ASHRAE Standard 90.1/189.1 for achieving minimum energy-efficient requirements for commercial buildings

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- Structure and Scope
- Compliance Options
- Energy Cost Budget Method
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ASHRAE Standard 90.1

- **ASHRAE** = American Society of Heating, Refrigerating and Air-Conditioning Engineers
- Global leader in the arts and sciences of heating, ventilation, air conditioning and refrigeration
- [www.ashrae.org](http://www.ashrae.org)
- Important ASHRAE Standards:
  - 55: thermal comfort
  - 62.1: indoor air quality
  - 90.1: building energy conservation
  - 135: BACnet (building automation & control)
  - 189.1: high performance green buildings
ASHRAE Standard 90.1

- ASHRAE Standard 90.1 ([www.ashrae.org/standard901](http://www.ashrae.org/standard901))
  - Energy Standard for Buildings Except Low-Rise Residential Buildings
    - Include (new) commercial & institutional buildings
  - SSPC 90.1 Standing Standard Project Committee
- Other relevant ASHRAE Standards:
  - 90.2 -- for low-rise residential buildings
  - 90.4 – for data centers
  - 100 -- for existing buildings
Why ASHRAE Standards 90.1 is important?
- It is the reference standard for US Energy Policy Act and many building energy codes in USA
- It has been adopted in many countries as a model for energy efficiency guidelines and codes
- It is the professional “standard of care” set by ASHRAE consensus, with support from
  - IES (Illuminating Engineering Society) or IESNA
  - ANSI (American National Standards Institute)
- Required for LEED green building certification
ASHRAE Standard 90.1

- ASHRAE 90.1 timeline*:
  - 90-1975: first issued
  - 90A-1980: updated
  - 90.1-1989: updated
  - 90.1-1999: major rewrite
  - 90.1-2001: minor revisions
  - 90.1-2004: updates, reorganization
  - 90.1-2007: updates
  - 90.1-2010: updates
  - 90.1-2013: expanded & updates

(*See also: http://en.wikipedia.org/wiki/ASHRAE_90.1)
ASHRAE Standard 90.1

- ASHRAE 90.1-2013 (current version)
  - Goal: to achieve 30% energy savings compared to 90.1-2004 (may not be met for all buildings types in all locations)
- Standard 90.1 is on a 3-year cycle under a “continuous maintenance process”
  - Ongoing changes through “addenda”
  - Consensus standard (open ANSI process)
    - Jointly sponsored by IES and ANSI
Structure and Scope

- Structure of Standard 90.1-2013
  - 1. Purpose
  - 2. Scope
  - 3. Definitions, Abbreviations, and Acronyms
  - 4. Administration and Enforcement
  - 5. Building Envelope
  - 6. Heating, Ventilating, and Air Conditioning
  - 7. Service Water Heating
Structure and Scope

- Structure of Standard 90.1-2013 (cont’d)
  - 8. Power
  - 9. Lighting
  - 10. Other Equipment
  - 11. Energy Cost Budget Method
  - 12. Normative References
Structure and Scope

- Standard 90.1-2013 Normative Appendices
  - A – Rated R-Value of Insulation and Assembly U-Factor, C-Factor, and F-Factor Determinations
  - B – Building Envelope Climate Criteria
  - C – Methodology for Building Envelope Trade-Off Option
  - D – Climatic Data
  - E – Informative References
  - F – Addenda Description Information
  - G – Performance Rating Method
Structure and Scope

• **Purpose**: provide *minimum* requirements for the energy-efficient design of buildings except low-rise residential buildings

• Not a design or advanced building guide
  - Separate advanced energy design guides were developed by ASHRAE and other related bodies

• **Consensus standard** (open ANSI process)
  - Jointly sponsored by IESNA and ANSI

* IESNA = Illuminating Engineering Society of North America (now IES)
  ANSI = American National Standards Institute
Structure and Scope

• **Scope**
  - New buildings and their systems
  - New portions of buildings and their systems (additions)
  - New systems and equipment in existing buildings (alterations), e.g. computer rooms

• **Exemptions, such as**
  - Equipment and portions of building systems that use energy primarily for industrial or manufacturing purposes
Main areas of ASHRAE 90.1

1. Building Envelope
   - Roofs, walls, floors, slabs, doors, vertical glazing, skylights

2. HVAC Equipment and System
   - Cooling equipment efficiency, heating equipment efficiency, supply fans, ventilation control, ducts

