

Green Building Overview: LEED 2009 Update and ASHRAE Standard 189.1-2011

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Faculty of Engineering

An interdisciplinary approach to engineering at the University of Georgia



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Introduction and greetings from the University of Georgia

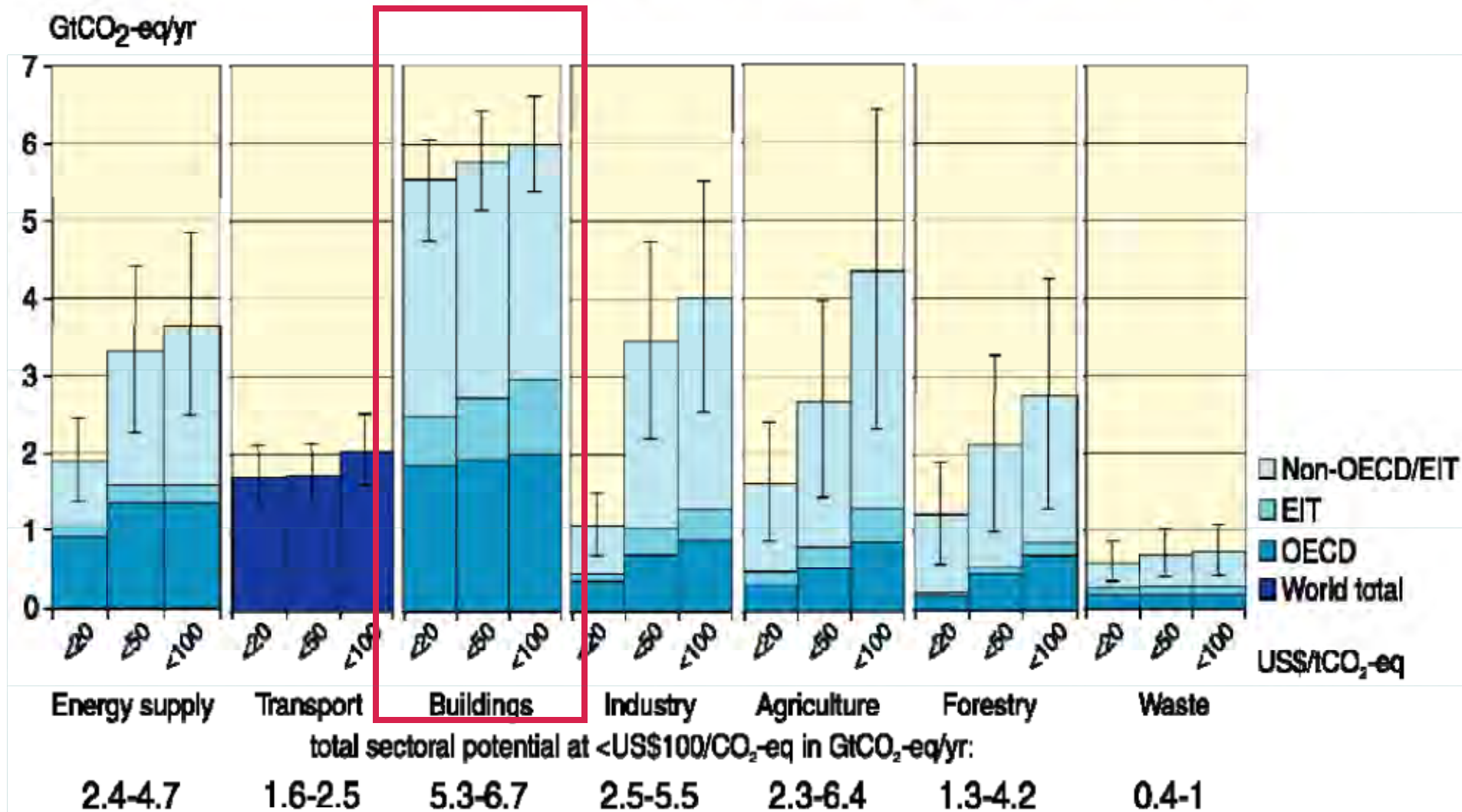


Environmental Impact of Buildings in U.S.*

- 65.2% of total U.S. electricity consumption
- > 36% of total U.S. primary energy use
- 30% of total U.S. greenhouse gas emissions
- 136 million tons of construction and demolition waste in the U.S. (approx. 2.8 lbs/person/day)
- 12% of potable water in the U.S.
- 40% (3 billion tons annually) of raw materials use globally

* Commercial and residential

Economic mitigation potential by sector in 2030



WMO

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC)



UNEP

Green Building Rating Systems (LEED and Other Programs)

Green Buildings Overview,
Standard 189 - 8

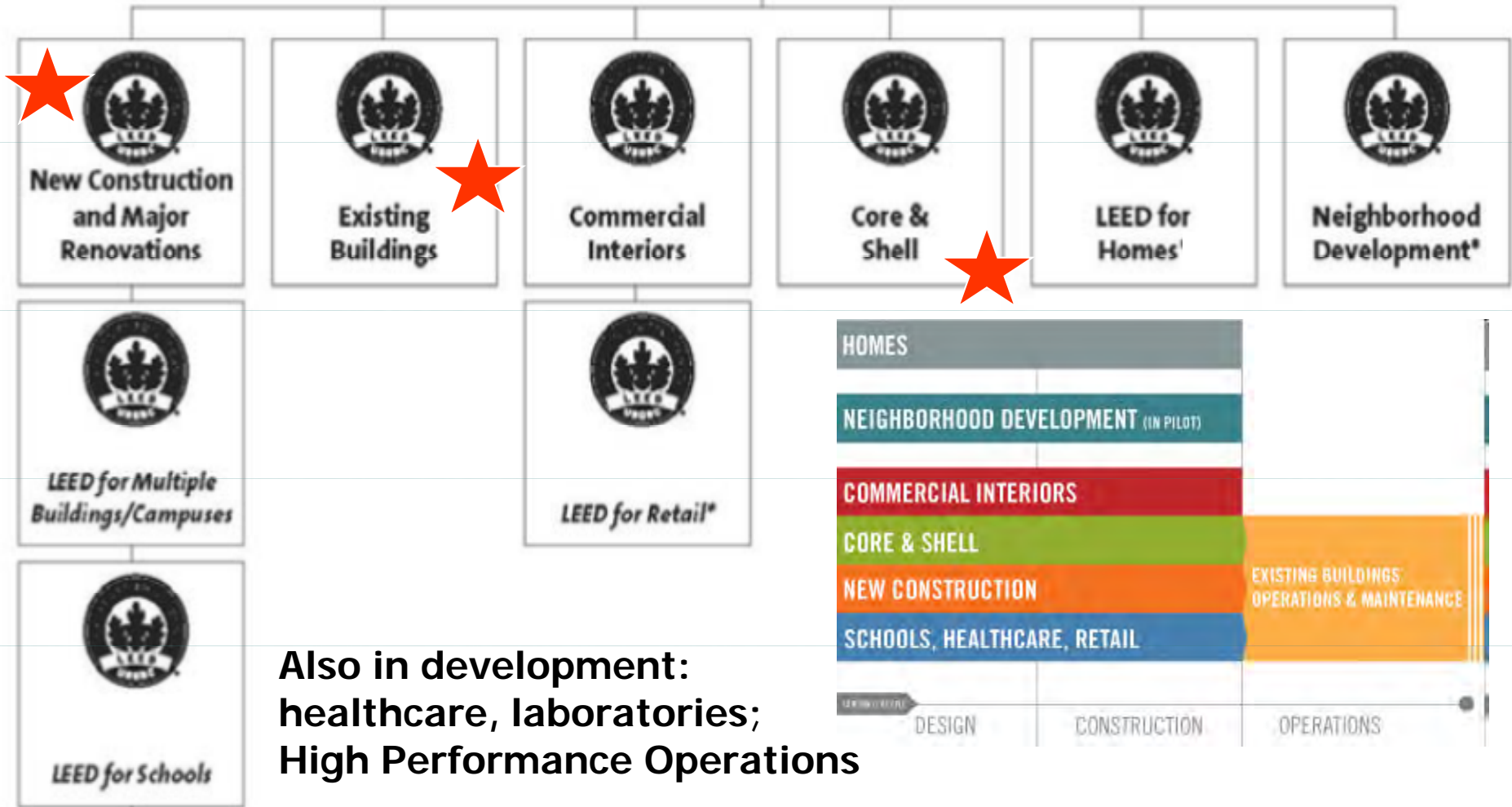
USGBC and LEED

- Leadership in Energy and Environmental Design
- Overview of LEED programs mostly relevant to ASHRAE and its members



Green Buildings Overview,
Standard 189 - 9

LEED Programs



Also in development:
healthcare, laboratories;
High Performance Operations

Five Categories - WISER

- Water Efficiency
- Indoor Environmental Quality
- Sustainable Sites
- Energy & Atmosphere
- Resources & Materials



Summary of LEED-NC 2009 Points

•Sustainable Site	8 credits / 26 points
•Water Conservation and Efficiency	3 credits / 10 points
•Energy and Atmosphere	6 credits / 35 points
•Materials and Resources	7 credits / 14 points
•Indoor Environmental Quality	8 credits / 15 points

LEED™ Rating System (2009 Update)

- **Certified Level** 40-49 points
- **Silver Level** 50-59 points
- **Gold Level** 60-79 points
- **Platinum Level** 80+ points

