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

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the University of Georgia
Environmental ENGINEERING
A conscience for the world. A foundation in technology. The blending of both…

Engineering Outreach SERVICE
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Basic Agenda

- The Proposed ASHRAE Standard 189.1 for "High-Performance, Green Buildings"
  - Why have it?
  - Why ASHRAE?
  - Background, status
  - What's in it?
  - Relationship to other Stds.
  - 'Case Study' examples

ASHRAE Standards Process

- Title, Purpose, Scope approved by Standards Committee and Board
- Project Committee (SPC) formed after invitation in *ASHRAE Journal* and Web site
- SPC Chair approved by Standards Committee and Technology Council

Standards Process (Cont.)

- Chair forms SPC; Goal is to achieve a balance among affected interests
- SPC develops draft
- Approved for Public Review and posted
- SPC responds to comments; negotiate as necessary

Standards Process (Cont.)

- Revised and reissued for Public Review, as necessary
- Approved for publication by Standards Committee, Technology Council, and BOD

Standards Process (Cont.)

- Assures
  - Due Process
  - Openness
  - Balance (typically producers, users, others)
- Consensus: More than a simple majority, but not necessarily unanimity
- Attempt to write Standards in code compliant language

Continuous Maintenance

- An addendum must be a recommended addition, modification, or deletion, not just a comment
- Addenda may be proposed anytime
- Proposed addenda processed semi-annually and published every 18 months
- Addenda available for download at no cost
- Standard as a whole updated every 3-5 years

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

Standard 189.1: Intent

- Intended to be used in conjunction with ASHRAE Standards 90.1-2007, 62.1-2007 and 55-2004

Why is this Needed?

- Localities are beginning to adopt “green building” as a requirement
  - LEED certification (to some level)
  - Others are more vague
- Intended to fill a gap in evolving building codes
- ASHRAE partnership with USGBC, IESNA, and will be submitted for ANSI approval

Section 2 - Purpose

"The purpose of this standard is to provide minimum requirements for the ***siting, design, and construction (including 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:**
  - one 'problem' with existing rating systems is that they contain few mandatory provisions
  - avoids claims about a 'green building', but still making **no** improvements in some areas
- **Provide simple compliance options:**
  - another critique of existing rating systems is the need for extensive calculations (e.g. energy)
- **Complement green building rating programs:**
  - Std 189.1 is **not** intended to compete with green building rating programs

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:
  22 voting members;
  variety of disciplines,
  industries & organizations

Challenges

- Using normative (code) language
- Determining the stringency for a "minimum" standard
- Identifying standards or regulations to cite *(could not reference guidelines)*
- Prescribing universal strategies *(requirements for all, not a menu)*
- Coordination with other initiatives
- Creating something that is enforceable

Indirect Benefits of Establishing Baseline

- **More certainty for manufacturers**
  - Will develop and provide next generation products if a market is known to exist
- **Benefits to existing buildings**
  - Suppliers will stock better performing products as they become available

Potential Users of Std. 189.1

- Organizations with green building rating systems (LEED, Green Building Initiative)
- **Developers:** individual projects
- **Corporations:** corporate owned
- **Universities:** campus buildings
- **States / provinces / municipalities:**
  - their own buildings
  - basis for incentives
  - private construction, through reference in local codes

Why AHSRAE?

ASHRAE's More Active Role in Sustainable Design

- Sustainability Policy

Strategic Plan

Strategic Plan Directives

- ASHRAE will lead the advancement of sustainable building design and operations.
- ASHRAE will be a world-class provider of education and certification programs.
- ASHRAE will position itself as premier provider of HVAC&R expertise.
- ASHRAE will be a global leader in the HVAC&R community.

ASHRAE Insights

The Newspaper of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

More Focus on Sustainability

ASHRAE has launched a new campaign emphasizing its role as "the engineering engine that drives sustainability."

As part of ASHRAE's stronger focus on its involvement in green buildings, the Society has introduced a new logo; a new theme, "Engineering for Sustainability"; and www.engineeringforsustainability.org, a new Web site. These will be used to identify ASHRAE products and services related to sustainability.

"ASHRAE has long provided 'engineering for sustainability' by applying its diverse technology assets to the sustainability movement in energy efficiency, indoor environment and industrial processes," Ron Jarnagin, chair of a committee developing a roadmap for sustainability for the Society, said. "With growing focus in the industry on the green movement, we need to emphasize that ASHRAE is the engineering engine that drives sustainability."

Jarnagin noted that the Society's recent efforts include publishing and working on the *Advanced Energy Design Guide* series, Standard 90.1, which contains a section guiding designers on how to meet requirements for building rating programs, and the *ASHRAE GreenGuide*, all part of an ASHRAE green "tool kit."

Sustainability also is addressed through other standards and special publications, ASHRAE Journal articles, ASHRAE Learn

ASHRAE Engineering for Sustainability

For Consideration

1. What is ASHRAE's "control volume"?
2. What are barriers to 'green' building getting further market acceptance?

TC 2.8: "What's our scope of coverage?"

ASHRAE Already is Broad Based

- Technical Committees exist focusing on:
  - Business, management, general legal (1.7)
  - Electrical systems (1.9)
  - Physiology and human environment (2.1)
  - Global climate change (2.5)
  - Building environmental impacts and sustainability (2.8)
  - Building envelope (4.4)
  - Integrated building design (7.1)

Progress and Status

- 1st Draft created: June 2006 – April 2007
- 45-Day public review period May-July '07 - 964 total comments received
- 189.1 committee met in Aug and Oct to work through the comments
- **2nd public review schedule**
  - Feb. 22 – April 7, 2008: 2nd public review
  - May 2008 – committee review comments
  - Late 2008 ASHRAE Standard and ANSI approval
  - Early 2009 – Formally issued??

Organization and What it Covers

- Similar to LEED and other ASHRAE standards

ASHRAE/USGBC/IESNA Standard 189,
Standard for High-Performance Green Buildings
Except Low-Rise Residential Buildings

SECTION

Foreword

1 Purpose

2 Scope

3 Definitions, Abbreviations, and Acronyms

4 Administration and Enforcement

5 Sustainable Sites

6 Water Use Efficiency

7 Energy Efficiency

8 The Building's Impact on the Atmosphere, Materials and Resources

9 Indoor Environmental Quality (IEQ)

10 Construction and Operation

11 Normative References

- **Mandatory**
- **Prescriptive**
- **Performance**

Standard 189.1 Basic Structure

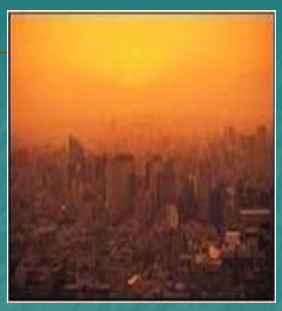
- x.1: Scope
- x.2: Compliance
- x.3: Mandatory
  (required for all projects)
- x.4: Prescriptive **option**
  (simple option, minimal choices, very few calculations)
- x.5: Performance **option**
  (more sophisticated, flexibility, but more effort)

Highlights of Standard 189.1

Chapter 5 - Sites:

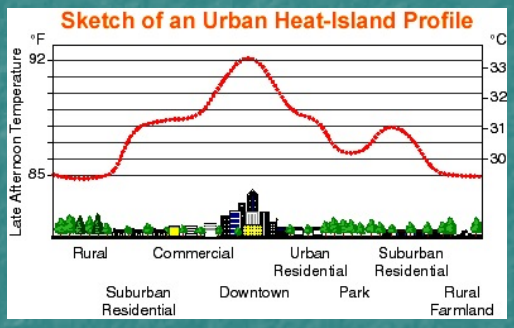
- **Discourages unmitigated sprawl**
- **Prohibited development activity**
  - Flood plains, wetlands, fish and wildlife habitat
- **Other areas that are addressed:**
  - Amount of impervious surface area *[max of 60% of total site to be impervious]*
  - Urban heat island *[shaded or higher solar reflective index materials]*
  - Light “pollution” limitations

Sustainable Sites



Mandatory Provisions

- **Heat island effect**
  - Site hardscape: to be shaded, be SRI 29, or porous pavers
  - Wall: to be shaded up to 20 feet above grade
  - Roofs: to be SRI 78 (low-slope)/29 (steep-slope) or cool roof



Sustainable Sites

Mandatory Provisions

- **Reduction of light pollution**
  - Outdoor lighting trespass: limits on horizontal and vertical lux

Sustainable Sites

Prescriptive / Performance Options

- **Site development**
  - All sites: Min. 40% of area to be effective pervious surface (vegetation, green roof, porous pavers)
  - Greenfield sites: Min. 20% of area native or adapted plants