3. Lighting
   - Interiors electric lighting, controls, daylighting

4. Services Water Heating (SWH)
   - Equipment efficiency, pipe insulation

5. Power and Others
   - Motors, plug loads
ASHRAE 90.1 compliance approaches

### Building System
- Envelope
- HVAC
- SWH
- Power
- Lighting
- Other

### Compliance Options
- Mandatory Provisions
  (required for most compliance options)
- Prescriptive Option
- Trade Off Option
- Energy Cost Budget
- Simplified

### Energy Code Compliance

(Source: US Department of Energy)
Envelope compliance options in ASHRAE 90.1

Mandatory Provisions

Prescriptive Option

Trade-off Option

Energy Cost Budget

Compliance

Envelop compliance options in ASHRAE 90.1
Compliance Options

• Building envelope prescriptive option:
  • Window-to-wall ratio (WWR) ≤ 40%, skylight-roof ratio ≤ 5%
  • 8 Criteria sets for different climate types
    • Insulation level, fenestration criteria

• Building envelope trade-off option:
  • Envelope performance factor (EPF) of proposed building ≤ EPF of budget building
    • ENVSTD and ComCheck software
US climate zones for building envelope prescriptive option

(Source: US Department of Energy)
Compliance Options

- HVAC simplified approach option:
  - Limited to small buildings (< 2,500 sq.m)

- HVAC mandatory provisions:
  - Minimum equipment efficiency
  - Load calculations
  - Controls
  - HVAC system construction and insulation
  - Completion requirements
Examples of HVAC equipment efficiencies

<table>
<thead>
<tr>
<th>Equipment type</th>
<th>Minimum efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-contained, water-cooled w/electric resistance heat (20–100 tons)</td>
<td>11.0 EER 10.3 IPLV</td>
</tr>
<tr>
<td>Water-source heat pump (1.5–5.25 tons)</td>
<td>12.0 EER (cooling) 4.2 COP (heating)</td>
</tr>
<tr>
<td>Centrifugal chiller, water-cooled (≥ 300 tons)</td>
<td>6.10 COP 0.576 kW/ton 6.40 IPLV 0.549 IPLV (at ARI rating conditions)</td>
</tr>
</tbody>
</table>

§6.4.1.1: “… Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements …”

(Source: Trane)
Compliance Options

- HVAC prescriptive path:
  - Economizers
  - Simultaneous heating and cooling limitation
  - Air system design and control
  - Hydronic system design and control
  - Heat rejection equipment
  - Energy recovery
  - Exhaust hoods, radiant heating systems
  - Hot gas bypass limitation
Lighting compliance requirements

Mandatory Requirements (Interior and Exterior)

- Controls
- Switching
- Efficiency

Interior Lighting Power Limits

- Total Connected Power < Interior Lighting Power Allowance

Whole Building

OR

Space-by-Space

Additional Allowances

Exemptions

Exterior Lighting Power Limits

- Tradable
- Non-Tradable

Total Connected Power < Exterior Lighting Power Allowance

(Source: US Department of Energy)
Compliance Options

• Interior lighting power
  • Two methods to determine the interior lighting power allowance (ILPA):
    • 1) **Building area method**
      • For whole building, grossed lighted area is multiplied by allowance (more restrictive)
    • 2) **Space-by-space method**
      • For projects with well-defined space types
  • Exemptions, e.g. video production, medical
Compliance Options

- The ILPA is to be determined for:
  - The entire building OR
  - Separately metered or permitted portions of the building
    - Tradeoffs between portions are NOT allowed if they use different methods of calculation
- Exterior lighting power
  - Lamp efficacy
  - Exterior lighting power wattage limits
Compliance Options

- Service Water Heating
  - Prescriptive and energy cost budget
  - Mandatory provisions (Section 7.4)
    - Load calculations
    - Equipment efficiency
    - Service hot water piping insulation
    - System controls
    - Pools
    - Heat traps
  - Prescriptive path (Section 7.5)
    - Space heating and water heating
    - Service water heating equipment
Compliance Options

- Power and Other Equipment
  - Max voltage drop allowed at design load
    - Feeder conductors
    - Branch circuit conductors
  - Motor efficiency levels correspond to Energy Policy Act’s manufacturing standards
    - Mandatory provisions are for General Purpose Design A and Design B motors only
    - Motors in new buildings, additions to existing buildings, and alterations to existing buildings must comply
Energy Cost Budget Method

