

# The (Proposed) ASHRAE Standard 189.1 High-Performance, Green Buildings

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# ASHRAE Will Give You The World

**NETWORK**

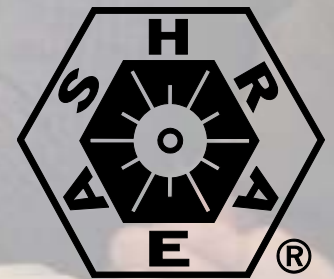
**GROW**

**LEARN**

**TEACH**

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**Give Back To ASHRAE**



This ASHRAE Distinguished Lecturer is brought to you by the Society Chapter  
Technology Transfer Committee

# Introduction and greetings from the University of Georgia



# ASHRAE Standard 189.1

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



BSR/ASHRAE/USGBC/IESNA Standard  
189.1P

**Draft**

ASHRAE® Standard

**Proposed Standard 189.1P,  
*Standard for the Design of  
High-Performance Green  
Buildings Except Low-Rise  
Residential Buildings***

Draft as of April 2, 2009

# 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

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

# Sponsors and Project Committee

- Consensus process
- Sponsor and co-sponsors:
  - ASHRAE (American Society of Heating, Refrigeration and Air Conditioning Engineers)
  - USGBC (U.S. Green Building Council)
  - IESNA (Illuminating Engineering Society of North America)
- Project committee:  
Voting members represent variety of disciplines, industries & organizations



# Progress and Status

- 1<sup>st</sup> Draft created: June 2006 – April 2007
- 45-Day public review period May-July '07
  - 964 total comments received
- Fall 2007, 189.1 committee modified for 2<sup>nd</sup> Public Review Draft
- 2<sup>nd</sup> public review (Feb – April 2008)
- Summer –Fall 2008 –review comments;
- Fall 2008 Committee reorganization
- 3<sup>rd</sup> public review “soon” May/June 2009?

# 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

62.1 (current version)

Ventilation for Acceptable Indoor Air Quality

Adapt, with modifications

BSR/ASHRAE/USGBC/IESNA Standard 189.1P

**Public Review Draft**

ASHRAE® Standard

Proposed Standard 189.1P, Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

Adapt, with minor modifications

Adapt

55 (current version)



## ASHRAE STANDARD

Thermal Environmental Conditions for Human Occupancy

# Organization and What it Covers

- Similar to other ASHRAE standards and LEED

**ASHRAE/USGBC/IESNA Standard 189.1,  
Standard for High-Performance Green Buildings  
Except Low-Rise Residential Buildings**

SECTION	PAGE
Foreword.....	2
1 Purpose.....	4
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■ **Mandatory**  
■ **Prescriptive**  
■ **Performance**

## Section 2 - Purpose

“The purpose of this standard is to provide minimum requirements for the *siting, design, construction, and plans for operation* of high performance, green buildings to:

(a) *balance* environmental responsibility, resource efficiency, occupant comfort and well being, and community sensitivity, and

(b) support the goal of development that *meets the needs of the present without compromising* the ability of future generations to meet their own needs. ”

## Section 2 - Scope

- Provides minimum criteria that:
  - (a) Apply to **new buildings and major renovation projects** (new portions or new systems).
  - (b) Addresses site sustainability, water and energy efficiency, IEQ the building's impact on the atmosphere, materials and resources.
- **Does not apply to:**
  - (a) single-family residential, multi-family <3 stories, manufactured houses (mobile or modular homes);
  - (b) buildings that do not use electricity, fossil fuel or water.

# Goals for Standard 189.1

- Establish mandatory criteria in all topical areas:
- Provide simple compliance options:
- Complement green building rating programs:
  - Std 189.1 is not intended to compete with green building rating programs

# Standard 189.1 Basic Structure

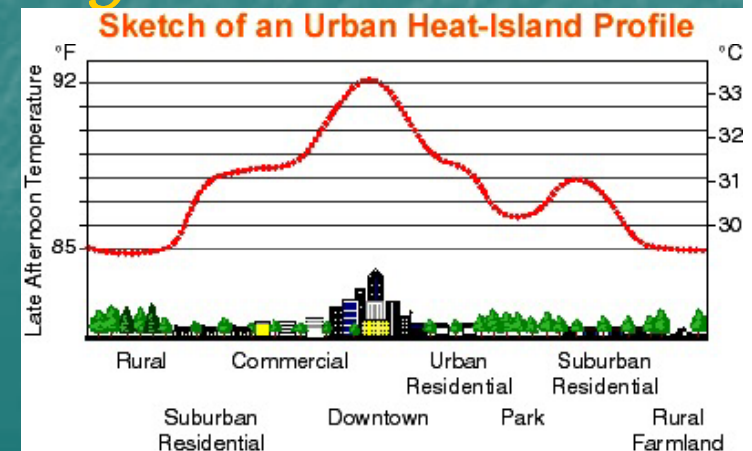
*For Each Section*

- x.1: Scope
- x.2: Compliance
- x.3: Mandatory  
(required for all projects)
- x.4: Prescriptive option  
(‘simple’ option, minimal choices,  
very few calculations)
- x.5: Performance option  
(more sophisticated, flexibility, but  
more effort)