Case Study and Points of Emphasis

Chapter 6 – Water Use Efficiency

Mandatory Provisions

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

Chapter 6 – Water Use Efficiency

Mandatory Provisions

- **Building water use**: plumbing fixtures & fittings, appliances, HVAC systems & equipment, generally 20% lower than U.S. EPAct criteria (when possible)
- **Metering**: meters, meter data collection, data storage & retrieval

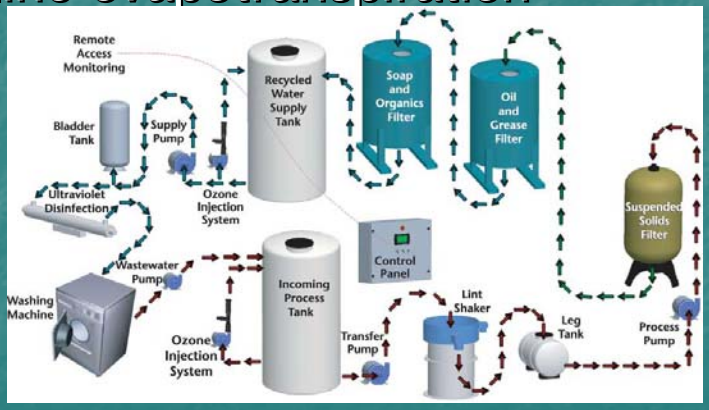
Chapter 6 – Water Use Efficiency

- Exterior
  - Minimize need through plant selection
  - Smart (evapotranspiration) controllers
- Interior – *Energy Star* and other standards
- No "once through" cooling for HVAC
- 5 cycles for cooling tower water (or specified minimum water concentration)
- Metering installed for monitoring during operation

Chapter 6 – Water Use Efficiency

Performance Option

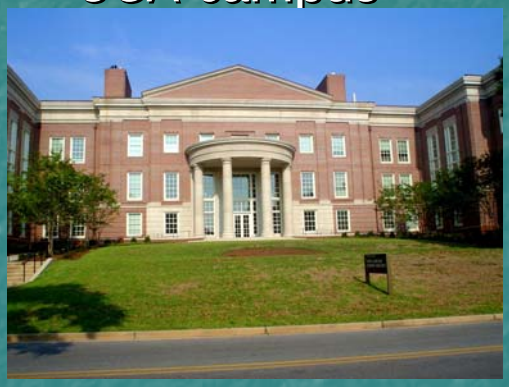
- **Site water use reduction**:
  proposed potable water for irrigation
  < 35% of baseline evapotranspiration
- **Building use**:



Proposed use < [mandatory+ prescriptive]

Example of Reuse

- Coverdell Veterinary Research building, UGA campus



Completed summer 2005, Cx summer, fall 2005 along with initial occupancy, dedicated by George Bush (Sr.) spring 2006

Annual condensate collection

Georgia: ~ 12.6 gal/cfm OA
Sacramento: ~ 1.3 gal/cfm OA
Moline: ~ 6.1 gal/cfm OA

Coverdell Water Conservation

"Inputs"

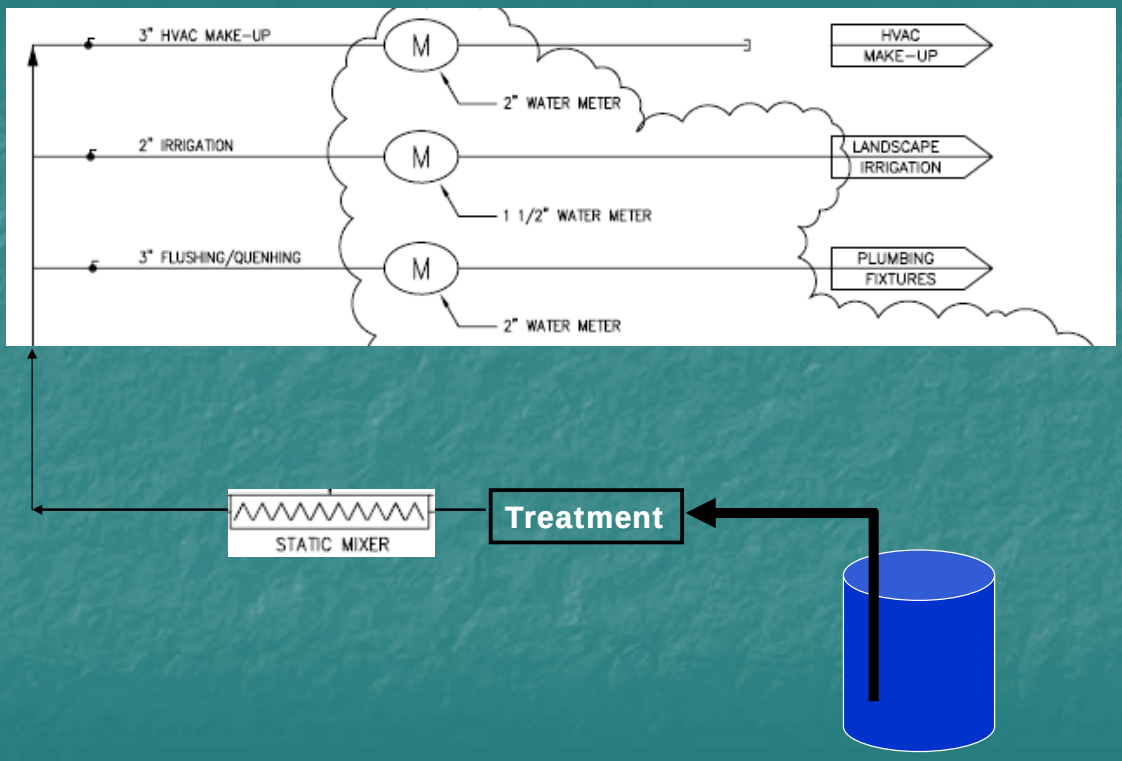
- Roof rainwater collection
- AHU condensate collection
- Building perimeter sump water collection

"Outputs"

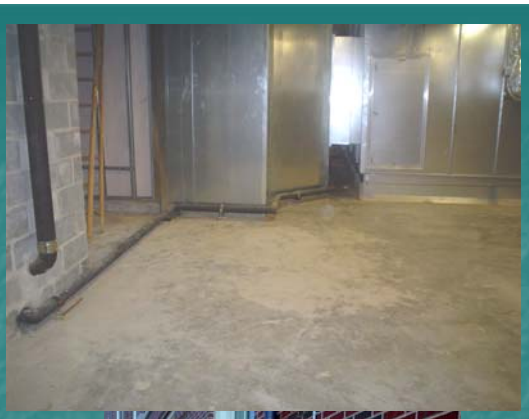
- Toilet flushing
- Cooling tower makeup

Condensate Water Collected
≈ 750,000 gallons per year
(not including rain, sumps)

Incremental additional cost
≈ $300,000



Water Collection



Water Storage

Water (Re)use

Issues

Not so good

- Condensation on outside of downspout pipes

Good

- Integrated well with ‘normal’ city water supply

Case Study and Points of Emphasis

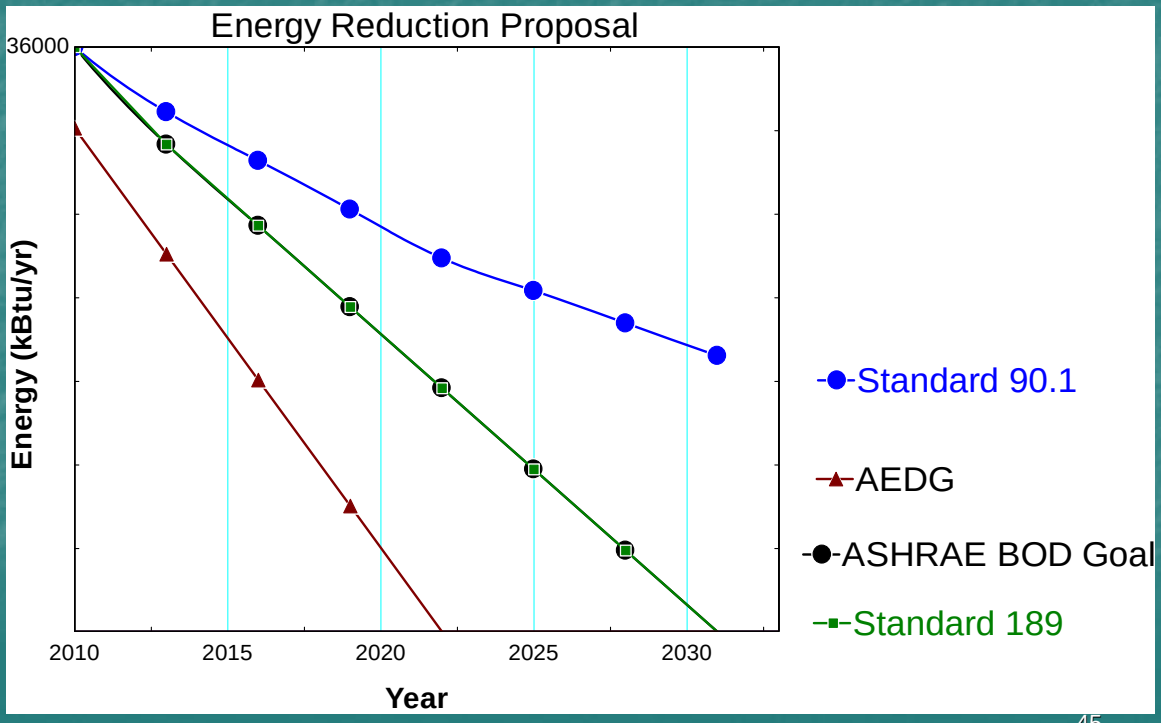
Energy – Chapter 7

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:**
  - "Energy Star" rated equipment and appliances
  - **On-site renewable power (§7.3.2)**
    peak electrical generation
    1% of service load
  - Exception allowed is 100% solar hot water heating, **OR** by combined 10% improvement in energy and CO_{2e}

the *service overcurrent protection device rating*. The rating of the *on-site renewable energy power system* shall be the nameplate rating in kVA (dc).

