - design room temperature – supply air temp at cooling design condition = > 20°F, allowable fan system power may be adjusted

84

Section 6.5.3.1 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Part-Load Fan Power Limitation

- Individual VAV fans with motors ≥ 15 hp
  - Must have either:
    - Variable Speed Drive
    - Vane axial fan with variable-pitch fan blades
    - Other controls and devices to result in fan motor demand ≤ 30% of design wattage at 50% of design air volume when static pressure set point = 1/3 of total design static pressure, based on manufacturer's certified fan data

Section	Mandatory Provisions				Prescriptive Option			
6.5.3.2.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Static Pressure Sensor Location

- Placed so controller set point is ≤ 1/3 the total design fan static pressure
  - Except for digital control systems with zone reset capabilities where it may be at the fan discharge
- Install multiple sensors in each major branch if sensor would be located downstream of a major duct split

86

Section	Mandatory Provisions				Prescriptive Option			
6.5.3.2.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Set Point Reset

- For systems with direct digital control of individual zone boxes reporting to the central control panel
  - Static pressure set point reset based on zone requiring the most pressure

87

Section	Mandatory Provisions				Prescriptive Option			
6.5.3.2.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Hydronic System Design and Control

- HVAC hydronic systems with total pump system power > 10 hp shall meet 6.5.4.1 – 6.5.4.4
  - Hydronic Variable Flow Systems
  - Pump Isolation
  - Chilled and Hot Water Temperature Reset
  - Hydronic (water-loop) Heat Pump Systems

88

Section	Mandatory Provisions				Prescriptive Option			
6.5.4	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Hydronic Variable Flow

- HVAC pumping systems to include control valves
  - Designed to modulate or step open and close as a function of load
  - Designed for variable fluid flow
  - Capable of reducing flow rates to ≤ 50% of design flow rate
- Individual pumps serving variable flow systems with a pump head > 100 ft and motor > 50 hp
  - Have controls and/or devices resulting in pump motor demand ≤ 30% of design wattage at 50% of design water flow

89

Section	Mandatory Provisions				Prescriptive Option			
6.5.4.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Hydronic Variable Flow - Exceptions

- Systems where
  - Minimum flow is < minimum flow required by equipment manufacturer for proper operation of equipment served by the system
  - Total pump system power ≤ 75 hp
- Systems that include ≤ 3 control valves

90

Section	Mandatory Provisions				Prescriptive Option			
6.5.4.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Pump Isolation

- If chilled water plant has more than one chiller or boiler plant has more than one boiler
  - Provide for flow reduction when chiller or boiler is shut down

91

Section	Mandatory Provisions				Prescriptive Option			
6.5.4.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Chilled and Hot Water Temperature Reset Controls

- Affects systems with design capacity > 300,000 Btu/h
  - To include controls to automatically reset supply water temperatures by representative building loads (including return water temperature) or by outside air temperature
- Exceptions
  - If controls would result in improper operation
  - Hydronic systems with variable flow

Section	Mandatory Provisions				Prescriptive Option			
6.5.4.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Hydronic Heat Pump

- For heat pump loops with total pump system power > 10 hp
  - Two-position valves at each hydronic heat pump must be provided and interlocked to shut off water flow to the heat pump when the compressor is off
    - This basically converts the system into a variable flow system. As such, these systems must also comply with 6.3.4.1

93

Section	Mandatory Provisions				Prescriptive Option			
6.5.4.4	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Heat Rejection Equipment

- Applies to heat rejection equipment used in comfort cooling systems such as
  - Air-cooled condensers
  - Open cooling towers
  - Closed-circuit cooling towers
  - Evaporative condensers
- Exceptions
  - Heat rejection devices included as an integral part of equipment listed devices whose energy usage is included in Tables 6.8.1A-6.8.1D

94

Section	Mandatory Provisions				Prescriptive Option			
6.5.5	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Fan Speed Control