# Highlights of Standard 189.1

## Chapter 5 - Sites:

- **Discourages unmitigated sprawl**
- **Prohibited development activity**
  - Flood plains, wetlands, fish & wildlife habitat
- **Other areas that are addressed:**
  - Amount of impervious surface area *[max % of total site to be impervious - Prescriptive]*
  - Urban heat island *[shaded or higher solar reflective index materials]*
  - Light "pollution" limitations *[max lumens per site, backlight and glare limits]*



# Chapter 6 – Water Use Efficiency

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## Mandatory Provisions

- **Site water use:** bio-diverse plantings, hydrozoning, & smart irrigation controllers



# Chapter 6 – Water Use Efficiency

## Mandatory Provisions



- **Building water use:**

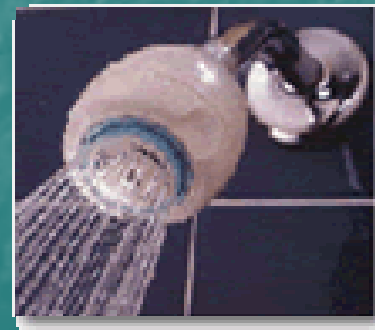
- (§6.3.2.1) plumbing fixtures & fittings per U.S. EPA WaterSense or ASME Standards

- (§6.3.2.2) appliances per U.S. EPA EnergyStar, with water use factor for public access appliances

- Water Metering

- [leased space > 50,000 ft<sup>2</sup>]

- other users > 1000 gal/day]



# Chapter 6 – Water Use Efficiency

## Mandatory Provisions (Cont'd)

### ■ **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/hr)

### Annual condensate collection

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

Iowa: ~ 6.1 gal/cfm OA

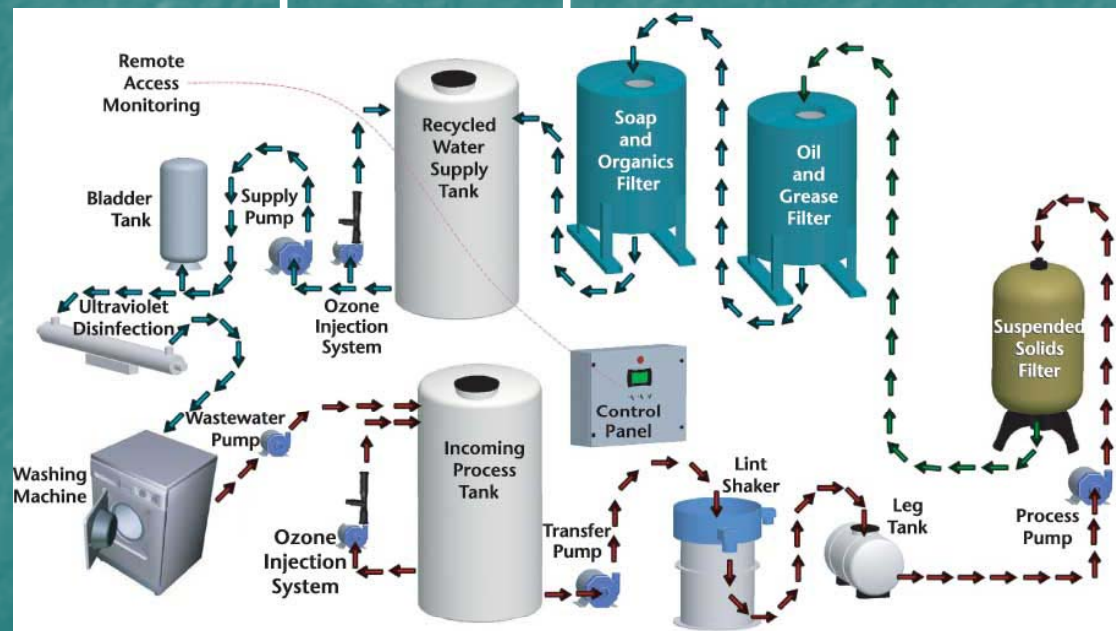
Sacramento: ~ 1.3 gal/cfm OA



# Chapter 6 – Water Use Efficiency

## Performance Option

- **Site water use reduction:**  
proposed potable water for irrigation  
< 35% of baseline evapotranspiration
- **Building use:**