<i>total core points</i>	100
<i>innovation & design</i>	6
<i><u>regional priority</u></i>	4
<i>TOTAL POSSIBLE</i>	110
<i>prerequisites required</i>	8

Water Efficiency

Water Efficiency

10 Possible Points

<input checked="" type="checkbox"/>	Prerequisite 1	Water Use Reduction	Required
<input type="checkbox"/>	Credit 1	Water Efficient Landscaping	2-4
<input type="checkbox"/>	Credit 2	Innovative Wastewater Technologies	2
<input type="checkbox"/>	Credit 3	Water Use Reduction	2-4

Energy and Atmosphere

Prerequisites

- **Functional Commissioning**
- **Minimum Energy Performance**
- **Refrigerant Management**

Credits

1. **Optimize Energy Performance**
2. **Renewable Energy**
3. **Additional Commissioning**
4. **Elimination of HCFC's & Halons**
5. **Measurement and Verification**
6. **Green Power**



Energy Performance Determination

- Minimum level (prerequisite)
 - 10% better than ASHRAE Standard 90.1-2007
 - Applicable ASHRAE Adv. Energy Design Guide (Small office, retail or warehouse)
 - Adv. Buildings Core Performance Guide (from New Buildings Institute)

Energy Performance Determination

- For credits: Three options

I) Whole building simulation (90.1-2007 App. G)

New Buildings	Existing Building Renovations	Points
12%	8%	1
14%	10%	2

44%	40%	17
46%	42%	18
48%	44%	19

Energy Performance (Cont'd)

- Three options (cont'd)

(II) Prescriptive measures in applicable ASHRAE's *Adv. Energy Design Guide* (1 pt)

(III) *Advanced Buildings Benchmark, Core Performance Guide*

Points achieved under Option 3 (1 point):

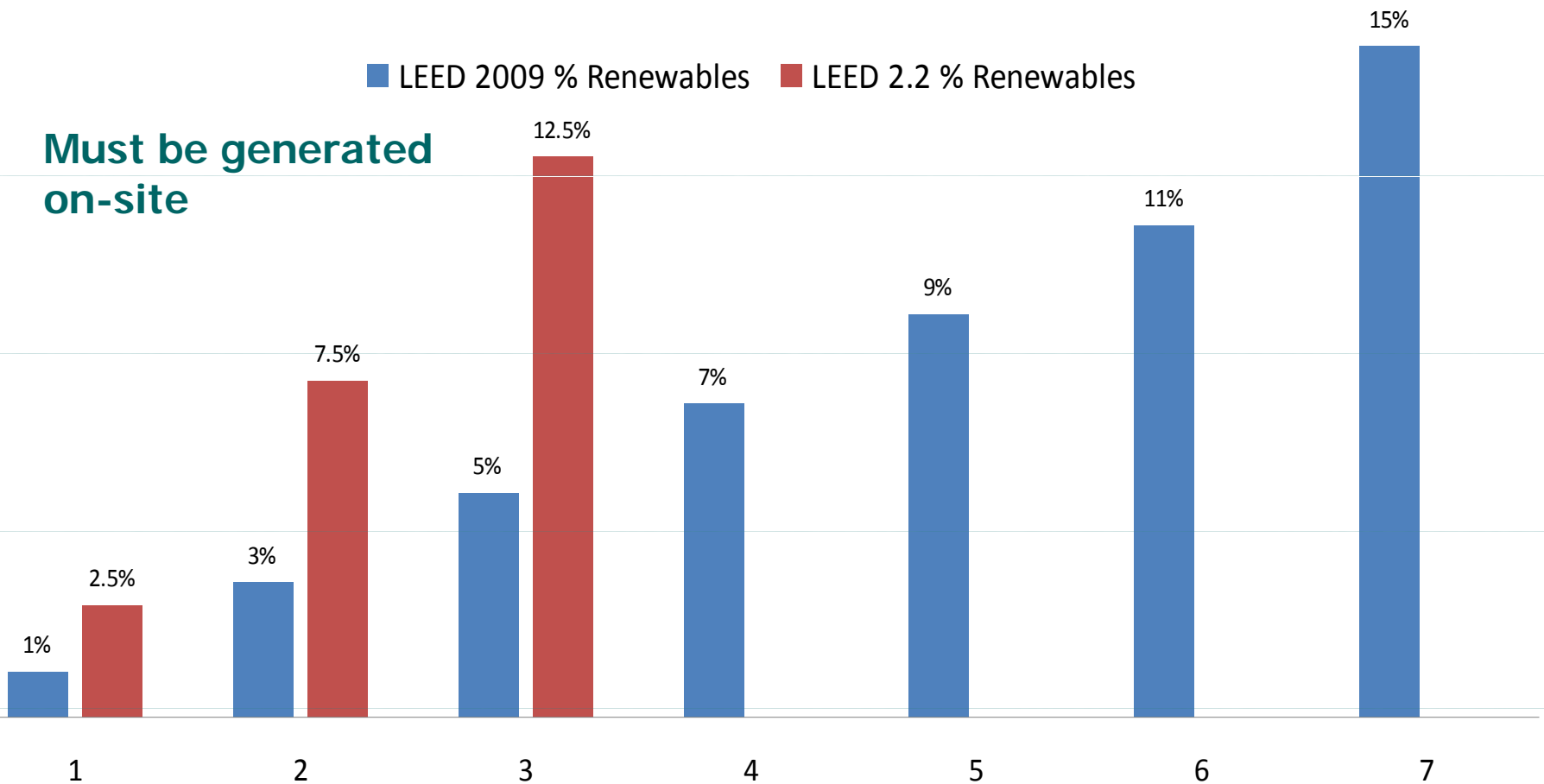
- 1 point is available for all projects (office, school, public assembly, and retail projects) less than 100,000 square feet that comply with Sections 1 and 2 of the Core Performance Guide.
- Up to 2 additional points are available to projects that implement performance strategies listed in Section 3, Enhanced Performance. For every 3 strategies implemented from this section, 1 point is available.
- The following strategies are addressed by other aspects of LEED and are not eligible for additional points under EA Credit 1:
 - 3.1 — Cool Roofs
 - 3.8 — Night Venting
 - 3.13 — Additional Commissioning

EA Credit 2: Renewable Energy

Comparison of Renewable Energy Credit Points (EA Credit 2)

Must be generated on-site

■ LEED 2009 % Renewables ■ LEED 2.2 % Renewables



Credit Points

EA Cr 3: Additional Commissioning

- Contract for enhanced Cx (as described in the *Reference Guide*). To include:
 - Review of Owner's Project Req'ts, Basis of Design, submittals
 - Develop systems (operations) manual
 - Verify training completion
 - Review building operation within 10 months of 'substantial completion'

EA Cr 4: Refrigerants

- Option 1: Don't use refrigerants
- Option 2: Comply with formula that gives a weighted average of building equipment based on both lifetime ozone depletion and global warming potentials
 - Excludes small charge devices

EA Cr 5: Measurement & Verification

- Develop and implement (for minimum of 1 year post-construction) a plan that complies with IPMVP
 - Option D (Whole Building Calibrated Simulation)
 - Option B (ECM isolation), as applied to monitoring and accountability of significant energy using systems, easily isolated

Indoor Environmental Quality

Prereq 1	Minimum IAQ Performance	Required
Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required
★	Credit 1 Outdoor Air Delivery Monitoring	1
★	Credit 2 Increased Ventilation	1
	Credit 3.1 Construction IAQ Management Plan, During Construction	1
★	Credit 3.2 Construction IAQ Management Plan, Before Occupancy	1
	Credit 4.1 Low-Emitting Materials, Adhesives & Sealants	1
	Credit 4.2 Low-Emitting Materials, Paints & Coatings	1
	Credit 4.3 Low-Emitting Materials, Flooring Systems	1
	Credit 4.4 Low-Emitting Materials, Composite Wood & Agrifiber Products	1
	Credit 5 Indoor Chemical & Pollutant Source Control	1
	Credit 6.1 Controllability of Systems, Lighting	1
★	Credit 6.2 Controllability of Systems, Thermal Comfort	1
★	Credit 7.1 Thermal Comfort, Design	1
★	Credit 7.2 Thermal Comfort, Verification	1
	Credit 8.1 Daylight & Views, Daylight 75% of Spaces	1
	Credit 8.2 Daylight & Views, Views for 90% of Spaces	1

Questions?

Green Buildings Overview,
Standard 189 - 23

ASHRAE Standard 189.1

- Overview of ASHRAE Standard 189.1 for “High-Performance, Green Buildings”
 - What is it?
 - Why have it?
 - Highlights



ANSI/ASHRAE/USGBC/IES
Standard 189.1-2011

Standard for the Design of High-Performance Green Buildings

Except Low-Rise
Residential Buildings

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



24

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A Jurisdictional Compliance Option of the International Green Construction Code™

Compare Standard 189.1 to LEED

LEED 2009 FOR
NEW
CONSTRUCTION
AND MAJOR RENOVATIONS

For Public Use and Display
LEED 2009 for New Construction and
Major Renovations Rating System
USGBC Member Approved November 2008



- Voluntary vs. mandatory



ANSI/ASHRAE/USGBC/IES
Standard 189.1-2011

**Standard for
the Design of
High-Performance
Green Buildings**

Except Low-Rise
Residential Buildings



A Jurisdictional Compliance Option of the International Green Construction Code™

- Std. 189.1:
 - Improvement in all topical areas
 - Pushes the envelope

ASHRAE Standard 189.1-2011

- 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

The image shows the front cover of the 2012 International Green Construction Code (IGCC) and ASHRAE Standard 189.1-2011. The cover is divided into two main sections. The left section is green and features the ICC International Code Council logo at the top, followed by the text 'INTERNATIONAL GREEN CONSTRUCTION CODE' and 'A Member of the International Code Family'. Below this is the large '2012 igCC' logo. The right section is white and features the ANSI/ASHRAE/USGBC/IES Standard 189.1-2011 logo at the top, followed by the title 'Standard for the Design of High-Performance Green Buildings' and the subtitle 'Except Low-Rise Residential Buildings'. At the bottom of the white section is the IGCC logo and the text 'A Jurisdictional Compliance Option of the International Green Construction Code™'. Below the IGCC logo is a paragraph of text explaining the standard's maintenance and availability. At the very bottom of the cover are logos for the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE), the U.S. Green Building Council (USGBC), and the International Code Council (ICC).

