

ANSI/ASHRAE/IESNA Standard 90.
 U.S. Department of Energy
 Building Energy Codes Program

Why is Standard 90.1-2004 important?
 90.1-2004

It replaces ANSI/ASHRAE/IESNA Standard
 90.1-2001
 It proposed to be the reference standard for the 2006 ICC
 IECC
 It is proposed to be the commercial building energy
 reference in NFPA 5000, NFPA's family of building codes
 It is the professional "standard of care" set by ASHRAE
 consensus

2

How have requirements changed?

Envelope and mechanical requirements
 expressed using new climate zones
 Lighting requirements more stringent by about
 25%
 Entire document has been reformatted

3

How can I find out more about the differences?

Detailed comparisons of Standards
 90.1-1989 and 90.1-1999 may be found at
http://www.energycodes.gov/implement/determinations_com.stm
 Preliminary comparisons of Standards 90.1-1999
 and 90.1-2001 may be found at
http://www.energycodes.gov/news/2003_workshop/presentations.stm#ashrae
 DOE will be formally comparing Standards
 90.1-2001 and 90.1-2004 in 2005

4

How can I get a copy?

Standard 90.1-2004
 and the Standard
 90.1-2004 Users
 Manual are available
 from ASHRAE
www.ashrae.org

404-636-8400

5

Standard 90.1-2004
 90.1-2004

Section 1 - Purpose
 Section 2 - Scope
 Section 3 - Definitions, Abbreviations, and
 Acronyms
 Section 4 - Administration and Enforcement
 Section 5 - Building Envelope
 Section 6 - Heating, Ventilating, and Air-
 Conditioning

6

Standard 90.1-2004
 90.1-2004

Section 7 - Service Water Heating
 Section 8 - Power
 Section 9 - Lighting
 Section 10 - Other Equipment
 Section 11 - Energy Cost Budget Method
 Section 12 - Normative References

7

Standard 90.1-2004 Appendices
90.1-2004

Appendix A – Rated R-Value of Insulation in Assembly, U-Factor, C-Factor, and F-Factor Determinations	
Appendix B – Building Envelope Climate Criteria	
Appendix C – Methodology for Building Envelope Trade-Off Option in Subsection 5.6	
Appendix D – Climatic Data	
Appendix E - Informative References	
Appendix F - Addenda Description Information (Informative)	
Appendix G - Performance Rating Method (Informative)	8

Section 1 - Purpose

The purpose of this standard is to provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings

9

Section 2 - Scope

New buildings and their systems
New portions of buildings and their systems (additions)
New systems and equipment in existing buildings (alterations)

10

(cont'd)

Section 2 – Scope (cont'd)

Envelope

- if heated by a heating system with an output capacity \geq 3.4 btu/h-ft² or
- if cooled by a cooling system with a sensible output \geq 5 btu/h-ft²

Virtually all mechanical and lighting systems are covered

11

Scope Exceptions

Too little heating or cooling
Single-family, multifamily of three stories or less, manufactured or modular homes
Buildings that don't use electricity or fossil fuel
Equipment and portions of building systems that use energy primarily for industrial, manufacturing, or commercial purposes

12

Section 3 - Definitions, Abbreviations,
and Acronyms

10 pages of definitions
1 page of abbreviations and acronyms
Defined terms are italicized in text of standard

13

Section 4 – Administration and Enforcement
 Addresses new buildings, additions to existing buildings, and alterations to existing buildings
 Addresses replacement of portions of existing buildings
 Discusses changes in space conditioning

14

Section 4 – Administration and Enforcement
 Addresses compliance documentation
 Addresses labeling of materials and equipment
 • Fenestration, doors, insulation, mechanical equipment, and packaged terminal air conditioners
 Addresses alternative materials and methods of construction
 Addresses inspections

15

Section 4 – Administration and Enforcement
 Section 4 merely provides the overall statement that new buildings, additions, alterations, replacements, and changes in space conditioning fall under the requirements of the Standard
 Details of which requirements the building must actually meet in various situations are discussed in the technical sections 5, 6, 7, 8,9, 10, and 11 in the X.1 section named "General"

16

Section 4 – Administration and Enforcement
 Important Exceptions for Alterations of Existing Buildings
 • Buildings that are specifically designated as historic by the adopting authority or on the National Register of Historic Places or eligible for listing by the U.S. Secretary of Interior
 • If the the building's annual energy consumption is the same as a building that meets the requirements of Sections 5-10 and such compliance is verified by a design professional using methods acceptable to the authority having jurisdiction

17

Building System	Compliance Options		
	Prescriptive		
Envelope		Option	
	Mandatory		
HVAC		Trade Off	Energy Code
	Provisions	Option	Compliance
SWH	(required for most		
Power	compliance options)	Energy Cost	
		Budget	
Lighting			
		Simplified	
Other			

18

Building System	Compliance Options		
	Prescriptive		
Envelope		Option	
	Mandatory		
HVAC			Energy Code

	Provisions (required for most compliance options)	Trade Off Option	Compliance	
SWH Power		Energy Cost Budget		
Lighting				19
Other		Simplified		

Section 5 – Building Envelope

General (Section 5.1)

- Scope
- Space-Conditioning Categories
- Envelope Alterations
- Climate

Compliance Methods (Section 5.2)

Simplified Building Option (Section 5.3) Not Used

Mandatory Provisions (Section 5.4)

- Insulation
- Fenestration and Doors
- Air Leakage

		Mandatory Provisions		Prescriptive Option	20
Section 5	Envelope	HVAC	SWH Lighting	Envelope HVAC SWH	Lighting

Section number in 90.1-2004				Presentation Reference Type of requirement covered by material	
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Section 5		Mandatory Provisions		Prescriptive Option	
	Envelope HVAC	SWH	Lighting	Envelope HVAC SWH	Lighting
			Building System covered by material		21

(cont'd)

Section 5 – Building Envelope (cont'd)

Prescriptive Building Envelope Option (Section 5.5)

- Opaque Areas
- Fenestration

Building Envelope Trade-Off Options (Section 5.6)

Submittals (Section 5.7)

Product Information and Insulation Requirements
(Section 5.8)

Section 5		Mandatory Provisions		Prescriptive Option	22
	Envelope HVAC	SWH	Lighting	Envelope HVAC SWH	Lighting

Scope

Envelope components that enclose

- Conditioned space
- Semi-heated space

Has a heating system with a capacity > 3.4 Btu/h·ft² of floor area but is not conditioned space

Requirements apply to three types of spaces

- Nonresidential
- Residential

- Semi-heated Exceptions

								23
		Mandatory Provisions				Prescriptive Option		
Section 5.1.2			SWH	Lighting				Lighting
	Envelope	HVAC			Envelope	HVAC	SWH	

Building Envelope
24

Space-Conditioning Categories and Basis
Space-Conditioning
Envelope Requirements Are Specified by Space-Conditioning Categories
Envelope Requirements Are Specified by Space-Conditioning Categories
Each space to be included in a category