- Each fan powered by a motor ≥ 7.5 hp
  - Have capability to operate fan at ≤ 2/3 full speed
  - Have controls to automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device
- Exceptions
  - Condenser fans serving multiple refrigerant circuits or flooded condensers
  - Installations located in climates zones 1 and 2
  - 1/3 of the fans on a multiple fan application speed controlled

95

Section	Mandatory Provisions				Prescriptive Option			
6.5.5.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Exhaust Air Energy Recovery

- Incorporate exhaust air energy recovery in systems with
  - ≥ 70% outside air and ≥ 5000 cfm total
  - 50% energy recovery effectiveness

96

Section	Mandatory Provisions				Prescriptive Option			
6.5.6.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Exhaust Air Energy Recovery Exceptions

- Lab systems meeting 6.5.7.2
- Systems serving uncooled spaces that are heated to < 60°F
- Systems exhausting toxic, flammable, paint or corrosive fumes or dust
- Commercial kitchen hoods used for collecting grease or smoke
- Where > 60% of outdoor heating energy is provided from site-recovered or site solar energy
- Heating systems in climate zones 1 through 3
- Cooling systems in climate zones 3c, 4c, 5b, 5c, 6b, 7, and 8
- Where largest exhaust source is < 75% of the design outdoor airflow
- Systems requiring dehumidification that employ energy recovery in series with the cooling coil

97

Section	Mandatory Provisions				Prescriptive Option			
6.5.6.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Heat Recovery for Service Water Heating

- Condenser recovery required if
  - 24 hrs per day **and**
  - Heat rejection > 6,000,000 Btu/h **and**
  - SWH load > 1,000,000 Btu/h

98

Section	Mandatory Provisions				Prescriptive Option			
6.5.6.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Kitchen Hoods (Exhaust)

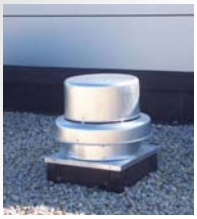
- Hoods > 5,000 cfm to be provided with makeup air sized for at least 50% of exhaust air volume that is a) unheated or heated to more than 60°F and b) uncooled or cooled without the use of mechanical cooling
- Exceptions
  - Where hoods are used to exhaust ventilation air that would otherwise exfiltrate or be exhausted by other fan systems
  - Certified grease extractor hoods that require a face velocity no greater than 60 fpm

99

Section	Mandatory Provisions				Prescriptive Option			
6.5.7.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Fume Hoods

- Hood systems with a total exhaust rate > 15,000 cfm to have ONE of the following features
  - Operation to < 50% design flow **OR**
  - Direct make up at least 75% of exhaust rate at specified conditions **OR**
  - Heat recovery for make-up air



100

Section	Mandatory Provisions				Prescriptive Option			
6.5.7.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Radiant Heating Systems

- Required for unenclosed spaces except loading docks with air curtains
- "Radiant heating systems that are used as primary or supplemental enclosed space heating must be in conformance with the governing provisions of the standard"

101

Section	Mandatory Provisions				Prescriptive Option			
6.5.8	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Hot Gas Bypass Limitation

- Not used (including other evaporator pressure control systems) unless system is designed with multiple steps of unloading or continuous capacity modulation
- Exception
  - Unitary packaged systems with cooling capacities ≤ 90,000 Btu/h

102

Section	Mandatory Provisions				Prescriptive Option			
6.5.9	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Submittals

- Record drawings
- Operating and maintenance manuals
- System balancing
- System commissioning

103

Section 6.7 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Drawings

- Record drawings of actual installation to building owner within 90 days of system acceptance and include, as a minimum
  - Location and performance data on each piece of equipment
  - General configuration of duct and pipe distribution system including sizes
  - Terminal air or water design flow rates

Section 6.7.2.1 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Manuals

- Operating and maintenance manuals to building owner within 90 days of system acceptance and include several items

105

Section 6.7.2.2 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

System Balancing

- Systems shall be balanced in accordance with accepted engineering standards
- Written report for conditioned spaces > 5000 ft^2
- Minimize throttling losses
- For fans with system power > 1 hp
  - Adjust fan speed to meet design flow conditions