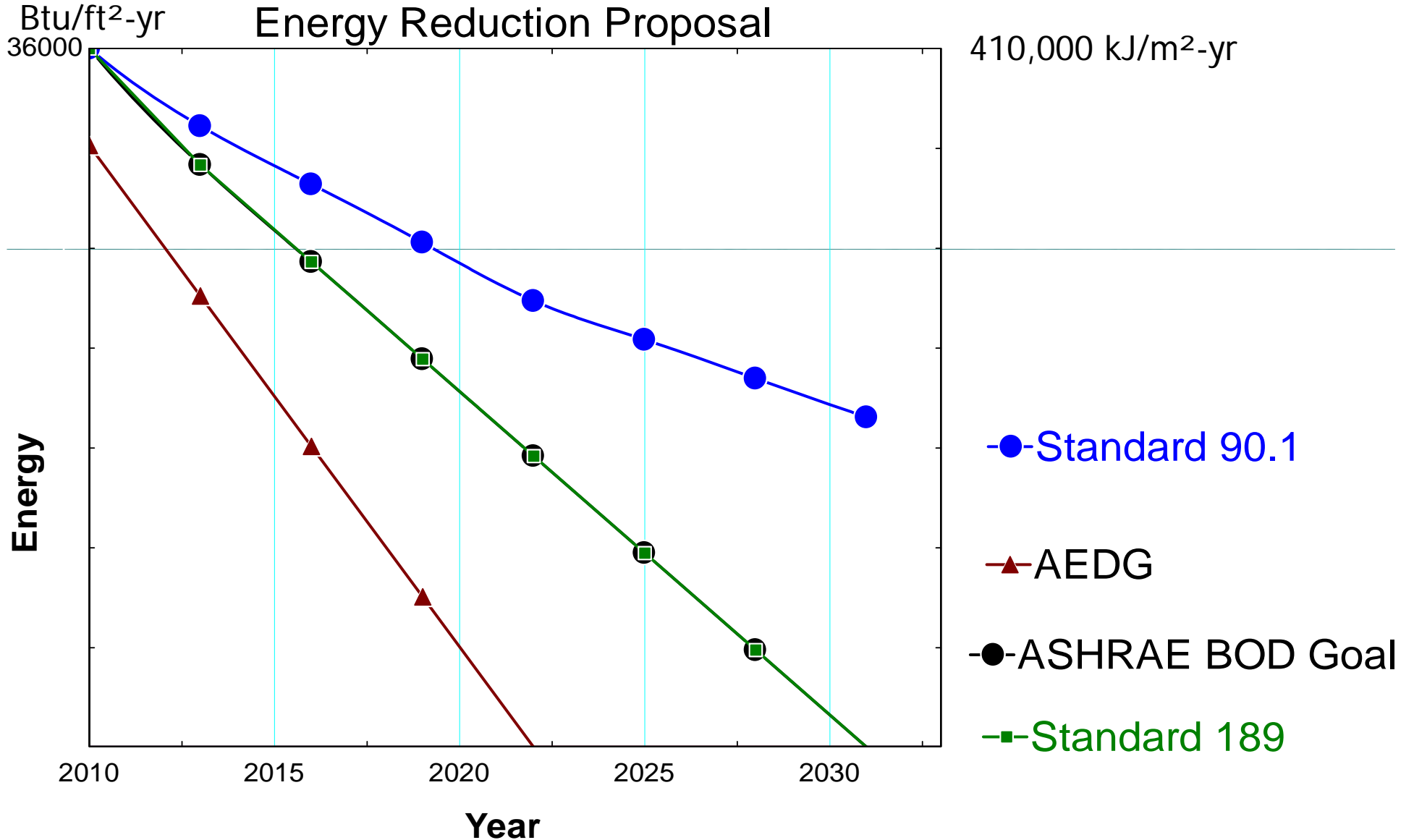
Proposed use < [mandatory+ prescriptive]

# Highlights for Energy (Chapter 7)

## Energy - General:

- Goal is 30% less than Standard 90.1-2007  
***INCLUDING PROCESS LOADS***
- Appendix G from Standard 90.1 is incorporated as a Normative Appendix
- Metering for verification
- Peak load reduction
- Other areas increase stringency beyond Standard 90.1

# ASHRAE Energy Goals



# Highlights for Energy (Chapter 7)

- **Mandatory Requirements:**

- **On-site renewable power (§7.3.2)**

Provisions for future installation with minimum rating of  $13 \text{ Btu/ft}^2$  [ $40 \text{ W/m}^2$ ] x roof area in  $\text{ft}^2$  [ $\text{m}^2$ ]

Exception for areas with low incident solar ( $4.0 \text{ kWh/m}^2/\text{day}$ ), account local shading



# Highlights for Energy (Chapter 7)

## Energy – Mandatory continued:

- **Remote or automatic reading measuring devices (§7.3.3)**  
*criteria based on size*
  - Energy sources (Table 7.3.3-1)
  - Key systems (Table 7.3.3-2)
- Communicate to central recording system

# Energy Metering Thresholds

**Table 7.3.3.1-1 Energy Source Thresholds**

<b>Energy Source</b>	<b>Threshold</b>
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 7.3.3.1-2 System Energy Use Thresholds**

<b>Use (total of all loads)</b>	<b>Sub-System Threshold</b>
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	Connected load > 50 kVA
Process	Connected gas or district services load > 250,000 Btu/h (75 kW)

# Highlights for Energy (Chapter 7)

## Prescriptive Option



- Prescriptive Option: Renewable Energy
  - On-site renewable energy system with "4 kBtu/ft<sup>2</sup>-yr [45 MJ/m<sup>2</sup>-yr]"

