

Standard 189.1: Structure, Requirements and Energy Savings

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27 February 2017



ASHRAE Standard 189.1

Overview

- What is it?
- Why was it created?
- Highlights

<http://www.ashrae.org/greenstandard>



Standard 189.1: Intent

Standard 189.1 *is*:

- a standard
- applies to all buildings except low-rise residential buildings (same as ASHRAE Std 90.1)
- intended for adoption into model building codes

Standard 189.1 *is not*:

- a design guide
- a rating system

***Even if not adopted by local authorities,
this Standard is indication of future industry trends***

Sponsors and Project Committee

ANSI consensus process

Sponsor and co-sponsors:

- ASHRAE
- USGBC (U.S. Green Building Council)
- IES (Illuminating Engineering Society)

Project committee:
35+/- voting members;
variety of disciplines,
industries & organizations



ASHRAE Standard 189.1

An optional compliance path (“Jurisdictional Compliance Option”) to the International Green Construction Code (IGCC)

Official description of Standard 189.1 within U.S.



“... compliance option of the International Green Construction Code.” Choice of the project team to use IGCC or Std 189.1



From 2018, 189.1 will be the technical compliance path for IGCC

Differences between Standard 189.1, LEED and BEAM



Voluntary vs. mandatory



- Standard 189.1:
- Improvement in all topical areas
 - Pushes the envelope

Progress and Status

3-½ years of development, 4 public reviews

January 2010: Standard 189.1-2009 initial release

December 2011: Standard 189.1-2011

December 2014: Standard 189.1-2014

In progress: Standard 189.1-2017



Standard 189.1: Relation to Other ASHRAE Standards



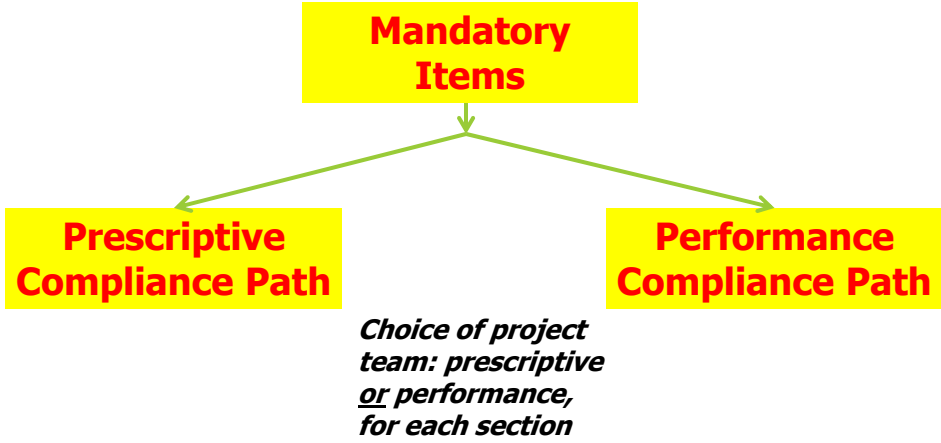
Organization and What it Covers

Similar to other ASHRAE standards and LEED

CONTENTS
ANSI/ASHRAE/USGBC/IES Standard 189.1-2014,
Standard for the Design of High-Performance Green Buildings
Except Low-Rise Residential Buildings

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Standard 189.1 Compliance Paths



Standard 189.1 Basic Structure

x.1: Scope

For Each Section

x.2: Compliance

x.3: Mandatory
(required for all projects)

x.4: Prescriptive path
(simple option, minimal choices,
very few calculations)

x.5: Performance path
(more sophisticated, flexibility, but more effort)

Section 5 Site Sustainability

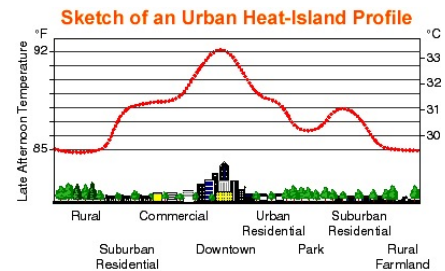
Section 5 – Site Sustainability

All requirements now mandatory

Allowable sites, where to build; or where not to allow a building

Other areas:

- Urban heat island
- Light “pollution” limitations
- Stormwater management
- Transportation impacts
- Protection of natural areas and native site features



Section 6 Water Use Efficiency

Section 6 – Water Use Efficiency

Mandatory Provisions

Site water use:

- ❖ Landscape design: bio-diverse and adapted plantings 60% of landscape
- ❖ Irrigation design: hydrozoning
- ❖ Controls: smart irrigation controllers



Section 6 – Water Use Efficiency

Mandatory Provisions

Building water use:

- ❖ (§6.3.2.1) plumbing fixtures & fittings per U.S. EPA WaterSense or ASME Standards, with specific limit on flow amount or rate
- ❖ (§6.3.2.2) appliances per U.S. EPA EnergyStar, with water use factor for dwelling unit or public access



Section 6 – Water Use Efficiency

Mandatory Provisions (cont.)