106

Section 6.7.2.3 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Hydronic System Balancing

- Proportionately balanced to minimize throttling losses
- Pump impeller trimmed or pump speed adjusted to meet design flow conditions
- Each system to have either the ability to measure differential pressure increase across the pump or have test ports at each side of the pump
- Exceptions
  - Pumps with pump motors ≤ 10 hp
  - When throttling results in < 5% of the nameplate hp draw, or 3 hp, whichever is greater, above that required if the impeller was trimmed

107

Section 6.7.2.3.3 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

System Commissioning

- Control elements are calibrated, adjusted, and in proper working condition
- > 50,000 ft^2 conditioned area
  - Except warehouses and semiheated spaces
  - Requires commissioning instructions

108

Section 6.7.2.4 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

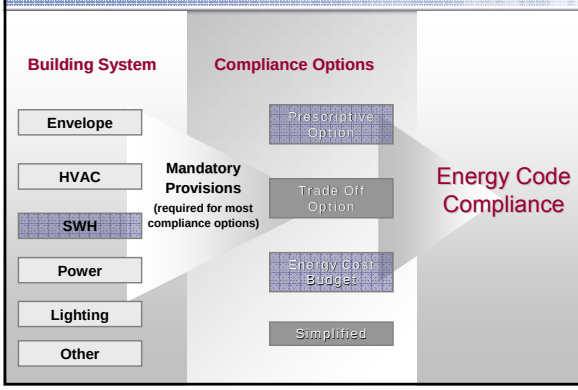
Minimum Equipment Efficiency Tables

- Equipment efficiency tables 6.8.1A to 6.8.1J
- Duct Insulation Tables 6.8.2A and 6.8.2B
- Pipe Insulation Table 6.8.3

109

Section 6.8	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

SWH Compliance



Section 7 - Service Water Heating

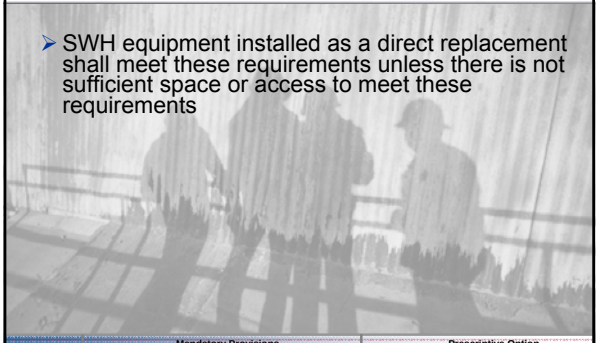
- General *(Section 7.1)*
- Compliance Path(s) *(Section 7.2)*
- Mandatory Provisions *(Section 7.4)*
  - Load calculations
  - Equipment efficiency
  - Service hot water piping insulation
  - System controls
  - Pools
  - Heat traps
- Prescriptive Path *(Section 7.5)*
  - Space heating and water heating
  - Service water heating equipment
- Submittals *(Section 7.7)*

111

Section 7	Mandatory Provisions				Prescriptive Option			
	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

SWH Alterations

- SWH equipment installed as a direct replacement shall meet these requirements unless there is not sufficient space or access to meet these requirements



Section	Mandatory Provisions				Prescriptive Option			
7.1.1.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

SWH Compliance Paths

- Section 7.2
- You have to follow Sections 7.1, 7.4, 7.5, 7.7, and 7.8
- Alternatively, you can follow Section 11 (ECB), in which case Section 7.4 is mandatory

113

Load Calculations

- In accordance with manufacturer's published sizing guidelines or generally accepted engineering standards and handbooks

114

Section	Mandatory Provisions				Prescriptive Option			
7.4.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Equipment Efficiency