ICC
INTERNATIONAL
CODE COUNCIL

2012
INTERNATIONAL
GREEN
CONSTRUCTION
CODE
A Member of the International Code Family
igCC

ANSI/ASHRAE/USGBC/IES
Standard 189.1-2011

Standard for
the Design of
High-Performance
Green Buildings
Except Low-Rise
Residential Buildings

IGCC
A Jurisdictional Compliance Option of the International Green Construction Code™

See Appendix I for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the U.S. Green Building Council, the Illuminating Engineering Society of North America, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site (www.ashrae.org), or in paper form from the ASHRAE Manager of Standards.

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ASHRAE USGBC IES ICC

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**NEW
SLIDE**

Standard 189.1: Intent

- What 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
- What Standard 189.1 is not:
 - not a design guide
 - not a rating system

This Standard is an indication of future industry trends

Standard 189.1: Relation to Other ASHRAE Standards

ASHRAE STANDARD

90.1 (current version)

Energy Standard for Buildings Except Low-Rise Residential Buildings



ASHRAE STANDARD

Standard 62.1

Ventilation for Acceptable Indoor Air Quality

Adopt, with modifications



ANSI/ASHRAE/USGBC/IES
Standard 189.1-2011

Standard for the Design of High-Performance Green Buildings

Adopt, with minor modifications

Except Low-Rise Residential Buildings

Adopt



Standard 55

ASHRAE STANDARD

Thermal Environmental Conditions for Human Occupancy

Jurisdictional Compliance Option of the International Green Construction Code™
Standard 109 - 20

Organization and What it Covers

- Similar to other ASHRAE standards and LEED

ANSI/ASHRAE/USGBC/IES Standard 189.1-2011 Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

SECTION	PAGE
Foreword	2
1 Purpose	4
2 Scope	5
3 Definitions, Abbreviations, and Acronyms	6
4 Administration and Enforcement	14
5 Site Sustainability	15
6 Water Use Efficiency	19
7 Energy Efficiency	23
8 Indoor Environmental Quality (IEQ)	31
9 The Building's Impact on the Atmosphere, Materials, and Resources	36
10 Construction and Plans for Operation	38
11 Normative References	44
Normative Appendix A: Prescriptive Building Envelope Tables	51
Normative Appendix B: Prescriptive Continuous Air Barrier	70
Normative Appendix C: Prescriptive Equipment Efficiency Tables	71
Normative Appendix D: Performance Option for Energy Efficiency	97
Normative Appendix E: IAQ Limit Requirements for Office Furniture Systems and Seating	100
Normative Appendix F: Building Concentrations	102

Standard 189.1 Basic Structure

For Each Section

- x.1: Scope
- 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)

**NEW
SLIDE**

Important Note

- *Standard 189.1 mostly sets standards for performance or lists specific equipment requirements ...*

But does not specify exact design and implementation methods

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SLIDE**

Highlights of Standard 189.1

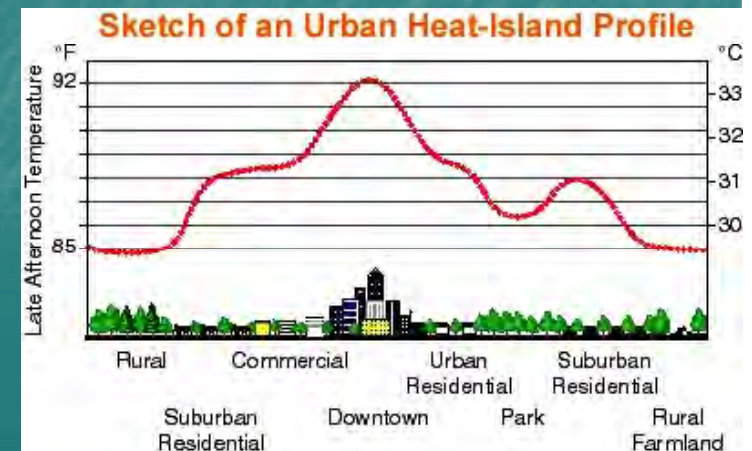
Section 5 – Sites:

Mandatory provisions

- Allowable sites, where to build; or where not to allow a building
- Other areas that are addressed:
 - Urban heat island
 - Light “pollution” limitations

Prescriptive option

- Pervious surface area
- Greenfield site, maintaining or restoring existing native plants (20% of site)



**NEW
SLIDE**

Sustainable Sites



Mandatory Provisions

■ Reduction of light pollution

- Modification of Standard 90.1 exterior lighting power allowances
- Maximum BUG limit (Backlight, Uplight, Glare) ratings Tables

TABLE 5.3.3.2A Maximum Allowable Backlight, Uplight, and Glare (BUG) Ratings^{1,2,3,4}

	LZ0	LZ1	LZ2	LZ3	LZ4
Allowed Backlight Rating					
>2 mounting heights from property line	B0	B1	B2	B3	B4
1 to 2 mounting heights from property line	B0	B1	B2	B3	B3
0.5 to 1 mounting height to property line	B0	B0	B1	B2	B2
<0.5 mounting height to property line	B0	B0	B0	B1	B2
Allowed Uplight Rating	U0	U1	U2	U3	U4
Allowed Glare Rating	G0	G1	G2	G3	G4

BUG ratings defined per lumen limits in IESNA TM-15 Addendum A

**NEW
SLIDE**

Light 'Leakage'

TABLE 5.3.3.2B Maximum Allowable Glare Ratings for Building Mounted Luminaires Within Two Mounting Heights of Any Property Line

	LZ0	LZ1	LZ2	LZ3	LZ4
Glare	G0	G0	G1	G1	G2

Notes to Table 5.3.3.2B:

1. For property lines that abut public walkways, bikeways, plazas, and parking lots, the property line may be considered to be 5 feet (1.5 m) beyond the actual property line for purpose of determining compliance with this section. For property lines that abut public roadways and public transit corridors, the property line may be considered to be the centerline of the public roadway or public transit corridor for the purpose of determining compliance with this section
2. Backlight, Uplight, and Glare ratings are defined based on specific lumen limits per IESNA TM-15 Addendum A.

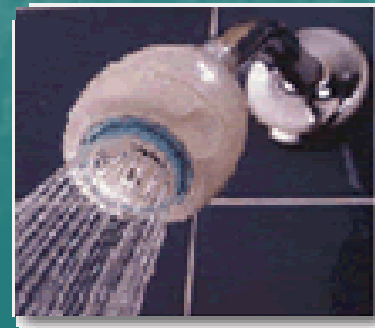
TABLE 5.3.3.3 Maximum Allowable Percentage of Uplight

	LZ0	LZ1	LZ2	LZ3	LZ4
Percentage of total exterior fixture lumens allowed to be emitted above 90 degrees or higher from nadir (straight down)	0%	0%	1%	2%	5%