HVAC Systems (§6.3.2.3):

- Subsystem metering above thresholds
- Efficient drift eliminators (0.002% counterflow, 0.005% cross-flow)
- Condensate collection from units >19 kW (65,000 Btu/h) in areas with mean coincident wet bulb > 22°C (72°F)

Annual condensate collection
Georgia: ~12.6 gal/cfm Outdoor air
or about 100 liters water/(l/s)



Section 6 – Water Use Efficiency

Prescriptive Option

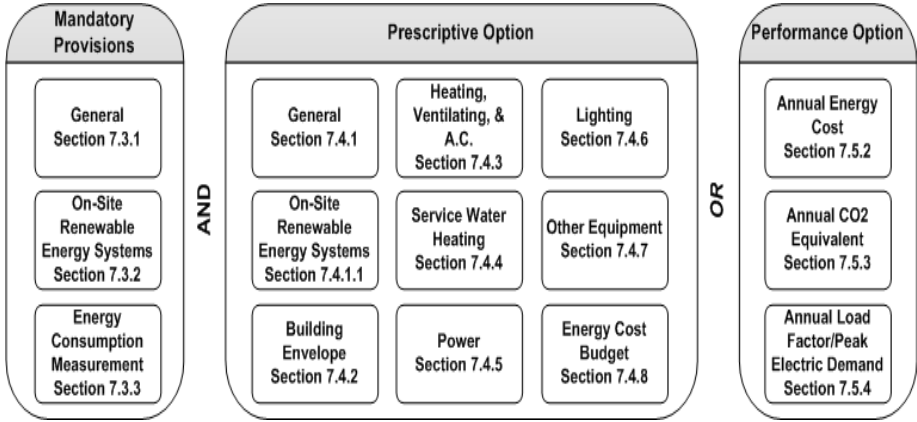
Building Water Use (§6.4.2):

- Cooling tower cycles of concentration
- Commercial food service
 - Use high efficiency equipment (Energy Star or equivalent)
 - Air cooled ice machines only
- Other requirements for medical and laboratory facilities
- Water features



Section 7 Energy Efficiency

General Compliance Paths - Energy



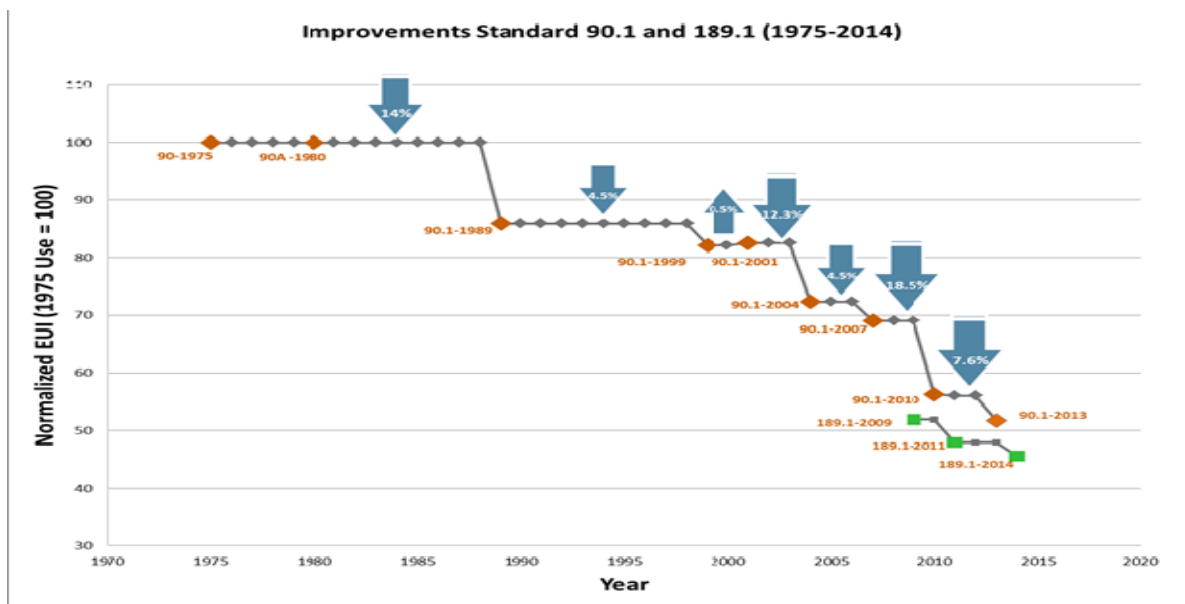
ASHRAE Energy Goals

ASHRAE goal: net-zero energy and carbon by 2020

ASHRAE's Tech Council was tasked to suggest EUI targets for Standards 189.1 and 90.1