Highlights for Energy (Chapter 7)

Energy – Mandatory continued:

- **Communicating submetering** of key systems (criteria based on size) **(§7.3.3)**

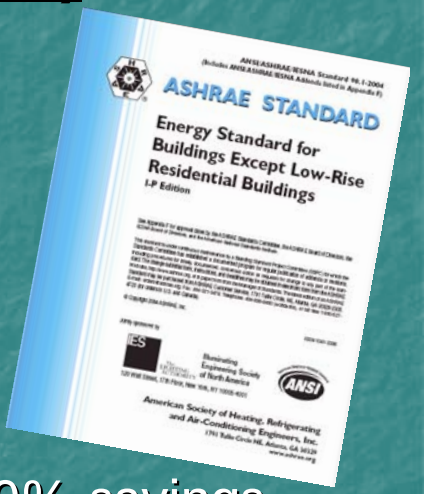
Table 7.3.3-2 Component Energy Metering Thresholds

Component	Sub-Metering Threshold
Chillers/heat pumps	> 70 kW (240,000 Btu/h) cooling capacity
Packaged AC units	> 70 kW (240,000 Btu/h) cooling
Fans	> 15 kW (20 hp)
Pumps	> 15 kW (20 hp)
Cooling towers	> 15 kW (20 hp)
Boilers and other heating equipment	> 300 kW (1,000,000 Btu/h) input
General lighting circuits	> 100 kVA
Miscellaneous electric loads	> 100 kVA

Highlights for Energy (Chapter 7)

Prescriptive Option (General)

- Maximum size limits for individual dwelling units



- Target is to comply with ASHRAE/IESNA Standard 90.1-2007 plus...30% savings

Highlights for Energy (Chapter 7)

(§7.4.2 a)

Prescriptive Option (Building Envelope)

- Generally increased insulation required for roof elements, walls (adds continuous req't)

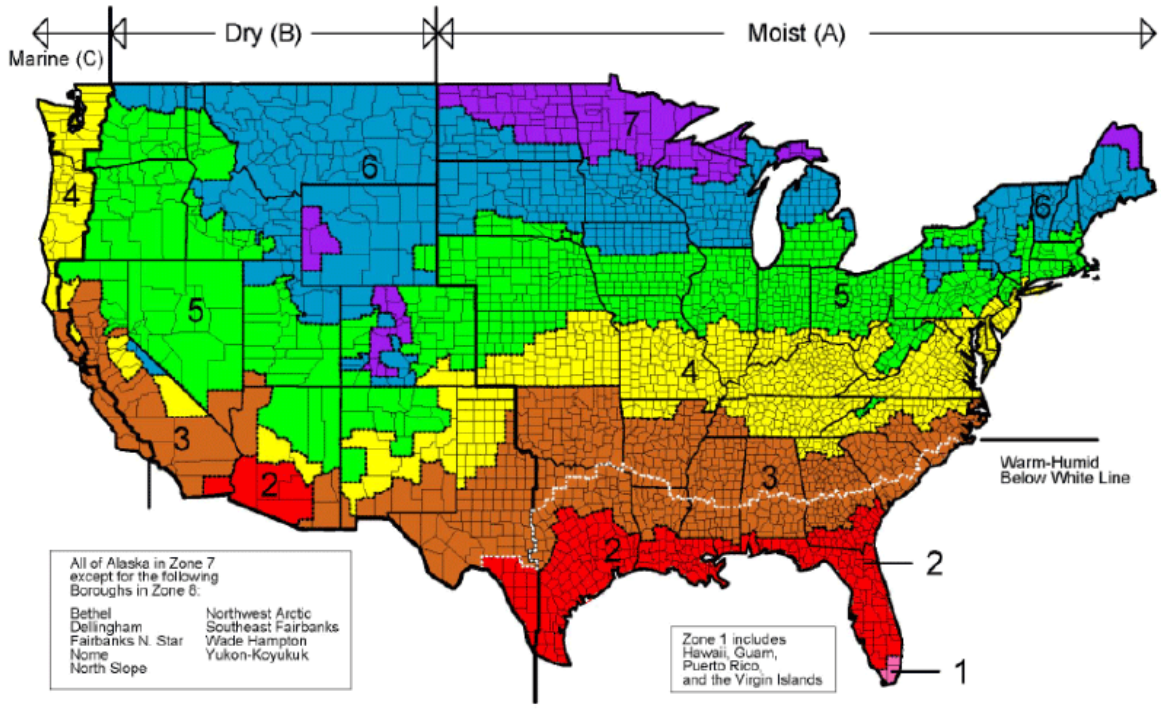
Example:

Climate zone 3	Std 90.1	Std 189.1
Insulation above deck	R-15	➔ R-25

- More stringent SHGC

Example for 10-40% window area:
Climate zone 5
Std. 90.1: 0.39 (0.49 north)
Std. 189.1: 0.35 all orientations

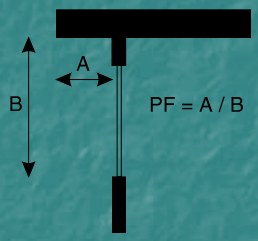
Climate Zones



Highlights for Energy (Chapter 7)

Prescriptive Option (Building Envelope)

- Vertical fenestration <40% wall area **(§7.4.2 d)**
- Overhang: PF > 0.5



  - For west, east & south
  - Climate zones 1-5 **(§7.4.2 e)**

Highlights for Energy (Chapter 7)

Prescriptive Option (Building Envelope)

- SHGC Multipliers **(§7.4.2 f)**

Table 7.4.2 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

Highlights for Energy (Chapter 7)

Prescriptive Option (Building Envelope)

- Fenestration orientation and SHGC

(§7.4.2 i)

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

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

2. For *climate zones* 5 and 6:

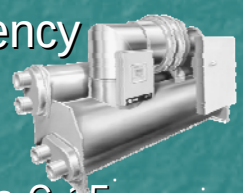
$$1/3{*}(A_N{*}SHGC_N + A_S{*}SHGC_S + A_E{*}SHGC_E) \geq 1.1{*}(A_W{*}SHGC_W)$$

Where:

$SHGC_x$	=	the *SHGC* for orientation x
A_x	=	*fenestration area* for orientation x
N	=	north (oriented less than 45 degrees of true north)
S	=	south (oriented less than 45 degrees of true south)
E	=	east (oriented less than or equal to 45 degrees of true east)
W	=	west (oriented less than or equal to 45 degrees of true west)

§7.4.3 HVAC (page 59)

- Comply with ASHRAE Standard 90.1 (current version), with modifications for:
  - Higher minimum efficiency to eliminate air economizer requirement **Table 7.4.3**
  - §7.4.3 (b) Minimum equipment efficiency
    - EPAct baseline + higher renewables, peak reduction, or
    - Energy Star or values listed Tables C-1 to C-15



  - §7.4.3 (c) Eliminate low-rise or climate zone 1-3 exception
  - §7.4.3 (d) Lowers DCV threshold

§7.4.3 HVAC (Cont'd)

- Standard 90.1 modifications:
  - §7.4.3 (e) Duct sealing level A everywhere
  - §7.4.3 (f) Expanded economizer requirement

Table 7.4.3-2 Minimum System Size for Which an Economizer is Required

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	≥ 9.7 kW (33,000 Btu/h)[a]

Standard 90.1
- **Included 3A and 4A**
- **Capacity > 65,000**

eliminates cooling efficiency Exception (i), rooftop units < 5 tons with 2-stage cooling

- §7.4.3 (h) Fan power limitation 10% lower
- §7.4.3 (i) Added part-load fan power limits