- **Energy Cost Budget (ECB) Method**
  - The ultimate trade-off method to trade-off across building systems through the use of annual, hourly simulation tools and a baseline building
  - The only real way to deal with unique designs, renewables, high-efficiency equipment, etc.
  - Buildings must still meet all mandatory requirements
  - Basis of *performance-based* codes
Basic concept of Energy Cost Budget (ECB) Method

Proposed Building

- Meets basic requirements
- Exempt from prescriptive and system performance requirements

Simulate Annual Energy Cost

Design Energy Cost

must be less than

Energy Cost Budget

Reference Building

- Meets basic requirements
- Meets prescriptive and system performance requirements

(Source: Hawaii building energy code)
Energy Cost Budget (ECB) Method in ASHRAE 90.1

1. Proposed Design
2. Building Energy Cost Budget Method
   - Proposed Design
   - Energy Cost Budget
     - Prototype Building
     - Reference Building
   - Design Energy Consumption (DECON)
     - Design Energy Cost (DECOS)
6. Is DECOS <= ECB?
   - No: Modify proposed design
   - Yes: Compliance Ok
Energy Cost Budget Method

- **Step 1**: Verify compliance with the mandatory provisions of Standard 90.1
- **Step 2**: Determine which prescriptive requirements to implement
- **Step 3**: Model the proposed design in accordance with Section 11.3 of Standard 90.1
- **Step 4**: Model the budget design to determine the annual energy cost budget
- **Step 5**: Compare the annual energy costs of the two models
Energy Cost Budget Method

- Budget design (reference building)
  - Based on the proposed design, but changes all Standard 90.1-governed design details to represent minimum compliance, e.g.
    - Building envelope characteristics
    - Lighting power densities
    - Economizer type (if required)
    - Heat-recovery type (if required)
    - HVAC system type
    - Fan energy, cooling & heating equipment
Performance Rating Method

- **Performance Rating (PR) Method**
  - Appendix G of Standard 90.1
  - Instructions for using the ASHRAE Standard 90.1 Energy Cost Budget Method in conjunction with the LEED program
    - LEED = Leadership in Energy and Environmental Design (developed by US Green Building Council)
  - ECB forms the basis of the energy portion of the LEED rating
Performance Rating Method

- From 90.1-2010, Appendix G becomes a normative section (previously informative)
  - It incorporates Appendix G fully into the standard making it subject to the same rigorous public review process the rest of the standard undergoes
- Using 90.1 as baseline for energy efficient and green building programmes
  - Use performance rating method to calculate energy savings; give credits to advanced design strategies, more flexible than ECB method
### Comparing the simulation requirements for ECB & PR methods

<table>
<thead>
<tr>
<th><strong>Energy Cost Budget Method</strong></th>
<th><strong>Performance Rating Method</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>(from 90.1 Section 11 for EAp2)</td>
<td>(from 90.1 Appendix G for EAc1)</td>
</tr>
<tr>
<td>Calculates at least 1,400 hours of building operation to simulate annual energy use</td>
<td>Calculates 8,760 hours of building operation to simulate annual energy use</td>
</tr>
<tr>
<td>Accounts for hourly variations (defined separately for each day of the week and holidays) in occupancy, lighting power, miscellaneous equipment power, thermostat setpoints, and HVAC operation</td>
<td>[Same]</td>
</tr>
<tr>
<td>Accounts for thermal mass effects</td>
<td>[Same]</td>
</tr>
<tr>
<td>Models 10 or more thermal zones</td>
<td>[Same]</td>
</tr>
<tr>
<td>Accounts for part-load performance of mechanical equipment</td>
<td>[Same]</td>
</tr>
<tr>
<td>Includes capacity and efficiency corrections for mechanical cooling &amp; heating equipment</td>
<td>[Same]</td>
</tr>
<tr>
<td>Models airside and waterside economizers with integrated control</td>
<td>Models airside economizers with integrated control</td>
</tr>
</tbody>
</table>
Comparing the simulation requirements for ECB & PR methods (cont’d)