- Nonresidential conditioned space
- Residential conditioned space
- Semiheated space

Spaces in climates > 1800 HDD65 assumed to be conditioned space unless

- Space will only be semiheated or unconditioned and
- Approved as such by the building official

								25
		Mandatory Provisions				Prescriptive Option		
Section 5.1.2			SWH	Lighting				Lighting
	Envelope	HVAC			Envelope	HVAC	SWH	

Semi-heated Space
Semi-heated
Has a heating system with a capacity > 3.4 Btu/h.ft2 (10W/m2) of floor area but is not conditioned space
Space is not cooled at all

								26
		Mandatory Provisions				Prescriptive Option		
Definition			SWH	Lighting				Lighting
	Envelope	HVAC			Envelope	HVAC	SWH	

Envelope Alterations
Alterations to the building envelope shall comply with the requirements of Section 5

- Exceptions that are allowed if they don't increase energy usage of building
 - Installation of storm windows
 - Replacement of glazing in existing sash and frame
 - Alterations to envelope cavities provided they are insulated to full depth with a nominal R-3.0 per in.
 - Roof and floor alterations where no new cavities are created
 - Replacement of roof membranes
 - Replacement of existing doors
 - Replacement of existing fenestration provided area of replacement is no more than 25% of total fenestration area

								27
		Mandatory Provisions				Prescriptive Option		
Section 5.1.3			SWH	Lighting				Lighting
	Envelope	HVAC			Envelope	HVAC	SWH	

Zones based on
Climate

several climatic parameters and expressed in map shown in Figure B-1.

- Locations listed in Appendix B on county-by-county basis for United States

							28
		Mandatory Provisions			Prescriptive Option		
Section 5.1.4		Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting

Envelope Compliance Paths

Section 5.2

You have to follow Sections 5.1, 5.4, 5.7, and 5.8, and then you can either follow Section 5.5 or Section 5.6

Alternatively, you can follow Section 11 (ECB), in which case Section 5.4 is mandatory

- However, Section 5.4 merely refers to Section 5.8

29

Mandatory Provisions

Insulation (Section 5.8.1)

- Installation (Section 5.8.1.1)
- Substantial Contact (Section 5.8.1.5)
- Recessed Equipment (Section 5.8.1.6)
- Insulation Above Suspended Ceilings (Section 5.8.1.8)
- Insulation Protection (Section 5.8.1.7)

Fenestration and Doors (Section 5.8.2)

Air Leakage (Section 5.4.3)

							30
		Mandatory Provisions			Prescriptive Option		
Section 5.4		Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting

Air Leakage

Seal, caulk, gasket, or weather-strip

- Openings and joints in building envelope
- Fenestration and doors per NFRC 400
- Loading docks in climates in climate zones 4-8
- Vestibules and doors separating conditioned space from exterior

							31
		Mandatory Provisions			Prescriptive Option		
Section 5.4.3		Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting

Building Envelope Sealing

Joints around fenestration and door frames
 Junctions between walls
 • and foundations
 • at building corners
 • and structural floors or roofs
 • and roof or wall panels
 Openings for utility services through roofs, walls, and floors
 Site-built fenestration and doors
 Building assemblies used as ducts or plenums
 Joints, seams, and penetrations of vapor retarders

32

All other openings in the building envelope

Mandatory Provisions

Prescriptive Option

Section
 5.4.3.1

Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
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Fenestration and Doors

NFRC 400
 Labeled and certified by manufacturer
 Glazed swinging entrance doors and revolving doors – not to exceed 1.0 cfm/ft²
 All other products – not to exceed 0.4 cfm/ft²
 Exceptions
 • Field-fabricated fenestration and doors
 • Garage doors – ANSI/DASMA 105

33

Mandatory Provisions

Prescriptive Option

Section
 5.4.3.2

Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
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Loading Dock Weatherseals

In climate zones 4-8
 • Cargo doors and loading dock doors equipped with weatherseals
 To restrict infiltration when vehicles are parked in the doorway

34

Mandatory Provisions

Prescriptive Option

Section
 5.4.3.3

Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
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Vestibules

All exterior doors in tall buildings in climate zones 3-8 must have a vestibule with
 • Self-closing doors
 • Interior and exterior doors must not be open at the same time
 • Distance between interior and exterior doors not < 7 ft when in closed position (remember ADA!)

							35
		Mandatory Provisions			Prescriptive Option		
Section							
5.4.3.4	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	Lighting
						SWH	

Vestibule Exceptions

Non-entrance doors
(mechanical/electrical
rooms)
Vehicle and material
handling doors and
adjacent personnel doors
OR revolving doors
All doors in climate zones 1
and 2 OR in buildings
< 4 stories
All doors that open into
spaces < 3000 ft² OR into
dwelling units

36

Prescriptive Building Envelope Option

WWR ≤ 50% of gross wall area

Skylight-roof ratio ≤ 5% of roof area

Each envelope component must separately meet requirements

8 criteria sets for different climate types

- Set = single page that summarizes all prescriptive requirements

Insulation levels for roofs, walls, floors

Fenestration criteria

37

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

Designers

Specify

- R-values for walls, floors, and roofs
- U-factors for opaque doors
- U-factor and SHGC for fenestration, OR

Use

- Pre-calculated assemblies from Appendix A

38

Opaque Areas

Compliance

- Meet or exceed minimum R-values in table
Only R-value of insulation, not to include air films, etc
OR
- Meet maximum U-factor, C-factor, or F-factor for the entire assembly
OR
- Perform area-weighted average U-factor, C-factor, or F-factor
Only if there are multiple assemblies within a single class of construction for a single space-conditioning category

39

Mandatory Provisions

Prescriptive Option

R-value is for continuous insulation or when uninterrupted by framing other than metal clips no closer than 24 in. o.c. horizontally and 16 in. o.c. vertically

- Exception – requirement of U-0.151

43

	Mandatory Provisions			Prescriptive Option			
Section 5.5.3.2	Envelope	HVAC	SWH Lighting	Envelope	HVAC SWH	Lighting	

(cont'd)

Above-Grade Wall Insulation (cont'd)
Above-Grade

- Metal building wall R-value is for insulation compressed between metal wall panels and the steel structure
- Steel-framed wall R-value is for uncompressed insulation installed in the cavity between steel studs
- Wood-framed and other R-value is for uncompressed insulation installed in the cavity between wood studs; also acceptable to be continuous insulation uninterrupted by studs

44

	Mandatory Provisions			Prescriptive Option			
Section 5.5.3.2	Envelope	HVAC	SWH Lighting	Envelope	HVAC SWH	Lighting	

Below-Grade Wall Insulation
Below-Grade

Meet or exceed values in appropriate table for climate zone
R-value is for continuous insulation
If framing is used, compliance is based on maximum assembly C-factor

45

	Mandatory Provisions			Prescriptive Option			
Section 5.5.3.3	Envelope HVAC	SWH	Lighting	Envelope	HVAC SWH	Lighting	