§7.4.3 HVAC (Cont'd)

- Standard 90.1 modifications:
  - §7.4.3 (j) Lowered pump power threshold
  - §7.4.3 (k) Expand energy recovery based on climate zone and airflow, increased required efficiency to 60%, maintains 90.1 exceptions

Zone	% Outside Air at full design cfm							
	≥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 CFM							
2B,3B,3C,4B,4C,5B	NR	NR	NR	≥16500	≥9500	≥5500	≥4500	≥4000
3A,4A	≥11000	≥7000	≥5500	≥4500	≥4000	≥3500	≥2000	≥1000
1A,2A, 5A, 6A, 6B	≥5000	≥4500	≥4000	≥3500	≥2500	≥1500	>0	>0
7,8	≥2000	≥0	>0	>0	>0	>0	>0	>0

§7.4.3 HVAC (Cont'd)

- Standard 90.1 modifications:
  - §7.4.3 (l) Kitchen hoods add variable speed
  - §7.4.3 (m and n) Minimum duct and pipe insulation increased (Tables C-16, 17 and 18)
  - §7.4.3 (o) Added pipe sizing/flow limitation

Table 7.4.3-6: Piping System Design Maximum Flow Rate in GPM (I-P)

	<=2000 hours/yr			<=4400 hours/year			<=8760 hours/year		
Pipe Size (in)	Constant Flow/ Constant Speed	Variable Flow/ Constant Speed	Variable Flow/ Variable Speed	Constant Flow/ Constant Speed	Variable Flow/ Constant Speed	Variable Flow/ Variable Speed	Constant Flow/ Constant Speed	Variable Flow/ Constant Speed	Variable Flow/ Variable Speed
½	4	4.8	6.2	3	3.6	4.7	2.4	2.8	3.6
¾	8.9	11	14	6.7	8.1	10	5.3	6.3	8.1
1	15	18	23	12	14	18	9.2	11	14

§7.4.3 HVAC (Cont'd)

- Standard 90.1 modifications:
  - §7.4.3 (p) Unoccupied hotel/motel guest rooms to have auto-shutoff with temperature setback
    - Access activated
    - Occupancy sensor

Highlights for Energy (Chapter 7)

Prescriptive Option Continued

- Only slight modifications for Service Water Heating (§7.4.4)
- §7.4.5 Power
  - Transformer efficiency requirements added
  - **Load factor / peak load reduction**
    Reduce peak capacity of the building through demand-limiting or load shifting measures

Highlights for Energy (Chapter 7)

Prescriptive Option (Lighting)

- Interior lighting power to be 10% less than ASHRAE Standard 90.1 (except retail)
- Occupancy sensor controls (§7.4.6 (b)) page 66
- Egress lighting control Auto-controls for daylight zones, outdoor lighting

Highlights for Energy (Chapter 7)

Performance Based Option:

- Demonstrated equivalent performance in **both** ***energy*** and ***CO_2 equivalent*** compared to if using the Prescriptive path

Proposed ≤ Mandatory + Prescriptive Path

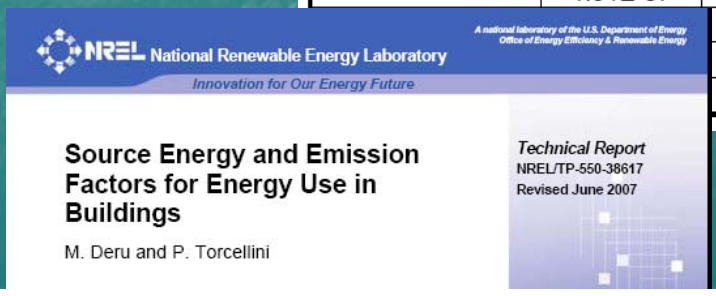
Using Appendix D "Performance Option for Energy Efficiency"

Energy – Environmental (Background)

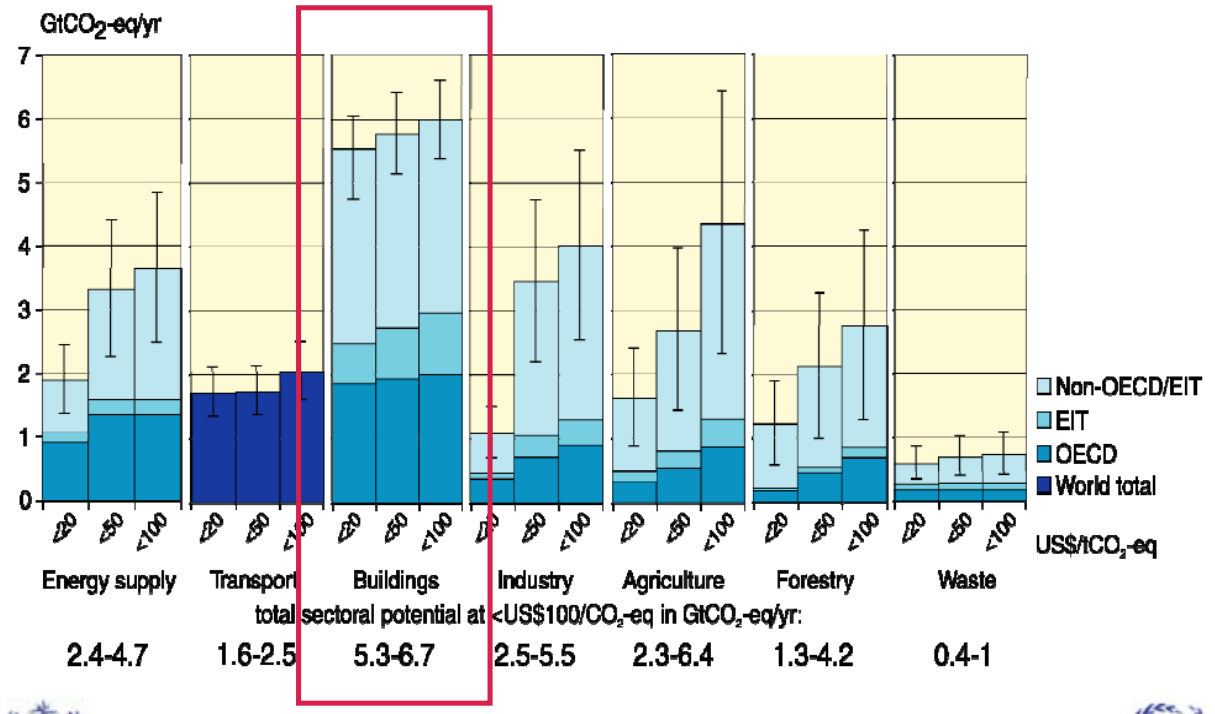
Energy generation emissions factors per kWh electricity consumed

BUT, where does your power come from?

Pollutant (lb)	National	Eastern	Western	ERCOT
CO_{2e}	1.67E+00	1.74E+00	1.31E+00	1.84E+00
CO_2	1.57E+00	1.64E+00	1.22E+00	1.71E+00
CH_4	3.71E-03	3.59E-03	3.51E-03	5.30E-03
N_2O	3.73E-05	3.87E-05	2.97E-05	4.02E-05
NO_X	2.76E-03	3.00E-03	1.95E-03	2.20E-03
SO_X	8.36E-03	8.57E-03	6.82E-03	9.70E-03
CO	8.05E-04	8.54E-04	5.46E-04	9.07E-04
TNMOC	7.13E-05	7.26E-05	6.45E-05	7.44E-05
Lead	1.31E-07	1.39E-07	8.95E-08	1.42E-07
			1.86E-08	2.79E-08
			6.99E-05	1.30E-04
			1.39E-01	1.66E-01



Economic mitigation potential by sector in 2030



WMO INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (IPCC) UNEP

Highlights for Energy (Chapter 7)

Performance Based Option:

- ***CO_2 equivalent*** compared to if using the Prescriptive path

Table 7.5.3: CO_2e Emission Factors

Building Project Energy Source	CO_2e 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)

Highlights for Energy (Chapter 7)

Performance Based Option:

§7.5.4 Load Factor/Peak Electric Demand

- Same or less peak electric demand as if following the prescriptive path
- Minimum electrical load factor of 0.25

Lunch Break!