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):**

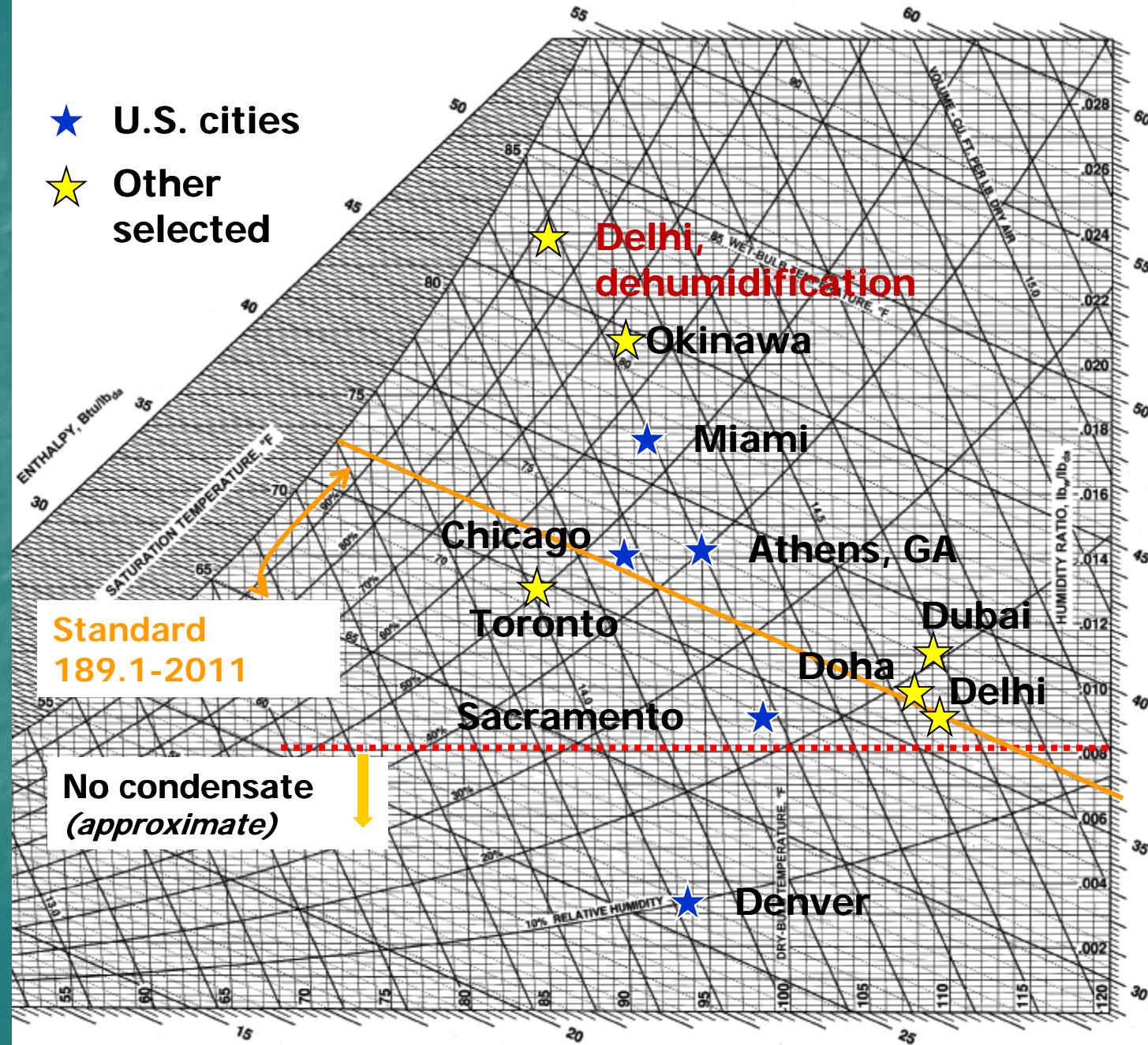
- Subsystem metering above thresholds
- Cooling tower cycles of concentration limit, efficient drift eliminators
- Condensate collection from units >19 kW (65,000 Btu/h) in areas with mean coincident wet bulb $>72^{\circ}\text{F}$ (22°C)

Annual condensate collection

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



Selected Cooling Design Conditions



Values are cooling load design conditions, ASHRAE Fundamentals 2009

NEW SLIDE

Condensate Collection

- *How Would You Comply with This?*

How Would You Use the Water?

How to Calculate Estimated Water Collected?

**NEW
SLIDE**

Energy – Section 7

Green Buildings Overview,
Standard 189 - 40

ASHRAE Energy Goals

- ASHRAE goal to have net-zero energy and carbon by 2030
- ASHRAE's Tech Council will suggest EUI targets for Standards 189.1 and 90.1
- Monitoring of progress based on standardized computer modeling
- Goal is to have 189.1 reach Net Energy Use Intensity targets (but not net zero) by 2020

What is EUI, NEUI?

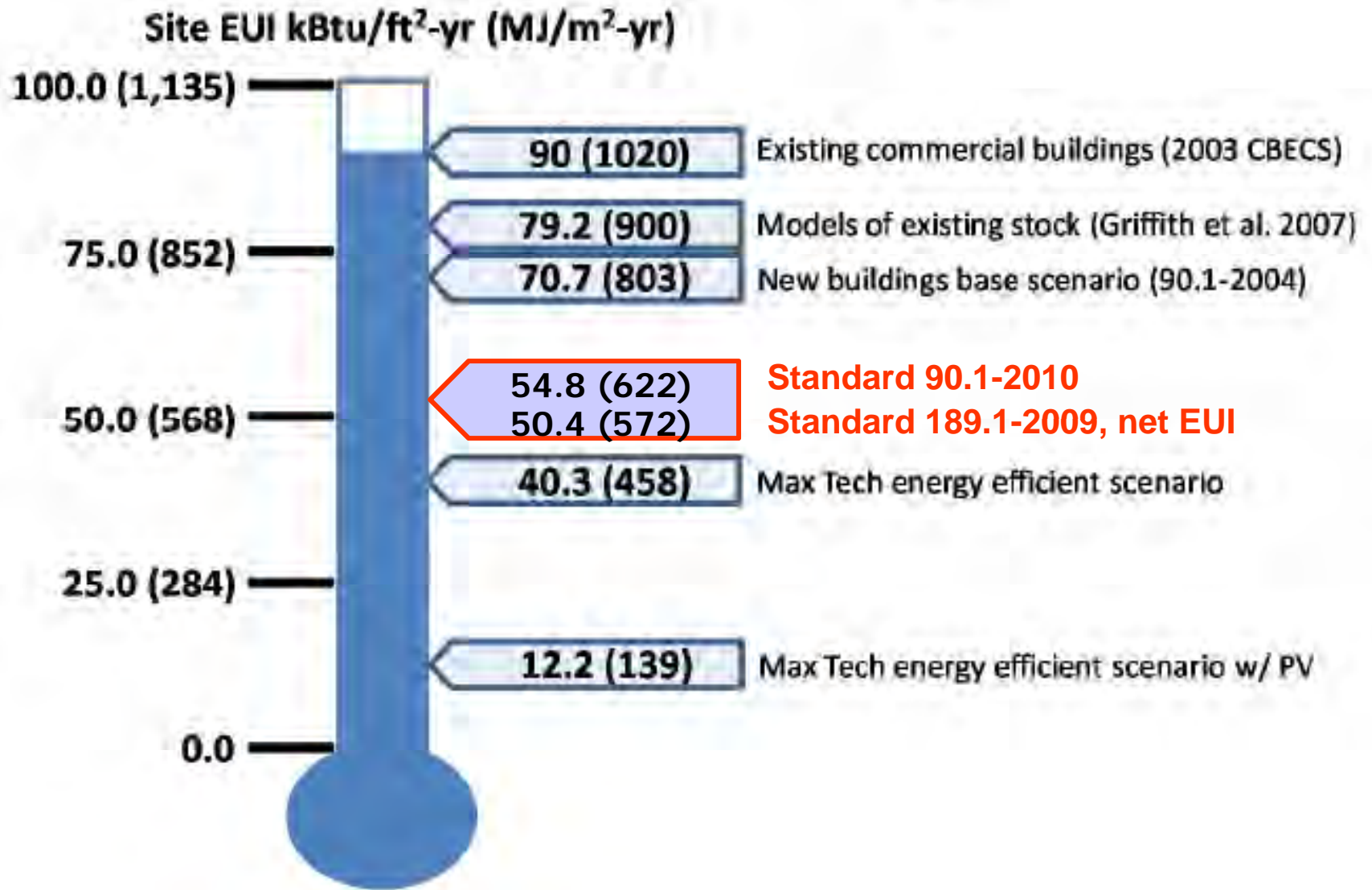
$$\text{Total Energy Use Intensity (EUI)} = \frac{\text{TotalAnnualEnergyUse}}{\text{GrossFloorArea}} \text{ kBtu/ft}^2 \text{ yr (kWh/m}^2 \text{ yr)}$$

$$\text{Net Energy Use Intensity (NEUI)} = \frac{\text{NetAnnualEnergyUse}}{\text{GrossFloorArea}} \text{ kBtu/ft}^2 \text{ yr (kWh/m}^2 \text{ yr)}$$

$$\text{Energy Cost Intensity (ECI)} = \frac{\text{NetAnnualCost}}{\text{GrossFloorArea}} \text{ \$US/ft}^2 \text{ yr (\$US/m}^2 \text{ yr)}$$

Source (June 2010):

**REPORT OF THE TECHNOLOGY COUNCIL AD HOC COMMITTEE ON
ENERGY TARGETS**



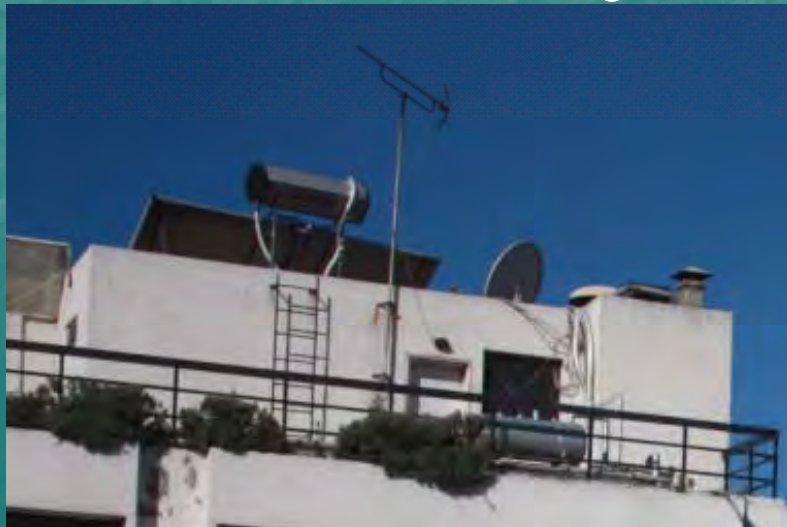
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SLIDE**

Highlights for Energy (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
Exception for areas with low incident solar (4.0 kWh/m²/day), *account for local shading*



Highlights for Energy (Section 7)

Energy – Mandatory (*cont.*):

- **Remote or automatic reading meters (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 7.3.3.1-1 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)
<i>Geothermal energy</i>	> 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)