<table>
<thead>
<tr>
<th>Energy Cost Budget Method</th>
<th>Performance Rating Method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(from 90.1 Section 11 for EAp2)</strong></td>
<td><strong>(from 90.1 Appendix G for EAc1)</strong></td>
</tr>
<tr>
<td>Models budget building design characteristics per Section 11.5</td>
<td>Models baseline building design characteristics per Section G3</td>
</tr>
<tr>
<td>Calculates design loads</td>
<td>[Same]</td>
</tr>
<tr>
<td>Uses hourly weather data, such as temperature and humidity, for the climate that best represents the location of the proposed design</td>
<td>[Same]</td>
</tr>
<tr>
<td>Calculates annual energy costs using rates for purchased energy approved by the adopting authority; or, exports hourly reports of energy use to a program that can</td>
<td>Calculates annual energy costs using either actual rates for purchased energy or state average energy prices published by DOE’s Energy Information Administration, <a href="http://www.eia.doe.gov/">http://www.eia.doe.gov/</a>; or exports hourly reports of energy use to a program that can</td>
</tr>
<tr>
<td>Tested in accordance with ASHRAE Std 140-2007, Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs</td>
<td>Includes calculation methodologies for the building components being modeled</td>
</tr>
</tbody>
</table>
Performance Rating Method

• Trade-off limits
  • Does not allow energy savings based on promises about the future or measures made in the past
  • Savings must be based on “real time” conditions

• Documentation requirements
  • Project summary & project overview
  • Energy efficiency features
  • Mandatory features
  • Prescriptive tradeoffs
  • Energy results
《建築物能源效益條例》
The Buildings Energy Efficiency Ordinance

空調裝置
Air-conditioning installation

電力裝置
Electrical installation

照明裝置
Lighting installation

升降機及自動梯裝置
Lift & escalator installation

能源審核表格

(Source: EMSD)  (See http://www.beeo.emsd.gov.hk for details)
Proposed framework of the comprehensive BECs in Hong Kong

Compliance for the Proposed Design

Basic Requirements

Prescriptive Approach

Building Envelope
Lighting
HVAC
Electrical
Lift & Escalator

Performance Approach

Total Building Energy Performance

(Source: EMSD)
Performance compliance for building energy code

Proposed Building Design

- Designed Building
  - Design Energy Consumption

- Reference Building
  - Total Energy Budget

Consumption \( \leq \) budget?

Yes

Compliance with the building energy code

Basic requirements must be met
Rating tools of building environmental performances around the world

(Adapted from CASBEE in Progress for Market Transformation in Japan, by Prof. Kazuo Iwamura, Tokyo City University)
LEED Rating System

• LEED Green Building Rating System
  • Leadership in Energy & Environmental Design
    • By US Green Building Council
• Current LEED systems:
  • New construction (LEED-NC) or Building design and construction (BD+C)
  • Existing buildings operations & maintenance (LEED-EBOM) (O+M)
  • Commercial interiors (LEED-CI)
  • Core and shell (LEED-CS)
  • Homes, Schools, Healthcare, Retail
  • Neighborhood development (LEED-ND)
### LEED® for New Construction

<table>
<thead>
<tr>
<th>Category</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable Sites</td>
<td>26</td>
</tr>
<tr>
<td>Water Efficiency</td>
<td>10</td>
</tr>
<tr>
<td>Energy &amp; Atmosphere</td>
<td>35</td>
</tr>
<tr>
<td>Materials &amp; Resources</td>
<td>14</td>
</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>15</td>
</tr>
</tbody>
</table>

Total Possible Points: **110**

*Out of a possible 100 points + 10 bonus points
Certified 40+ points, Silver 50+ points, Gold 60+ points, Platinum 80+ points

### LEED® for Existing Buildings

<table>
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</tr>
</thead>
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<td>Sustainable Sites</td>
<td>26</td>
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<td>Energy &amp; Atmosphere</td>
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</tr>
<tr>
<td>Indoor Environmental Quality</td>
<td>15</td>
</tr>
</tbody>
</table>

Total Possible Points: **110**

*Out of a possible 100 points + 10 bonus points
Certified 40+ points, Silver 50+ points, Gold 60+ points, Platinum 80+ points