Monitoring of progress based on standardized computer modeling

Goal: 189.1 reaches net-zero ready (but not net zero) by 2020



Source: DOE Building Energy Codes Program

Energy Efficiency – Section 7

Mandatory Requirements:

- On-site renewable power (§7.3.2)
Provisions for future installation annual energy production ≥ 6 kBtu/ft² (20 kWh/m²) single-story; ≥ 10 kBtu/ft² (32 kWh/m²) multi-story



Energy Efficiency – Section 7

Mandatory Requirements (continued)

Remote or automatic energy monitoring (§7.3.3) criteria based on size

- Energy sources (Table 7.3.3-1)
- Key systems (Table 7.3.3-2)

Meters communicate to central recording system

Data storage for minimum 36 months

Exception: Residential portions of buildings complying with this Standard

Energy Metering Thresholds

TABLE 7.3.3.1A Energy Source Thresholds

Energy Source	Threshold
Electrical service	>200 kVA
On-site renewable electric power	All systems > 1 kVA (peak)
Gas and district services	>1,000,000 Btu/h (300 kW)
Geothermal energy	>1,000,000 Btu/h (300 kW) heating
On-site renewable thermal energy	>100,000 Btu/h (30 kW)

TABLE 7.3.3.1B System Energy Use Thresholds

Use (Total of All Loads)	Subsystem Threshold
HVAC system	Connected electric load > 100kVA
HVAC system	Connected gas or district services load > 500,000 Btu/h (150 kW)
People moving	Sum of all feeders > 50 kVA
Lighting	Connected load > 50 kVA
Process and plug process	Connected load > 50 kVA
	Connected gas or district services load > 250,000 Btu/h (75 kW)

Energy Efficiency – Section 7

Prescriptive Option: Renewable Energy

Two options for demonstrating compliance:

- Baseline: Install the amount of on-site renewable energy specified in mandatory section.
 - ≥6 kBtu/ft² (20 kWh/m²) single-story;
 - ≥10 kBtu/ft² (32 kWh/m²) multi-story

Exception (meet both of these):

- Low incident solar locations (<4.0 kWh/m²/day)
- Purchase of green power in terms of “7 kWh/ft²-yr [75 kWh/m²-yr]” annually until cumulative purchase of 70 kWh/ft²-yr [750 kWh/m²-yr]

Energy Efficiency – Section 7

Prescriptive Option: Renewable Energy

Alternate Renewables Approach:
Reduced On-Site Renewable Energy
and Higher Efficiency Equipment

- If project complies with higher energy efficiency requirements in Appendix B, water heating, other efficiency measures (Energy Star® etc.), lower on-site renewables required:
- ≥ 4 kBtu/ft² (13 kWh/m²) single-story;
- ≥ 7 kBtu/ft² (22 kWh/m²) multi-story

Energy Efficiency – Section 7

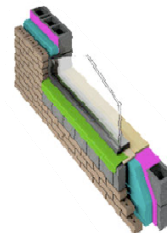
Prescriptive Option: Building Envelope

(§7.4.2)

Comply with Std 90.1, Section 5 as modified...

Comply with Table 5.5-1 through 5.5-8 on building envelope in 90.1, as modified for Climate Zones 4 – 8:

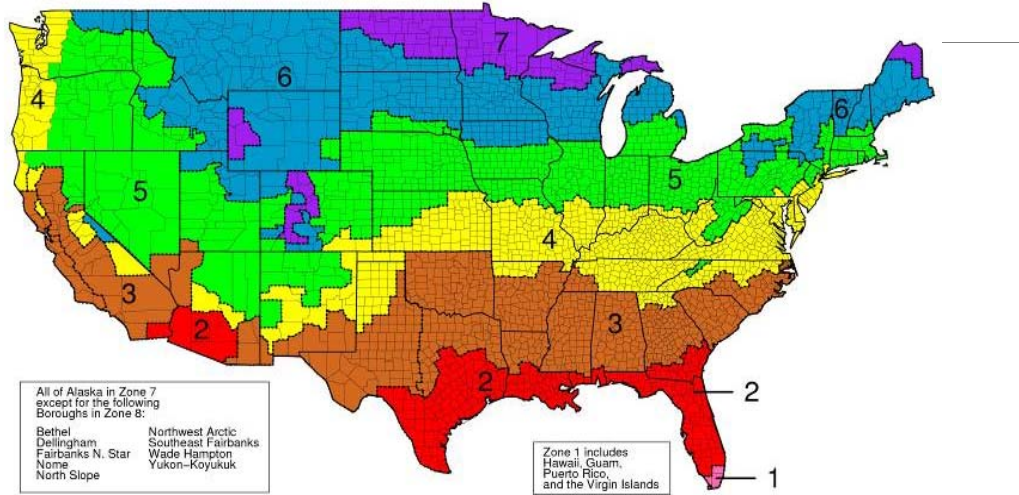
- U-, C- and F- factors reduced by 10% (Tables 5.5-4 thru 5.5-8)
- Insulation Min. R-Value Column of Std. 90.1 shall not apply
- Solar Heat Gain Coefficient (SHGC) for east and west oriented fenestration reduced by 10%