### Exceptions:

- Low incident solar regions (4.0 kWh/m<sup>2</sup>/day)
- Purchase of green power in terms of "75 kWh/ft<sup>2</sup>-yr [750 kWh/m<sup>2</sup>-yr]"

# Highlights for Energy (Chapter 7)

## Prescriptive Option (Building Envelope)

- Section 7.4.2 generally has more stringent requirements for building envelope
- Replaces Table 5.5-1 thru 8 on building envelope in 90.1, for example: **(§7.4.2)**

**Table A-3 (supersedes Table 5.5-3 in ASHRAE/IESNA Standard 90.1)  
Building Envelope Requirements For Climate Zone 3 (A,B,C) (I-P)**

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Max.	Insulation Min. R-Value	Assembly Max.	Insulation Min. R-Value	Assembly Max.	Insulation Min.R-Value
<i>Roofs</i>						
Insulation Entirely above Deck	U-0.039	R-25.0 ci	U-0.039	R-25.0 ci	U-0.119	R-7.6 ci
Metal Building	U-0.035	R-19.0 + R-11.0 Ls	U-0.035	R-19.0 + R-11.0 Ls	U-0.068	R-13.0 + R-19.0
Attic and Other	U-0.021	R-49.0	U-0.021	R-49.0	U-0.034	R-30.0
<i>Walls, Above-grade</i>						
Mass	U-0.104	R-9.5 ci	U-0.090	R-11.4 ci	U-0.151 <sup>a</sup>	R-5.7 ci <sup>a</sup>
Metal Building	U-0.079	R-13.0 + R-6.5 ci	U-0.052	R-13.0 + R-13.0 ci	U-0.079	R-13.0 + R-6.5 ci
Steel Framed	U-0.077	R-13.0 + R-5.0 ci	U-0.055	R-13.0 + R-10.0 ci	U-0.084	R-13.0 + R-3.8 ci
Wood Framed and Other	U-0.064	R-13.0 + R-3.8 ci	U-0.064	R-13.0 + R-3.8 ci	U-0.064	R-13.0 + R-3.8 ci

# Highlights for Energy (Chapter 7)

(§7.4.2)

## Prescriptive Option (Building Envelope)

- Example comparisons:

### Example:

Climate zone 3

Std 90.1

Std 189.1

Insulation above deck

R-20



R-25

- More stringent SHGC

**R=4.4 SI**

### Example for <40% window area:

Climate zone 5

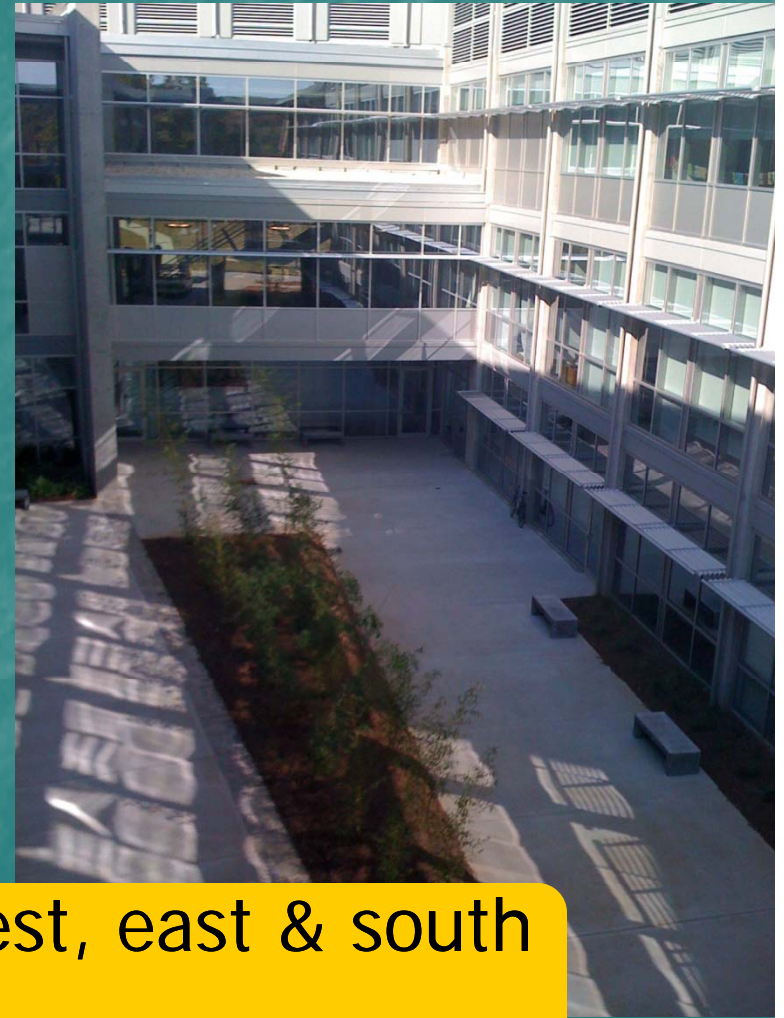
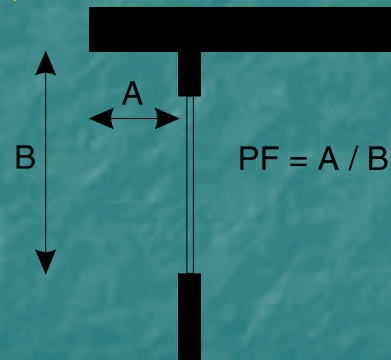
Std. 90.1: 0.40