Indoor Environmental Quality (Ch 8)

Indoor Environmental Quality:

- Mandatory (page 73):
  - ***1.3 times Standard 62.1-2004 outdoor airflow for offices and classrooms (climate zone and other exceptions)***

Indoor Environmental Quality (Ch 8)

Indoor Environmental Quality:

Mandatory:

- **§8.3.3 Outdoor Air Monitoring**
  - CO_2 monitoring for systems serving densely occupied spaces (lower threshold for *densely occupied* than Std. 62.1-2007)
    Table for action levels

  - Non-densely occupied spaces monitor outdoor airflow to ±15% of min. outdoor airflow

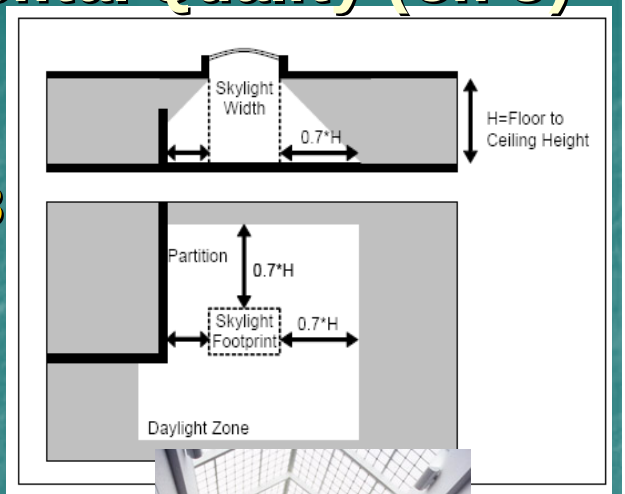
CO_2 Action Levels

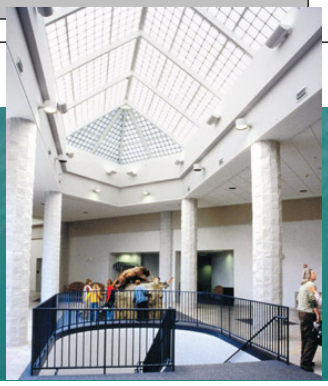
Ventilation per Person cfm	Actual Δ Concentration (ppm) MET=1.0	MET=1.2	MET=1.5	Action Level Δ Concentration (ppm) MET=1.0	MET=1.2	MET=1.5
5	1,680	2,000	2,520	1,800	2,200	2,600
6	1,400	1,667	2,100	1,500	1,800	2,200
7	1,200	1,429	1,800	1,300	1,600	1,900
8	1,050	1,250	1,575	1,200	1,400	1,700
9	933	1,111	1,400	1,100	1,300	1,500
10	840	1,000	1,260	1,000	1,100	1,400
11	764	909	1,145	900	1,100	1,300
12	700	833	1,050	800	1,000	1,200
13	646	769	969	800	900	1,100
14	600	714	900	700	900	1,000
15	560	667	840	700	800	1,000
16	525	625	788	700	800	900
17	494	588	741	600	700	900
18	467	556	700	600	700	800
19	442	526	663	600	700	800
20	420	500	630	600	700	800
21	400	476	600	500	600	700
22	382	455	573	500	600	700
23	365	435	548	500	600	700
24	350	417	525	500	600	700
25	336	400	504	500	600	600
26 or more	323	388	485	500	600	600

Indoor Environmental Quality (Ch 8)

Mandatory:

- **Minimum MERV 8 filtration**
- Daylighting by toplighting for large open spaces

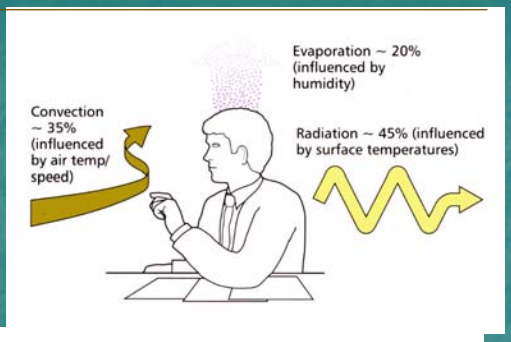


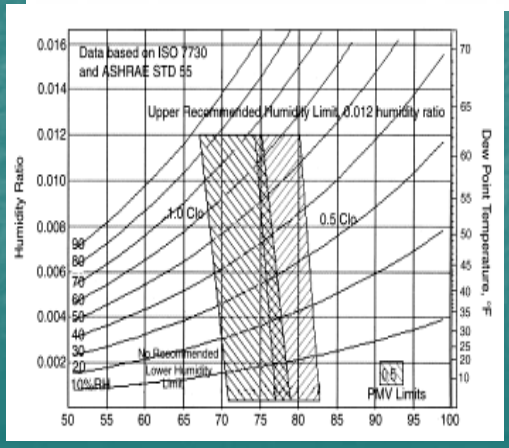


Indoor Environmental Quality (Ch 8)

Mandatory:

- Thermal Comfort
  - Comply with ASHRAE Std 55
- Mat systems at building entrances



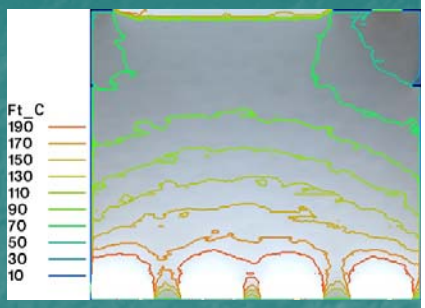


Indoor Environmental Quality (Ch 8)

Prescriptive Option:

- Side daylighting for offices and classrooms, with shading requirements
- Low emitting materials
  - Adhesives and sealants
  - Paints and coatings
  - Floor covering materials
  - Composite wood and agrifiber products
- Office space shading

Indoor Environmental Quality (Ch 8)



Performance Option:

- Daylighting simulation
  - All regularly occupied spaces
  - Minimum illuminance target: 300 lux (30 fc) on work surfaces, 4.5 m (15 ft) from façade, 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)

Case Study and Points of Emphasis

Materials (Chapter 9)

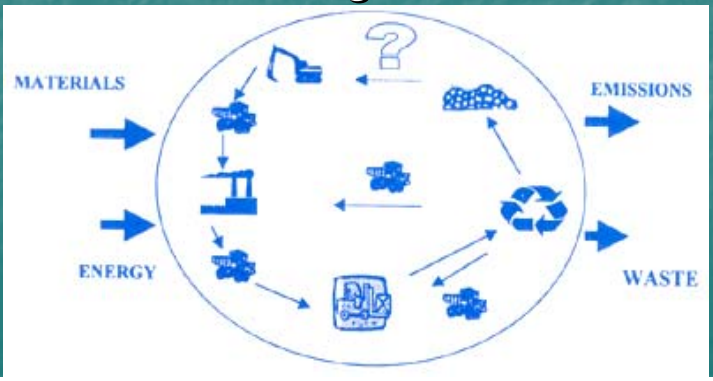
- Mandatory:
  - CFC, other refrigerant restrictions
  - ***Divert 50% of non-hazardous construction waste, demolition debris***
- Prescriptive Option:
  - Minimum 10% recycled content (cost)
  - Regionally Extracted, Processed, & Manufactured Materials
  - Biobased products
- Performance Option:
  - ***Life Cycle Assessment*** per ISO 14044

Highlights of Standard 189.1

- **Life Cycle Assessment (performance)**
  - Must include operating energy consumption
  - LCA to include <u>all</u> 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

Life Cycle ***COST*** is not Life Cycle ***ASSESSMENT***

- ***LCC*** is focused on just cost evaluations, but at least over the life of the system (not first cost only mentality)
- ***LCA*** is a total environmental impact assessment of the building over its life



Life Cycle Assessment: Tools

- BEES (U.S.) [Not sufficient for 189]
- ENVEST2 (UK)
- SimaPro (Netherlands) [Sufficient for 189]
- GaBi (Germany)
- Athena (Canada) *Environmental Impact Estimator* [Not sufficient for 189]

Case Study and Points of Emphasis

10 - Construction and Operation Plans

Mandatory:

- Full commissioning for projects > 5,000 ft^2
  - 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

§10.3.3.3 Energy Efficiency

Two compliance paths

- Comparison to CBECS benchmark 12-18 months after CO
- Energy simulation

- Done every 3 years

Table 10.3.3.3 Threshold for Energy M&V Evaluation

Building Usage Category	M&V Threshold, m^2 (ft^2)
Food Service (Restaurant)/ Food Sales (Grocery Store) Health Care Inpatient Health	>2,000 (20,000)
Lodging Office Public Order & Safety Outpatient Health Public Assembly Education	> 4,000 (40,000)
Retail Religious Worship	> 5,000 (50,000)
Warehouse Non-Refrigerated Storage Other*	> 8,000 (80,000) > 2,000 (20,000)

10 - Construction and Operation Plans

§10.3.3.4 Indoor Environmental Quality

- If CO2 monitoring, procedure for increasing outdoor air using **Action Levels** from Appendix E
- For outdoor air flow, verify quarterly
- IAQ Plan **§10.3.3.4 (f)**

