ASHRAE Basics and LEED Rating System

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• ASHRAE 62.1
• ASHRAE 90.1
• Structure and Scope
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• ASHRAE 189.1
Background

- **Dr. Sam C. M. Hui**
  - PhD, BEng(Hons), CEng, CEM, MASHRAE, MCIBSE, MHKIE, MIESNA, LifeMAEE, AssocAIA
  - ASHRAE Distinguished Lecturer (2009-2011)
  - CEng = Chartered Engineer
  - CEM = Certified Energy Manager
  - LifeMAEE = Life Member, Associatn of Energy Engineers
  - Worked in 1998 as a visiting researcher in the Asia Pacific Energy Research Centre, Japan
  - Research interests: energy efficiency in buildings and sustainable building technologies
Background

- **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)
- **LEED** = Leadership in Energy & Environmental Design
  - A green building rating system by U.S. Green Building Council
  - [www.leedbuilding.org](http://www.leedbuilding.org)
LEED registered projects in international market

**Top 10 Countries (Registered + Certified)**
*(as of June 30, 2012)*

<table>
<thead>
<tr>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>China (incl. HK, Macau, and Taiwan)</td>
</tr>
<tr>
<td>United Arab Emirates</td>
</tr>
<tr>
<td>Brazil</td>
</tr>
<tr>
<td>India</td>
</tr>
<tr>
<td>Canada</td>
</tr>
<tr>
<td>Mexico</td>
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<tr>
<td>Germany</td>
</tr>
<tr>
<td>Republic of Korea</td>
</tr>
<tr>
<td>Qatar</td>
</tr>
<tr>
<td>Chile</td>
</tr>
</tbody>
</table>
Background

• 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

• Other ASHRAE publications:
  • ASHRAE Handbooks (4 nos.)
  • Design guides, books, research papers
### LEED referenced ASHRAE Standards/publications

<table>
<thead>
<tr>
<th>ASHRAE Standard</th>
<th>Keywords</th>
<th>Related LEED Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>52.2-2012</td>
<td>Filters, MERV (minimum efficiency reporting value)</td>
<td>EQ 3.1, EQ 5</td>
</tr>
<tr>
<td>55-2004</td>
<td>Thermal comfort (temperature, air speed, humidity)</td>
<td>EQ 6.2 (multi-occupant spaces), EQ 7.1, EQ 7.2</td>
</tr>
<tr>
<td>62.1-2007</td>
<td>Indoor air quality (IAQ), Natural ventilation</td>
<td>EQ P1, EQ 2, EQ 6.2</td>
</tr>
<tr>
<td>90.1-2007</td>
<td>Building energy systems, Performance rating, HVAC, lighting &amp; envelope</td>
<td>SS 8, EA P2, EA 1 (option 1) &amp; EA 2</td>
</tr>
<tr>
<td>Advanced Energy Design Guides</td>
<td>Prescriptive compliance path</td>
<td>EA 1 (option 2)</td>
</tr>
</tbody>
</table>

**LEED for Existing Buildings (LEED-EB):**
- 62.1-2007 (IAQ)
- ASHRAE Procedures for Commercial Building Energy Audits
ASHRAE 62.1

Std 62.1-2010 is the most current version
ASHRAE 62.1

- ASHRAE 62.1-2007 is being used in current LEED version 3.0
  - Ventilation for acceptable indoor air quality (IAQ)
  - Industry standard of care for IAQ systems design and evaluation
  - Prerequisite for the LEED – NC building rating system (EQp1: minimum IAQ performance)
ASHRAE Standard 62.1: History

62-1989
- Removed Thermal Comfort
- Ventilation Rate Proc.
- IAQ Proc.