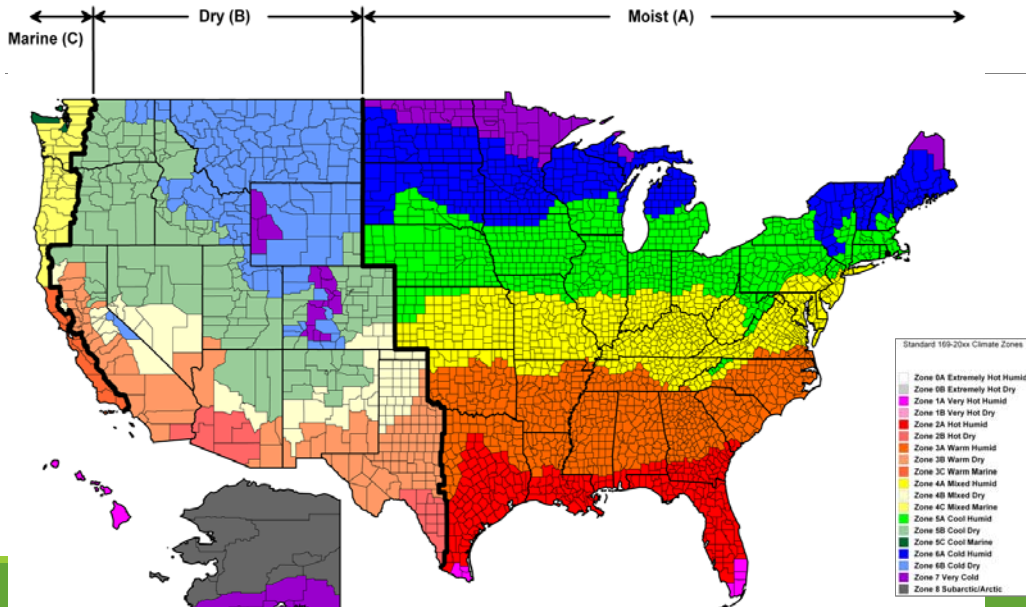
If no requirement ('NR') listed, does not apply

SHGC reduction not applicable to spaces meeting daylighting area requirements in §8.4.1