Std. 189.1: 0.35 all orientations

# Highlights for Energy (Chapter 7)

## Prescriptive Option (Building Envelope)

- Vertical fenestration < 40% wall area  
(§7.4.2.4)
- Overhang:  $PF > 0.5$   
(§7.4.2.5)



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

# §7.4.3 HVAC

## ASHRAE STANDARD

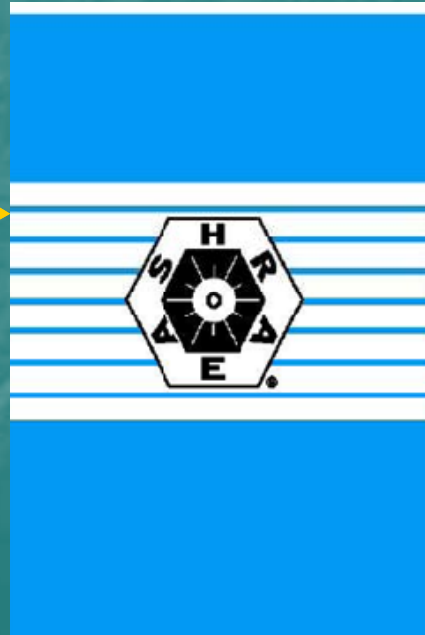
90.1 (current version)

Energy Standard for  
Buildings Except Low-Rise  
Residential Buildings

### General Concept:

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

Adapt, with  
modifications



BSR/ASHRAE/USGBC/IESNA Standard  
189.1P

**Public Review  
Draft**

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## §7.4.3 HVAC

- Brief mention of modifications to Std. 90.1
  - §7.4.3.1 Minimum equipment efficiency  
Either use equipment with efficiencies of:
    - *EPAAct baseline → more on-site renewable and peak load reduction, **OR***
    - *Higher efficiency levels*
      - Includes new definition of chiller efficiency formula from ARI Standard test conditions*
  - §7.4.3.2 Lowers DCV occupancy threshold

## §7.4.3 HVAC

- Brief mention of modifications to Std. 90.1
  - §7.4.3.3 Duct sealing level A everywhere
  - §7.4.3.4 Expanded economizer requirement

Climate Zones	Cooling Capacity for Which an Economizer is Required
1A, 1B, 2A	No Economizer Requirement
2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	$\geq 9.7 \text{ kW (33,000 Btu/h)}^a$

**Table 7.4.3.4.2 Minimum Efficiency Improvement to Eliminate Airside Economizer**

Climate Zones	Cooling Efficiency Improvement <sup>a</sup>
1A, 1B, 2A	NR
2B, 3A, 3B, 4A	15%
4B, 5A, 5B	35%
6A, 6B	58%
3C, 4C, 5C, 7, 8	NA

- §7.4.3.5 Zone controls for limit on reheat
- §7.4.3.6 Fan power limits

## §7.4.3 HVAC

- §7.4.3.7 System controls  
(2 stages for DX > 65,000 Btu/hr, fan power as reduced flow)
- §7.4.3.8 Expand energy recovery req't

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	≥26000	≥12000	≥5000	≥4000
6B	NR	≥22500	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
1A, 2A, 3A, 4A, 5A, 6A	≥30000	≥13000	≥5500	≥4500	≥3500	≥2000	≥1000	≥0
7,8	≥4000	≥3000	≥2500	≥1000	≥0	≥0	≥0	≥0

## §7.4.3 HVAC

- §7.4.3.9 Kitchen hoods add variable speed
- §7.4.3.10 and .11 Minimum duct and pipe insulation increased (Tables C-9, 10 and 11)
- §7.4.3.12 Unoccupied hotel/motel guest rooms

# Highlights for Energy (Chapter 7)

## Prescriptive Option (Other Equipment)

- Service water heating efficiency
- Peak load reduction through demand shifting or limiting measures
- Lighting power:
  - 90% of Standard 90.1
  - Occupancy sensor controls (offices, meeting rooms. Some with multi-level switching)
  - Daylighting controls
- Condenser heat recovery (supermarket)
- Energy Star equipment when appropriate