Highlights for Energy (Section 7)

Prescriptive Option



- Prescriptive Option: Renewable Energy
 - On-site renewable energy system with ≥ 6 kBtu/ft²-yr [20 kWh/m²-yr] single story or 10.0 kBtu/ft²-yr [32 kWh/m²-yr] multiple story, *based on roof area*

Highlights for Energy (Section 7)

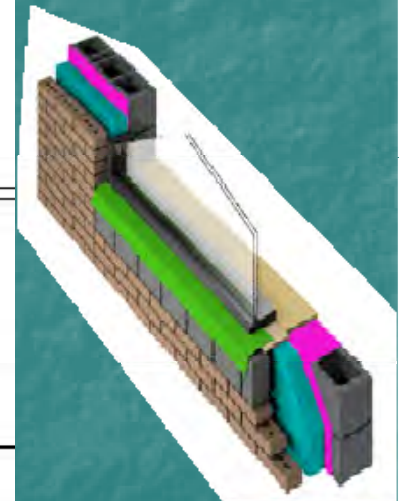
Prescriptive Option (Building Envelope)

- Replaces Table 5.5-1 thru 8 on building envelope in 90.1, for example:

**TABLE A-1 (Supersedes Table 5.5-1 in ANSI/ASHRAE/IES Standard 90.1)
Building Envelope Requirements for Climate Zone 1 (A, B) (SI)**

(§7.4.2)

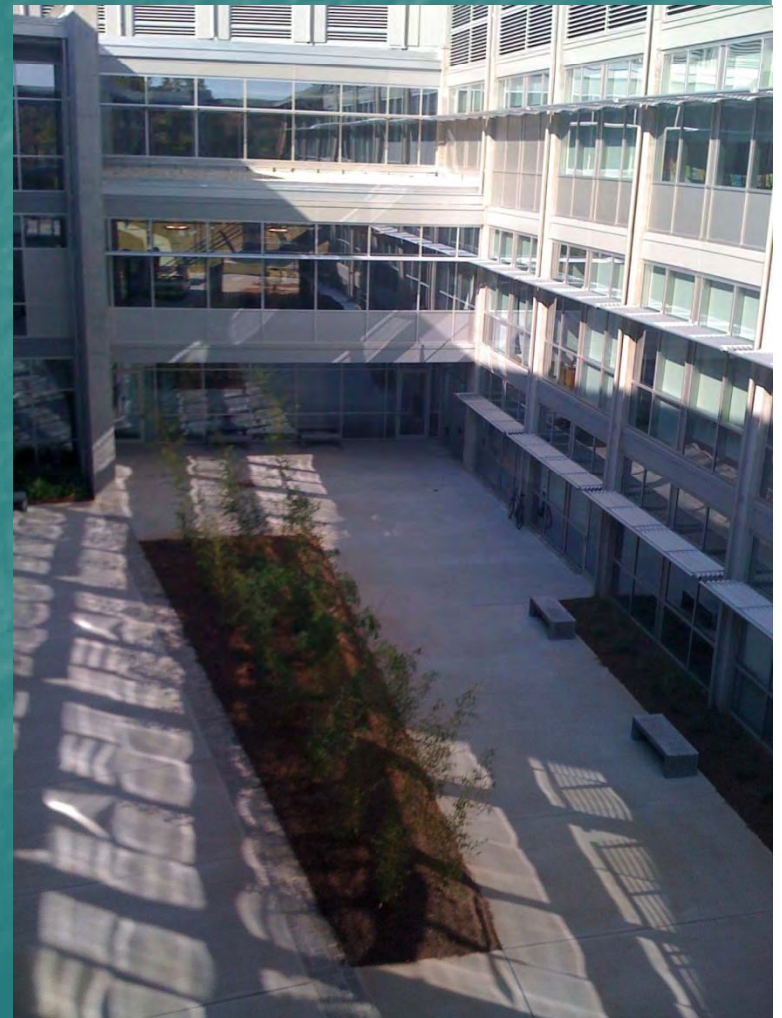
Opaque Elements	Nonresidential		Residential	
	Assembly	Insulation	Assembly	Insulation
	Max.	Min. R-Value	Max.	Min. R-Value
<i>Roofs</i>				
Insulation Entirely above Deck	U-0.27	R-3.5 ci	U-0.22	R-4.4 ci
Metal Building	U-0.25	R-3.3 + R-1.9 Ls ^d	U-0.20	R-3.3 + R-1.9 Ls
Attic and Other	U-0.15	R-6.7	U-0.12	R-8.6
<i>Walls, Above Grade</i>				
Mass	U-0.86 ^a	R-1.0 ci ^a	U-0.70	R-1.3 ci
Metal Building	U-0.45	R-2.3 + R-1.1 ci	U-0.45	R-2.3 + R-1.1 ci
Steel Framed	U-0.43	R-2.3 + R-0.9 ci	U-0.43	R-2.3 + R-0.9 ci
Wood Framed and Other	U-0.36	R-2.3 + R-0.7 ci	U-0.36	R-2.3 + R-0.7 ci



Highlights for Energy (Section 7)

Prescriptive Option (Building Envelope)

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



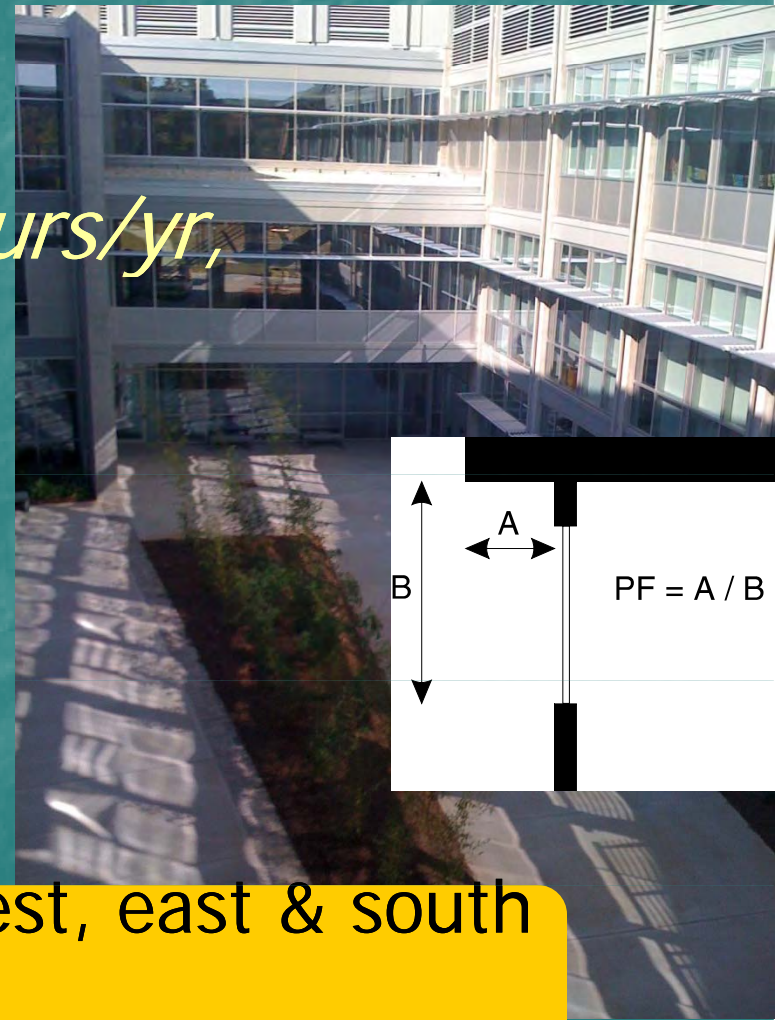
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SLIDE**

Highlights for Energy (Section 7)

Prescriptive Option (Building Envelope)

- Overhang: $PF > 0.5$
(§7.4.2.5)

*Exceptions for < 250 hours/yr,
dynamic glazing,
or automated shading*



- Permanent projections: west, east & south
- Climate zones 1-5

**NEW
SLIDE**

Highlights for Energy (Section 7)

Prescriptive Option (Building Envelope)

- SHGC Multipliers
(different than Std 90.1)
(§7.4.2.6)

**Table 7.4.2.6 SHGC Multipliers
for Permanent Projections**

Projection Factor	SHGC Multiplier (All Other Orientations)	SHGC Multiplier (North- Oriented)
0-0.60	1.00	1.00
>0.60-0.70	0.92	0.96
>0.70-0.80	0.84	0.94
>0.80-0.90	0.77	0.93
>0.90-1.00	0.72	0.90



**NEW
SLIDE**

Highlights for Energy (Section 7)

Prescriptive Option (Building Envelope)

- Fenestration area and SHGC complies with **(§7.4.2.8) Total window area greater on north + south sides of building than east + west**

Exception

Buildings
adjacent to
or shaded by
other
buildings

- a. For *climate zones 1, 2, 3, and 4:*

$$\frac{(A_N \times SHGC_N + A_S \times SHGC_S)}{(A_E \times SHGC_E + A_W \times SHGC_W)} \geq 1.1 \times$$

- b. For *climate zones 5 and 6:*

$$\frac{1}{3} \times (A_N \times SHGC_N + A_S \times SHGC_S + A_E \times SHGC_E) \geq 1.1 \times (A_W \times SHGC_W)$$

**NEW
SLIDE**

Highlights for Energy (Section 7)

Prescriptive Option (Building Envelope)