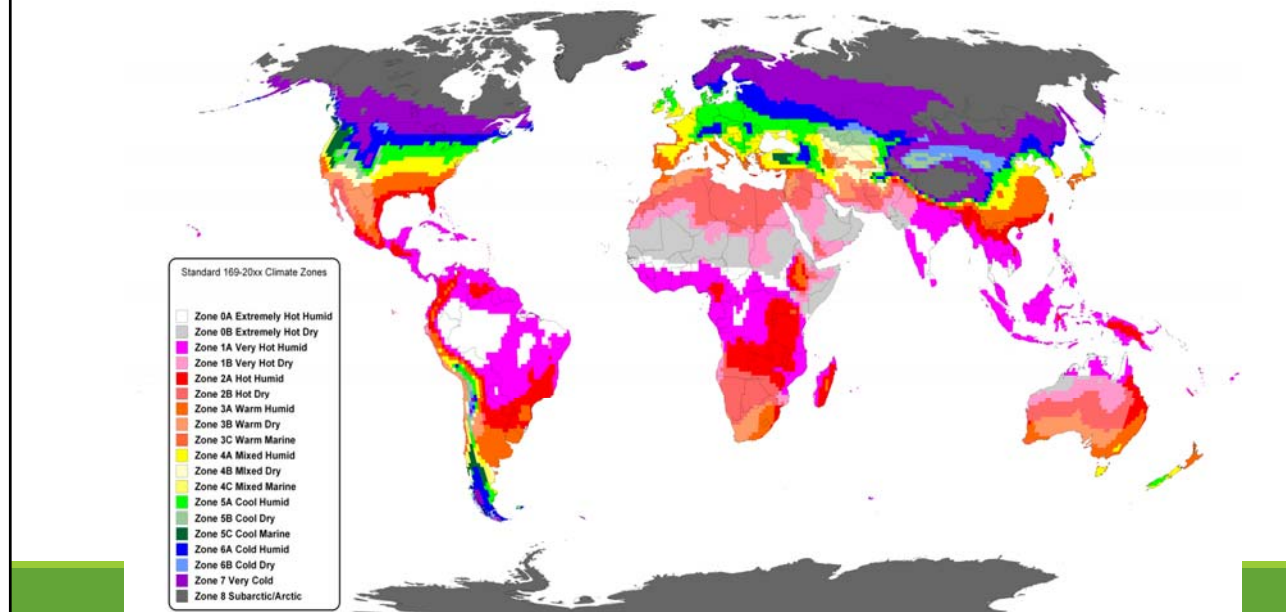
Standard 90.1-2013 Climate Zones



New Climate Zones – Standard 169-2013



World Climate Zones in Standard 169-2013



Energy Efficiency – Section 7

Prescriptive Option: Building Envelope

Vertical fenestration <40% gross wall area
(§7.4.2.4)



Energy Efficiency – Section 7

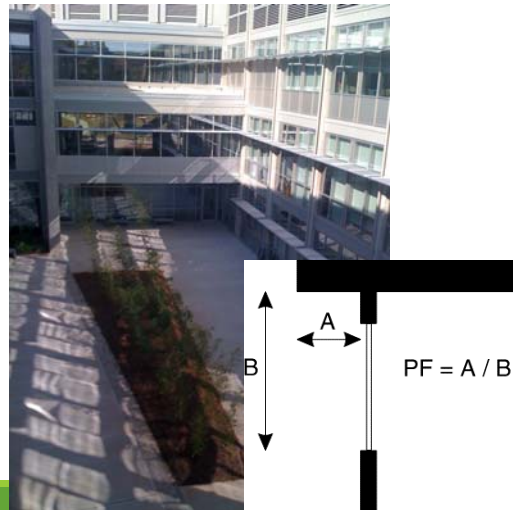
Prescriptive Option: Building Envelope

Permanent Projections

Overhang: PF > 0.5 (§7.4.2.5)

Exceptions for < 250 hours/yr direct sun, dynamic glazing, or automated controlled shading in response to daylight levels (with restrictions as listed)

- West, east & south orientations
- Climate zones 1-5



Energy Efficiency – Section 7

Prescriptive Option: Building Envelope

Building envelope trade-off option of Standard 90.1 does not apply unless this incorporates all modifications in Standard 189.1 section (§7.4.2)

Push toward “smarter” window placement and selection (§7.4.2.8)

Exceptions

Buildings adjacent to or shaded by other buildings, hills, etc.

7.4.2.8 Orientation. The vertical fenestration shall comply with either (a) or (b):

- a. $A_W \leq (A_N + A_S)/4$ and $A_E \leq (A_N + A_S)/4$
- b. $A_W \times SHGC_W \leq (A_N \times SHGC_C + A_S \times SHGC_C)/6$ and $A_E \times SHGC_E \leq (A_N \times SHGC_C + A_S \times SHGC_C)/6$