Ventilation per Person	Actual Δ Concentration (ppm)			Action Level Δ Concentration (ppm)		
cfm	MET=1.0	MET=1.2	MET=1.5	MET=1.0	MET=1.2	MET=1.5
5	1,680	2,000	2,520	1,800	2,200	2,600
6	1,400	1,667	2,100	1,500	1,800	2,200
7	1,200	1,429	1,800	1,300	1,600	1,900
8	1,050	1,250	1,575	1,200	1,400	1,700
9	933	1,111	1,400	1,100	1,300	1,500
10	840	1,000	1,260	1,000	1,100	1,400
11	764	909	1,145	900	1,100	1,300
12	700	833	1,050	800	1,000	1,200
13	646	769	969	800	900	1,100
14	600	714	900	700	900	1,000
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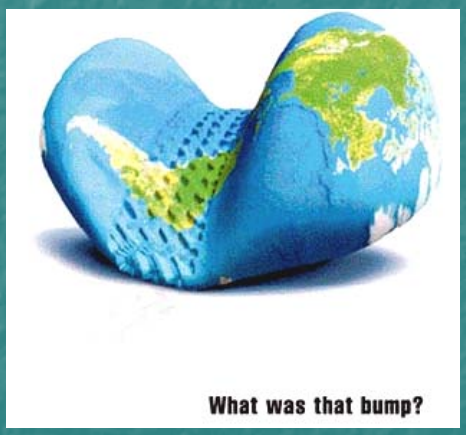
16	525	625	788	700	800	900
17	494	588	741	600	700	900
18	467	556	700	600	700	800
19	442	526	663	600	700	800
20	420	500	630	600	700	800
21	400	476	600	500	600	700
22	382	455	573	500	600	700
23	365	435	548	500	600	700
24	350	417	525	500	600	700
25	336	400	504	500	600	600
26 or more	323	388	485	500	600	600

Construction and Operation

Mandatory:

- Transportation Management Plan
  - Target: 14% reduction in vehicle trips in 18 months
- Building service life plan



Construction and Operation

Mandatory Provisions

- Construction
  - Minimize idling of construction vehicles
  - Moisture control measures during construction

Prescriptive Option - **NONE**

Performance Option - **NONE**

Stretch Break!

NORMATIVE APPENDIX D

PERFORMANCE OPTION FOR ENERGY EFFICIENCY

- Overview
- Example application

NORMATIVE APPENDIX D

PERFORMANCE OPTION FOR ENERGY EFFICIENCY

- Purpose and Scope
  - ***Performance*** based alternate compliance option to the ***Prescriptive*** path in §7.4
- Must comply with all mandatory provisions of Standard 90.1 and §7.3

$$\% \text{ Improvement} = 100 \times \left(\frac{\text{Baseline - Proposed}}{\text{Baseline}} \right)$$

Std. 90.1 Appendix G Performance Rating Method

- Technically not part of the standard and not substitute for ECB (modification) **THUS rewritten into Normative for Standard 189.1**
- Used for situations when energy usage is 'substationally' less than budget building, **LEED EVALUATIONS AND STD 189.1**
- Allows for different variations not readily treated within Energy Cost Budget in Std. 90.1 §11
  - Underfloor or Thermal Displacement Ventilation
  - PV
  - 'Better' building orientation

Std. 90.1 Appendix G Referred to in LEED

OPTION 1 — WHOLE BUILDING ENERGY SIMULATION (1–10 Points)

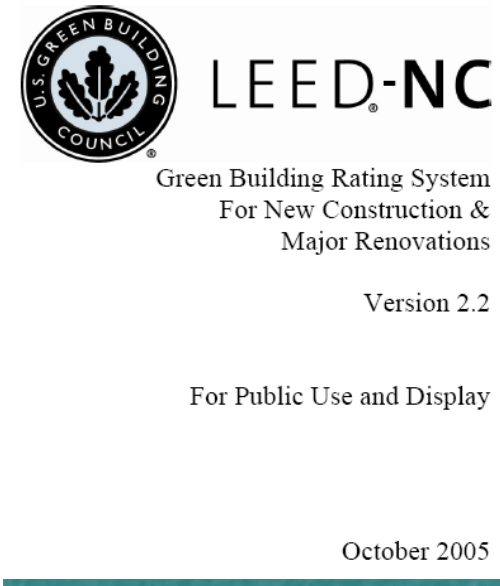
Demonstrate a percentage improvement in the proposed building performance rating compared to the baseline building performance rating per ASHRAE/IESNA Standard 90.1-2004 (without amendments) by a whole building project simulation using the Building Performance Rating Method in Appendix G of the Standard. The minimum energy cost savings percentage for each point threshold is as follows:

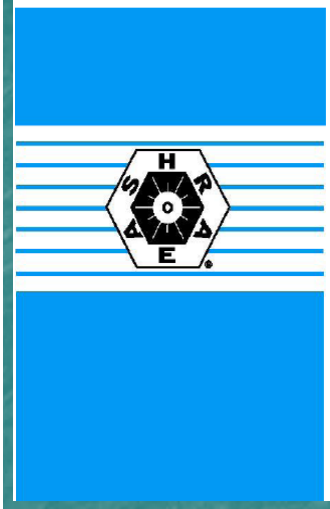
New Buildings	Existing Building Renovations	Points
10.5%	3.5%	1
14%	7%	2
17.5%	10.5%	3
21%	14%	4
24.5%	17.5%	5
28%	21%	6
31.5%	24.5%	7
35%	28%	8
38.5%	31.5%	9
42%	35%	10

ECB Vs. Appendix G

Baseline Building Characteristics		
Parameter	**ECB**	**Appendix G**
Building Orientation	**Same as Proposed Design**	**Neutral**
Window Distribution	**Same as Proposed Design**	**Neutral**
Building Mass	**Same as Proposed Design**	**Light Frame Construction**
HVAC System Type	**Based on Proposed Design – System Map.**	**Based on Building Size and Function**
Demand Controlled Ventilation	**Minimum Ventilation Same as Proposed**	**Minimum Ventilation May Be Greater Than Proposed (DCV)**
Equipment Sizing	**Same as Proposed**	**Typical oversizing factors**
Fan and Pump Energy Use	**Same as Proposed (up to max)**	**Highest Allowed By Standard**
Natural Ventilation	**Proposed Requires Fans to Run and Cooling Provided.**	**Proposed Building Can Take Credit (fans cycling, no cooling)**

Compare Standard 189.1 to LEED





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***

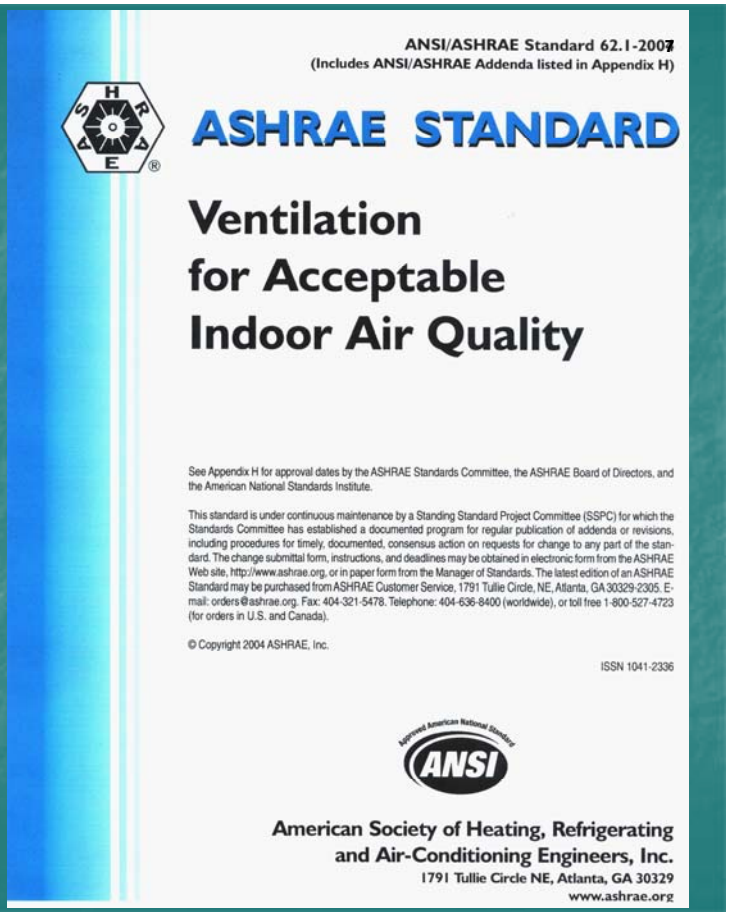
Second Public Review (February 2008) (Complete Draft for Full Review)

- Voluntary vs. mandatory
- 189.1 is:
  - More comprehensive
  - Pushes the envelope

Relation to Other ASHRAE Standards

- Standard 90.1
  - Directly refers to, but sometimes modifies
  - Appendix G rewritten and incorporated as a Normative Appendix D in 189.1
- Standard 62.1
  - Directly refers to, but modifies for the increased ventilation, filtration requirements
- Standard 55 - "*Comply with*"
- Standard 105 – Indirectly