- Continuous air barrier requirement
(§7.4.2 10)
- Complies with Normative Appendix B to control air leakage in and out
- Detailed on construction documents

§7.4.3 HVAC

ASHRAE STANDARD

90.1 (current version)

Energy Standard for
Buildings Except Low-Rise
Residential Buildings

General Concept:

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

Adapt, with
modifications



ANSI/ASHRAE/USGBC/IES
Standard 189.1-2011

**Standard for
the Design of
High-Performance
Green Buildings**

Except Low-Rise
Residential Buildings

Green
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A Jurisdictional Compliance Option of the International Green Construction Code™

§7.4.3 HVAC

- §7.4.3.2 Lowers occupancy threshold for demand-controlled ventilation (DCV)

ASHRAE STANDARD 90.1 (current version)

Energy Standard for
Buildings Except Low-Rise
Residential Buildings

Standard 90.1-2010: 40 people/1000 ft² (100 m²) and area >500 ft² (50 m²)



ANSI/ASHRAE/USGBC/IES
Standard 189.1-2011

Standard for the Design of High-Performance Green Buildings

Except Low-Rise
Residential Buildings

25 people/1000 ft²

If with CO₂ sensors,
install per §7.4.3.2

Note: Type of DCV used
is not specified in
Standard 189.1

§7.4.3 HVAC

■ §7.4.3.4 Zone controls

- Have adapted Standard 90.1-2010 approach, but more restrictive
- Exceptions allowed:

b. *Zones* that comply with all of the following:

1. The air flow rate in *dead band* between heating and cooling does not exceed the larger of the following:
 - i. 20% of the *zone* design peak supply rate;
 - ii. The *outdoor air* flow rate required to meet the ventilation requirements of Section 6.2 of ASHRAE Standard 62.1 for the *zone*;
 - iii. Any higher rate that can be demonstrated, to the satisfaction of the *authority having jurisdiction*, to reduce overall system annual energy usage by offsetting reheat/recool energy losses through a reduction in *outdoor air* intake.
2. The air flow rate that is reheated, recooled, or mixed in peak heating demand shall be less than 50% of the *zone* design peak supply rate.

6.5.2 Simultaneous Heating and Cooling Limitation

6.5.2.1 *Zone Controls.* *Zone* thermostatic controls shall prevent

- a. *reheating*,
- b. *recooling*,
- c. mixing or simultaneously supplying air that has been previously mechanically heated and air that has been previously cooled, either by mechanical cooling or by economizer systems, and
- d. other simultaneous operation of heating and cooling systems to the same *zone*.

3. Airflow between *dead band* and full heating or full cooling shall be modulated.

- c. Laboratory exhaust systems that comply with 6.5.7.2.
- d. *Zones* where at least 75% of the energy for reheating or for providing warm air in mixing systems is provided from a *site-recovered* (including condenser heat) or *site-solar energy source*.

§7.4.3 HVAC

- §7.4.3.5 Fan power limits, below Standard 90.1-2010



- 10%

Example and Points of Emphasis and Discussion

- How to get 10% lower fan power?

§7.4.3 HVAC

■ §7.4.3.6 Expand energy recovery req't

TABLE 7.4.3.8 Energy Recovery Requirement (I-P)

Climate Zone	% Outside Air at Full Design Flow							
	≥10% and < 20%	≥20% and < 30%	≥30% and < 40%	≥40% and < 50%	≥50% and < 60%	≥60% and < 70%	≥70% and < 80%	≥80%
	Design Supply Fan Flow, cfm							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	≥5000	≥5000
1B, 2B, 5C	NR	NR	NR	NR	≥26,000	≥12,000	≥5000	≥4000
6B	NR	≥22,500	≥11,000	≥5500	≥4500	≥3500	≥2500	≥1500
1A, 2A, 3A, 4A, 5A, 6A	≥30,000	≥13,000	≥5500	≥4500	≥3500	≥2000	≥1000	≥0
7, 8	≥4000	≥3000	≥2500	≥1000	≥0	≥0	≥0	≥0

- **60%** energy recovery effectiveness (enthalpy)

§7.4.3 HVAC

- §7.4.3.7 Kitchen hoods add variable speed, $\geq 50\%$ reduction in flow when not needed (*significant impact*)
- §7.4.3.8 Minimum duct insulation increased (Tables C-9 and 10)
- §7.4.3.12 Unoccupied hotel/motel >50 guest rooms
 - Lighting, outlets, TV off
 - HVAC setpoint raised/lowered by 5°F (3° C)



Implementation: How to Avoid this?



10.3.2 Plans for Operation. This section specifies the items to be included in plans for operation of a *building project* that falls under the requirements of this Standard.

Highlights for Energy (Section 7)

Prescriptive Option (*cont.*)

■ §7.4.5 Power

Peak load reduction:

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

Highlights for Energy (Section 7)

Prescriptive Option (Lighting)

- (§7.4.6.1) Interior lighting power allowance reduced from Table 9.5.1 in Standard 90.1-2010

TABLE 7.4.6.1B LPD Factors when Using the Space-by-Space Method

Common Space Type	LPD Factor
Classroom/Lecture/Training	0.85
Conference Meeting/Multipurpose	0.90
Corridor/Transition	0.85
Dining Area	0.90
Dining Area for Family Dining	0.85
Laboratory for Medical/Industrial Research	0.95
Lobby	0.95
Lobby for Elevator	0.85
Lobby for Motion Picture Theater	0.95
Lounge/Recreation	0.85
Office—Enclosed	0.95
Office—Open Plan	0.85
Sales Area	0.95
All Other Common Space Types	1.00



**Example for Space-by-Space Method:
LPD Factor is multiplier for
90.1-2010 values**

Highlights for Energy (Section 7)

Prescriptive Option (Lighting)

- (§7.4.6.4) Occupancy sensors:
Manual on, auto off, except following where auto on is allowed
 - Areas per 7.4.6.2
 - Public corridors, stairwells
 - Restrooms
 - Entrance areas and lobbies

Highlights for Energy (Section 7)

7.5 Performance Based Option:



- Demonstrated equivalent performance in both *energy cost* and *CO₂ equivalent* compared to if using the Prescriptive path



**Proposed \leq Mandatory +
Prescriptive Path**

**Using Normative Appendix D
"Performance Option for Energy
Efficiency"**

Highlights for Energy (Section 7)

Performance Based Option:

- *CO₂ equivalent* compared to building designed to the Prescriptive path

Table 7.5.3: CO₂e Emission Factors

Building Project Energy Source	CO ₂ e kg/kWh (lb/kWh)
Grid delivered electricity and other fuels not specified in this table	0.758 (1.670)
LPG or propane	0.274 (0.602)
Fuel oil (residual)	0.312 (0.686)
Fuel oil (distillate)	0.279 (0.614)
Coal (except lignite)	0.373 (0.822)
Coal (lignite)	0.583 (1.287)
Gasoline	0.309 (0.681)
Natural gas	0.232 (0.510)

**National
(U.S.)
based
numbers**

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Section 8

Indoor Environmental Quality

■ Key Items

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



Comparison to LEED: Indoor Environmental Quality

Prereq 1	Minimum IAQ Performance	Required
Prereq 2	Environmental Tobacco Smoke (ETS) Control	Required
Credit 1	Outdoor Air Delivery Monitoring	1
Credit 2	Increased Ventilation	1
Credit 3.1	Construction IAQ Management Plan, During Construction	1
Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1
Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1
Credit 4.2	Low-Emitting Materials, Paints & Coatings	1
Credit 4.3	Low-Emitting Materials, Flooring Systems	1
Credit 4.4	Low-Emitting Materials, Composite Wood & Agrifiber Products	1
Credit 5	Indoor Chemical & Pollutant Source Control	1
Credit 6.1	Controllability of Systems, Lighting	1
Credit 6.2	Controllability of Systems, Thermal Comfort	1
Credit 7.1	Thermal Comfort, Design	1
Credit 7.2	Thermal Comfort, Verification	1
Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1
Credit 8.2	Daylight & Views, Views for 90% of Spaces	1

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Indoor Environmental Quality

8.3.1 IAQ

- Using Ventilation Rate Procedure only

8.3.1.1

- Outdoor air monitoring

8.3.1.2

- Permanently mounted,
direct outdoor airflow

15% of *minimum outdoor airflow*

(Differs from LEED in that CO₂ monitoring for densely occupied spaces not specified)

- Exception for constant volume air supply,
damper position feedback



Indoor Environmental Quality

■ 8.3.1.3 Filtration

- (a) Particulates - Minimum **MERV 8** upstream of wetted surfaces or to reduce PM_{10} , **MERV 13** when designed to reduce $PM_{2.5}$
(Modifies and strengthens Std. 62.1 §6.2.1.1)
- (b) Ozone cleaners for outdoor air in building projects located in high ozone areas. *(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

6.2.1.3 Ozone. Air-cleaning devices for ozone shall be provided when the most recent three-year average annual fourth-highest daily maximum eight-hour average ozone concentration exceeds 0.107 ppm (209 $\mu\text{g}/\text{m}^3$).

From Std. 62.1-2010

Indoor Environmental Quality

■ 8.3.1.4

Environmental Tobacco Smoke Control

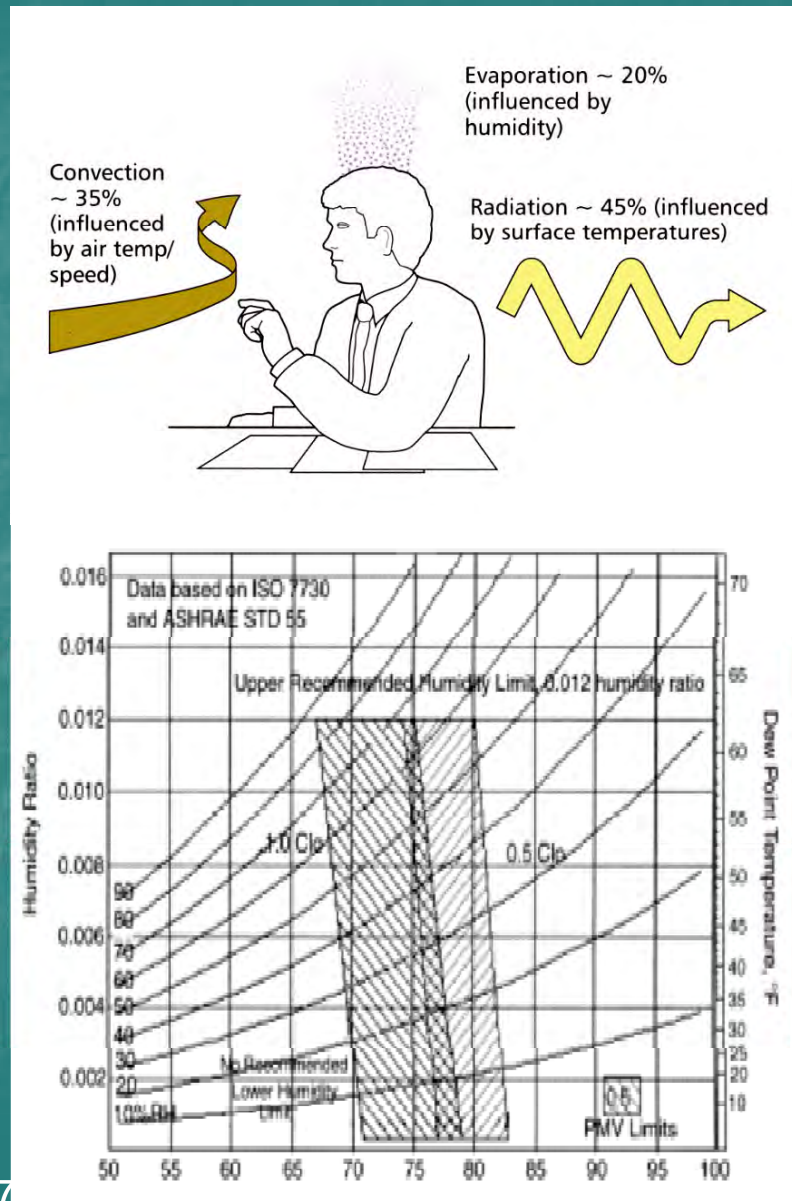


- *No smoking inside, with signage*
- *No smoking within 25 feet (7.5 m) of entrance, outdoor air intakes or operable windows*

Indoor Environmental Quality

Other Mandatory:

- Thermal Comfort
 - Comply with Std. 55 Sections 6.1 and 6.2 (Design and Documentation)
- Mat systems at building entrances
- Envelop acoustical design (sound transmission rating criteria)



Design for Thermal Comfort

- A primary purpose of HVAC in the first place!
- Standard 189.1 requires compliance with Sections 6.1 and 6.2 of Standard 55 (design and documentation)
- Not maintaining adequate thermal comfort is one primary reason why "*good buildings go bad*"
A *High Performance* building can become a *Low Performance* building

Indoor Environmental Quality

Other Mandatory – Acoustical Control:

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

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



Indoor Environmental Quality

Prescriptive Option (*cont.*):

■ 8.4.2 Materials

- Adhesives and sealants
- Paints and coatings
- Floor covering materials
- Composite wood and agrifiber products

- VOC Exception:
Plastic piping cleaners,
cement, primers
HVAC air duct sealants applied
<40°F (4.5°C)

STANDARD PRACTICE
FOR THE
TESTING OF VOLATILE ORGANIC EMISSIONS FROM VARIOUS SOURCES
USING SMALL-SCALE ENVIRONMENTAL CHAMBERS
*(Supersedes previous versions of small-scale environmental chamber testing
portion of California Specification 91350)*



INDUSTRY
Indoor Air Quality Section
Environmental Health Laboratory Branch
Division of Environmental and Occupational Disease Control
California Department of Health Services

ORIGINATOR
THE CALIFORNIA SUSTAINABLE BUILDING TASK FORCE

JULY 18, 2004
(INCLUDES AMENDMENT 2004-01)



State of California
ARNOLD SCHWARZENEGGER, Governor
California Health and Human Services Agency
Kentucky Ukeda, Secretary
Department of Health Services
Susan Murray, Director

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Indoor Environmental Quality



Performance Option (8.5):

- Daylighting simulation
 - Office space and classrooms
 - Minimum illuminance target:
300 lux (30 fc) on work surfaces in 75% of
daylight zone, at noon equinox
- Direct sun limitation on office worksurface
 - Direct sunlight on worksurface <20% of occupied
hours on equinox day
(worksurface = 2.4 feet [0.75 m] above floor)



Construction and Operation Plans OVERVIEW

All Mandatory Provisions:

- **10.3.1 Construction**
- **10.3.2 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 $>500 \text{ m}^2$ (5,000 ft^2)
 - 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

*Discussion: Should commissioning
be mandatory regardless of
building size?*

Construction Requirements (*cont.*)

Commissioning

- Activities prior to occupancy
 - Verify installation, verification of operation
 - Verify system manual, including O&M documentation
 - Verify training done per owner's requirements

Exception for seasonal dependant system operations, Required to be done when system can be fully demonstrated

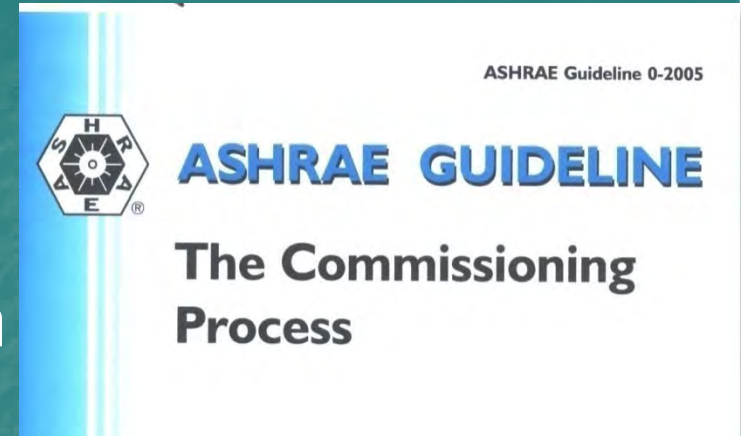
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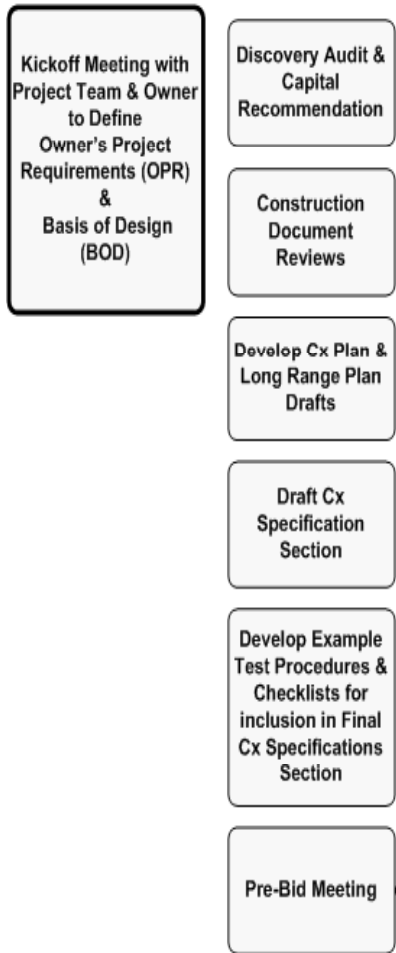
Construction Requirements (*cont.*)