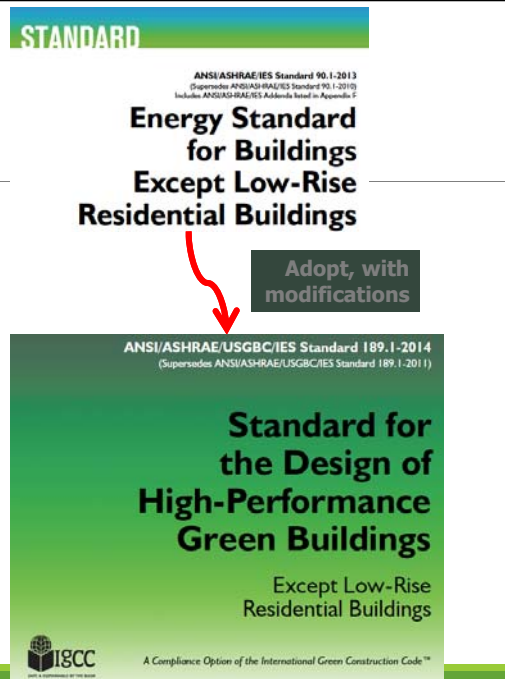
where

$SHGC_x$ = the SHGC for orientation x that complies with Section 7.4.2.6

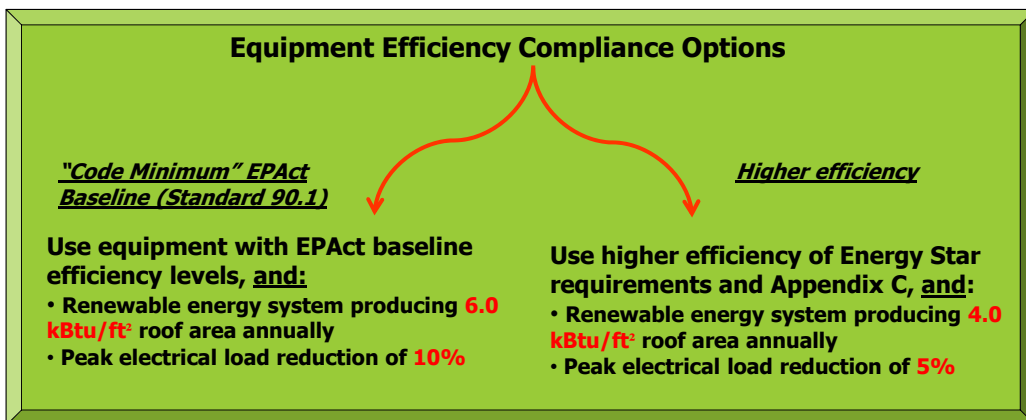
$SHGC_C$ = the SHGC criteria for each climate zone from Section 7.4.2.1

§7.4.3 HVAC

General Concept:
Based on Standard 90.1, but modify to gain improved energy performance over code minimum standards



§7.4.3 HVAC – Equipment Efficiency



§7.4.3.9 Hotel/Motel Guest Rooms

§7.4.3.9 Unoccupied hotel/motel (>50 guest rooms) occupancy control of HVAC (setback), ventilation and lighting, TV after 30-minute delay

Reset thermostat for unrented or unoccupied rooms

Captive keycard systems do not meet this requirement



§7.4.5 Power and Peak Load

§7.4.5 Power

- Peak load reduction:
- Reduce peak capacity of the building through demand-limiting or load shifting measures (10%)
- Standby generation does not count...

The "Alternate Renewables Approach" exception

Exception: *Building projects* complying with the Alternate Renewables Approach in Section 7.4.1.1.2 and containing *automatic* systems, such as demand limiting or load shifting, that are capable of reducing electric peak demand by not less than 5% of the projected peak demand.

§7.4.6 Lighting Power Allowance

Interior lighting power allowance reduced from Tables 9.5.1(Building Area) or 9.6.1(Space-by-Space) in Standard 90.1

TABLE 7.4.6.1A LPD Factors when Using the Building Area Method

Building Area Type	LPD Factor
Courthouse	0.95
Dining—Cafeteria/Fast Food	0.95
Dining—Family	0.95
Dormitory	0.95
Exercise Center	0.95
Healthcare Clinic	0.95
Hospital	0.95
Library	0.95
Multifamily	0.95
Office	0.95
Penitentiary	0.95
Police Station	0.95
Religious Building	0.95
School/University	0.90
Town Hall	0.95
Transportation	0.95
All Other Building Area Types	1.00

Exterior lighting allowance

TABLE 7.4.6.1C Lighting Power Allowance Factors

	Lighting Zone				
	LZ0	LZ1	LZ2	LZ3	LZ4
For tradable areas	1.00	0.90	0.90	0.95	0.95
For nontradable areas	1.00	0.95	0.95	0.95	0.95

LPD Factor multiplier for 90.1 values

§7.4.6 Lighting Power Allowance

For Table 9.6.1(Space-by-Space) in Standard 90.1 (partial example)

TABLE 7.4.6.1B Lighting Power Density (LPD) Factors When Using the Space-by-Space Method

Common Space Types		Common Space Types	
Space Type	LPD Factor	Space Type	LPD Factor
Audience seating area		Office	
... in an auditorium	1.00	... enclosed	0.95
... in a convention center	1.00	... open plan	0.85
... in a gymnasium	0.85	Sales area	0.95
... in a motion picture theater	1.00	All other common space types	1.00
... in a penitentiary	1.00	Building-Type Specific Space Types	
... in a performing arts theater	1.00	Space Type	LPD Factor
... in a religious building	1.00	Convention center—Exhibit space	0.85
... in a sports arena	1.00	Gymnasium/fitness center	
... in all other audience seating areas	1.00	... in an exercise area	0.85
Classroom/lecture hall/training room		... in a playing area	1.00
... in a penitentiary	1.00	Healthcare facility	
... in all other classrooms/lecture halls/training rooms	0.85	... in an exam/treatment room	0.85
Conference/meeting/multipurpose room	0.90	... in an imaging room	1.00

§7.4.6 Lighting Controls

(§7.4.6.2) Occupancy sensor control to reduce power to <50% for commercial, industrial storage stack aisles

- Exception: HID lit areas < 0.8 W/ft² or 8 W/m²

Egress lighting control (§7.4.6.3)

< 0.1 W/ft² (1 W/m²)

Additional allowed if w/ auto shut-off

Also mentions exterior and parking lighting

§7.5 Energy Performance Options

Performance option 'A' % energy, CO_{2e} savings

TABLE 7.5.2(a) Performance Option A: Energy Cost and CO_{2e} Reductions

Building Type	Percent Reduction
Apartments	10%
Restaurants	5%
Lodging	12%
Semi-heated Warehouses (Note 1)	45%
Other (Note 2)	24%

Note 1. Conditioned warehouses shall use the "Other" category.