62-1999
- IAQ-Health disclaimers
- Smoking disclaimers
- Clarified CO₂ as ventilation metric

62-2001
- Prescriptive
- Commissioning
- O&M
- Combustion air
- Filtration

62-2007 Updated

62-2004
- Commercial and High Rise Res.
- Enforceable code language
- ETS vent. rates not covered
- Vent. Rate. Proc. Modified
- Occupant and area vent. rates

62-1981
- Alternative Air Quality Proc.

62-1973
first issued
Purpose:

1.1 Specify minimum ventilation rates and other measures intended to provide IAQ that is acceptable to human occupants and that minimizes adverse health effects

1.2 Intended for regulatory application to new buildings and additions

1.3 Guide the improvement of IAQ in existing buildings
ASHRAE 62.1

• **Scope:**
  
  • **2.1** All spaces intended for human occupancy excluding low-rise residential (62.2)
  
  • **2.2** Defines requirements for ventilation, air-cleaning design, commissioning, installation and O&M
  
  • **2.3** Additional requirements and other standards may apply (labs, healthcare, industrial, etc.)
  
  • **2.4** May be applied to both new and existing buildings, not intended to be used retroactively
Scope: (cont’d)

- **2.5** Does not prescribe specific ventilation rates for smoking spaces
- **2.6** Ventilation requirements based on chemical, physical, & biological contaminants
- **2.7** Consideration or control of thermal comfort is not included
- **2.8** In addition to ventilation, contains requirements related to certain sources
• Scope: (cont’d)
  • 2.9 Acceptable IAQ may not be achieved in all buildings meeting these requirements because of:
    • Diversity of sources and contaminants
    • Air temperature, humidity, noise, lighting, and psychological/social factors
    • Varied susceptibility in the occupants
    • Introduction of outdoor contaminants
Outdoor Air Quality

- Standard requires a survey of the project site to determine quality of outdoor air
- Local air quality: Conduct observational site survey to identify local sources of air contaminants
  - Limit values for various air contaminants
  - Air cleaning is required in some cases in non-attainment areas
- Options for compliance
ASHRAE 62.1

- Ventilation requirements procedures:
  - 6.1 General- Three different procedures are available to determine the outdoor airflow rates for mechanical ventilation systems.
  - (1) **Ventilation Rate Procedure** - Prescribes rates & procedures based on typical space contaminant sources & source strengths
Ventilation requirements procedures:

(2) **IAQ Procedure** - Requires calculation of rates based on analysis of contaminate sources, concentration and perceived air quality targets

(3) **Natural Ventilation Rate Procedure** - Prescribes design criteria for ventilation air to be provided through openings to the outdoors
ASHRAE 62.1

- Construction and start-up requirements:
  - Requires protection of occupied spaces adjacent to construction zones
  - Required air balance of systems
  - Testing of condensate drain pans
- Similarly – ASHRAE 90.1 requires commissioning of M/E Systems in buildings exceeding 5,000 m²
Key to Ventilation System Requirements

Example: Exhaust Duct Location

Figure 5-G—Correct Exhaust Duct, Negatively Pressurized
The fan is located at the exterior wall where the duct negatively pressurized.

Figure 5-H—Incorrect Exhaust Duct, Pressurized and Not Seal Class A
The portion of the ductwork downstream of the exhaust fan will be have a positive pressure relative to the space the duct is traveling through and this does not comply.

Figure 5-I—Correct Exhaust Duct, SMACNA Seal Class A (4 in. w.g. pressure class, all seams sealed.)

ASHRAE Standard 62.1: update

- User’s Manual for 62.1-2010 and Apps for smartphone
- IAQ Design Guideline is published
- Next publication of ASHRAE 62.1-2013
ASHRAE 90.1

- ASHRAE Standard 90.1
  - Energy Standard for Buildings Except Low-Rise Residential Buildings
  - SSPC 90.1 Standing Standard Project Committee
- **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
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)
  - ANSI (American National Standards Institute)
- Required for LEED certification
ASHRAE 90.1