Commissioning

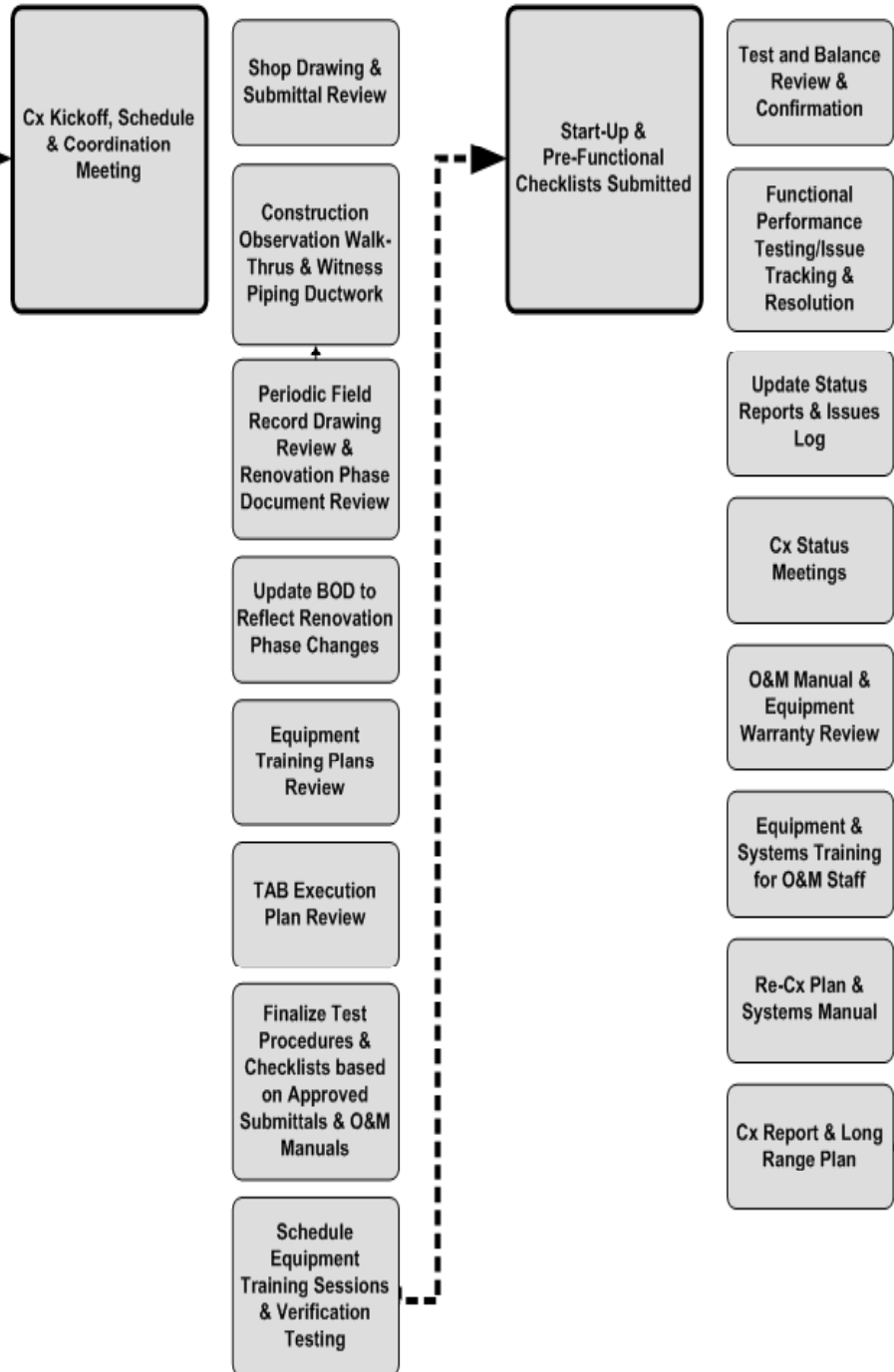
- Systems involved:
 - HVAC, IAQ and refrigeration
 - Building envelope (thermal, moisture integrity, pressurization)
 - Lighting and shading controls
 - Irrigation, plumbing, domestic water
 - Renewable energy systems
 - Energy and water measuring devices



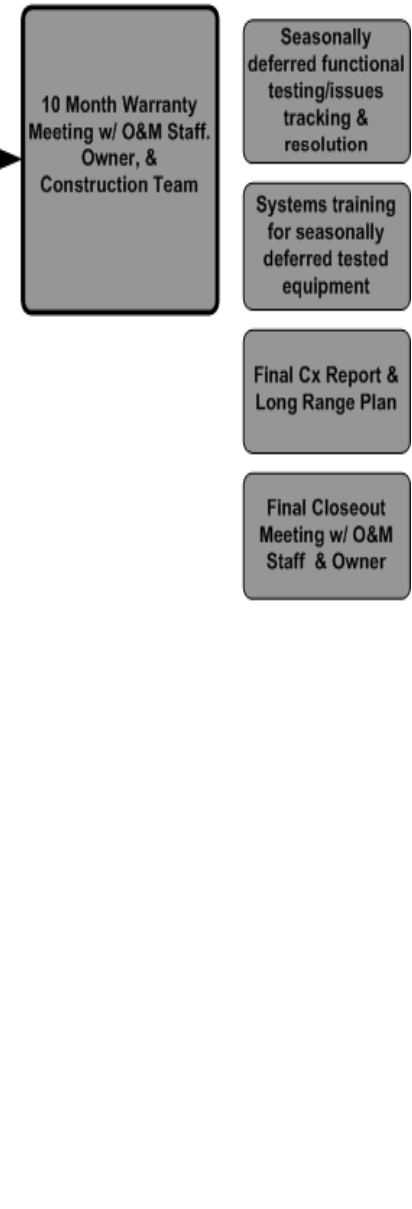
Design Phase Prior to Building Permit



Construction, Testing, & Acceptance Phase Prior to Building Occupancy



Post Occupancy Phase



Integrated Commissioning Process

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Construction Requirements (*cont.*)

10.3.1.4 IAQ Construction Mgmt

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

Equation 10.3.1.4:

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

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

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)

2. Baseline IAQ Testing for 34 contaminants

10.3.2 Plans for Operation

1. High Performance Building Operation
 - Site Sustainability
 - Water Use Efficiency
 - Energy Efficiency
 - Indoor Environmental Quality
2. Maintenance
3. Service Life
4. Transportation Management

Monitoring, Measurement and Verification

- During building design process, only can ensure the following:
 - Tools are in place to do necessary monitoring
 - Operational planning is done (what and how)
" You can lead a horse to water... but can you make it drink? "



For the High-Performance Building Designer:
Follow the Standard 189.1 requirements for monitoring devices and developing "plans for operation"

Investment in monitoring devices beyond the minimums set in Standard 189.1

High Performance Building Operation Plan

Energy Efficiency

1. Initial measurement & verification (M&V)
 - Using energy measurement devices specified in Section 7
2. Procedures to track and assess energy
 - I. Hourly load profile
 - II. Monthly average daily load profile
 - III. Monthly and annual energy use
 - IV. Monthly and annual peak demand

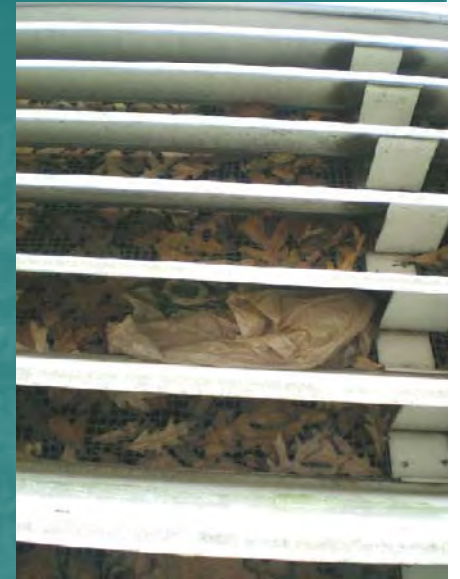


Discussion: What is needed to set up and implement this energy efficiency and usage plan?

High Performance Building Operation Plan

Indoor Environmental Quality

- Outdoor airflow monitoring
 - Equipment verified using handheld devices or permanent stations
 - Procedure to react if 15% lower than *minimum outdoor airflow rate*
- Indoor air quality
 - Air cleaning equipm't in non-attainment areas
 - Biennial monitoring through testing, occupant perception or complaint/response programs
- Green cleaning



Discussion: What are options for sensing outdoor airflow and for responding to 'low flow' readings?

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Planning for Maintenance

- Design for **ease of maintainability** of building systems
- Prepare building **Maintenance Plan** that complies with ASHRAE Standard 180 for mechanical, electrical, plumbing and fire protection systems



High Performance Building Operation Plan

Maintenance Plan

- HVAC, electrical, plumbing - Standard 180
- Documentation of the Plan via electronic storage and Maintenance Manuals

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High Performance Building Operation Plan

Service Life Plan

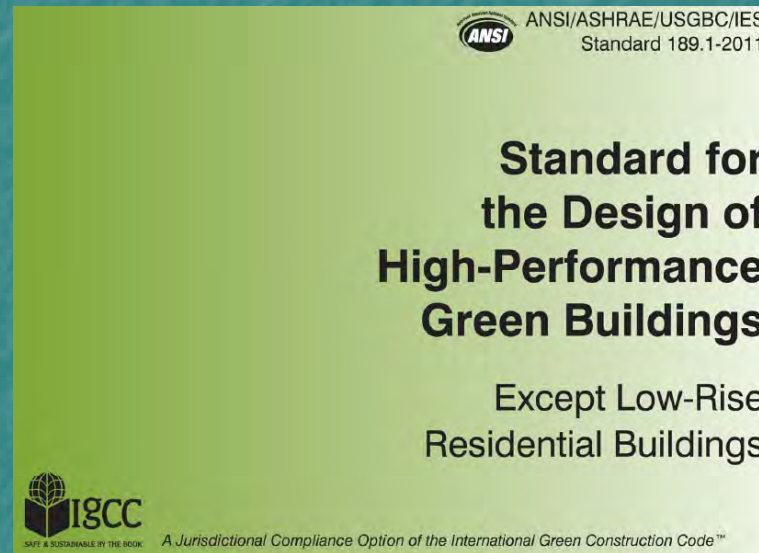
- Maintenance and repair on structure, envelope and hardscape

TABLE 10.3.2.3 Minimum Design Service Life for Buildings

Category	Minimum Service Life	Building Types
Temporary	Up to 10 years	Non-permanent construction buildings (sales offices, bunkhouses) Temporary exhibition buildings
Medium life	25 years	Industrial buildings Stand-alone parking structures
Long life	50 years	All buildings not temporary or medium life, including the parking structures below buildings designed for long life category

Thank you!

- Comments, questions, concerns, advice ...



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