ASHRAE Standard 62.1-2007



The (Revised) Ventilation Rate Procedure

The of Standard 62.1

- Rationale for revision of ventilation rates in the 2004 revision
- Calculation method

Motivation for Revising the Ventilation Rate Procedure

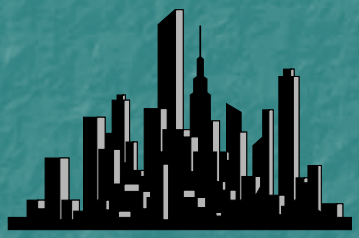
- New info since original proposal in 1986
- Some felt too high ventilation rates than needed in densely occupied spaces
- Others believed too low rates in sparsely occupied spaces
- Some thought rates were too low in general
- Confusion on ventilation effectiveness, system efficiency and intermittent occupancy

Rationale for New Ventilation Rates

- Recognizes building as a source of indoor air pollutants
- Accounts for ventilation efficiency
- Rates still largely based on judgment of the ASHRAE Project Committee

Revised Ventilation Rate Procedure

People Component | Building Component



Outdoor Air Ventilation Rate for Space

$$V_o = (D)\ R_p P_d + R_b A_b$$

Allowance to account for occupancy diversity

The *occupancy diversity* is defined as

$$D = P_s / \Sigma_{all\ zones} P_z$$

Minimum cfm/Person × Number of People + Minimum cfm/sq ft × Building Area

Ventilation Rate for System

$$V_{ot} = \Sigma V_o / E_v$$

System Efficiency

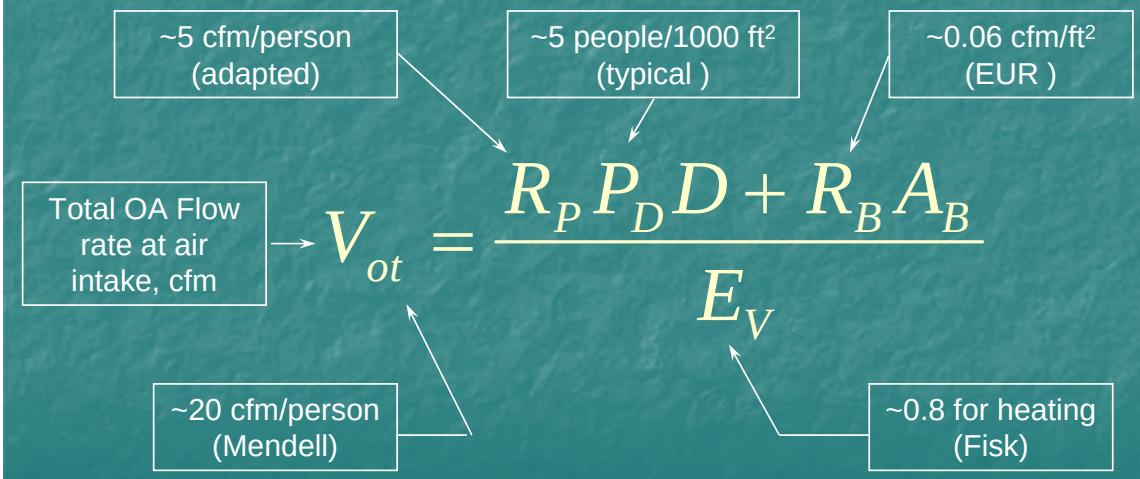
Air Distribution Effectiveness

- Standard 129 (+ lab/field experience)
- Ventilation Rate Procedure table, or test

Air Distribution Configuration (Examples)	*Ez*
Ceiling supply of cool air	1.0
Ceiling supply of warm air 15°F (8°C) or more above space temperature and ceiling return.	0.8
Floor supply of cool air and ceiling return, provided low-velocity displacement ventilation achieves unidirectional flow and thermal stratification	1.2
Floor supply of warm air and floor return	1.0
Floor supply of warm air and ceiling return	0.7
Makeup supply drawn in on the opposite side of the room from the exhaust and/or return	0.8
Makeup supply drawn in near to the exhaust and/or return location	0.5

Determining Total Ventilation Rates: Example

Office Buildings



Ventilation Rate Procedure

Space	62-2001 (cfm/person)	62-2004 rate at occupancy (people/1000 ft²)
Office	20	17 (5); 14 (7)
Conference room	20	5 (50)
Classroom	15	15 (25); 12 (50)
Lecture room	--	8 (65)
Auditorium	15	5 (150)

Example: Modular Schoolroom

$$V_{bz} = R_p P_z + R_a A_z$$

where :

R_p = 10 cfm

R_z = 0.12 cfm/ft^2

P_z = occupancy

A_z = zone floor area

$$V_{bz} = 10 \cdot 33 + 0.12 \cdot 800$$

$$V_{bz} = 426 \text{ cfm}$$

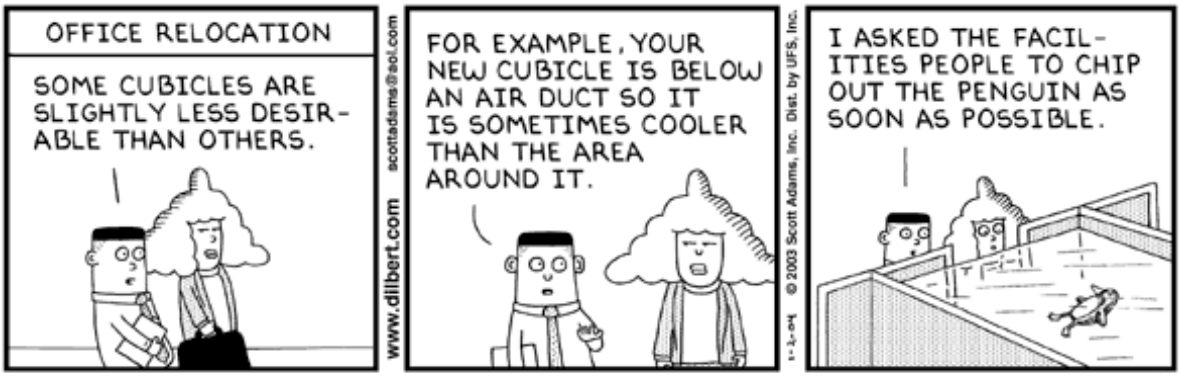
Example: This Room

	Zones served by system	Zone 1
	Space type (select from pull-down list)	Conference / mee
Az	Floor area of zone, ft2	1600
Pz	Zone population, largest # of people expected to occupy zone	40
Rp	Area outdoor air rate from Table 6.1, cfm/ft2	5
Ra	People outdoor air rate from Table 6.1, cfm/person	0.06
Pz*Rp		200
Az*Ra		96
Ez	Zone air distribution effectiveness, Table 6.2	0.9
Voz	Outdoor airflow to the zone corrected for zone air distribution effectiveness, (Pz*Rp + Az*Ra)/Ez, cfm	**329**

From ASHRAE Calculator

Now Adjust for Std. 189.1 (if applicable)

ASHRAE Standard 55 "Thermal Environmental Conditions for Human Occupancy"



Good Environment Condition = Good Performance

Standard 55: Key Definitions

- Predicted Mean Vote (PMV)
  - Index to predict the mean value of votes between cool to warm
- Predicted Percentage Dissatisfied (PPD)
  - Index to establish a quantitative prediction of people who are dissatisfied with thermal conditions, as determined from PMV
- Operative Temperature
  - Room equivalent temperature which accounts for radiation and convection heat transfer