- US Energy Policy Act requires State codes to meet or exceed 90.1 (different versions)
  - It becomes law when the States adopt it
- Other codes or standards also refer to it, e.g.
  - International Energy Conservation Code (IECC)
  - NFPA 5000
  - Federal codes
  - State or local specific codes (e.g. California Title24)
ASHRAE 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

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

- ASHRAE 90.1-2010 (current version)
  - Goal: to achieve 30% energy savings compared to 90.1-2004 (may not be met for all building 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
ASHRAE 90.1

- Different versions of ASHRAE 90.1
  - **90-1975**
    - Earliest version (in response to energy crisis)
  - **90A-1980** (w/ 90B-1975 and 90C-1977)
    - Modified & included lighting procedure from IESNA
  - **90.1-1989** and 1993 codified version of 1989
    - Significant change in envelope compliance
    - Towards a building energy performance standard
    - Upgrades in lighting and HVAC requirements
• Different versions of ASHRAE 90.1 (cont’d)
  • **90.1-1999/2001**
    • Changes in format and technical content
    • Written in mandatory, enforceable language
    • Expanded climatic data to international locations
    • Both IP and SI units included
  • **90.1-2004**
    • Envelope and mechanical requirements expressed using new climate zones
    • Lighting requirements more stringent by about 25%
    • Entire document has been reformatted
ASHRAE 90.1

- Different versions of ASHRAE 90.1 (cont’d)
  - **90.1-2007**
    - Incorporate 42 addenda
    - Further reduction in lighting power densities
    - Fan power limitation is based on either nameplate horsepower, or system brake-horsepower
    - Fan pressure drop adjustment & VAV fan control
  - **90.1-2010**
    - Incorporate 60+ addenda, elevator was included
  - **90.1-2013 (proposed)**
    - Expand to new areas; holistic building design
ASHRAE 90.1

- Related ASHRAE Standards
  - 90.2-2007: for low-rise residential buildings
  - 100-2006: energy conservation in existing buildings
  - 105-2007: standard methods of measuring, expressing and comparing building energy performance
  - 140-2011: evaluation of building energy analysis computer programs
  - 169-2006: weather data for building design standards
  - 55-2010: thermal comfort standard
  - 62.1-2010: ventilation for acceptable indoor air quality
  - 189.1-2011: high performance green buildings
ASHRAE 90.1 development process

Committee Proposes Standard Changes

Public Review and Comment

Comment Accepted

Committee Approval

ASHRAE Board of Directors Approval

ANSI Approval

New Standards or Addenda Published

Substantive Changes

Appeal of Committee Approval upheld denied

(Source: US Department of Energy)
Code compliance and the building process in USA

Local Government

Local Code

Architects, Builders and Engineers

Building Construction

Review Plans
Review products, materials, equipment specifications
Review tests, certification reports, product listings
Inspect building and its systems during construction
Evaluate materials substituted in the field
Inspect prior to occupancy

Save Energy and Money
Reduce Carbon Emissions

Source: US Department of Energy
Structure and Scope

- Structure of Standard 90.1-2010
  - Section 1 - Purpose
  - Section 2 - Scope
  - Section 3 - Definitions, Abbreviations, and Acronyms
  - Section 4 - Administration and Enforcement
  - Section 5 - Building Envelope
  - Section 6 - Heating, Ventilating, and Air Conditioning
Structure and Scope

• Structure of Standard 90.1-2010 (cont’d)
  • Section 7 - Service Water Heating
  • Section 8 - Power
  • Section 9 - Lighting
  • Section 10 - Other Equipment
  • Section 11 - Energy Cost Budget Method
  • Section 12 - Normative References
Structure and Scope

- Standard 90.1-2010 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
Structure and Scope