# Highlights for Energy (Chapter 7)

## Performance Based Option:

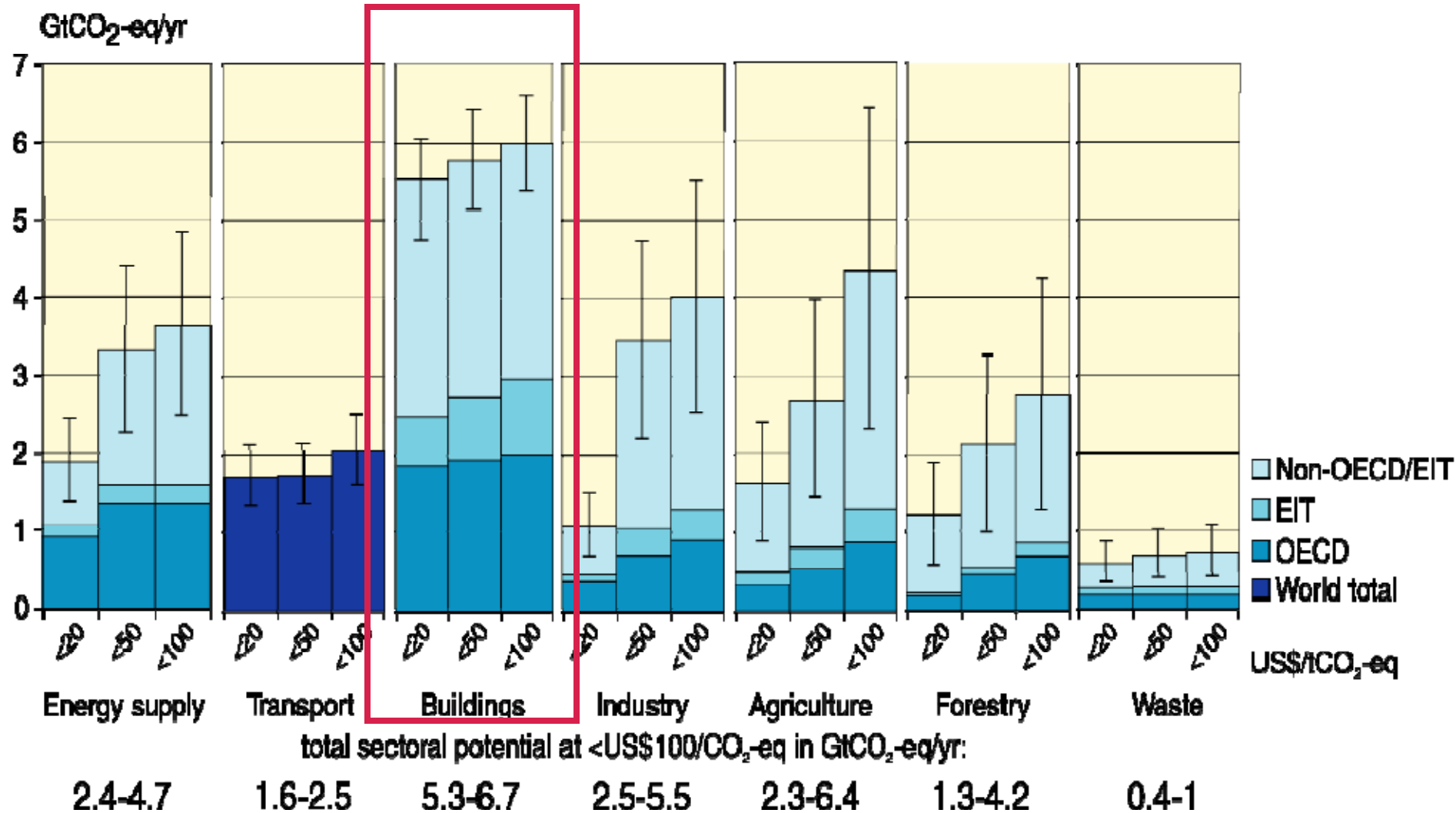
- Demonstrated equivalent performance in both *energy* and *CO<sub>2</sub> equivalent* compared to if using the Prescriptive path



**Proposed  $\leq$  Mandatory +  
Prescriptive Path**

**Using Appendix D  
“Performance Option  
for Energy Efficiency”**

## Economic mitigation potential by sector in 2030



# Highlights for Energy (Chapter 7)

## Performance Based Option:

- ***CO<sub>2</sub> equivalent*** compared to building designed to the Prescriptive path

**Table 7.5.3: CO<sub>2</sub>e Emission Factors**

<b>Building Project Energy Source</b>	<b>CO<sub>2</sub>e kg/kWh (lb/kWh)</b>
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**

# Indoor Environmental Quality

- Mandatory Key Items to ASHRAE members:
  - **Outdoor airflow**
  - **Tobacco smoke control**
  - **Outdoor air monitoring**
  - **Filtration and air cleaning**



# Indoor Environmental Quality

## §8.3.1 IAQ

- Minimum ventilation design outdoor airflow rate per Standard 62.1, using Ventilation Rate Procedure
- Outdoor air delivery monitoring
  - VAV systems permanently mounted, direct outdoor airflow measurement  $\pm 15\%$  of *minimum outdoor airflow*
  - CO<sub>2</sub> monitoring instead if system serves only densely occupied spaces
  - Constant volume air supply, damper position feedback allowable instead