New Features in 2004 Edition

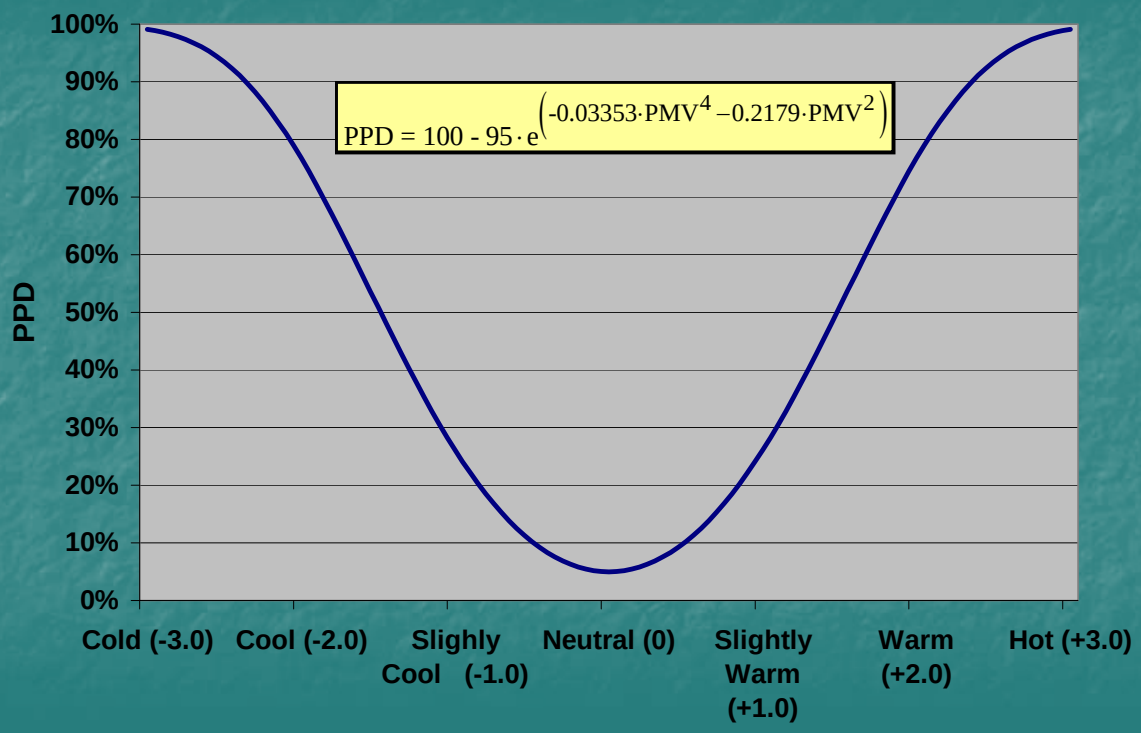
- Method for computing the PMV, PPD (program available for download)
- Includes concept of *adaptation* of building occupants
- Humidification downplayed

Determining Acceptable Thermal Conditions (Cont'd)

- Computational method for operative temperature and humidity ratio for larger activity level range (1.0 to 2.0 MET) and clothing level ($\leq$ 1.5 clo)

$$PPD = 100 - 95 \cdot e^{\left(-0.03353 \cdot PMV^4 - 0.2179 \cdot PMV^2\right)}$$

Relationship of PPD and PMV

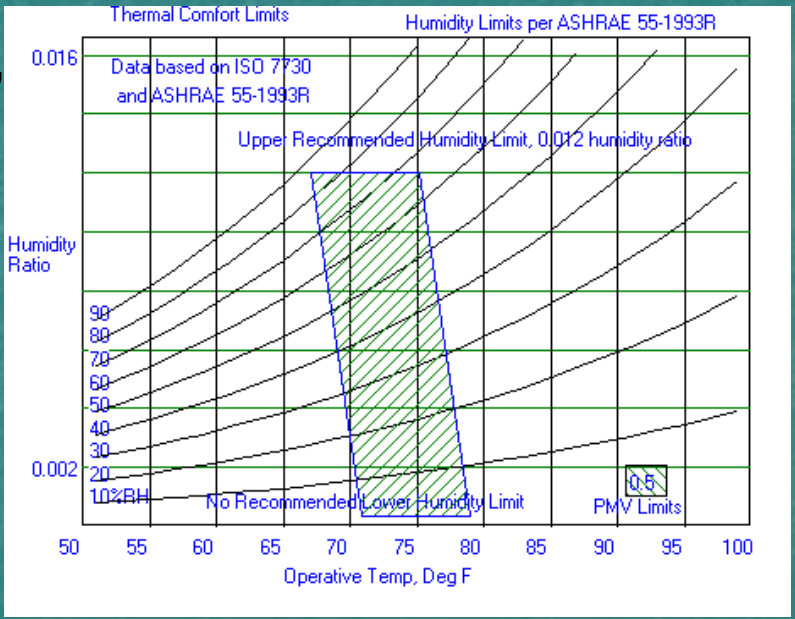


PMV for this Room

PREDICTED MEAN VOTE ESTIMATOR		
"COMFORT"	#Votes	Score
Cold	1	-3
Cool	2	-4
Slightly Cool	3	-3
Neutral	5	0
Slightly Warm	7	7
Warm	3	6
Hot	2	6
Total	23	9
	PMV=	0.39130435
	PPD =	8.2%

Sample Thermal Comfort Range

For MET = 1.1,
CLO = 1.0,
20 fpm
air velocity



Standard 105

- Purpose:
  - Common reporting of building energy use (existing or proposed)
- EPAct 2005 sets Standard 105 as the "Commercial building reference standard for ... energy code incentives"
- Required info summary for existing buildings, LEED-EB and Energy Star

Standard 105

- Scope

- Does not
  - Set goals
  - Certify modeling methods

a. covers the measurement of energy use for existing buildings and the prediction of energy use for proposed buildings,
b. specifies techniques for measuring, expressing, and comparing the energy performance of buildings,
c. provides minimum requirements for reporting predicted or measured energy performance, and
d. provides minimum requirements for specifying a building energy performance comparison method.

Complying with Standard 105

- Compliance requirements

Section		
5	Basic Measurement and Expression of Energy Performance	**Mandatory Minimum**
6	Additional Expressions of Building Energy Performance	**Optional**
7	Comparison of Building Energy Performance	

Std. 105

Std. 105 – Section 5
Basic Measurement and Expression

- Basic building description – Form 1
- Energy performance summary – Form 2
  - Source of data

a.	Utility bill or meter
b.	Installed meter
c.	Estimate (requires a brief description)
d.	Hourly simulation
e.	Other (requires a brief explanation)

  - Metering, install one if needed
  - On-site renewable – metering (kWh or Btu) *does not include passive means or that collected through ground source heat pump*

Std. 105

ASHRAE Standard 105 Form 2

Std. 105

Energy Performance Summary

Energy Type	Source of Energy Data	Energy Use Numerical Value	Units	Conversion Multiplier to kBtu (kWh)	Energy, kBtu/yr (kWh/yr)	Energy Cost, $
1. Electricity—Purchased						
2. Natural gas				Table 5.1		
3. Steam						
9. Thermal—On-Site Renewable						
10. Other						
11. Electricity—On-Site Generated						
12. Thermal or Electricity—Exported						
Total Energy [1] sum of 1 to 11 minus 12					A:	
Net Energy [2] Sum of 1 to 11 minus 9 and solar PV-generated kWh in 11					B:	C:

Computing and Summarizing Energy Use

Energy and Cost Indices

Total Energy Index (A ÷ Gross Floor Area) _____ kBtu/ft²·yr (kWh/m²·yr)

Net Energy Index (B ÷ Gross Floor Area) _____ kBtu/ft²·yr (kWh/m²·yr)

Energy Cost Index (C ÷ Gross Floor Area) _____ $/ft²·yr ($/m²·yr)

- Conversion factors, example Table 5.1

Fuel Oils	Btu/U.S. gal
#1	135,000
#2	139,000
#4	146,000
#5L	148,000
#5H	150,000
#6	154,000
Gas	
Natural Gas	1,030 Btu/ft³
Propane	91,600 Btu/US gal

Std. 105

Additional Expressions of Energy Performance

- Other performance measures such as air emissions (CO_2 or otherwise)
- Other normalizations (example)

Additional Numerical Expressions of Energy Use Performance

TOTAL ENERGY kBtu (kWh) Total from Form 2 (provide note if other energy total is used)	Factor or Characteristic for Normalization	Expression of Energy Performance (numerical value)	Units of Performance
Number of licensed hospital beds			

Examples:	Factors	Might include factors such as licensed beds for hospitals, number of annual transactions for retail stores, number of students for schools.
	Corresponding Units of Performance	Could be kBtu/yr (kWh/yr) per bed for hospitals, per each transaction for retail stores, per student for schools.

Std. 105

Comparison of Performance

ASHRAE Standard 105 **Form 4**

Comparison of Energy Performance

BUILDING IDENTIFICATION

Building ID _____ Comparison Start Date _____

Address _____ Comparison End Date _____

City, State, Country, ZIP (mail) Code _____

Gross Floor Area from Form 1 _____ ft^2 (m^2)

Total Energy Index from Form 2 _____ kBtu/ft^2·yr (kWh/m^2·yr)

Net Energy Index from Form 2 _____ kBtu/ft^2·yr (kWh/m^2·yr)

Cost Index from Form 2 _____ \$/ft^2·yr (\$/m^2·yr)

Performance Comparison Value(s)	Type of Value (numeric scale, grade, other)	Range of Performance Scale (Worst to Best)	Units of Performance Scale (or N/A)

Publicly available?

TYPE of COMPARISON METHOD: ___★___ Documented _____ Ad hoc/Undocumented

TIME PERIOD: _____ Annual _____ Other—Specify: _____

NAME of COMPARISON METHOD: _____

Std. 105

Informative Appendices

- Appendix A: Measuring Energy Use (existing buildings)
- Appendix B: Adjusting to 365-day year baseline

FURTHER INFORMATION

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

Thank you!

- Comments, questions, concerns, advice ...

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