- **Main areas**
  - **Building Envelope**
    - Roofs, walls, floors, slabs, doors, vertical glazing, skylights
  - **HVAC Equipment and System**
    - Cooling equipment efficiency, heating equipment efficiency, supply fans, ventilation control, ducts
  - **Lighting**
    - Interiors electric lighting, controls, daylighting
  - **Services Water Heating (SWH)**
    - Equipment efficiency, pipe insulation
  - **Power and others**
    - Motors, plug loads
ASHRAE 90.1 compliance approaches

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

**Compliance Options**
- Prescriptive Option
- Trade Off Option
- Energy Cost Budget
- Simplified

**Mandatory Provisions**
(required for most compliance options)

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

- Mandatory Provisions
  - Prescriptive Option
  - Trade-off Option
  - Energy Cost Budget

Compliance
Building envelope compliance paths

- Prescriptive Building Envelope Option (§.5)
- Building Envelope Trade-Off Option (§.6, performance)
- Energy Cost Budget Method (ECB, ¶1)

proposed building design

90.1-compliant building

(Source: Trane)
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
HVAC compliance paths

- proposed HVAC design
- mandatory provisions (§6.4)
- prescriptive requirements (§6.5)
- Energy Cost Budget Method (ECB, §11)
- Simplified Approach Option (§6.3)
- 90.1-compliant HVAC system

(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
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
Economizer cycle control (outdoor air enthalpy)

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)
Mandatory HVAC provisions:
Zone thermostatic controls: perimeter zones

Core and each long exposure must be zoned separately

Building plan view: thermal zoning example

Treating these exposures as a single zone is okay
Lighting compliance requirements

Mandatory Requirements (Interior and Exterior)
- Controls
- Switching
- Efficiency

Interior Lighting Power Limits
- Total Connected Power
- Interior Lighting Power Allowance

Exemptions

Whole Building OR Space-by-Space

Exterior Lighting Power Limits
- Tradable
- Non-Tradable

Total Connected Power
- Exterior Lighting Power Allowance

Additional Allowances

(Source: US Department of Energy)
Compliance Options

- Interior lighting power
  - Building area method
    - For whole building, grossed area
  - Space-by-space method
    - For projects with well defined space types
- Exterior lighting power
  - Lamp efficacy
  - Exterior lighting power wattage limits
Compliance Options

• How were the Lighting Power Densities (LPD) developed?
  • Basis: A space type lighting design modeling that applies:
    • Current lighting product performance data
    • Current lamp/ballast efficacy and light loss factors
    • Latest IESNA recommended light levels
    • Professional consensus of quality lighted environments
  • Combine these elements into building space models to calculate lighting power densities
  • Apply space type LPDs to real building data to generate whole building LPDs
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
Energy Cost Budget Method

- ECB method’s Pros and Cons
  - User sophistication
  - Enforcement sophistication
  - Better buildings
  - Aging of the standard
  - Gamesmanship
  - Cheating
  - Innovation
Basic concept of Energy Cost Budget (ECB) Method

Proposed Building
Meet basic requirements
Exempt from prescriptive and system performance requirements

Reference Building
Meet basic requirements
Meets prescriptive and system performance requirements

Simulate Annual Energy Cost

Design Energy Cost
must be less than

Energy Cost Budget
Energy Cost Budget (ECB) Method in ASHRAE 90.1

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

Simulation tool (computer program)

Simulation outputs
- energy consumption (MWh)
- energy demands (kW)
- environmental conditions

Weather data
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
Energy Cost Budget Method

• Typical requirements by authorities
  • Must document all the info in great detail
  • Must use a good and approved simulation program
  • Must use appropriate and approved climate data
  • Must use appropriate and approved purchased energy rates
  • All details not covered by the 90.1 must be identical in both models
• ECB method compliance forms
Energy Cost Budget Method

- Building Performance Rating Method
  - Appendix G
  - Instructions for using the ASHRAE Standard 90.1-2010 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
ASHRAE 90.1 and LEED

- A technical guide for learning and using ASHRAE 90.1
- “Standard 90.1-2010 User’s Manual”
  - List price at US$99
    - Available at www.ashrae.org
Advanced Energy Design Guides
www.ashrae.org/freeaedg

Now Available for Free Download from ASHRAE
ASHRAE 90.1 and LEED

• LEED Green Building Rating System
  • Leadership in Energy & Environmental Design
  • By US Green Building Council
  • Current LEED systems:
    • New construction & major renovation (LEED-NC)
    • Existing building operations (LEED-EB)
    • Commercial interiors projects (LEED-CI)
    • Core and shell projects (LEED-CS)
    • Schools, Retail, Healthcare, Homes
    • Neighborhood development (LEED-ND) (in pilot)
ASHRAE 90.1 and LEED

- LEED Green Building Rating System
  - Evaluates and recognizes performance in accepted green design categories, including:
    - Sustainable sites
    - Water efficiency
    - Energy and atmosphere
    - Materials and resources
    - Indoor environmental quality
    - Innovation credits
  - Website: www.leedbuilding.org
ASHRAE 90.1 and LEED

- LEED Green Building Rating System
  - Whole-building approach encourages & guides a collaborative, integrated design & construction process
  - Optimizes environmental and economic factors
- Four levels of certification (for version 2 or before)
  - LEED Certified  26 - 32 points
  - Silver Level     33 - 38 points
  - Gold Level      39 - 51 points
  - Platinum Level  52+ points (69 possible)
- LEED Accredited Professional
ASHRAE 90.1 and LEED

- LEED version 3 and new schemes
  - Include other criteria
    - Locations & linkages
    - Awareness & education
    - Regional priority
  - LEED Professionals
    - LEED Green Associate
    - LEED AP (different types)
      - Bldg design & construction, O&M, Homes, Interior design, Neighborhood development
ASHRAE 90.1 and LEED

- Credits in LEED 2009 NC:
  - Sustainable Sites (SS)
  - Water Efficiency (WE)
  - **Energy and Atmosphere (EA)**
  - Materials and Resources (MR)
  - Indoor Environmental Quality (IEQ)
  - Innovation in Design (ID)
  - Regional Priority (RP)
<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>
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<tr>
<td>Energy &amp; Atmosphere</td>
<td>35</td>
</tr>
<tr>
<td>Materials &amp; Resources</td>
<td>14</td>
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<tr>
<td>Indoor Environmental Quality</td>
<td>15</td>
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<tr>
<td><strong>Total Possible Points</strong></td>
<td>110*</td>
</tr>
</tbody>
</table>

* Out of a possible 100 points + 10 bonus points

** Certified 40+ points, Silver 50+ points, Gold 60+ points, Platinum 80+ points

(Source: USGBC) For LEED version 3
ASHRAE 90.1 and LEED

- **Prerequisite** (New Construction)
  - SSp1: Construction activity pollution prevention
  - WEp1: Water use reduction
  - EAp1: Fundamental commissioning of building energy systems
  - **EAp2: Minimum energy performance**
  - EAp3: Fundamental refrigerant management
  - MRp1: Storage and collection of recyclables
  - IEQp1: Minimum IAQ performance
  - IEQp2: Environmental tobacco smoke control
ASHRAE 90.1 and LEED

• LEED 2009 NC award scale:
  • Platinum 80 points and above
  • Gold 60–79 points
  • Silver 50–59 points
  • Certified 40–49 points

• Credit weightings
  • Based on the potential environmental impacts and human benefits of each credit with respect to a set of impact categories
## LEED 2009 New Construction Checklist