- Section 7.4.2 refers to Table 7.8 for equipment efficiencies
- Equipment not listed in Table 7.8 has no minimum performance requirements
- Exception
  - Water heaters and hot water supply boilers > 140 gal storage capacity don't have to meet standby loss requirements when
    - Tank surface is thermally insulated to R-12.5, and
    - A standing pilot light isn't installed, and
    - Gas- or oil-fired water heaters have a flue damper or fan-assisted combustion
- Heat pump pool heaters added to Table 7.8 in Standard 90.1-2004

115

Section 7.4.2 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Service Hot Water Piping Insulation

- Table 6.8.3, Section 6
- Circulating water heater
  - Recirculating system piping, including supply and return piping
- Nonrecirculating storage system
  - First 8 ft of outlet piping
  - Inlet pipe between storage tank and heat trap
- Externally-heated pipes (heat trace or impedance heating)

116

Section 7.4.3 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Service Water Heating System Controls

- Temperature Controls
- Temperature Maintenance Controls
- Outlet Temperature Controls
- Circulating Pump Controls

117

Section 7.4.4 | Mandatory Provisions: Envelope, HVAC, SWH, Lighting | Prescriptive Option: Envelope, HVAC, SWH, Lighting

Temperature Controls

- To allow for storage temperature adjustment from 120°F or lower to a maximum temperature compatible with the intended use
- Exception
  - If manufacturer's installation instructions specify a higher minimum thermostat setting to minimize condensation and resulting corrosion

118

Mandatory Provisions | Prescriptive Option

Section 7.4.4.1 | Envelope | HVAC | SWH | Lighting | Envelope | HVAC | SWH | Lighting

Temperature Maintenance Controls

- Automatic time switches or other controls
  - Set to switch off usage temperature maintenance system during extended periods when hot water is not required

119

Mandatory Provisions | Prescriptive Option

Section 7.4.4.2 | Envelope | HVAC | SWH | Lighting | Envelope | HVAC | SWH | Lighting

Outlet Temperature Controls

- Automatic time switches or other controls
  - To limit maximum temperature of water delivered from lavatory faucets in public facility restrooms to 110°F

120

Mandatory Provisions | Prescriptive Option

Section 7.4.4.3 | Envelope | HVAC | SWH | Lighting | Envelope | HVAC | SWH | Lighting

Circulating Pump Controls

- To limit operation to a period from the start of the heating cycle to a maximum of five minutes after the end of the heating cycle

121

Section 7.4.4.4 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Pools

- Pool heaters to have readily accessible on-off switch
- Pool heaters fired by natural gas can NOT have continuously burning pilot lights
- Vapor retardant pool covers required (unless recovered or solar heat)
- Time switches required

122

Section 7.4.5 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Heat Traps

- Noncirculating systems to have heat traps on both the inlet and outlet piping as close as practical to storage tank (if no integral heat traps)
  - Either a device specifically designed for this purpose or
  - Arrangement of tubing that forms a loop of 360° or piping that from the point of connection to the water heater includes a length of piping directed downward before connection to the vertical piping of the supply water or hot water distribution system, as applicable

123

Section 7.4.6 | Mandatory Provisions: Envelope | HVAC | SWH | Lighting | Prescriptive Option: Envelope | HVAC | SWH | Lighting

Space Heating and Water Heating

- Gas- or oil-fired space heating boiler system (complying with Section 6) is allowed to provide total space heating and water heating when ONE of the following conditions is met
  - Single boiler or component that is heating the service water has a standby loss in Btu/h not exceeding
    - (13.3 x *pmd* + 400) / *n*; where *pmd* is probable maximum demand in gal/h and *n* is the fraction of the year when outdoor daily mean temperature is > 64.9°F
  - Jurisdiction agrees use of a single heat source will consume less energy than separate units
  - Energy input of the combined boiler and water heater system is < 150,000 Btu/h
- Instructions for determining standby loss are included in this Section

124

Section	Mandatory Provisions				Prescriptive Option			
7.5.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Service Water Heating Equipment

- Equipment used to provide the additional function of space heating as part of a combination (integrated) system shall satisfy all requirements for service water heating equipment

125

Section	Mandatory Provisions				Prescriptive Option			
7.5.2	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting