ASHRAE Basics and LEED Rating System

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1911-2011

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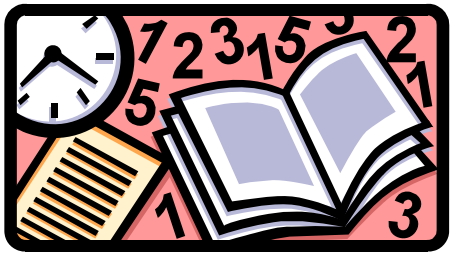
- Background
- ASHRAE 62.1
- ASHRAE 90.1
- Structure and Scope
- Compliance Options
- Energy Cost Budget Method
- ASHRAE 90.1 and LEED
- ASHRAE 189.1

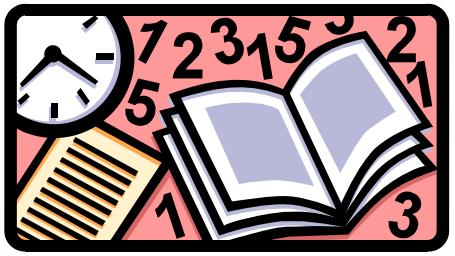
Background



- ***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 Shaping Tomorrow's Built Environment Today

- 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
- LEED = Leadership in Energy & Environmental Design
  - A green building rating system by U.S. Green Building Council
  - www.leedbuilding.org

U.S. GREEN BUILDING COUNCIL LEED LEADERSHIP IN ENERGY & ENVIRONMENTAL DESIGN

LEED registered projects in international market

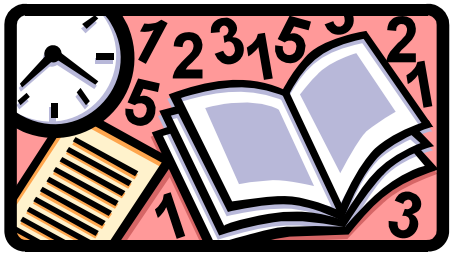
Top 10 Countries (Registered + Certified)

(as of June 30, 2012)

China (incl. HK, Macau, and Taiwan)
United Arab Emirates
Brazil
India
Canada
Mexico
Germany
Republic of Korea
Qatar
Chile

(Source: US Green Building Council)

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

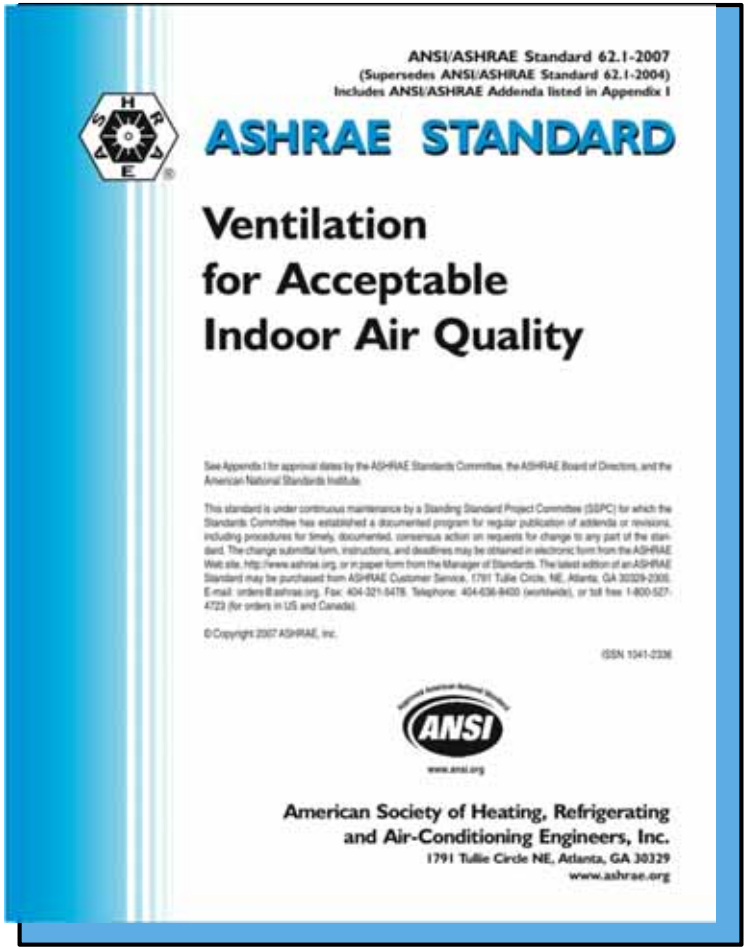
LEED referenced ASHRAE Standards/publications

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

LEED for Existing Buildings (LEED-EB):

- 62.1-2007 (IAQ)
- ASHRAE Procedures for Commercial Building Energy Audits

ASHRAE 62.1

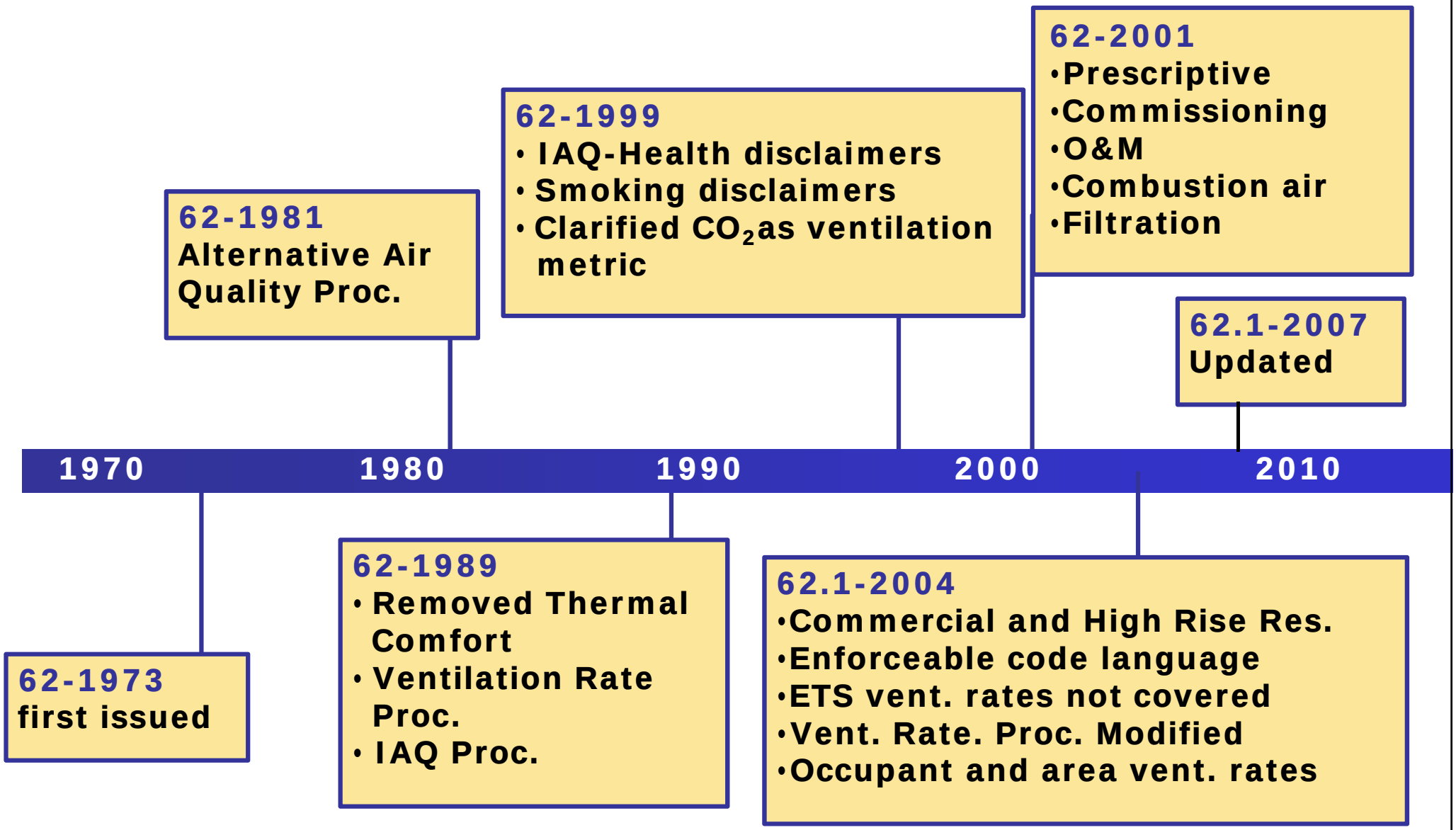


- Std 62.1-2010 is the most current version

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



ASHRAE 62.1

- **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

ASHRAE 62.1

- **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

ASHRAE 62.1

- **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

ASHRAE 62.1

- 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

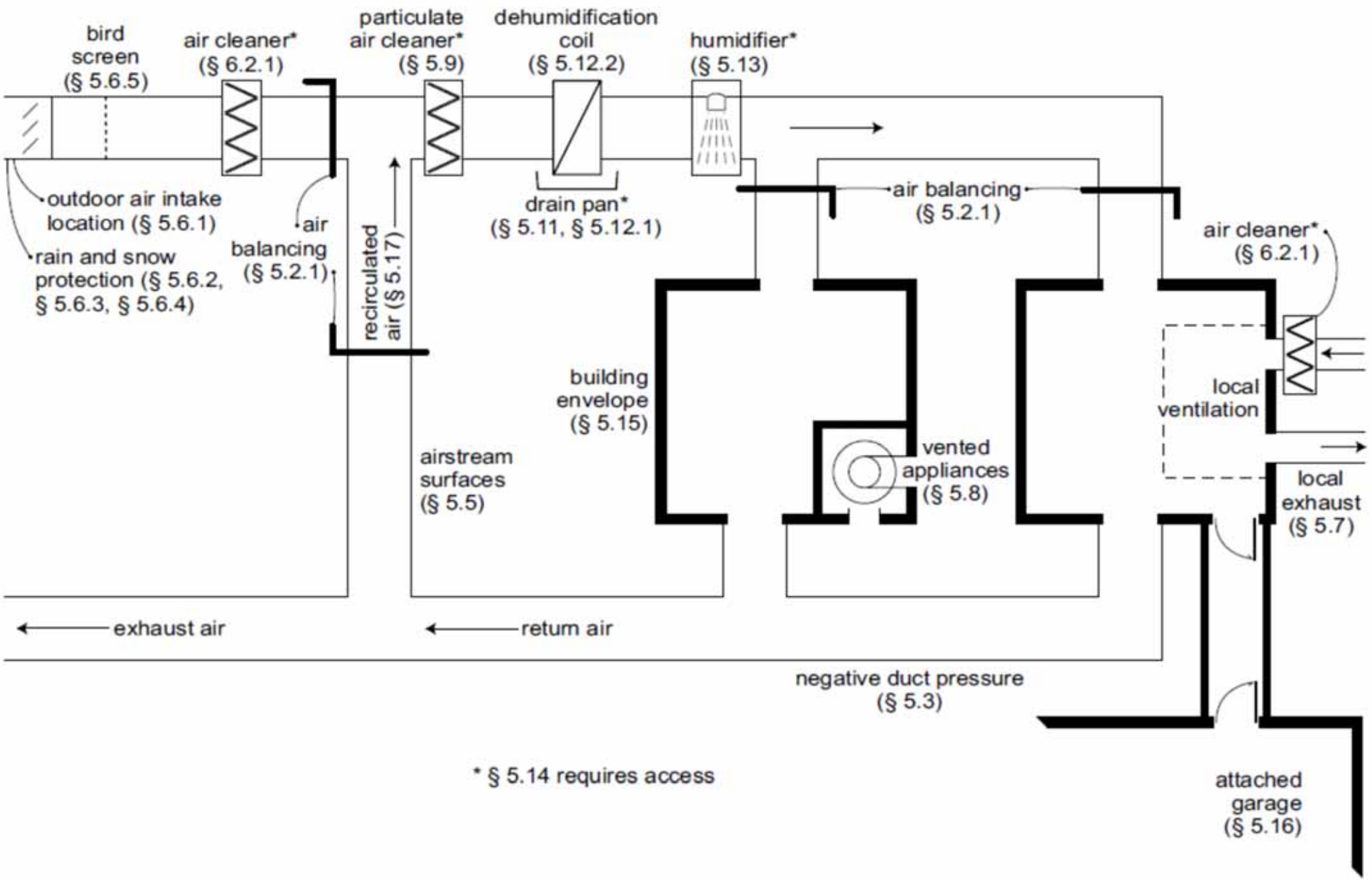
ASHRAE 62.1

- 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 - Proscribes 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 m^2

Key to Ventilation System Requirements



(Source: ASHRAE User's Manual for 62.1-2007)

Example: Exhaust Duct Location

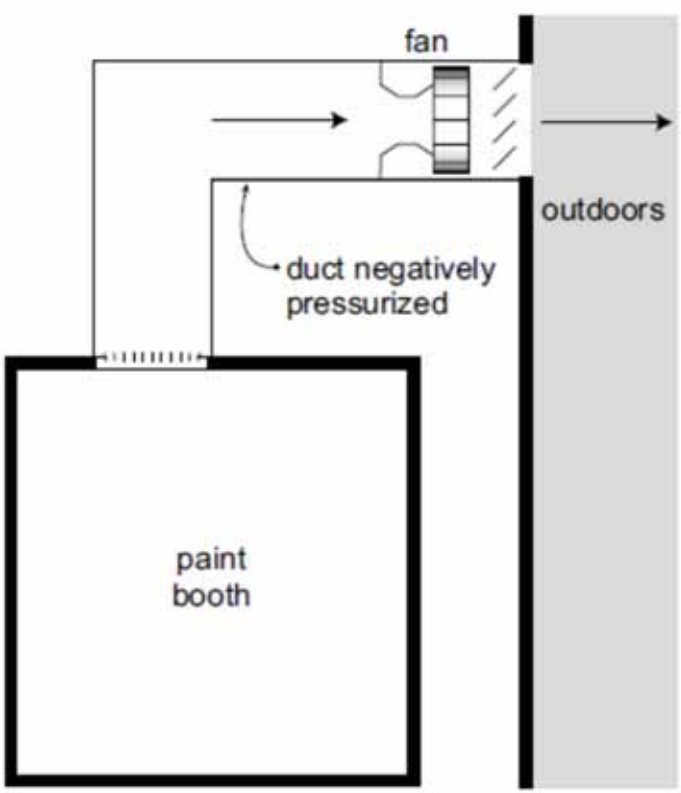


Figure 5-G—Correct Exhaust Duct, Negatively Pressurized

The fan is located at the exterior wall where the

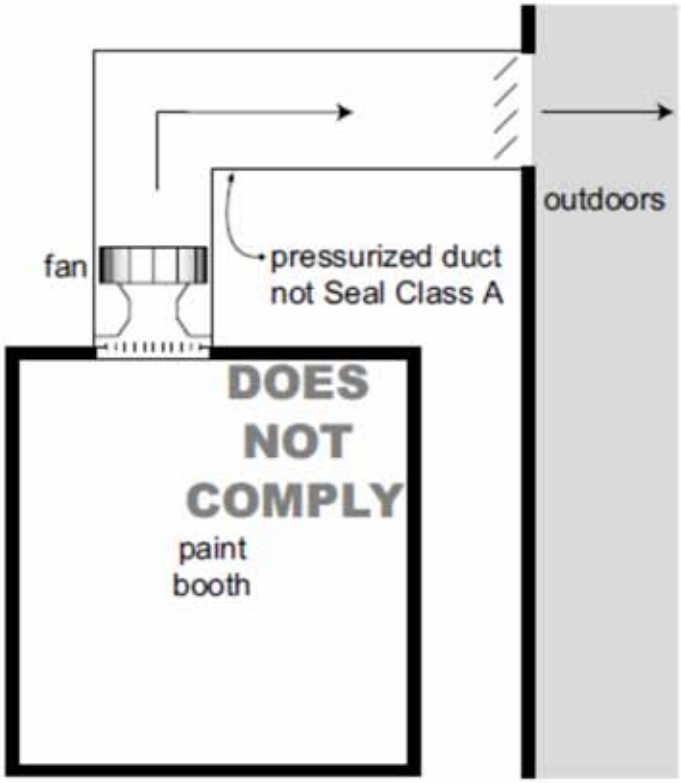


Figure 5-H—Incorrect Exhaust Duct, Pressurized and Not Seal Class A

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

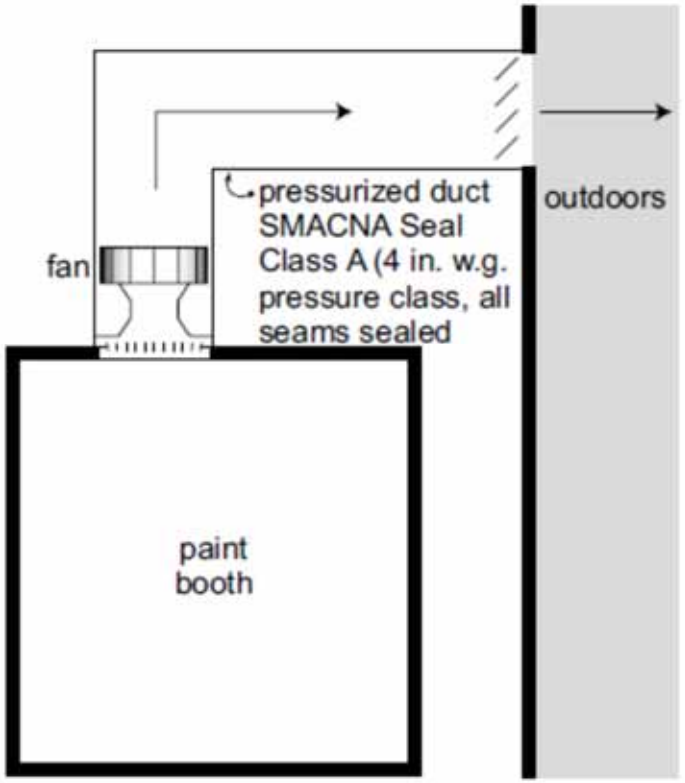
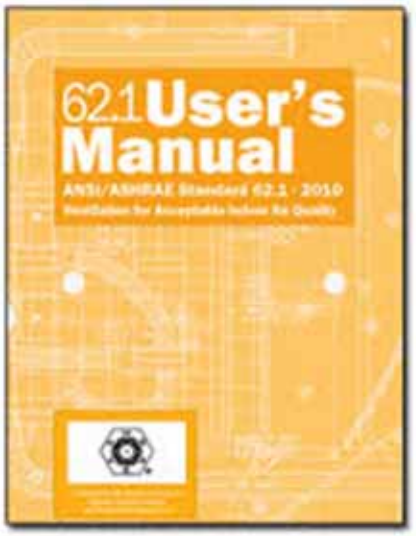


Figure 5-I—Correct Exhaust Duct,

(Source: ASHRAE User's Manual for 62.1-2007)

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

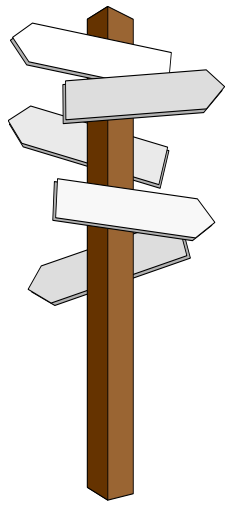
- ASHRAE Standard 90.1
  - Energy Standard for Buildings Except Low-Rise Residential Buildings
  - SSPC 90.1 Standing Standard Project Committee
- Purpose: provide *minimum* requirements for the energy-efficient design of buildings except low-rise residential buildings
- Not a design or advanced building guide
  - Separate advanced energy design guides were developed by ASHRAE and other related bodies

ASHRAE 90.1

- 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

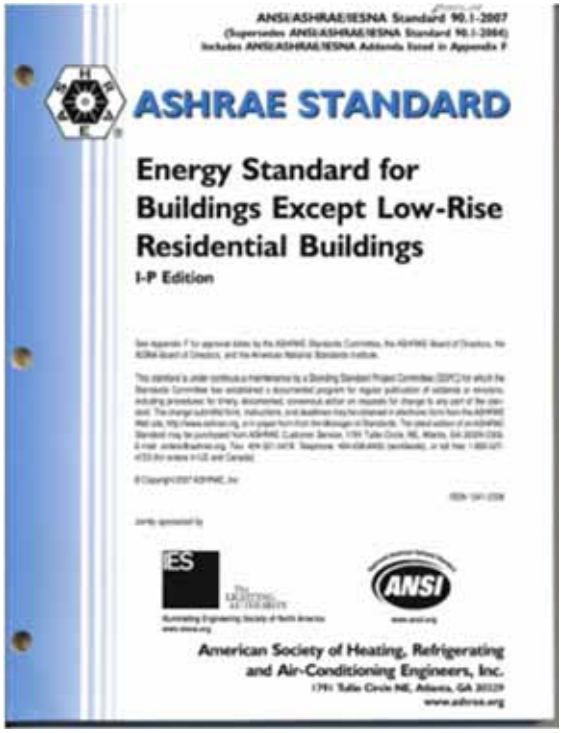
ASHRAE 90.1

- 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

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 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

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

ASHRAE 90.1

- 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

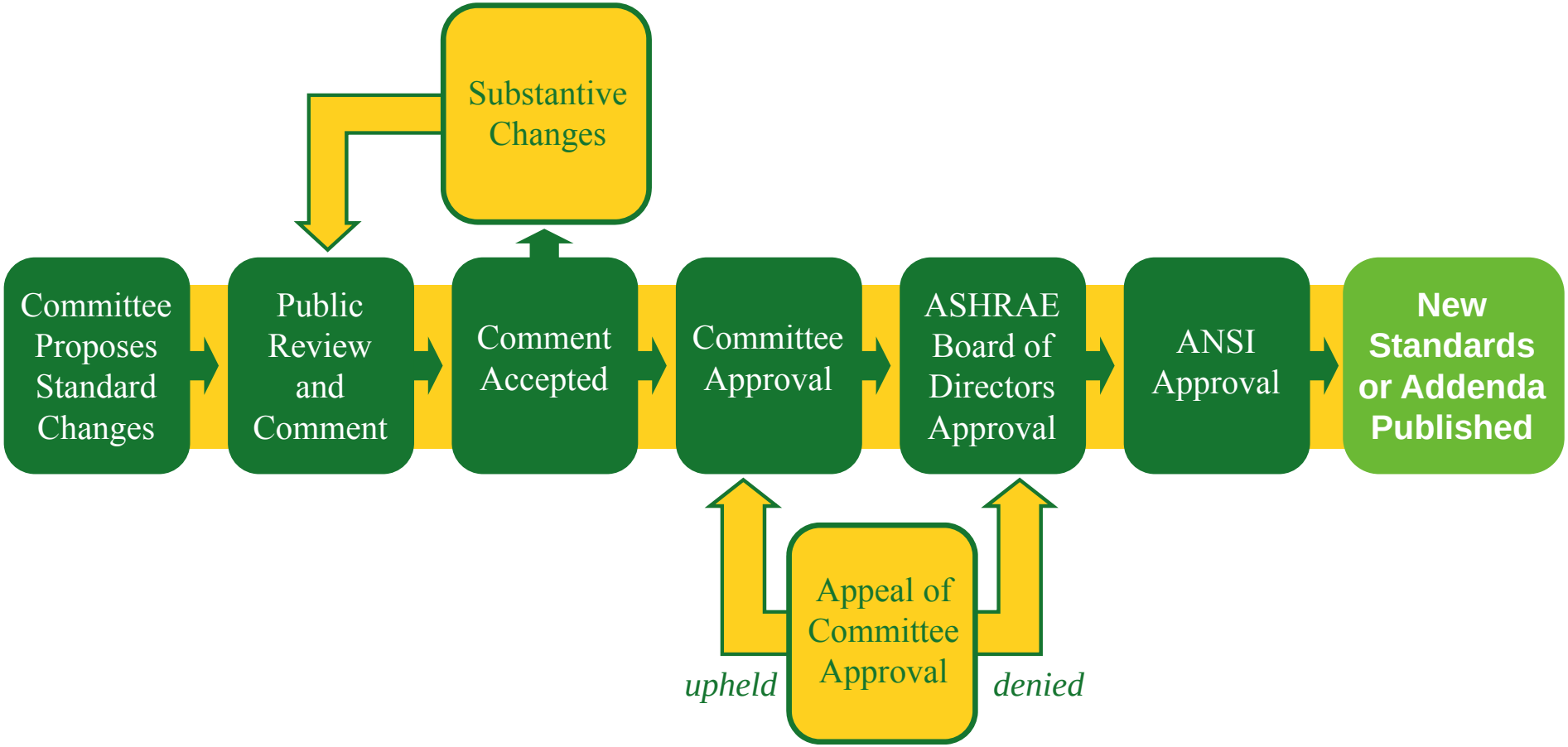
ASHRAE 90.1

- 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

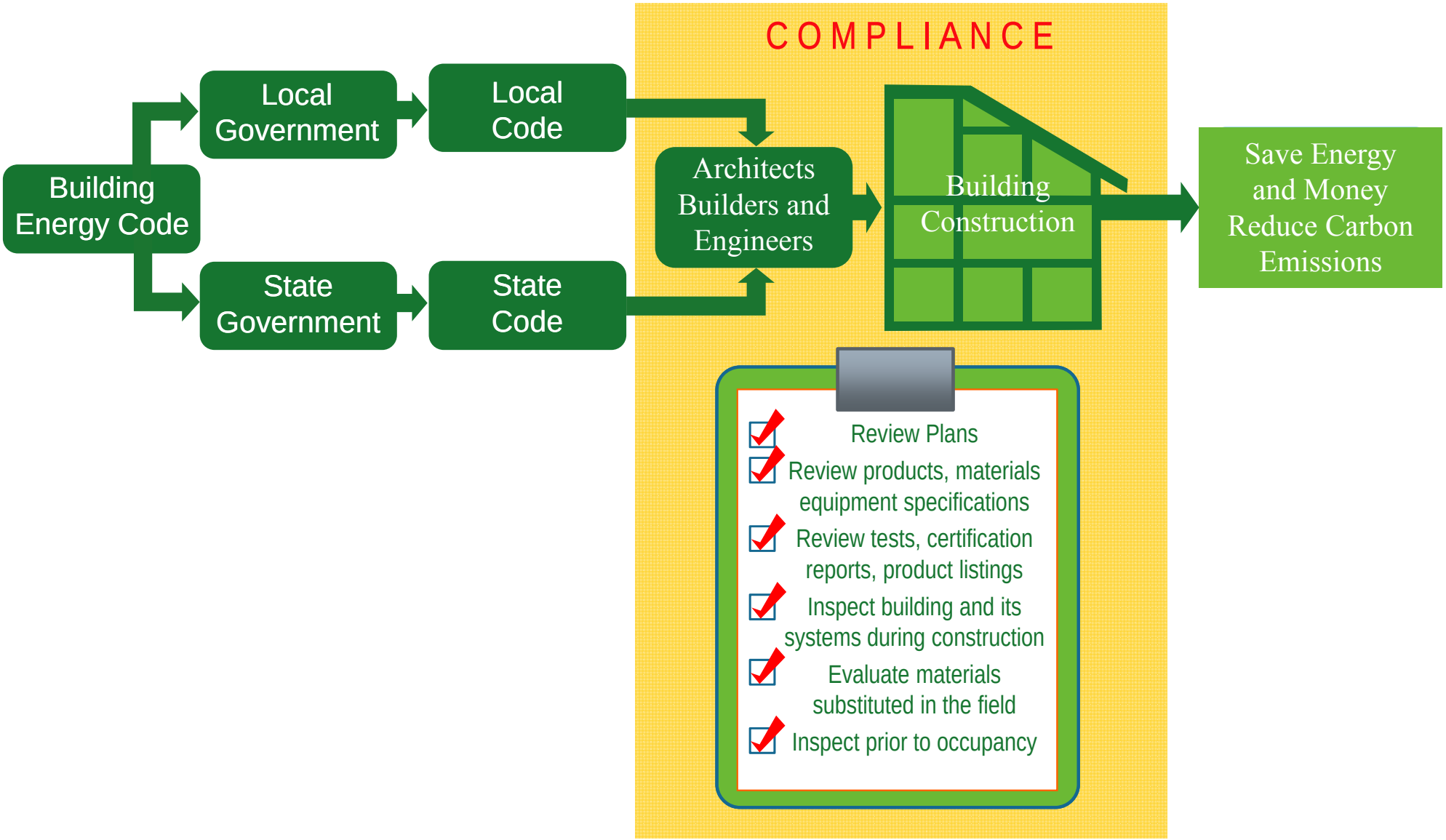
- Related ASHRAE Standards
  - 90.2-2007: for low-rise residential buildings
  - 100-2006: energy conservation in existing buildings
  - 105-2007: standard methods of measuring, expressing and comparing building energy performance
  - 140-2011: evaluation of building energy analysis computer programs
  - 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



(Source: US Department of Energy)

Code compliance and the building process in USA



(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
  - Building envelope
    - 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

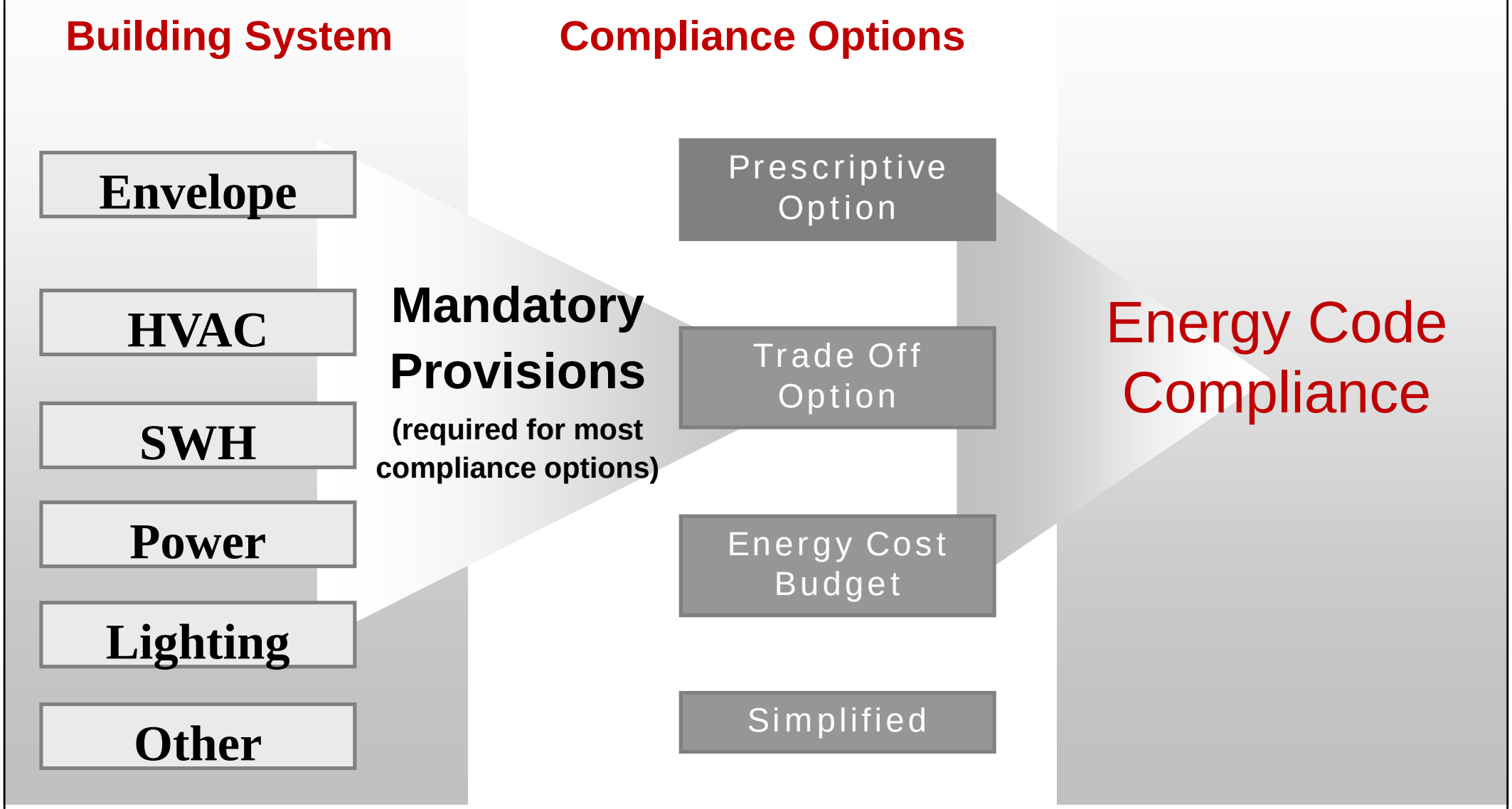
Structure and Scope

- 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

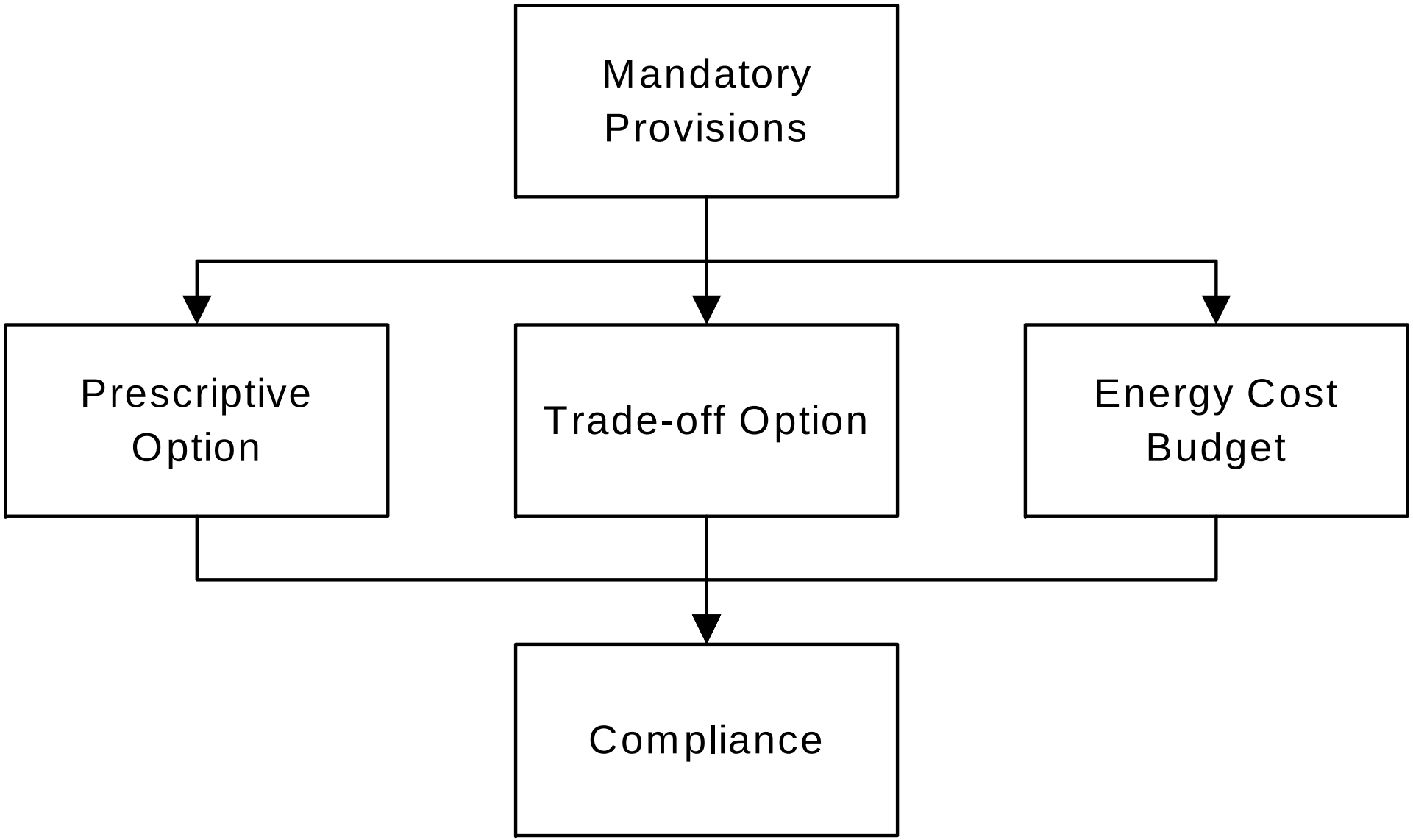
Structure and Scope

- 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

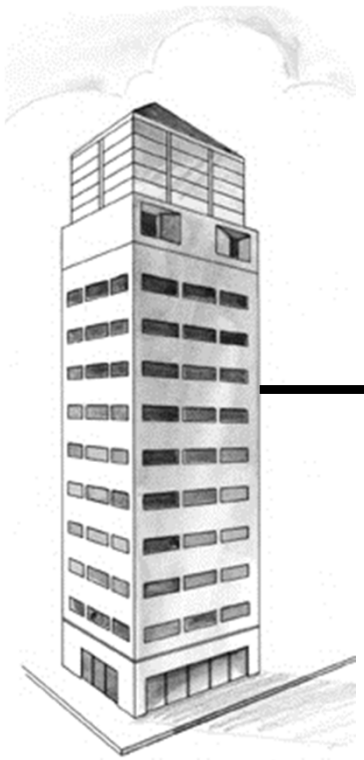


(Source: US Department of Energy)



Envelope compliance options in ASHRAE 90.1

Building envelope compliance paths



proposed
building design

general &
mandatory
provisions

Prescriptive
Building Envelope
Option (§5.5)

Building Envelope
Trade-Off Option
(§5.6, performance)

Energy Cost
Budget Method
(ECB, §11)

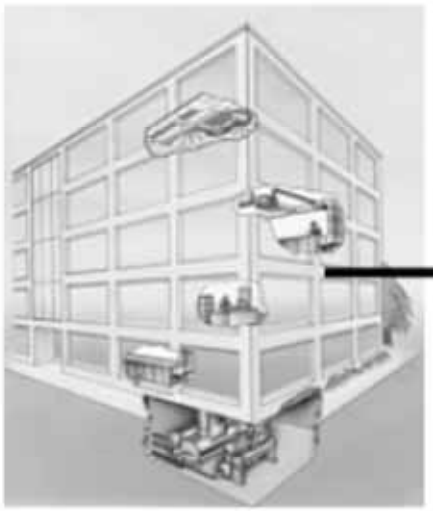
90.1-compliant
building

(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

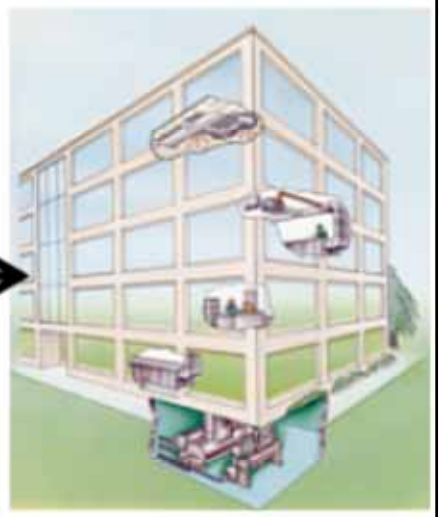
mandatory provisions (§6.4)

prescriptive requirements (§6.5)

Energy Cost Budget Method (ECB, §11)

Simplified Approach Option (§6.3)

(small buildings only)

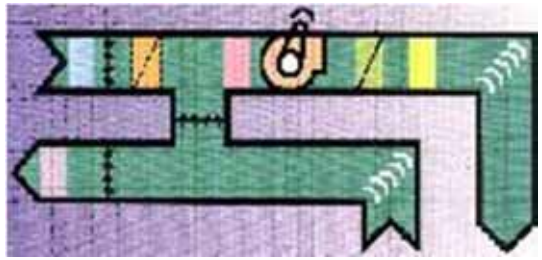


90.1-compliant HVAC system

(Source: US Department of Energy)

Compliance Options

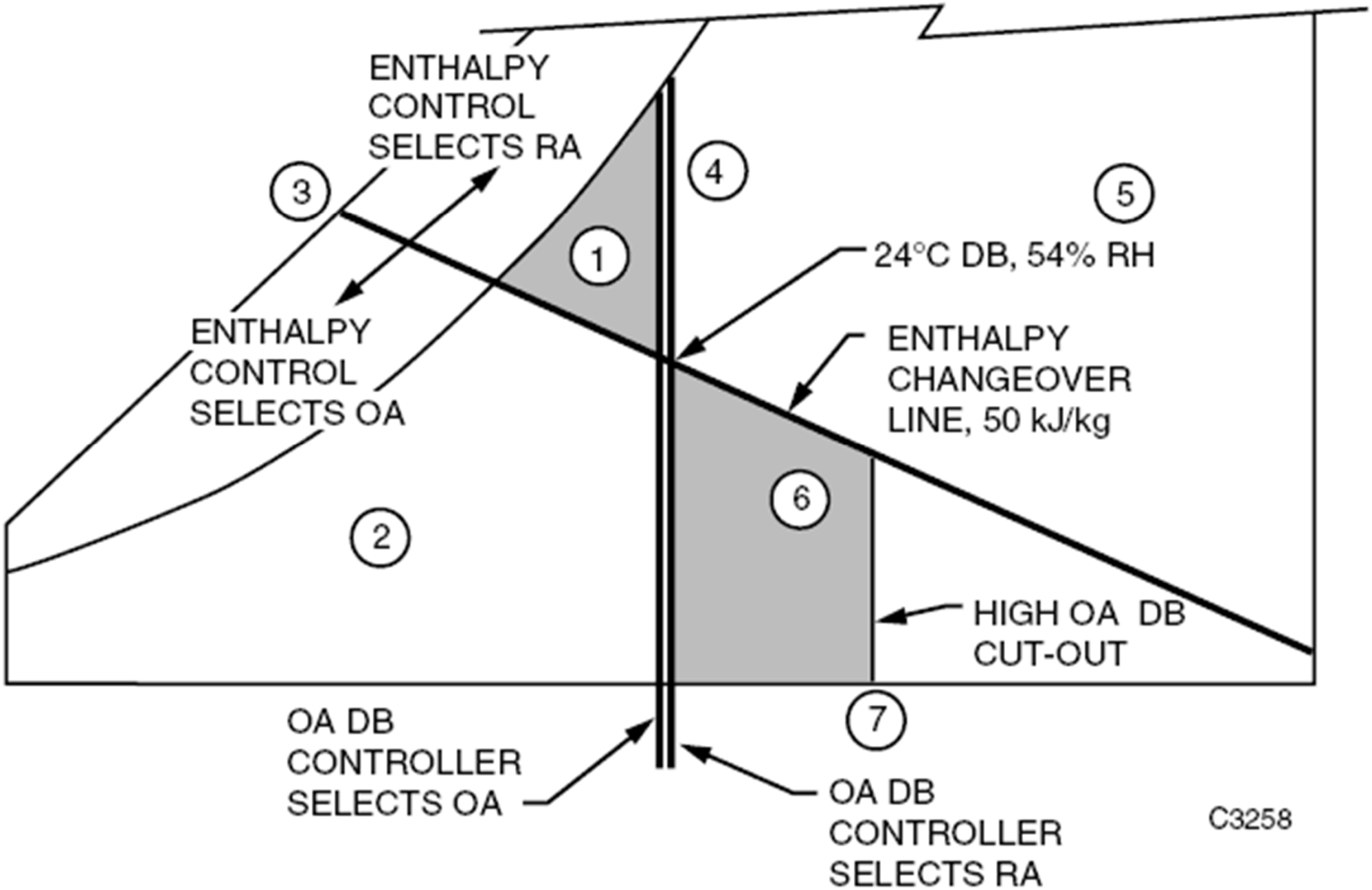
- HVAC simplified approach option:
  - Limited to small buildings (< 2,500 sq.m)
- HVAC mandatory provisions:
  - Minimum equipment efficiency
  - Load calculations
  - Controls
  - HVAC system construction and insulation
  - Completion requirements



Compliance Options

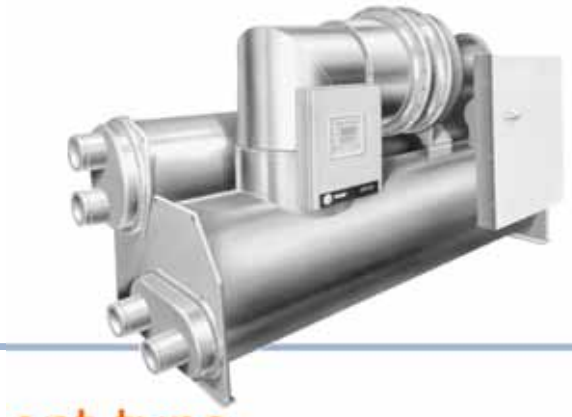
- HVAC prescriptive path:
  - Economizers
  - Simultaneous heating and cooling limitation
  - Air system design and control
  - Hydronic system design and control
  - Heat rejection equipment
  - Energy recovery
  - Exhaust hoods, radiant heating systems
  - Hot gas bypass limitation

Economizer cycle control (outdoor air enthalpy)



(Source: Honeywell, 1997. *Engineering Manual of Automatic Control: for Commercial Buildings*)

Examples of HVAC equipment efficiencies



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

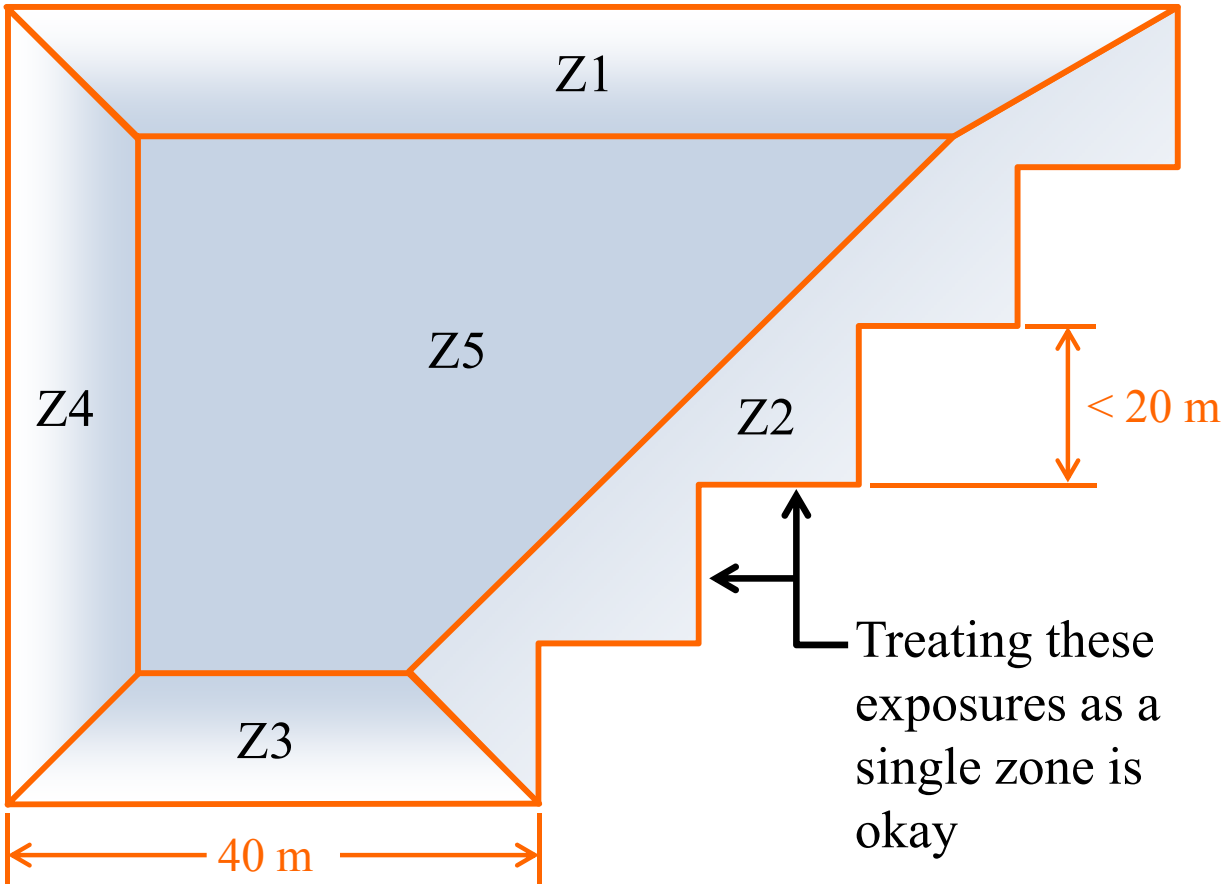
§6.4.1.1: " … Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements … "

(Source: Trane)

Mandatory HVAC provisions:
Zone thermostatic controls: perimeter zones

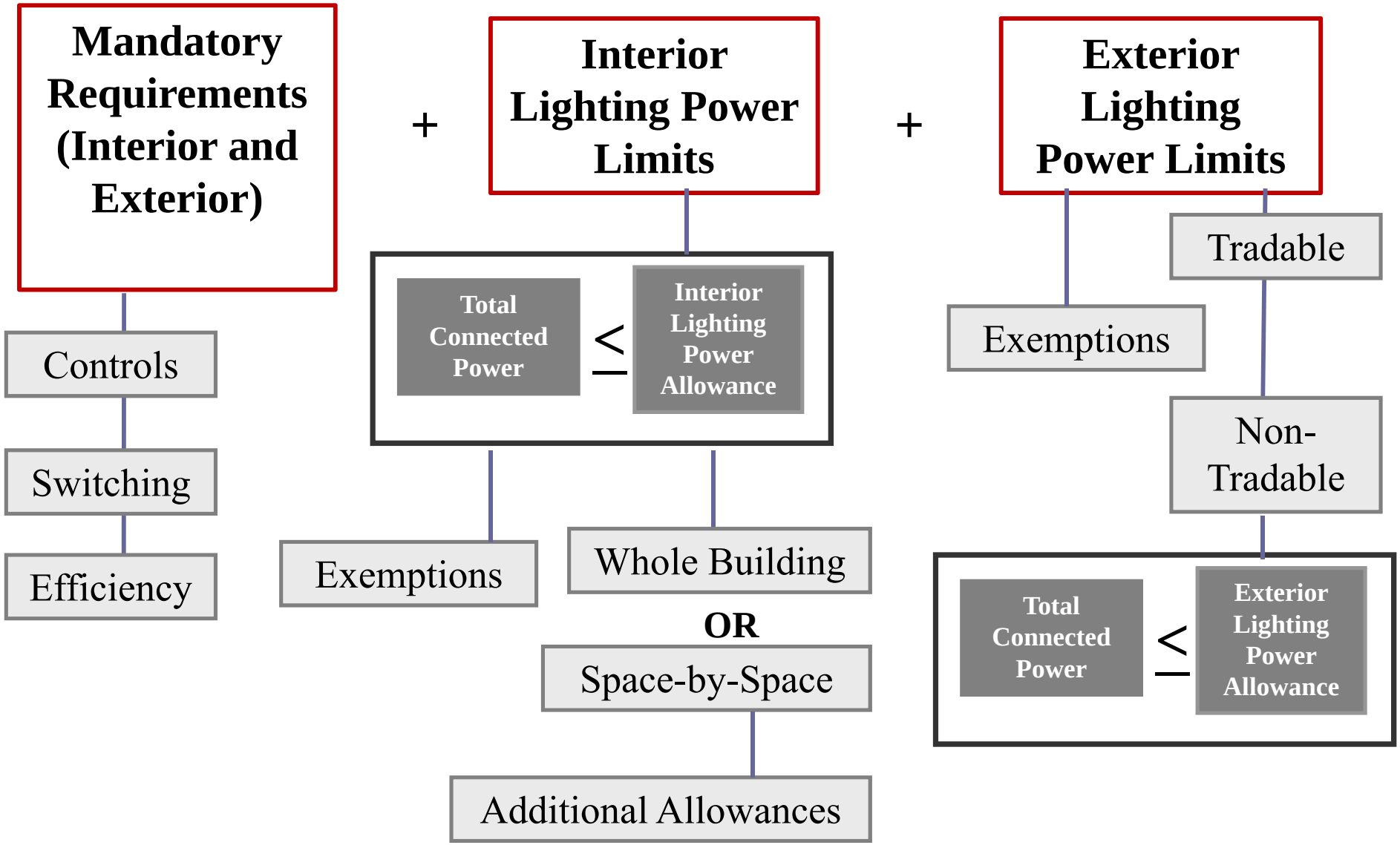
Core and each long exposure must be zoned separately

Building plan view: thermal zoning example



(Source: Trane)

Lighting compliance requirements



(Source: US Department of Energy)

Compliance Options

- Interior lighting power
  - Building area method
    - For whole building, grossed area
  - Space-by-space method
    - For projects w/ 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

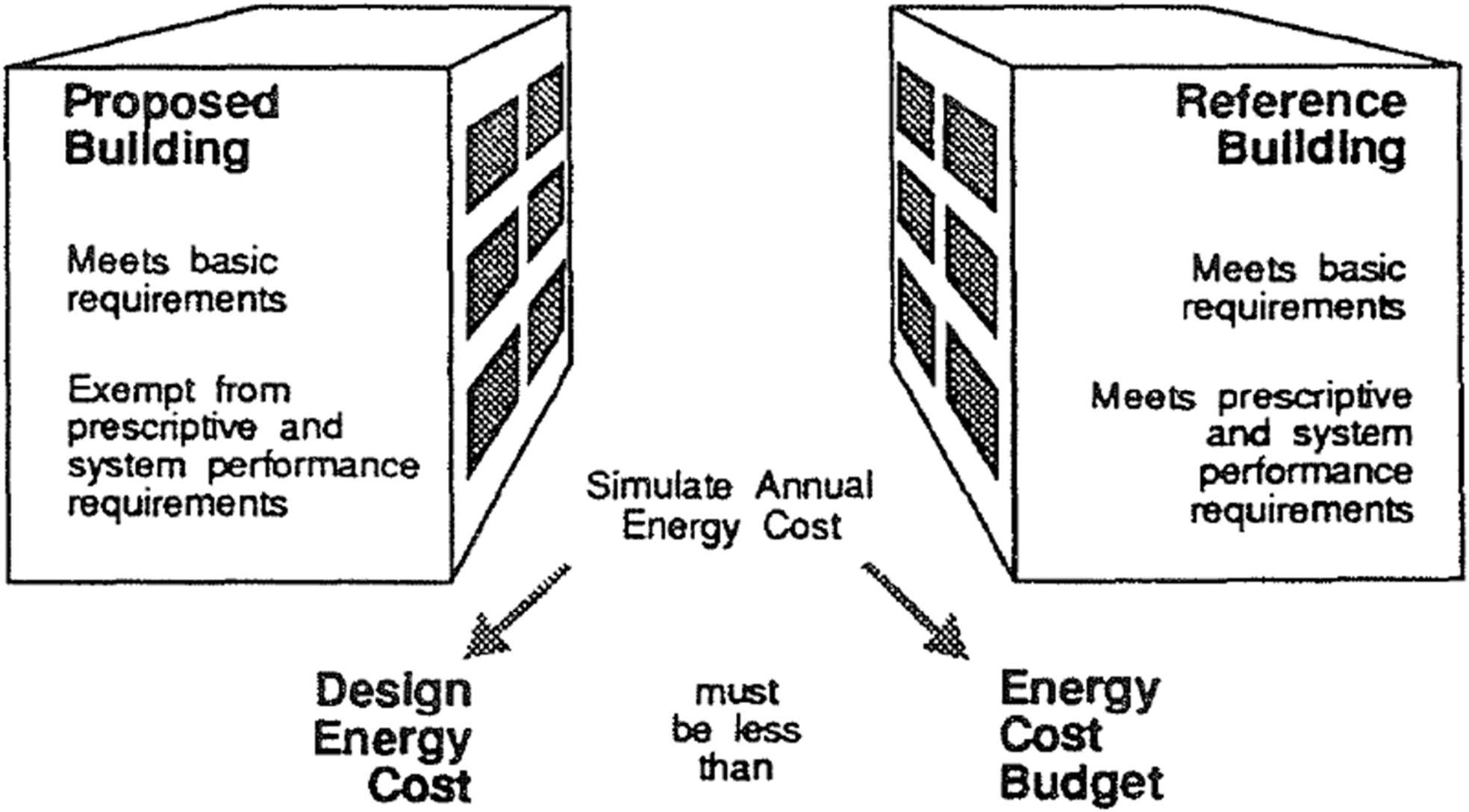
Energy Cost Budget Method

- 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

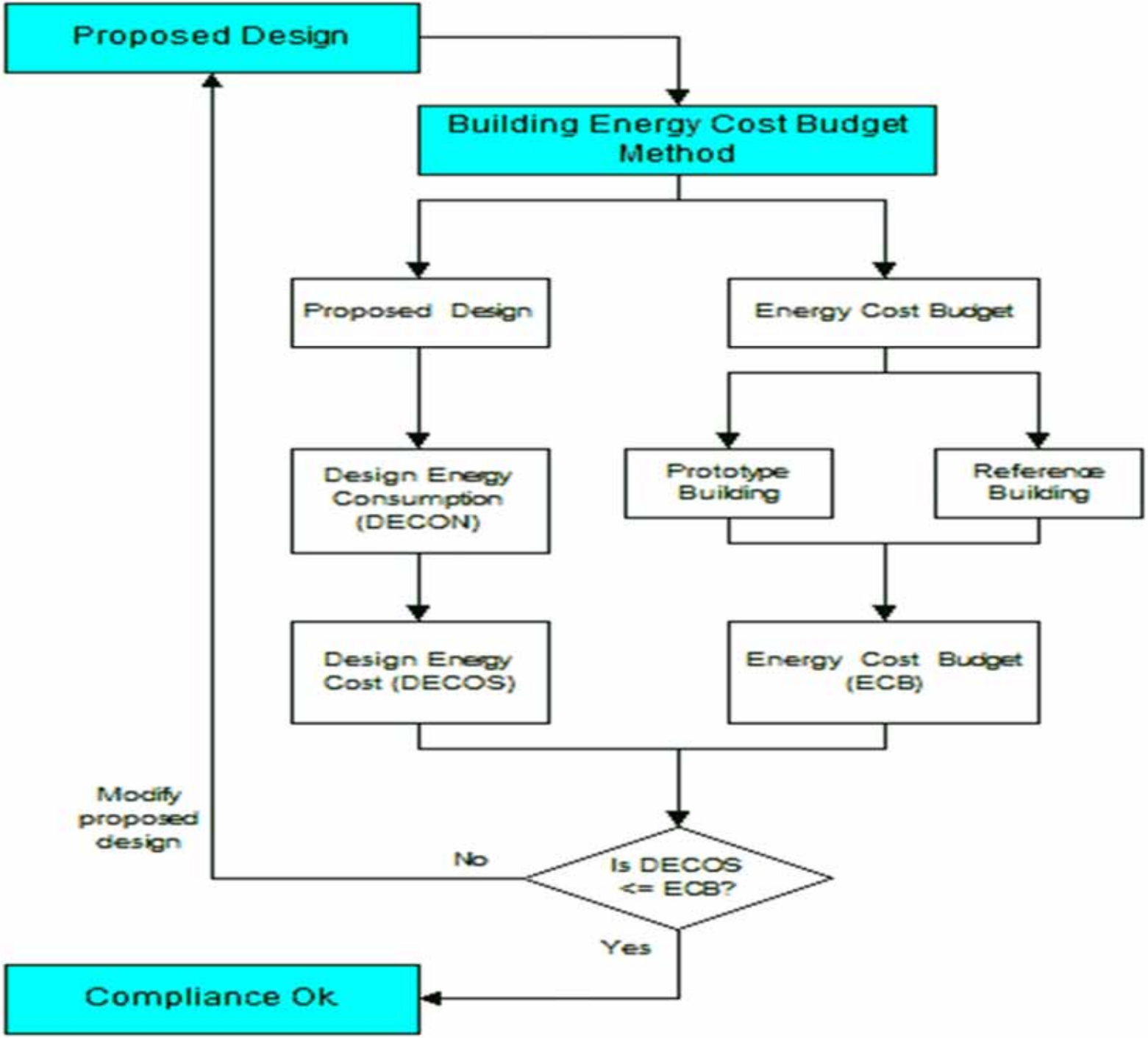
- ECB method's Pros and Cons
  - User sophistication
  - Enforcement sophistication
  - Better buildings
  - Aging of the standard
  - Gamesmanship
  - Cheating
  - Innovation

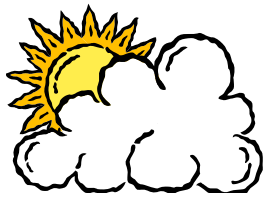
Basic concept of Energy Cost Budget (ECB) Method



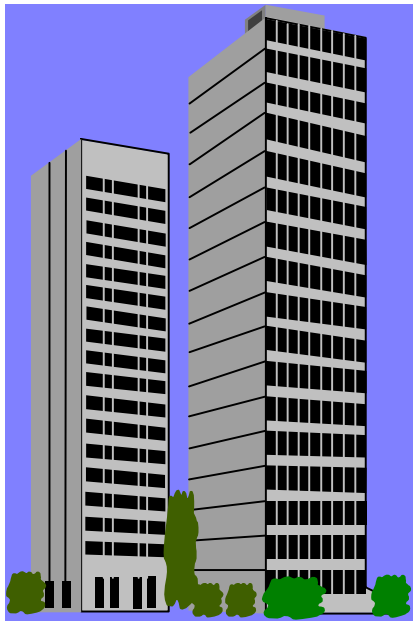
(Source: Hawaii building energy code)

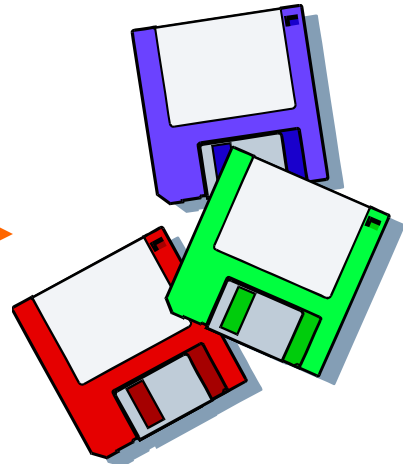
Energy Cost Budget (ECB) Method in ASHRAE 90.1





Weather data





Building description

- physical data
- design parameters

Simulation tool (computer program)

Simulation outputs

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

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

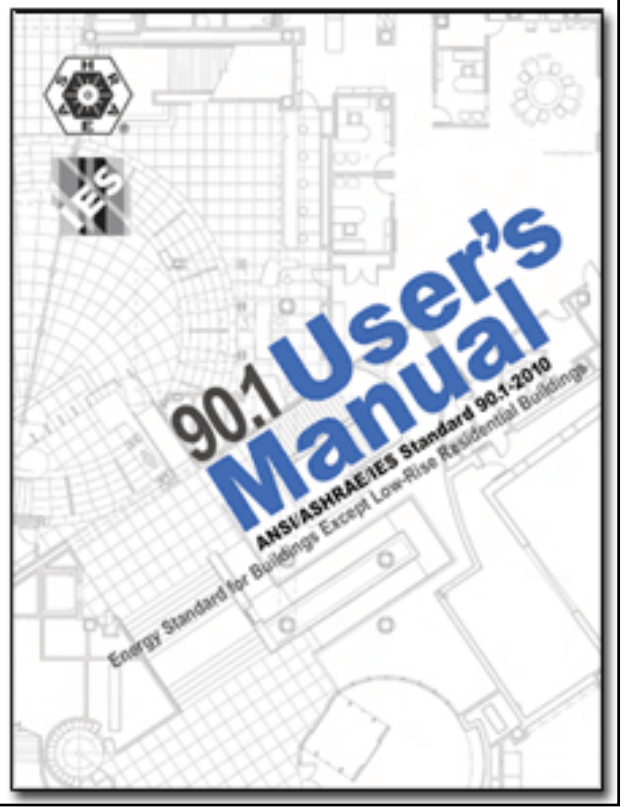
- Typical requirements by authorities
  - Must document all the info in great detail
  - Must use a good and approved simulation program
  - Must use appropriate and approved climate data
  - Must use appropriate and approved purchased energy rates
  - All details not covered by the 90.1 must be identical 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 = **L**eadership in **E**nergy and **E**nvironmental **D**esign (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

ASHRAE 90.1 and LEED

- LEED Green Building Rating System
  - **L**eadership in **E**nergy & **E**nvironmental **D**esign
  - 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

LEED GREEN ASSOCIATE™

LEED AP BD+C™

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)

LEED® for New Construction

Total Possible Points**	110*
Sustainable Sites	26
Water Efficiency	10
Energy & Atmosphere	35
Materials & Resources	14
Indoor Environmental Quality	15

*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
Regional Priority	4

LEED® for Existing Buildings

Total Possible Points**	110*
Sustainable Sites	26
Water Efficiency	14
Energy & Atmosphere	35
Materials & Resources	10
Indoor Environmental Quality	15

*Out of a possible 100 points + 10 bonus points

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

Innovation in Operations	6
Regional Priority	4

(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

Sustainable Sites		26 Possible Points
☑ Prerequisite 1	Construction Activity Pollution Prevention	Required
☐ Credit 1	Site Selection	1
☐ Credit 2	Development Density and Community Connectivity	5
☐ Credit 3	Brownfield Redevelopment	1
☐ Credit 4.1	Alternative Transportation—Public Transportation Access	6
☐ Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
☐ Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
☐ Credit 4.4	Alternative Transportation—Parking Capacity	2
☐ Credit 5.1	Site Development—Protect or Restore Habitat	1
☐ Credit 5.2	Site Development—Maximize Open Space	1
☐ Credit 6.1	Stormwater Design—Quantity Control	1
☐ Credit 6.2	Stormwater Design—Quality Control	1
☐ Credit 7.1	Heat Island Effect—Nonroof	1
☐ Credit 7.2	Heat Island Effect—Roof	1
☐ Credit 8	Light Pollution Reduction	1

Water Efficiency		10 Possible Points
☑ Prerequisite 1	Water Use Reduction	Required
☐ Credit 1	Water Efficient Landscaping	2-4
☐ Credit 2	Innovative Wastewater Technologies	2
☐ Credit 3	Water Use Reduction	2-4

(Source: USGBC)

LEED 2009 New Construction Checklist (cont'd)

Energy and Atmosphere		35 Possible Points
☑ Prerequisite 1	Fundamental Commissioning of Building Energy Systems	Required
☑ Prerequisite 2	Minimum Energy Performance	Required
☑ Prerequisite 3	Fundamental Refrigerant Management	Required
☐ Credit 1	Optimize Energy Performance	1–19
☐ Credit 2	On-site Renewable Energy	1–7
☐ Credit 3	Enhanced Commissioning	2
☐ Credit 4	Enhanced Refrigerant Management	2
☐ Credit 5	Measurement and Verification	3
☐ Credit 6	Green Power	2

Materials and Resources		14 Possible Points
☑ Prerequisite 1	Storage and Collection of Recyclables	Required
☐ Credit 1.1	Building Reuse—Maintain Existing Walls, Floors and Roof	1-3
☐ Credit 1.2	Building Reuse—Maintain Existing Interior Nonstructural Elements	1
☐ Credit 2	Construction Waste Management	1-2
☐ Credit 3	Materials Reuse	1-2
☐ Credit 4	Recycled Content	1-2
☐ Credit 5	Regional Materials	1-2
☐ Credit 6	Rapidly Renewable Materials	1
☐ Credit 7	Certified Wood	1

(Source: USGBC)

LEED 2009 New Construction Checklist (cont'd)

Indoor Environmental Quality		15 Possible Points
☑ Prerequisite 1	Minimum Indoor Air Quality Performance	Required
☑ Prerequisite 2	Environmental Tobacco Smoke (ETS) Control	Required
☐ Credit 1	Outdoor Air Delivery Monitoring	1
☐ Credit 2	Increased Ventilation	1
☐ Credit 3.1	Construction Indoor Air Quality Management Plan—During Construction	1
☐ Credit 3.2	Construction Indoor Air Quality Management Plan—Before Occupancy	1
☐ Credit 4.1	Low-Emitting Materials—Adhesives and Sealants	1
☐ Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
☐ Credit 4.3	Low-Emitting Materials—Flooring Systems	1
☐ Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
☐ Credit 5	Indoor Chemical and Pollutant Source Control	1
☐ Credit 6.1	Controllability of Systems—Lighting	1
☐ Credit 6.2	Controllability of Systems—Thermal Comfort	1
☐ Credit 7.1	Thermal Comfort—Design	1
☐ Credit 7.2	Thermal Comfort—Verification	1
☐ Credit 8.1	Daylight and Views—Daylight	1
☐ Credit 8.2	Daylight and Views—Views	1

Innovation in Design		6 Possible Points
☐ Credit 1	Innovation in Design	1-5
☐ Credit 2	LEED Accredited Professional	1

Regional Priority		4 Possible Points
☐ Credit 1	Regional Priority	1-4

(Source: USGBC)

ASHRAE 90.1 and LEED

- 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

ASHRAE 90.1 and LEED

- 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)

New Buildings	Existing Building Renovations	Points
12%	8%	1
14%	10%	2
16%	12%	3
18%	14%	4
20%	16%	5
22%	18%	6
24%	20%	7
26%	22%	8
28%	24%	9
30%	26%	10
32%	28%	11
34%	30%	12
36%	32%	13
38%	34%	14
40%	36%	15
42%	38%	16
44%	40%	17
46%	42%	18
48%	44%	19

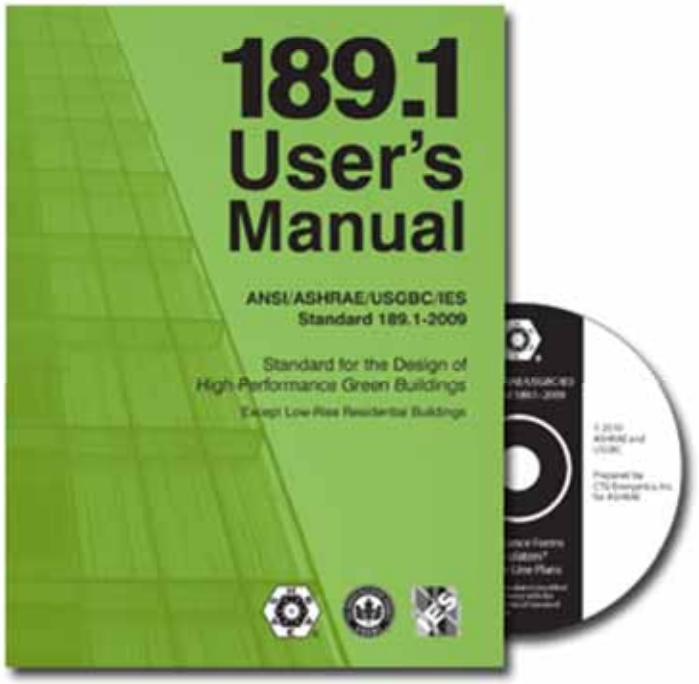
ASHRAE 189.1

- 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 power^2.



(Image source: ASHRAE)