Floor Insulation

Meet or exceed values in appropriate table for climate zone

Floors over unconditioned space:

- Mass floors
R-value is for continuous insulation
If framing is used, compliance is based on maximum assembly U-factor
- Steel joist floors
R-value is for uncompressed insulation or spray-on insulation, but is also acceptable for continuous insulation
- Wood-framed and others
R-value is for uncompressed insulation, but is also acceptable for continuous insulation

46

	Mandatory Provisions			Prescriptive Option			
Section 5.5.3.4	Envelope	HVAC	SWH Lighting	Envelope	HVAC SWH	Lighting	

Envelope

Slab-on-Grade Floor Insulation
Slab-on-Grade

Meet or exceed values in appropriate table for climate zone (includes R-value and depth or width of insulation)

Be installed around the perimeter to the distance specified

- Inside foundation wall – extend downward from top of slab a minimum distance specified or to the top of the footing, whichever is less
- Outside foundation wall – extend from top of the slab or downward to at least the bottom of the slab and then horizontally to a minimum distance specified

47

		Mandatory Provisions			Prescriptive Option			
Section 5.5.3.5	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting

Meet or exceed maximum U-factors in appropriate table for climate zone

	Opaque Doors				Opaque Doors		
	Swinging	U-0.700		U-0.700		U-0.700	
	Non-Swinging	U-1.450		U-1.450		U-1.450	

48

		Mandatory Provisions			Prescriptive Option			
Section 5.5.3.6	Envelope HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting	

Criteria apply to fenestration, including windows, glass doors, glass block, plastic panels, and skylights

Compliance

- Meet or exceed maximum U-factors in table
- Meet or exceed minimum SHGC in table
- Use NFRC ratings or default values in Appendix A

49

		Mandatory Provisions			Prescriptive Option			
Section 5.5.4	Envelope HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting	

Fenestration Area

Total vertical fenestration area to be < 50% of gross wall area

- Including both fixed and operable vertical fenestration

Total skylight area to be < 5% of gross roof area

- Including glass skylights, plastic skylights with a curb, and all skylights without a curb

50

		Mandatory Provisions			Prescriptive Option			
Section 5.5.4.2		SWH	Lighting				Lighting	

Envelope HVAC HVAC SWH
Envelope

Fenestration U-Factor U-Factor

NFRC or meet or exceed maximum U-factors in A-17

Exception

- Vertical fenestration complying with Exception (c) to 5.5.4.4.1 to have a U-factor \leq U-factor specified for 40% of the gross wall area
- The exception essentially allows a building to have street side, street-level glazing between 40% and 75% of the wall area while only meeting the requirement for 40%, subject to having a story height of 20 feet or less and an overhang

51

Mandatory Provisions Prescriptive Option

Section 5.5.4.3

Envelope HVAC SWH Lighting Envelope HVAC SWH Lighting

Fenestration SHGC

Vertical fenestration

- SHGC values < Table value for appropriate total vertical fenestration area

Skylights

- SHGC values < Table value for appropriate total skylight area

No SHGC requirements for semiheated spaces or for buildings in climates > 10800 HDD65

No criteria in the for Visible Light Transmittance in Prescriptive Building Envelope Option, but there are minimum criteria in the Trade-Off Option (Details in Appendix C)

52

Mandatory Provisions Prescriptive Option

Section 5.5.4.4

Envelope HVAC SWH Lighting Envelope HVAC SWH Lighting

Overhangs

Standard credits permanent overhangs by adjustment to SHGC

Size of overhang is determined by projection factor

53

Building Envelope Trade-Off Option Trade-Off

Building complies if

- It satisfies the provisions of 5.1, 5.4, 5.7, and 5.8
- Envelope performance factor (EPF) of proposed building is \leq EPF of budget building
- EPF considers only the building envelope components and is calculated using procedures in Normative Appendix C
- Schedules of operation, lighting power, equipment power, occupant density, and mechanical systems to be the same for both the proposed building and the budget building

54

Mandatory Provisions Prescriptive Option

Section
5.6

Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
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Product Information and Installation

Requirements

Labeling of Building Envelope Insulation (Section 5.8.1.1)
 Compliance with Manufacturer's Requirements
 (Section 5.8.1.2)
 Loose-Filled Insulation Limitation (Section 5.8.1.3)
 Baffles (Section 5.8.1.4)
 Substantial Contact (Section 5.8.1.5)
 Recessed equipment (Section 5.8.1.6)
 Insulation protection (Section 5.8.1.7)
 Location of roof insulation (Section 5.8.1.8)
 Extent of insulation (Section 5.8.1.9)

55

Mandatory Provisions

Prescriptive Option

Section
5.8

Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
----------	------	-----	----------	----------	------	-----	----------

Insulation Installation

Per manufacturer's instructions
 Achieve rated R-value
 No open-blown or poured loose-fill
 insulation when ceiling slope is > 3/12
 If eave vents installed

- Provide baffling of air vents to deflect incoming air above the surface of the insulation

 Exception

- Metal buildings – if roof and wall insulation is compressed between roof or wall skin and the structure

56

Mandatory Provisions

Prescriptive Option

Section
5.8.1

Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
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Insulation - Substantial Contact

Install insulation in a permanent manner in substantial contact with inside surface
 Flexible batt insulation in floor cavities

- To be supported in a permanent manner by supports no more than 24 in. o.c.

57

Mandatory Provisions

Prescriptive Option

Section
5.8.1.5

Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
----------	------	-----	----------	----------	------	-----	----------

Recessed Equipment

Do not recess equipment to affect insulation thickness

- Lighting fixtures
- HVAC equipment (includes wall heaters, ducts, and plenums)
- Other

Exceptions

- Glazed wall systems in vertical fenestration and skylights – may use U-factors in A.8.1
- A.8.2 acceptable for other vertical fenestration
- A.7 acceptable for opaque doors
- ANSI/DASMA 105 acceptable for garage doors

62

(SHGC)

Solar Heat Gain Coefficient (SHGC)

Exceptions

- SC x 0.86 is acceptable for overall fenestration area (NFRC 300)
- SHGC of center of glass is acceptable (NFRC 300) for overall fenestration area
- SHGC from A.8.1 for glazed wall systems in vertical fenestration and skylights
- SHGC from A.8.2 for other vertical fenestration

The glazing's effectiveness in rejecting solar heat gain

63

(cont'd)

SHGC (cont'd)

The glazing's effectiveness in rejecting solar heat gain
Part of a system for rating window performance

- used by the National Fenestration Rating Council (NFRC)

Gradually replacing shading coefficient (SC) in product literature and design standards

- convert SC to SHGC by multiplying the SC value by 0.86

64

Visible Light Transmittance

A measure of the amount of visible light that passes through fenestration

Affected by:

- composition of the glass
- coatings
- internal shading devices

65

HVAC Compliance

Building System

Compliance Options
Prescriptive

Envelope

Option

Mandatory

HVAC

Provisions
(required for most compliance options)

Trade Off
Option

Energy Code

Compliance

SWH

Energy Cost

Power

Budget

Lighting

66

Simplified

Other

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

67

Mandatory Provisions

Prescriptive Option

Section 6.1.1.3

Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
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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

68

to meet these requirements

Mandatory Provisions

Prescriptive Option

Section 6.1.1.3

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

69

which case Section 6.4 is mandatory

Simplified Approach Option

Limited to...

- Buildings with 1 or 2 stories
- Buildings < 25,000 ft²
- Each HVAC system in the building meets the following requirements

Requirements

- Single-zone systems
- Cooling - Unitary packaged or split-system AC

70

• Air-cooled or evaporatively cooled only

Mandatory Provisions

Prescriptive Option

Section 6.3

Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
----------	------	-----	----------	----------	------	-----	----------

Envelope

(cont'd)

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

71

Table 6.3.2

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

(cont'd)

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

72

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

(cont'd)

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)

73

	Mandatory Provisions			Prescriptive Option		
Section 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)

						74
	Mandatory Provisions			Prescriptive Option		
Section 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

75

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 $\geq 225,000$ Btu/h to have intermittent or interrupted ignition device and have either power venting or a flue damper
 All furnaces with input ratings $\geq 225,000$ Btu/h, including electric furnaces, not located in conditioned space, to have

76

jacket losses $\leq 0.75\%$ of the input rating

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

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

77

	Mandatory Provisions			Prescriptive Option		
Section 6.4.2	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting

Zone Thermostatic controls

- Required for each zone
- Dead Band controls
- Set Point Overlap Restrictions
- 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

78

	Mandatory Provisions			Prescriptive Option		
Section 6.4.3.1		SWH	Lighting			Lighting

Envelope HVAC

Envelope HVAC

SWH

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

79

Mandatory Provisions

Prescriptive Option

Section
6.4.3.2

Envelope

HVAC

SWH

Lighting

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

80

Mandatory Provisions

Prescriptive Option

Section
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 and a manual override

Each control to have

- Occupant sensor, OR
- Manually-operated timer with maximum two hour duration, OR
- Interlock to security system

Exception – Residential occupancies may use controls with two different time schedules per week

81

Mandatory Provisions

Prescriptive Option

Section
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 $\leq 55^{\circ}\text{F}$

For cooling systems in zones 1b, 2b, and 3b, cooling set point must be adjustable up to $\geq 90^{\circ}\text{F}$ or to prevent high space humidity levels

Exception

- Radiant floor and ceiling heating systems

82

Mandatory Provisions

Prescriptive Option

Section
6.4.3.3.2

Envelope HVAC

SWH

Lighting

HVAC

SWH

Lighting

Envelope

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

83

Mandatory Provisions

Prescriptive Option

Section 6.4.3.3.3

Envelope HVAC

SWH Lighting

Envelope HVAC

SWH Lighting

Zone Isolation

Each isolation area

- Maximum 25,000 ft² 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

84

Mandatory Provisions

Prescriptive Option

Section 6.4.3.3.4

Envelope HVAC

SWH Lighting

Envelope HVAC

SWH Lighting

(cont'd)

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)

85

Mandatory Provisions

Prescriptive Option

Section 6.4.3

Envelope HVAC

SWH Lighting

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

86

Mandatory Provisions

Prescriptive Option

Section 6.4.3.4.1

Envelope HVAC

SWH Lighting

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

87

Section	Mandatory Provisions			Prescriptive Option		
6.4.3.4.2	Envelope	HVAC	SWH	Lighting	Envelope	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)

88

Section	Mandatory Provisions			Prescriptive Option		
6.4.3.4.3	Envelope	HVAC	SWH	Lighting	Envelope	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 \leq 300 cfm

Table 6.4.3.4 provides maximum leakage rates for outdoor air supply and exhaust dampers

89

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

90

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

(cont'd)

Controls (cont'd)

Humidifier Preheat Controls (Section 6.4.3.6)
 Humidification and Dehumidification Controls

Envelope

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

96

Section
 6.4.4

Mandatory Provisions

Prescriptive Option

Envelope HVAC SWH Lighting HVAC SWH Lighting

Envelope

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

97

Section
 6.4.4.1.1

Mandatory Provisions

Prescriptive Option

Envelope HVAC SWH Lighting HVAC SWH Lighting

Envelope

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 ft² need not exceed R-2; those ≤ 5 ft² need not be insulated

98

Section
 6.4.4.1.2

Mandatory Provisions

Prescriptive Option

Envelope HVAC SWH Lighting HVAC SWH Lighting

Envelope

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)

								99
		Mandatory Provisions				Prescriptive Option		
Section 6.4.4.1.3	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
						Duct Sealing		
Table 6.4.4.2A						Table 6.4.4.2A		
						Minimum Duct Seal Level		
Requirements of 6.4.4.2								
Based on standard industry practice and definitions								

								100
		Mandatory Provisions				Prescriptive Option		
Section 6.4.4.2	Envelope HVAC		SWH	Lighting	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								
$L_{max} = CLP0.65$								
Where L_{max} = maximum permitted leakage in cfm/100 ft ² duct surface area								

								101
		Mandatory Provisions				Prescriptive Option		
Section 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								
• Operating and maintenance manuals								
• System balancing								
• System commissioning								

								102
		Mandatory Provisions				Prescriptive Option		
Section 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)

						103
		Mandatory Provisions			Prescriptive Option	
Section						
6.5		SWH	Lighting			Lighting
	Envelope HVAC			Envelope	HVAC SWH	
					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

						104
		Mandatory Provisions			Prescriptive Option	
Section						
6.5.1		SWH	Lighting			Lighting
	Envelope HVAC			Envelope	HVAC SWH	
					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

						105
		Mandatory Provisions			Prescriptive Option	
Section						
6.5.1.1		SWH	Lighting			Lighting
	Envelope HVAC			Envelope	HVAC SWH	
					Control Signal	

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)

						106
		Mandatory Provisions			Prescriptive Option	
Section						
6.5.1.1.2		SWH	Lighting			Lighting
	Envelope HVAC			Envelope	HVAC SWH	
					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

						107
		Mandatory Provisions			Prescriptive Option	

						112
	Mandatory Provisions			Prescriptive Option		
Section 6.5.1.3	Envelope HVAC	SWH	Lighting	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

						113
	Mandatory Provisions			Prescriptive Option		
Section 6.5.1.4	Envelope HVAC	SWH	Lighting	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

						114
	Mandatory Provisions			Prescriptive Option		
Section 6.5.2	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting

(cont'd)

Simultaneous Heating and Cooling Limitation (cont'd)
 Dehumidification controls
 Humidification controls

						115
	Mandatory Provisions			Prescriptive Option		
Section 6.5.2	Envelope HVAC	SWH	Lighting	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

						116
	Mandatory Provisions			Prescriptive Option		
Section 6.5.2.1		SWH	Lighting			Lighting

Envelope HVAC

HVAC

SWH

Envelope

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/ft² 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

117

Mandatory Provisions

Prescriptive Option

Section 6.5.2.1

Envelope

HVAC

SWH

Lighting

HVAC

SWH

Lighting

Envelope

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

118

Mandatory Provisions

Prescriptive Option

Section 6.5.2.2

Envelope HVAC

SWH

Lighting

HVAC

SWH

Lighting

Envelope

Three-Pipe System
Three-Pipe

No common return system for both hot and chilled water

119

Mandatory Provisions

Prescriptive Option

Section 6.5.2.2.1

Envelope HVAC

SWH

Lighting

HVAC

SWH

Lighting

Envelope

Two-Pipe Changeover System
Two-Pipe

Common distribution system acceptable if

- Deadband from one mode to another is $\geq 15^\circ\text{F}$ 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

120

Mandatory Provisions

Prescriptive Option

Section 6.5.2.2.2

Envelope HVAC

SWH

Lighting

HVAC

SWH

Lighting

Envelope

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

121

	Mandatory Provisions			Prescriptive Option		
Section 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

122

	Mandatory Provisions			Prescriptive Option		
Section 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

123

	Mandatory Provisions			Prescriptive Option		
Section 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

124

	Mandatory Provisions			Prescriptive Option		
Section 6.5.2.4	Envelope HVAC	SWH	Lighting	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

125

	Mandatory Provisions	Prescriptive Option
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Envelope

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

130

Section 6.5.4

Mandatory Provisions

Prescriptive Option

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

131

Section 6.5.4.1

Mandatory Provisions

Prescriptive Option

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

132

Section 6.5.4.1

Mandatory Provisions

Prescriptive Option

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

133

Section 6.5.4.2

Mandatory Provisions

Prescriptive Option

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

134

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

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

135

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

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

136

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

Fan Speed Control

Each fan powered by a motor ≥ 7.5 hp

- Have capability to operate fan at $\leq 2/3$ 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

137

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

Exhaust Air Energy Recovery

Incorporate exhaust air energy recovery in systems with

- $\geq 70\%$ outside air and ≥ 5000 cfm total
- 50% energy recovery effectiveness

138

Mandatory Provisions	Prescriptive Option
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Manuals

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

147

	Mandatory Provisions		Prescriptive Option	
Section 6.7.2.2	Envelope HVAC	SWH Lighting	Envelope HVAC SWH	Lighting

System Balancing

Systems shall be balanced in accordance with accepted engineering standards
 Written report for conditioned spaces > 5000 ft²
 Minimize throttling losses
 For fans with system power > 1 hp
 • Adjust fan speed to meet design flow conditions

148

	Mandatory Provisions		Prescriptive Option	
Section 6.7.2.3	Envelope HVAC	SWH Lighting	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

149

	Mandatory Provisions		Prescriptive Option	
Section 6.7.2.3.3	Envelope HVAC	SWH Lighting	Envelope HVAC SWH	Lighting

System Commissioning

Control elements are calibrated, adjusted, and in proper working condition
 > 50,000 ft² conditioned area
 • Except warehouses and semiheated spaces
 • Requires commissioning instructions

150

	Mandatory Provisions		Prescriptive Option	
Section 6.7.2.4	Envelope HVAC	SWH Lighting	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

151

Section	Mandatory Provisions		Prescriptive Option	
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6.8	Envelope	HVAC	SWH	Lighting	HVAC	SWH	Lighting
					Envelope		
					SWH Compliance		
Building System			Compliance Options				
	Envelope		Prescriptive				
			Option				
	HVAC	Mandatory			Energy Code		
		Provisions	Trade Off		Compliance		
		(required for most	Option				
	SWH	compliance options)					
	Power		Energy Cost				
			Budget				
Lighting						152	
			Simplified				
Other							

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)

			Mandatory Provisions		Prescriptive Option		153
Section 7	Envelope	HVAC	SWH	Lighting	Envelope	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

			Mandatory Provisions		Prescriptive Option		154
Section 7.1.1.3	Envelope	HVAC	SWH	Lighting	Envelope	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

155

Load Calculations

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

							156
		Mandatory Provisions			Prescriptive Option		
Section							
7.4.1		SWH	Lighting				Lighting
	Envelope HVAC			Envelope	HVAC	SWH	

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

							157
		Mandatory Provisions			Prescriptive Option		
Section							
7.4.2		SWH	Lighting				
Lighting	Envelope	HVAC		Envelope	HVAC	SWH	

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)

							158
		Mandatory Provisions			Prescriptive Option		
Section							
7.4.3		SWH	Lighting				Lighting
	Envelope	HVAC		Envelope	HVAC	SWH	

Service Water Heating System Controls

Temperature Controls

Temperature Maintenance Controls

Outlet Temperature Controls

Circulating Pump Controls

							159
		Mandatory Provisions			Prescriptive Option		
Section							
7.4.4		SWH	Lighting				Lighting
	Envelope	HVAC		Envelope	HVAC	SWH	

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

							160
		Mandatory Provisions			Prescriptive Option		
Section							

7.4.4.1	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting
						161
						Prescriptive Option
						Mandatory Provisions
						Temperature Maintenance Controls
						Automatic time switches or other controls
						<ul style="list-style-type: none"> Set to switch off usage temperature maintenance system during extended periods when hot water is not required
Section 7.4.4.2	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting
						162
						Prescriptive Option
						Mandatory Provisions
						Outlet Temperature Controls
						Controls provided
						<ul style="list-style-type: none"> To limit maximum temperature of water delivered from lavatory faucets in public facility restrooms to 110°F
Section 7.4.4.3	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting
						163
						Prescriptive Option
						Mandatory Provisions
						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
Section 7.4.4.4	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting
						164
						Prescriptive Option
						Mandatory Provisions
						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
Section 7.4.5	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting
						164
						Prescriptive Option
						Mandatory Provisions
						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)
						<ul style="list-style-type: none"> 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

165

Mandatory Provisions

Prescriptive Option

Section 7.4.6

Envelope HVAC SWH Lighting 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 $(13.3 \times \text{pmd} + 400) / n$; 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

166

Mandatory Provisions

Prescriptive Option

Section 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

167

Mandatory Provisions

Prescriptive Option

Section 7.5.2

Envelope HVAC SWH Lighting Envelope HVAC SWH Lighting

Service Water Heating Submittals

Authority having jurisdiction may require submittal of compliance documentation and supplemental information in accord with Section 4.2.2 of this standard.

168

Mandatory Provisions

Prescriptive Option

Section 7.7

Envelope HVAC SWH Lighting Envelope HVAC SWH Lighting

Power Compliance

Building System

Compliance Options Prescriptive

Envelope

Option

HVAC

Mandatory

Energy Code

SWH

Provisions (required for most compliance options)

Trade Off Option

Compliance

Power	Energy Cost	
	Budget	
Lighting		169
	Simplified	
Other		

Section 8 - Power

Voltage drop	
Submittals	170

Voltage Drop

Two types of conductors

- Feeder conductors
Run between the service entrance equipment and the branch circuit distribution equipment
2% maximum voltage drop allowed at design load
- Branch circuit conductors
Run from the final circuit breaker to the outlet or load
3% maximum voltage drop allowed at design load
- These are more stringent than non-enforceable requirements in the National Electric Code (NEC)

171

Mandatory Provisions

Prescriptive Option

Section 8.4.1	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
---------------	----------	------	-----	----------	----------	------	-----	----------

Power Submittals

Owner gets information about the building's electrical system

- Record drawings of actual installation within 30 days
Single-line diagram of electrical distribution system
Floor plans showing location and areas served for all distribution
- Manuals
Submittal data stating equipment rating
O&M manuals for equipment
Qualified service agency
Complete narrative of system as it's normally intended to operate

172

Mandatory Provisions

Prescriptive Option

Section 8.7	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting
-------------	----------	------	-----	----------	----------	------	-----	----------

Lighting Compliance

Building System	Compliance Options	
Envelope	Prescriptive	
	Option	
HVAC	Mandatory	Energy Code
	Provisions (required for most compliance options)	Trade Off Option
SWH		Compliance
Power		Energy Cost
		Budget
Lighting		173
		Simplified

Section 9 - Lighting

General Application (Section 9.1)

- Scope
- Lighting Alterations
- Installed Interior Lighting Power
- Luminaire Wattage

Compliance Path(s) (Section 9.2)

Mandatory Provisions (Section 9.4)

- Lighting control
- Tandem wiring
- Exit signs
- Exterior building grounds lighting
- Exterior building grounds lighting

Building Area Method Compliance Path (Section 9.5)

Alternative Compliance Path:

Space-by-Space Method (Section 9.6)

174

		Mandatory Provisions			Prescriptive Option		
Section 9	Envelope	HVAC	SWH	Lighting	Envelope	HVAC	SWH
				Lighting General			Lighting

Scope

- Interior spaces of buildings
- Exterior building features
- Exterior grounds lighting powered through building

Exceptions

- Emergency lighting
- Lighting required by life safety statute
- Lighting within living units of buildings
- Decorative gas lighting

Lighting Alterations – New lighting and lighting controls must comply with this section, unless an alteration replaces less than 50% of luminaires in a space and that alteration does not increase the installed lighting power

175

Lighting General

Installed Interior Lighting Power shall include all power used by the luminaires, including lamps, ballasts, current regulators, and controls

- Exception: in the case where there are two independently operated lighting systems that are controlled to prevent simultaneous operation

Include only the higher wattage system

Luminaire Wattage for various systems shall be determined in accordance with details in Section

176

9.1.4

Lighting Alterations

Interior spaces of buildings
 Exterior building features
 Exterior grounds lighting powered through building
 Exceptions

- Emergency lighting
- Lighting required by life safety statute
- Lighting within living units of buildings
- Decorative gas lighting

177

Lighting Scope

New construction
 Existing nonresidential and high-rise residential

- If ≥ 50% of existing luminaires are replaced
- If renovation increases lighting power

Control devices can't control

- > 2500 ft2 in spaces < 10,000 ft2
- > 10,000 ft2 in spaces > 10,000 ft2

Control must be readily accessible and located so occupants can see the controlled lighting

178

Installed Interior Lighting Power

Includes all permanent and portable interior lighting intended for general, ambient, or task illumination
Includes lamp, power used by ballast, the control (when applicable), current regulators, and any other power draws associated with the lighting system

Exception

- If 2 or more independently operating lighting systems in a space can be controlled to prevent simultaneous operation, can base IILP on lighting system with highest wattage

179

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

Luminaire Wattage

Standard incandescent = max. labeled wattage of the luminaire

Luminaires with ballasts = wattage of the lamp/ballast combination

Line voltage track = min. 30 W per foot

Low voltage track = transformer wattage

All others as specified

180

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

Lighting Control

Automatic lighting shutoff

- Applies to buildings > 5000 ft2
 - Time-scheduling devices
 - Accommodate separate schedules for each floor or each space > 25,000 ft2
 - Occupant-sensing devices
 - All general lighting controlled by one or more occupant sensors
 - Must turn off lights in each controlled space within 30 minutes of last occupant detection
- A signal from another control or alarm system that indicates the area is unoccupied

181

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

Space Control 1

At least one for each room or space enclosed by ceiling-height partitions
Readily accessible to occupants, unless there are safety or security issues

							182
	Mandatory Provisions				Prescriptive Option		
Section 9.4.1.2		SWH	Lighting				Lighting
	Envelope HVAC			Envelope	HVAC	SWH	

For classrooms, conference/meeting rooms, and employee lunch and break rooms:

- The control device shall automatically turn lighting off within 30 minutes of sensing that all occupants have left the space:

Exceptions

Spaces with multi-scene control
 Shop classrooms, laboratory classrooms, and preschool through 12th grade classrooms

- These spaces are not required to be connected to other automatic lighting shutoff controls

							183
	Mandatory Provisions		New in 2004		Prescriptive Option		
Section 9.4.1.2		SWH	Lighting				Lighting
	Envelope HVAC			Envelope	HVAC	SWH	
							Space Control 3

For all other spaces:

- In spaces ≤ 10,000 ft², each control can serve a maximum of 2500 ft²
- In spaces > 10,000 ft², each control can serve a maximum of 10,000 ft²

							184
	Mandatory Provisions				Prescriptive Option		
Section 9.4.1.2		SWH	Lighting				Lighting
	Envelope HVAC			Envelope	HVAC	SWH	

Exterior Lighting Control

Lighting for all exterior applications not exempted in 9.1 shall have automatic controls capable of turning off exterior lighting when sufficient daylighting is available or when the lighting is not required during nighttime hours.

- Lighting not designated "dusk-to-dawn" - astronomical time switch required
- Lighting designated "dusk-to-dawn" - astronomical time switch or photosensor

Astronomical time switches shall be capable of retaining programming and time setting during loss of power for a period of at least 10 hours

Exceptions - lighting for

- Covered vehicle entrances
- Exits from buildings or parking structures

(where required for safety, security, or eye adaptation)

							185
	Mandatory Provisions				Prescriptive Option		
Section 9.4.1.3		SWH	Lighting				Lighting
	Envelope HVAC			Envelope	HVAC	SWH	

Additional Control

Many special lighting applications must be controlled separately

- Display/accent lighting

- Case lighting
- Hotel/motel guest room lighting
- Task lighting
- Nonvisual lighting
- Demonstration lighting

							186
		Mandatory Provisions			Prescriptive Option		
Section							
9.4.1.4	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting	

							187
		Mandatory Provisions			Prescriptive Option		
Section							
9.4.2	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting	

Tandem Wiring Exceptions

Separated surface or pendant luminaires
 Recessed luminaires more than 10 ft apart
 Other luminaires

- With three-lamp ballasts
- On emergency lighting circuits
- With no available pair
- With one lamp, high frequency, electronic ballast

							188
		Mandatory Provisions			Prescriptive Option		
Section							
9.4.2	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting	

Exit Signs

Internally illuminated exit signs shall not exceed 5 watts per face

							189
		Mandatory Provisions New in 2004			Prescriptive Option		
Section							
9.4.3	Envelope HVAC	SWH	Lighting	Envelope HVAC	SWH	Lighting	

Efficacy

The ratio of light output to watts input

- lumens per watt

The higher the efficacy, the more efficient the light source

- 40 watt incandescent = 480 lumens
- 40 watt fluorescent = 2640 lumens

190

Exterior Building Grounds Lighting

Luminaires that operate at >
 100 W = efficacy
 > 60 lumens/W

Exceptions

- Traffic signals
- Lighting within outdoor signs
- Lighting used to illuminate public monuments or registered historic landmarks

- If an occupancy sensor or motion sensor controls the lighting application 191

Section 9.4.4

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

Efficacy 192

Exterior Building Lighting Power

In 2003 the ASHRAE 90.1 lighting subcommittee undertook re-writing of the 90.1-2001 Exterior Lighting Requirements

- Reviewed existing exterior lighting documents including the Outdoor Lighting Research proposal for California Outdoor Lighting Standards IESNA RP-33, RP-02, RP-20, RP-10 (draft), DG-5, and the 9th Edition Handbook
- Multiple lighting solution models were created and analyzed for; parking areas, walkways, plazas, building entries, canopies, façade lighting, and outdoor sales
- Metal halide was used as the base case!

193

Background Lighting

		Mandatory Provisions		Prescriptive Option	
	Envelope	HVAC	SWH Lighting	Envelope	HVAC SWH

Exterior Building Lighting Power

The total exterior lighting power allowance for all exterior building applications is the sum of the individual lighting power densities permitted in Table 9.4.5 for these applications plus an additional unrestricted allowance of 5% of that sum

Trade-offs are allowed only among exterior lighting applications listed in "Tradable Surfaces" section

194

Section 9.4.5

		Mandatory Provisions		Prescriptive Option	New in 2004
	Envelope	HVAC	SWH Lighting	Envelope	SWH Lighting

Exterior Building Lighting Power

Lighting used for the following exterior applications is exempt when equipped with a control device independent of the control of the nonexempt lighting:

- specialized signal, directional, and marker lighting associated with transportation;
- lighting that is integral to advertising signage or directional signage;
- lighting that is integral to equipment or instrumentation and is installed by its manufacturer;
- lighting for theatrical purposes, including performance, stage, film, and video production;
- lighting for athletic playing areas;
- temporary lighting;
- lighting for industrial production, material handling, transportation sites, and associated storage areas;
- theme elements in theme/amusement parks;
- lighting used to highlight features of public monuments and registered historic landmark structures or buildings.

195

Mandatory Provisions	Prescriptive
----------------------	--------------

OptionNew in 2004

Section

9.4.5

Lighting

SWH

Lighting

Envelope

HVAC

Envelope

HVAC

SWH

Exterior Building Lighting Power

Tradable Building Surface Requirements

- Uncovered Parking Areas 0.15 W/ft2
- Building Grounds 0.2 – 1 W/ft2
- Building Entrances and Exits 20 – 30 W/lf of door width
- Canopies and Overhangs 1.25 W/ft2
- Outdoor Sales 0.5 W/ft2

196

Mandatory Provisions

Prescriptive Option

Section

9.4.5

Envelope

HVAC

SWH

Lighting

Envelope

HVAC

SWH

Lighting

Exterior Building Lighting Power

Non-Tradeable Surfaces

- Building Facades – 0.2 w/ft2 or 5.0 W/linear foot
- Automated teller machines and night depositories
- Entrances and gatehouses
- Loading areas for law enforcement and public safety
- Drive-up windows at fast food restaurants
- Parking near 24-hour retail entrances

197

Mandatory Provisions

Prescriptive Option

Section

9.4.5

Envelope

HVAC

SWH

Lighting

Envelope

HVAC

SWH

Lighting

Lighting Power Development Concept

Create building space models to calculate power densities with:

- Current product performance data
- Updated efficacy and loss factors
- New building construction data
- IES-recommended light levels
- Professional lighting design consensus

198

Interior Lighting Power

Lots of exemptions

Calculation methods

- Building area
- Space-by-space
- Trade-offs of interior lighting power allowance among portions of the building for which a different calculation method has been used is not permitted

199

Mandatory Provisions

Prescriptive Option

SWH

Lighting

Lighting

Envelope HVAC

HVAC

SWH

Envelope

Lighting Power Allowance Exemptions

- Theatrical, stage, film, and video production
- Medical and dental procedures
- Exhibit displays for museums monuments, and galleries
- Plant growth or maintenance
- Integral to equipment or instrumentation installed by manufacturer
- Integral to both open and glass-enclosed refrigerator and freezer cases
- Retail display windows, provided the display is enclosed by ceiling-height partitions
- Interior spaces specifically designated as registered interior historic landmarks
- Integral part of advertising or directional signage
- Exit signs
- Sale or lighting educational demonstration systems
- Lighting for television broadcasting in sporting activity areas

200

Casino gaming areas
 For use in areas specifically designed for the visually impaired

Exemption Example
 201

Building Area Method of Calculating Interior
 Lighting Power Allowance

Used for projects involving

- An entire building
- A single, independent, and separate occupancy in a multi-occupancy building

Gross lighted area is multiplied by allowance from Table 9.5.1

Limitations

- Insensitive to specific space functions and room configurations
- Generally is more restrictive
- Does not apply to all building types - but "selection of a reasonably equivalent type" is permitted

202

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

Gross Lighted Area

Sum of total lighted area of a building

- Measured from the exterior faces of the exterior walls or from the centerline of walls separating buildings, but excluding a long list of areas. (See standard).

Used in the building area method of determining interior lighting power allowance

203

	Mandatory Provisions			Prescriptive Option		
	Envelope	HVAC	SWH	Lighting	Envelope	Lighting

Building Area Allowances

Table 9.5.1

Lighting Power

Building Type

	Density (W/ft2)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0

204

Mandatory Provisions		Prescriptive Option	
SWH	Lighting	HVAC	Lighting
Envelope HVAC			
	Envelope		

Space-by-Space Method of Calculating Space-by-Space

Interior Lighting Power Allowance

Identify different building types in your project
 Divide gross lighted area of the building into each of the space types
 Calculate lighting power allowance by multiplying area of space type by lighting power density for that specific space type
 Sum all the allowances

Advantages

- More flexible
- Applicable to all building types
- Accounts for room geometry (e.g., lighting needs of enclosed

205

Mandatory Provisions		Prescriptive Option	
SWH	Lighting	HVAC	Lighting
Envelope HVAC			
	Envelope		

Additional Interior Lighting Power

An increase in the ILPA is allowed for specific space functions when using the space-by-space method

- Decorative – 1.0 W/ft2 in space used
- Fluorescent designed to eliminate glare – .35 W/ft2
- Lighting equipment installed in retail spaces specifically to highlight merchandise in specific space used
 - Additional 1.6 W/ft2 times the area of specific display, or
 - Additional 3.9 W/ft2 times the area of specific display for fine merchandise

206

Mandatory Provisions		Prescriptive Option	
SWH	Lighting	HVAC	Lighting
Envelope HVAC			
	Envelope		

Submittals

There are no submittals associated with the lighting requirements

207

Mandatory Provisions		Prescriptive Option	
SWH	Lighting	HVAC	Lighting
Envelope HVAC			
	Envelope		

Other Compliance

Building System	Compliance Options		
	Prescriptive		
Envelope		Option	
	Mandatory		
HVAC		Trade Off	Energy Code
	Provisions (required for most compliance options)	Option	Compliance
SWH			
Power		Energy Cost	
		Budget	
Lighting			208
		Simplified	
Other			

Section 10 - Other Equipment

Motor efficiency levels correspond to Energy Policy Act of 1992 manufacturing standards

Mandatory provisions are for General Purpose Design A and Design B motors only

Motors in new buildings, additions to existing buildings, and alterations to existing buildings must comply

- Relocated or reused existing motors do not have to meet these requirements

No small building option, no prescriptive compliance path, no alternative compliance paths, no submittals

209

	Mandatory Provisions			Prescriptive Option		
Section 10		SWH	Lighting			Lighting
	Envelope	HVAC		Envelope	HVAC	SWH

Section 11 - Energy Cost Budget Method

The ultimate trade-off method allowing you to trade-off across building systems through the use of annual, hourly simulation tools and a baseline building

The only real way to deal with unique designs, renewables, high-efficiency equipment, etc.

The basis of the energy portion of the LEED rating

Limits allowable energy costs of the design to those of a building meeting the Standard Buildings must still meet all mandatory requirements (Section X.4)

210

	Mandatory Provisions			Prescriptive Option		
Section 11		SWH	Lighting			Lighting
	Envelope	HVAC		Envelope	HVAC	SWH

Section 11 - Energy Cost Budget Method

Tradeoff limited to building permit

You have to have an approved building envelope design prior to ECB submittal

You must meet all the X.4 sections AND the design energy cost cannot exceed the energy cost budget AND the energy efficiency level of components must meet or exceed the levels used to calculate the design energy cost

You must document all this in great detail

						211
	Mandatory Provisions				Prescriptive Option	
Section						
11.1		SWH	Lighting			Lighting
	Envelope HVAC			Envelope	HVAC	SWH

Section 11 - Energy Cost Budget Method
 You must use a good and approved simulation program
 You must use appropriate and approved climate data
 You must use appropriate and approved purchased energy rates
 You must use the same simulation program, climate data, and purchased energy rates for both the design energy cost and energy cost budget
 You must get approval to deal with exceptional calculations that aren't covered in the simulation program

						212
	Mandatory Provisions				Prescriptive Option	
Section						
11.2		SWH	Lighting			Lighting
	Envelope HVAC			Envelope	HVAC	SWH

Section 11 - Energy Cost Budget Method
 You must develop your proposed building design and budget building design in accordance with Table 11.3.1
 • This table "locks down" a number of building design parameters
 You must choose your budget building HVAC system from Figure 11.3.2 and Table 11.3.2A

						213
	Mandatory Provisions				Prescriptive Option	
Section						
11.3		SWH	Lighting			Lighting
	Envelope HVAC			Envelope	HVAC	SWH

Section 11 - Energy Cost Budget Method
 If you are attempting to show that your building goes "above code" (say, for instance, for LEED energy points) as opposed to simply using ECB as a very flexible and complex code compliance tradeoff option, be sure to see Informative Appendix G, which contains many of the same elements as Section 11, but with modifications to accommodate the needs of "above code" programs

						214
	Mandatory Provisions				Prescriptive Option	
Section						
11		SWH	Lighting			Lighting
	Envelope HVAC			Envelope	HVAC	SWH

Section 12 - Normative References
 Normative (read "mandatory") reference documents
 Includes test methods, rating procedures, and other standards

						215
	Mandatory Provisions				Prescriptive Option	
Section						

12	Envelope HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting	
	Rated R-Value of Insulation and Assembly U-R-Value Factor, C-Factor, and F-Factor Determinations C-Factor, F-Factor Includes pre-calculated U-factors, C-factors, and F-factors						U-	
								216
Normative Appendix								
A	Envelope HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting	
	Building Envelope Climate Criteria Defines which of the envelope criteria tables (Tables 5.5-X) to use for your location							
	General							
	Climate Zone Map							
	U.S. Climate Zones (by County)							
	Canadian Climatic Zones (by City)							
	International Climate Zone (by City)							
	Major Climate Type Definitions (for use with non-U.S. locations)							
								217
Normative Appendix								
B	Envelope HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting	
	Methodology for Building Envelope Trade-Off Option in Subsection 5.6 Trade-Off							
	The details of how the envelope trade-off option referenced in Section 5.6 is implemented							
	This methodology is implemented in the ENVSTD software distributed with the 90.1 Users Manual							
								218
Normative Appendix								
C	Envelope HVAC	SWH	Lighting	Envelope	HVAC	SWH	Lighting	
	Climate Data							
	Climatic data for a number of US, Canadian, and international locations							
	• HDD65 and CDD50							

- Heating and cooling design temperatures
- “number of hours between 8 am and 4 pm with Tdb between 55 and 69”

Used exclusively for HVAC calculations

						219
	Mandatory Provisions			Prescriptive Option		
Normative Appendix		SWH	Lighting			Lighting
	Envelope HVAC			HVAC	SWH	
				Envelope		
D						

Informative References

Other useful references that are not mandatory, but are useful as examples for the user of Standard 90.1-2004

In general, these are not consensus documents so ASHRAE procedures do not allow them to be mandatory references

						220
	Mandatory Provisions			Prescriptive Option		
Informative Appendix		SWH	Lighting			Lighting
	Envelope HVAC			HVAC	SWH	
				Envelope		
E						

Addenda Description Information

Information on addenda to ANSI/ASHRAE/IESNA Standard 90.1-2001 (the predecessor to Standard 90.1-2004)

ASHRAE issued 31 addenda to Standard 90.1-2001

Standard 90.1-2001 plus these addenda plus the reformat forms the basis of Standard 90.1-2004

						221
	Mandatory Provisions			Prescriptive Option		
Informative Appendix		SWH	Lighting			Lighting
	Envelope HVAC			HVAC	SWH	
				Envelope		
F						

Performance Rating Method

Instructions for using the ANSI/ASHRAE/IESNA Standard 90.1-2004 Energy Cost Budget Method in conjunction with the U.S. Green Buildings Council (USGBC) Leadership in Energy and Environmental Design (LEED) program

						222
	Mandatory Provisions			Prescriptive Option		
Informative Appendix		SWH	Lighting			Lighting
	Envelope HVAC			Envelope HVAC	SWH	
G						