Note 2. When the modeled energy use that is not *regulated energy use* exceeds 35% of the total *proposed building* energy use, the reduction shall be calculated using the following equation: Percent reduction = 0.55 – 0.99 x Percent Non-Regulated Energy. The reduction shall be no lower than 5%.

Section 8

Indoor Environmental Quality

Section 8

Indoor Environmental Quality

Key Items

- Outdoor airflow
- Tobacco smoke control
- Outdoor air monitoring
- Filtration and air cleaning
- Daylighting
- Thermal comfort
- Acoustics



IEQ – Mandatory Items

Indoor Air Quality Related

- Ventilation requirement
- Outdoor air monitoring
- Filtration
- Smoking
- Building entrances
- Guest Room Preoccupancy Purge
- Preoccupancy ventilation control

Thermal Comfort

Acoustics

Lighting Quality

Building Envelope

IEQ – Mandatory: Filtration and Air Cleaning

§8.3.1.3 Filtration, Air Cleaner

- (a) Particulates - Minimum MERV 8 upstream of cooling coils, MERV 13 when project located in “non-attainment” area for PM2.5 (modifies Healthcare Std. 170) Equivalent to recently modified Std 62.1 values now.
- (b) Ozone cleaners for outdoor air in building projects located in non-attainment areas for ozone. (Ozone removal efficiency = 40%, per Std. 62.1 §6.2.1.2)
- (c) Filter frames, air cleaner racks, access doors sealed to eliminate bypass pathways (modified)

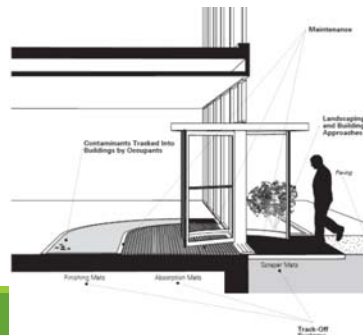
IEQ – Mandatory: Smoking and Building Entrances



§8.3.1.4

Environmental Tobacco Smoke Control

- No smoking inside, with signage
- No smoking within 25 feet (7.5 m) of entrance, outdoor air intakes or operable windows



§8.3.1.5

Mat systems at building entrances

IEQ – Mandatory: Acoustical Control

§8.3.3

Exterior: Envelope acoustical design for projects located near expressways, airports, or when yearly average sound levels at property >65 decibels (dB)

Interior: Wall and floor-ceiling assemblies with specified sound transmission class (STC) ratings in dwelling units, adjacent tenant or public spaces, classrooms and hotel or hospital/nursing home rooms

IEQ – Mandatory: Lighting Quality

§8.3.5

Enclosed Offices: Provide at least one of the following for 90% of offices < 250 ft²

- Multilevel lighting control
- Bi-level lighting control with separate task lighting.

Multi-occupant spaces

- Multilevel lighting control
- Gyms, auditoriums, ballrooms and cafeteria with at least two separate controlled groups of luminaires

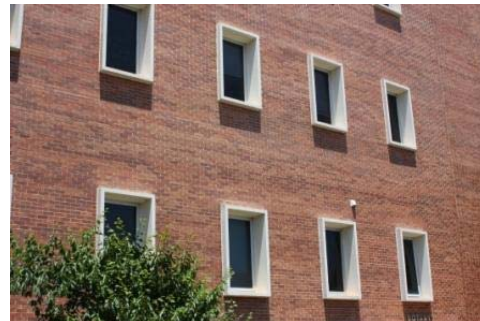
Indoor Environmental Quality

Prescriptive Option (§8.4)

Daylighting

Office space shading (glare)

Low-emitting materials



$$\text{Sidelighting Effective Aperture} = \frac{\sum \text{Window Area} \times \text{Window VLT}}{\text{Area of Primary Sidelighted Area}}$$

Indoor Environmental Quality

Prescriptive Option (§8.4):

Daylighting

Toplighting for spaces under 3 stories; larger open (>5,000 ft², 465 m²), ceilings > 15 ft [4 m] and lighting power >0.5 W/ft² [5.5 W/m²]

- Minimum daylight area 50%
- More flexibility recently added



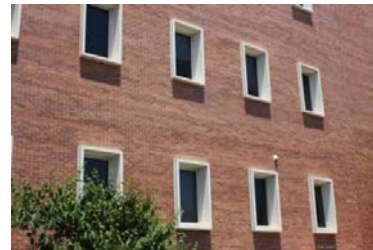
With exceptions for climate zones 7 and 8, and certain building types (auditorium, etc.)