<table>
<thead>
<tr>
<th>Sustainable Sites</th>
<th>26 Possible Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prerequisite 1</td>
<td>Construction Activity Pollution Prevention</td>
</tr>
<tr>
<td>Credit 1</td>
<td>Site Selection</td>
</tr>
<tr>
<td>Credit 2</td>
<td>Development Density and Community Connectivity</td>
</tr>
<tr>
<td>Credit 3</td>
<td>Brownfield Redevelopment</td>
</tr>
<tr>
<td>Credit 4.1</td>
<td>Alternative Transportation—Public Transportation Access</td>
</tr>
<tr>
<td>Credit 4.2</td>
<td>Alternative Transportation—Bicycle Storage and Changing Rooms</td>
</tr>
<tr>
<td>Credit 4.3</td>
<td>Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles</td>
</tr>
<tr>
<td>Credit 4.4</td>
<td>Alternative Transportation—Parking Capacity</td>
</tr>
<tr>
<td>Credit 5.1</td>
<td>Site Development—Protect or Restore Habitat</td>
</tr>
<tr>
<td>Credit 5.2</td>
<td>Site Development—Maximize Open Space</td>
</tr>
<tr>
<td>Credit 6.1</td>
<td>Stormwater Design—Quantity Control</td>
</tr>
<tr>
<td>Credit 6.2</td>
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<td>Heat Island Effect—Nonroof</td>
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<td>Heat Island Effect—Roof</td>
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<td>Credit 8</td>
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<tr>
<th>Water Efficiency</th>
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<td>Prerequisite 1</td>
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<tr>
<td>Credit 1</td>
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<td>Credit 2</td>
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<td>Credit 3</td>
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(Source: USGBC)
### Energy and Atmosphere

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<thead>
<tr>
<th>Credit</th>
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<tbody>
<tr>
<td>✔️ 1</td>
<td>Fundamental Commissioning of Building Energy Systems</td>
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<td>✔️ 2</td>
<td>Minimum Energy Performance</td>
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<tr>
<td>✔️ 3</td>
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<td>□ 1</td>
<td>Optimize Energy Performance</td>
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<td>On-site Renewable Energy</td>
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<td>□ 5</td>
<td>Measurement and Verification</td>
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### Materials and Resources

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<tr>
<td>✔️ 1</td>
<td>Storage and Collection of Recyclables</td>
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<td>Building Reuse—Maintain Existing Walls, Floors and Roof</td>
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(Source: USGBC)
### Indoor Environmental Quality

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<thead>
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<tr>
<td>✔️</td>
<td>Prerequisite 1 Minimum Indoor Air Quality Performance</td>
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<td>✔️</td>
<td>Prerequisite 2 Environmental Tobacco Smoke (ETS) Control</td>
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<td>□</td>
<td>Credit 1 Outdoor Air Delivery Monitoring</td>
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<td>Credit 3.1 Construction Indoor Air Quality Management Plan—During Construction</td>
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<td>Credit 4.2 Low-Emitting Materials—Paints and Coatings</td>
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<td>Credit 4.3 Low-Emitting Materials—Flooring Systems</td>
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<td>Credit 4.4 Low-Emitting Materials—Composite Wood and Agrifiber Products</td>
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<td>Credit 5 Indoor Chemical and Pollutant Source Control</td>
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<td>Credit 6.1 Controllability of Systems—Lighting</td>
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### Innovation in Design

<table>
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<td>Credit 2 LEED Accredited Professional</td>
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### Regional Priority

<table>
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<tr>
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<tbody>
<tr>
<td>□</td>
<td>Credit 1 Regional Priority</td>
<td>1-4</td>
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</table>

(Source: USGBC)
• **EAp2: Minimum energy performance**
  - **Intent**: Establish the minimum level of energy efficiency for the proposed building and systems
  - **Requirements**: Mandatory provisions of 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
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>
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<tr>
<td>48%</td>
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<td>19</td>
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</tbody>
</table>
ASHRAE 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

- It is jointly developed by:
  - ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers)
  - USGBC (U.S. Green Building Council)
  - IESNA (Illuminating Engineering Society of North America)
- It is also approved by American National Standards Institute (ANSI)
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
  - Water measurement for building and subsystems
Building Energy Codes (e.g. ASHRAE 90.1)
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
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
- 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

Questions?