### Innovation in Design

- **6** points

### Regional Priority

- **4** points

(Source: USGBC)
# LEED 2009 New Construction Checklist

## Energy and Atmosphere

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑️ Prerequisite 1</td>
<td>Fundamental Commissioning of Building Energy Systems</td>
<td>Required</td>
</tr>
<tr>
<td>☑️ Prerequisite 2</td>
<td>Minimum Energy Performance</td>
<td>Required</td>
</tr>
<tr>
<td>☑️ Prerequisite 3</td>
<td>Fundamental Refrigerant Management</td>
<td>Required</td>
</tr>
<tr>
<td>☐ Credit 1</td>
<td>Optimize Energy Performance</td>
<td>1–19</td>
</tr>
<tr>
<td>☐ Credit 2</td>
<td>On-site Renewable Energy</td>
<td>1–7</td>
</tr>
<tr>
<td>☐ Credit 3</td>
<td>Enhanced Commissioning</td>
<td>2</td>
</tr>
<tr>
<td>☐ Credit 4</td>
<td>Enhanced Refrigerant Management</td>
<td>2</td>
</tr>
<tr>
<td>☐ Credit 5</td>
<td>Measurement and Verification</td>
<td>3</td>
</tr>
<tr>
<td>☐ Credit 6</td>
<td>Green Power</td>
<td>2</td>
</tr>
</tbody>
</table>

## Materials and Resources

<table>
<thead>
<tr>
<th>Credit</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>☑️ Prerequisite 1</td>
<td>Storage and Collection of Recyclables</td>
<td>Required</td>
</tr>
<tr>
<td>☐ Credit 1.1</td>
<td>Building Reuse—Maintain Existing Walls, Floors and Roof</td>
<td>1–3</td>
</tr>
<tr>
<td>☐ Credit 1.2</td>
<td>Building Reuse—Maintain Existing Interior Nonstructural Elements</td>
<td>1</td>
</tr>
<tr>
<td>☐ Credit 2</td>
<td>Construction Waste Management</td>
<td>1–2</td>
</tr>
<tr>
<td>☐ Credit 3</td>
<td>Materials Reuse</td>
<td>1–2</td>
</tr>
<tr>
<td>☐ Credit 4</td>
<td>Recycled Content</td>
<td>1–2</td>
</tr>
<tr>
<td>☐ Credit 5</td>
<td>Regional Materials</td>
<td>1–2</td>
</tr>
<tr>
<td>☐ Credit 6</td>
<td>Rapidly Renewable Materials</td>
<td>1</td>
</tr>
<tr>
<td>☐ Credit 7</td>
<td>Certified Wood</td>
<td>1</td>
</tr>
</tbody>
</table>

(Source: USGBC)
LEED Rating System

• **EAp2: Minimum energy performance**
  
  • **Intent:** Establish the minimum level of energy efficiency for the proposed building and systems
  
  • **Requirements:** Mandatory provisions of ASHRAE 90.1 **and**
    
    • Prescriptive requirements of 90.1 **or**
    
    • Performance requirements of 90.1 Section 11 (Energy Cost Budget Method) **or**
    
    • The requirements in the local energy code, whichever is more stringent
LEED Rating System

• **EAc1: Optimize energy performance**
  
  • **Intent:** Achieve increasing levels of energy performance above the baseline in the prerequisite standard to reduce environmental impacts associated with excessive energy use
  
  • **Requirements:** Awards points for improving performance rating of the design building vs. baseline building as per ASHRAE Standard 90.1 (Appendix G) [1 to 19 points]
### EAc1: Optimize energy performance
(Up to 19 points)

<table>
<thead>
<tr>
<th>New Buildings</th>
<th>Existing Building Renovations</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>12%</td>
<td>8%</td>
<td>1</td>
</tr>
<tr>
<td>14%</td>
<td>10%</td>
<td>2</td>
</tr>
<tr>
<td>16%</td>
<td>12%</td>
<td>3</td>
</tr>
<tr>
<td>18%</td>
<td>14%</td>
<td>4</td>
</tr>
<tr>
<td>20%</td>
<td>16%</td>
<td>5</td>
</tr>
<tr>
<td>22%</td>
<td>18%</td>
<td>6</td>
</tr>
<tr>
<td>24%</td>
<td>20%</td>
<td>7</td>
</tr>
<tr>
<td>26%</td>
<td>22%</td>
<td>8</td>
</tr>
<tr>
<td>28%</td>
<td>24%</td>
<td>9</td>
</tr>
<tr>
<td>30%</td>
<td>26%</td>
<td>10</td>
</tr>
<tr>
<td>32%</td>
<td>28%</td>
<td>11</td>
</tr>
<tr>
<td>34%</td>
<td>30%</td>
<td>12</td>
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<tr>
<td>36%</td>
<td>32%</td>
<td>13</td>
</tr>
<tr>
<td>38%</td>
<td>34%</td>
<td>14</td>
</tr>
<tr>
<td>40%</td>
<td>36%</td>
<td>15</td>
</tr>
<tr>
<td>42%</td>
<td>38%</td>
<td>16</td>
</tr>
<tr>
<td>44%</td>
<td>40%</td>
<td>17</td>
</tr>
<tr>
<td>46%</td>
<td>42%</td>
<td>18</td>
</tr>
<tr>
<td>48%</td>
<td>44%</td>
<td>19</td>
</tr>
</tbody>
</table>
ASHRAE Standard 189.1