Indoor Environmental Quality

Prescriptive Option (§8.4):

Side daylighting

- Offices and classrooms
- Min. window sidelighting effective aperture
- Minimum visible reflectance of interior surfaces
- Exceptions for 'dark rooms', facades closely adjacent to other buildings



$$\text{Sidelighting Effective Aperture} = \frac{\sum \text{Window Area} \times \text{Window VLT}}{\text{Area of Primary Sidelighted Area}}$$

Indoor Environmental Quality

Prescriptive Option (cont.) :

Office space shading, with projections or other techniques (E,W,S)
projection factor ≥ 0.5

- Louvers, light shelves, etc.
- Self-shading

Exceptions:

- Translucent panels
- Direct solar <250 hrs/yr
- Automatically controlled shading devices
- Windows with dynamic glazing



IEQ – Materials (for IAQ)

§8.4.2

Sets requirements for materials that may emit volatile organic compounds (VOCs) as a total VOCs or individual compounds such as formaldehyde

- Adhesives and sealants
- Paints and coatings
- Floor coverings
- Composite wood, wood structural and agrifibers

IEQ – Performance Option

Daylighting simulation

Materials emissions

Lighting for presentations



Section 9 Building's Impact on the Atmosphere, Materials and Resources

Section 9 Building's Impact on the Atmosphere, Materials and Resources

Mandatory:

Construction waste management, materials extraction and harvesting, no CFC-based refrigerants, low mercury lamps, storage for recyclable and discarded goods

Prescriptive Option:

Reduced impact materials (recycled or salvaged, regional, bio-based)

Performance Option:

Life Cycle Assessment



Section 10 Construction and Plans for Operation

Construction and Operation Plans OVERVIEW

§10.3.1 Construction

Building acceptance testing

Commissioning

Erosion and sediment control

Indoor air quality

Moisture control

Construction vehicles



Construction Requirements (cont.)

§10.3.1.2 Building Project Commissioning

Full commissioning for
>500 m² (5,000 ft²)

- HVAC, building envelope, lighting, irrigation, plumbing, domestic water, renewable energy

Designate CxA

Develop OPR and Basis of Design

Design reviews at 50% and 'final' construction documents



**Doing full Cx
process also
satisfies the
Building
Acceptance
Test
requirements**

Addendum in process

Construction Requirements (cont.)

§10.3.1.4 IAQ Construction Management

Develop and implement an IAQ Construction Management Plan, to include:

- Air conveyance materials
- Permanent HVAC not used during construction, except for startup, balancing, commissioning
- Flush-out or baseline IAQ monitoring



Construction Requirements (cont.)

IAQ Construction Management

Post-construction, pre-occupancy

- Flush-out: Temp >60° F (15 C), RH ≤60%

Equation 10.3.1.4:

$$TAC = V_{or} \times 1/A \times 1/H \times 60 \text{ min/h} \times 24 \text{ h/day} \times 14 \text{ days (I-P)}$$

$$TAC = V_{or} \times 1 \text{ m}^3/1000 \text{ L} \times 1/A \times 1/H \times 3600 \text{ s/h} \times 24 \text{ h/day} \times 14 \text{ days (SI)}$$

where

TAC = total air changes

V_{or} = system design *outdoor air* intake flow cfm (L/s) (according to Equation 6-8 of ANSI/ASHRAE Standard 62.1)

A = floor area ft² (m²)

H = ceiling height, ft (m)

- Baseline IAQ Testing for 34 contaminants

§10.3.2 Plans for Operation

High-Performance Building Operation

- Site Sustainability
- Water Use Efficiency
- Energy Efficiency
- Indoor Environmental Quality

Maintenance

Service Life

Transportation Management

Summary

- Aggressive New Standard from ASHRAE, USGBC, and IES
- Baseline for green buildings in US
- Covers water, site, energy, IEQ, building startup and operation plans
- Target – get to Net-Zero Energy Ready buildings

More Information

Information on ASHRAE standards:
then follow “Standards”,
includes listserv for Standard 189.1

www.ashrae.org

Information on USGBC programs:

www.usgbc.org

Information on IES programs:

www.iesna.org

Thank you!

Comments, questions?

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