# Indoor Environmental Quality

## ■ §8.3.1.2 OA Monitoring (Continued)

- CO<sub>2</sub> monitoring for densely occupied spaces with natural ventilation
- Spaces with requirements for CO<sub>2</sub> sensors, compute the *target concentration* level (used in OA monitoring during operation)



# Indoor Environmental Quality

## ■ §8.3.1.3 Filtration

- (a) Particulates - Minimum MERV 8 upstream of cooling coils (revises 62.1).  
MERV 13 when project located in non-attainment area for  $PM_{2.5}$
- (b) Ozone cleaners for outdoor air in building projects located in non-attainment areas (primary and secondary)

# Indoor Environmental Quality

## ■ §8.3.1.4

### Environmental Tobacco Smoke Control



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

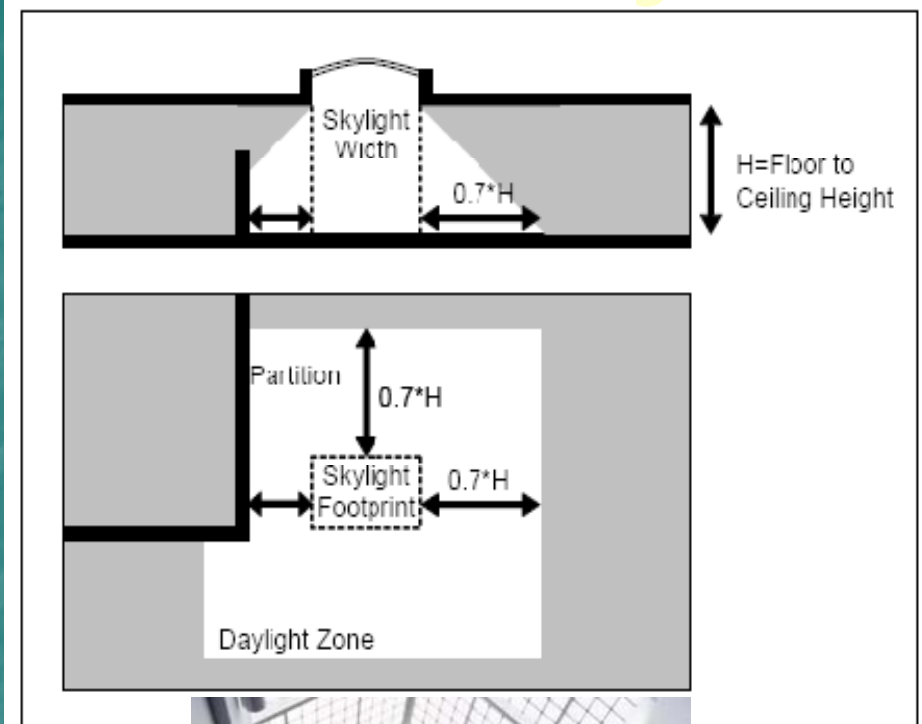
# Indoor Environmental Quality

- **§8.3.2** Thermal Comfort
  - Comply with ASHRAE Std 55
- **§8.3.3** Acoustic Control
  - Comply with ASHRAE Std 55

# Indoor Environmental Quality

## Other Mandatory:

- Daylighting by toplighting for large open spaces
- Soil gas retarder when for areas with high radon concerns



# Indoor Environmental Quality



## Prescriptive Option (§8.4):

- Side daylighting
  - Offices and classrooms
  - Minimum effective aperture of windows
  - Minimum visible reflectance of interior surfaces
  - Exceptions for 'dark rooms', facades closely adjacent to other buildings



# Indoor Environmental Quality

## Prescriptive Option (Cont'd):

- Office space shading, with projections or other techniques
- Low emitting materials
  - Adhesives and sealants
  - Paints and coatings
  - Floor covering materials
  - Composite wood and agrifiber products



# Indoor Environmental Quality



## Performance Option (§8.5):

- Daylighting simulation
  - All regularly occupied spaces
  - Minimum illuminance target: 300 lux (30 fc) on work surfaces in 75% of daylight zone, at noon equinox
  - Direct sunlight on workplane < 20% of occupied hours on equinox day
- Modeling to show compliance with California CA/DHS/EHLB/R-7174 (low emitting materials)



# Building's Impact on Atmosphere, Materials and Resources (§ 9)

## Mandatory Items Key to ASHRAE:

### ■ CFC, other refrigerant restrictions

- *No CFCs*
- *Global warming and ozone depletion potential balance*

$$LCGWP + LCODP \times 10^5 \leq 775 (100)$$

- *LCGWP = Life cycle global warming*
- *LCODP = Life cycle ozone depletion*

**Units: kg CFC11/kW-yr  
lb CFC11/ton-yr**

# Building's Impact on Atmosphere, Materials and Resources (§ 9)

## Refrigerant restrictions (Continued):

where:

$$LCGWP = [GWP_r \times (L_r \times Life + M_r) \times R_c] / Life$$

$$LCODP = [ODP_r \times (L_r \times Life + M_r) \times R_c] / Life$$

- $GWP_r$  = global warming potential  
0 to 12,000 kg CO<sub>2</sub> / kg refrigerant