• New **ASHRAE Standard 189.1**: Design of High-Performance Green Buildings
  • Developed by ASHRAE, USGBC and IESNA
  • A total building sustainability package
  • The first code-intended commercial green building standard in USA
  • It covers key topic areas similar to LEED
• Further information:
  • [www.ashrae.org/greenstandard](http://www.ashrae.org/greenstandard)
ASHRAE Standard 189.1

- What is Standard 189.1?
  - A standard developed in model code language
  - Provides minimum requirements for high-performance, green buildings
  - Applies to all buildings except low-rise residential buildings (same as ASHRAE Standard 90.1)
  - Optional compliance path to the International Green Construction Code (IgCC)
  - Not a design guide, not a rating system
ASHRAE Standard 189.1 Preview
www.ashrae.org/greenstandard

Knowledge is power. Understanding is power².
ASHRAE Standard 189.1

• Goals for Standard 189.1
  • Establish mandatory criteria in all topic areas
    • One “challenge” is existing green building rating systems contain few mandatory provisions
  • Provide simple prescriptive compliance options
  • Provide flexible performance compliance options
  • Complement green building rating programs
    • Standard is not intended to compete with green building rating programs (e.g. LEED)
Standard 189.1 building blocks

(Source: Mr. Kent W. Peterson)
Compliance paths of Standard 189.1

- Mandatory + Prescriptive Path
  - (simple option, very few calculations)

- Mandatory + Performance Path
  - (more options, but more effort)

(Source: Mr. Kent W. Peterson)
ASHRAE Standard 189.1

- Standard 189.1 topic areas:
  - SS: Sustainable Sites
  - WE: Water Use Efficiency
  - EE: Energy Efficiency
  - IEQ: Indoor Environmental Quality
  - MR: Building’s Impact on the Atmosphere, Materials & Resources
  - CO: Construction and Operations Plans
ASHRAE Standard 189.1

- Sustainable Sites Highlights
  - Site selection
    - Allowable sites (e.g. brownfield)
    - Prohibited development activity
  - Reduce heat island effect
    - Site hardscape
    - Wall and roof
  - Reduce light pollution
    - Outdoor lighting
    - Light trespass limits
ASHRAE Standard 189.1

• Water Use Efficiency Highlights
  • Site water use
    • Bio-diverse plantings, hydrozoning, and smart irrigation controllers
  • Building water use
    • Plumbing fixtures & fittings, appliances, HVAC systems & equipment
    • Cooling tower maximum cycles of concentration
  • HVAC Systems, equipment
  • Water consumption management
ASHRAE Standard 189.1

- Energy Efficiency Highlights
  - More stringent than Standard 90.1-2007
    - Equipment efficiency compliance
  - Includes plug/process loads
  - Electric peak load reduction
  - Renewable energy provisions
    - On-site renewable energy systems
  - Energy measurement for verification
    - Remote or automatic reading meters
ASHRAE Standard 189.1

- Indoor Environmental Quality Highlights
  - Indoor air quality
    - Ventilation rates per ASHRAE Standard 62.1
    - Outdoor air flow rate monitoring of min. outside air
    - MERV 8 filter (MERV 13 in PM2.5 non-attainment areas)
    - No smoking inside building
    - Source contaminant control
  - Daylighting
  - Acoustical control
ASHRAE Standard 189.1

• The Building’s Impact on the Atmosphere

Highlights

• Construction waste management
• Reduced impact materials
• Wood products
• Refrigerants (no CFC)
• Storage and collection of recyclables and discarded goods
ASHRAE Standard 189.1

- Construction and Operation Highlights
  - Acceptance testing / commissioning
  - IAQ construction management plan
- Plans for Operation
  - High-performance building operation
  - Maintenance
  - Service life
  - Transportation management
THANK YOU 謝謝！！