- $ODP_r$  = ozone depletion potential  
0 to 0.2 kg CO<sub>2</sub> / kg refrigerant

$L_r$  = Leak rate

$M_r$  = End of life refrigerant loss

$R_c$  = Charge

# Building's Impact on Atmosphere, Materials and Resources (§ 9)

## Refrigerant restrictions (Continued):

For multiple types of equipment, a weighted average of all HVAC&R equipment shall be applied using the following formula:

$$[ \sum (LCGWP + LCODP \times 10^5) \times Q_{unit} ] / Q_{total} \leq 775 (100)$$

where:

$Q_{unit}$  = Cooling capacity of an individual HVAC or refrigeration unit, kW (tons)

$Q_{total}$  = Total cooling capacity of all HVAC or refrigeration

- **Exception:**  
**Small HVAC units, coolers  
with < 0.5 lb refrigerant charge**

# Building's Impact on Atmosphere, Materials and Resources (§ 9)

- **Life Cycle Assessment (Performance)**
  - Must include operating energy consumption
  - LCA to include all of these impact categories:  
land use, resource use, climate change, ozone layer depletion, human health effects, ecotoxicity, smog, acidification, eutrophication
  - show 5% gain in two categories for the building

# 10 - Construction and Operation Plans

## All Mandatory Provisions:

- Full commissioning for projects > 500 m<sup>2</sup> (5,000 ft<sup>2</sup>)
  - HVAC, building envelope, lighting, irrigation, plumbing, domestic water, renewable energy
- Addition of monitoring equipment for measurement and verification, M&V plans
  - water, energy and IAQ
  - M&V plans in place
  - certification of lamp and ballast recycling

# 10 - Construction and Operation Plans

- IAQ Construction Management
  - Keep air conveyance materials (duct, etc) clean while in storage
  - Post-construction, pre-occupancy options:
    1. Flush-out (# air changes based on room volume)
    2. IAQ testing, 1 sample point per 25,000 ft<sup>2</sup> (2,500 m<sup>2</sup>) or each contiguous floor area.

# 10 - Construction and Operation Plans

## §10.3.2 Plans for Operation

- Site sustainability (vegetation shading)
- Water and energy use
  - Initial measurement & verification
  - Track and assess
- Indoor environmental quality
  - Outdoor airflow measurement and verification
  - IAQ: filtration for periods of non-attainment ambient air quality
  - Green cleaning plan

# 10 - Construction and Operation Plans

## §10.3.2 Plans for Operation (cont'd)

- Maintenance plan for MEP and fire protection
- Service life plan, consistent with Owner's Project Requirements
- Transportation management plan

# Compare Standard 189.1 to LEED



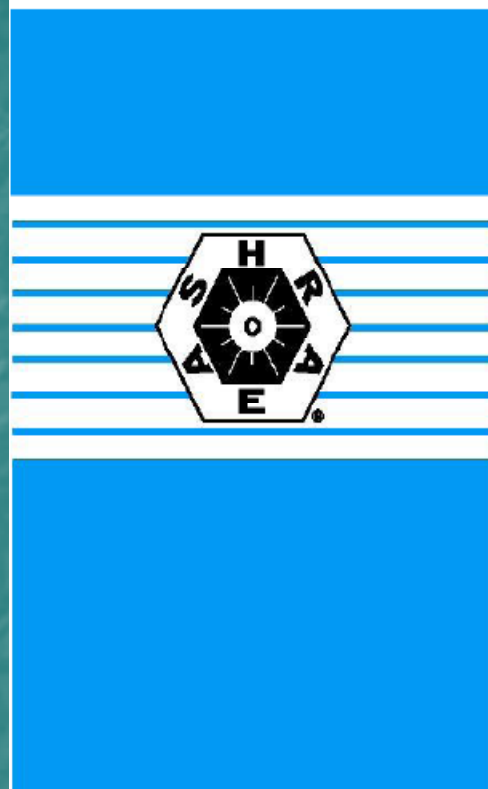
## LEED-NC

Green Building Rating System  
For New Construction &  
Major Renovations

Version 2.2

For Public Use and Display

October 2005



BSR/ASHRAE/USGBC/IESNA Standard  
189.1P

**Public Review  
Draft**

**ASHRAE® Standard**

**Proposed Standard 189.1P,  
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Second Public Review (February 2008)  
(Complete Draft for Full Review)

- Voluntary vs. mandatory

- Std. 189.1:

- Improvement in all topical areas
- Pushes the envelope

# FURTHER INFORMATION

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- Information on ASHRAE standards:  
[www.ashrae.org](http://www.ashrae.org) *then follow "Standards", includes listserv for Standard 189.1*
- Information on USGBC programs:  
[www.usgbc.org](http://www.usgbc.org)
- Information on IESNA programs:  
[www.iesna.org](http://www.iesna.org)

# Thank you!

- Comments, questions, concerns, advice ...

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