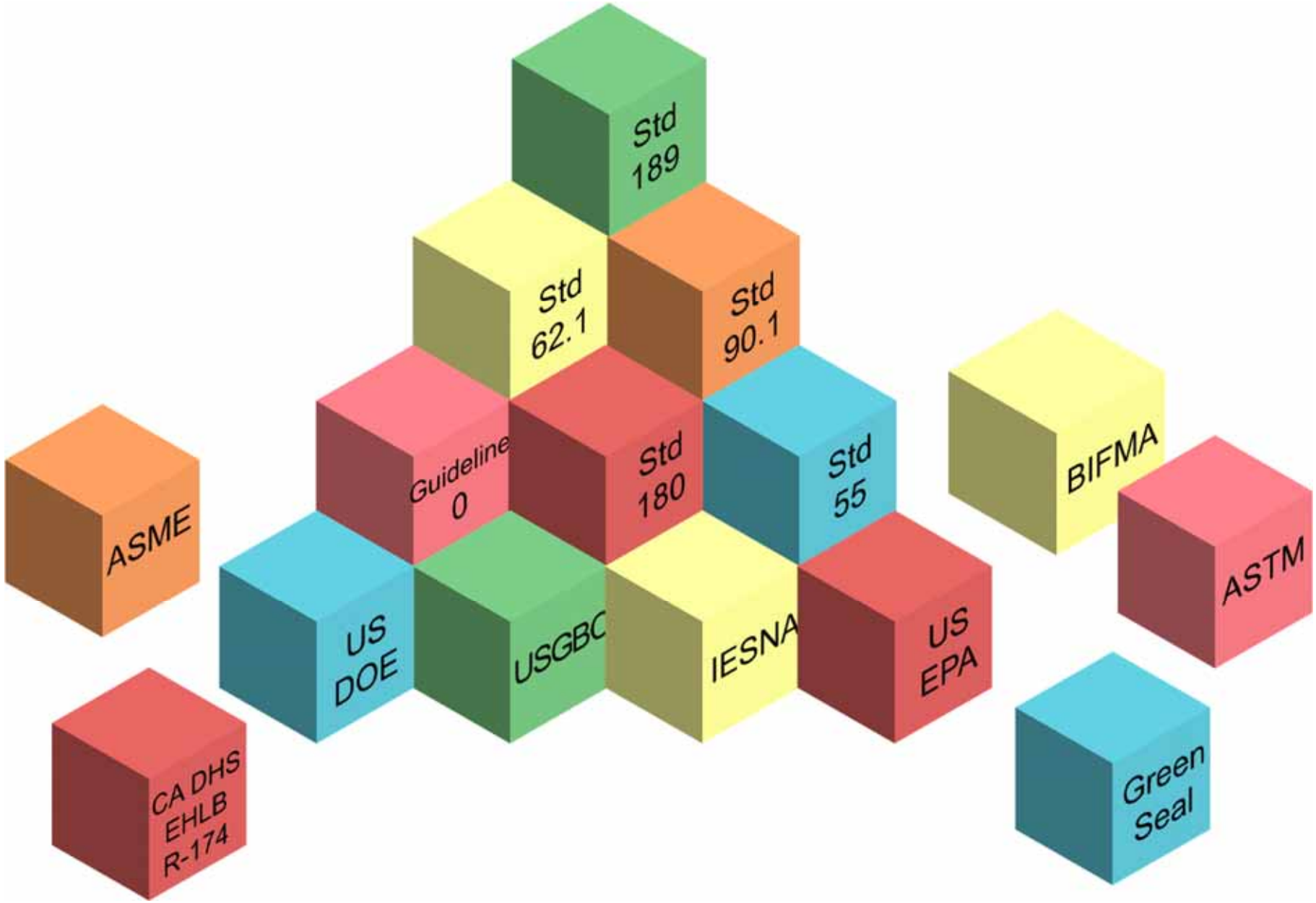
ASHRAE Standard 189.1

- 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

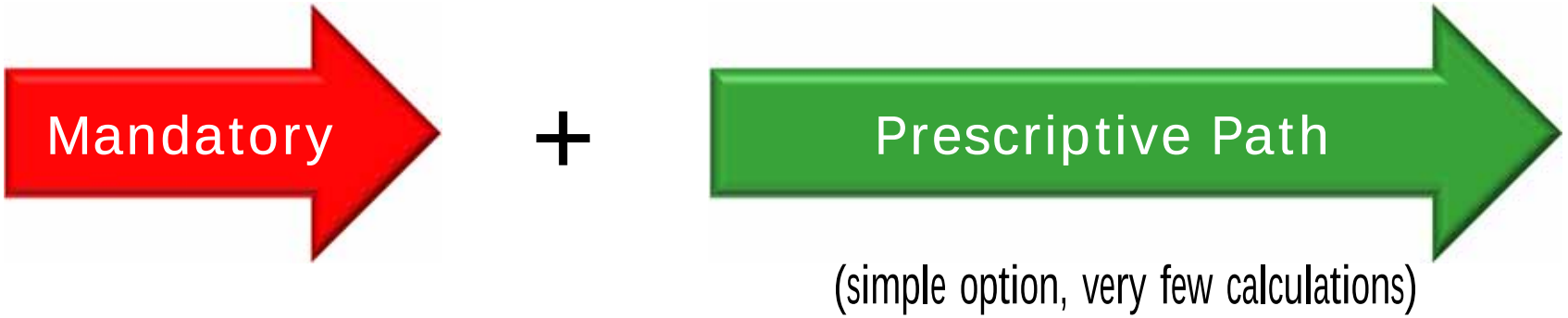
- Goals for Standard 189.1
  - Establish mandatory criteria in all topic areas
    - One “challenge” is existing green building rating systems contain few mandatory provisions
  - Provide simple prescriptive compliance options
  - Provide flexible performance compliance options
  - Complement green building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

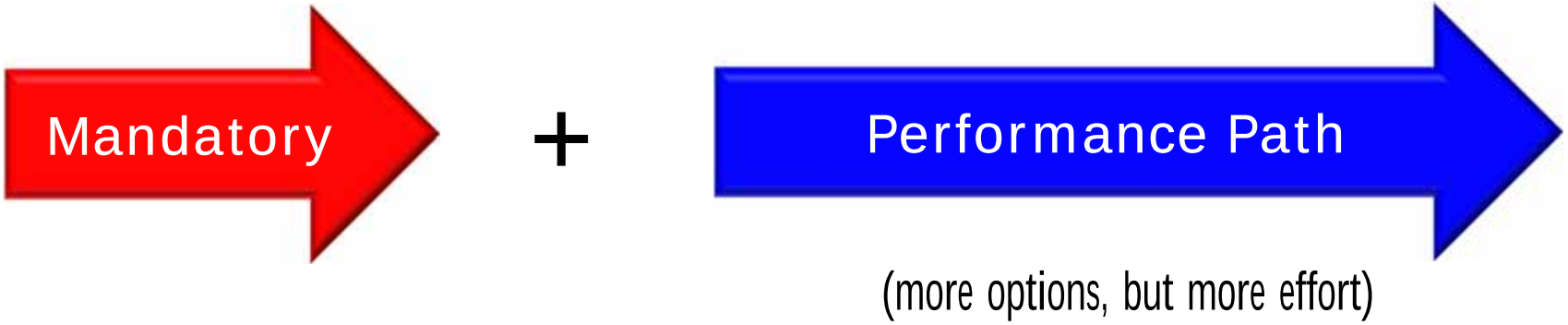
Standard 189.1 building blocks



(Source: Mr. Kent W. Peterson)

Compliance paths of Standard 189.1





(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

SS

  - 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 trepass limits

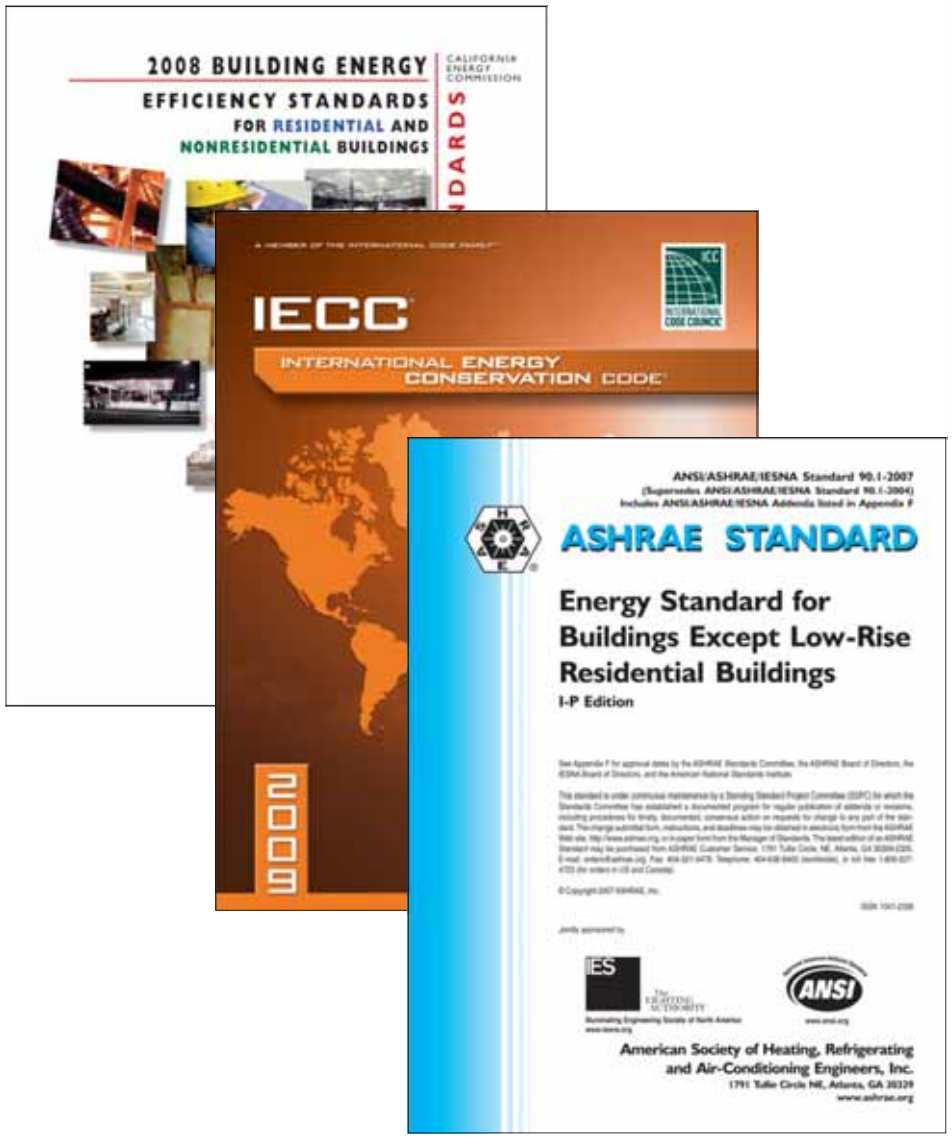
ASHRAE Standard 189.1

- Water Use Efficiency Highlights

WE

  - 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

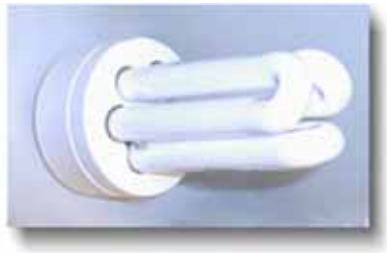
Building Energy Codes (e.g. ASHRAE 90.1)

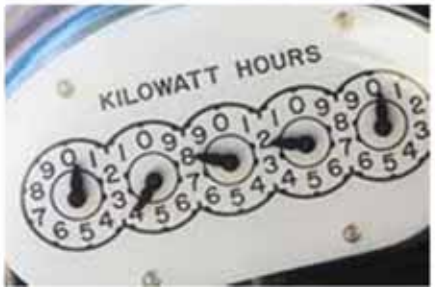


(Source: Mr. Kent W. Peterson)

ASHRAE Standard 189.1

- Energy Efficiency Highlights
  - EE
  - 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

IEQ

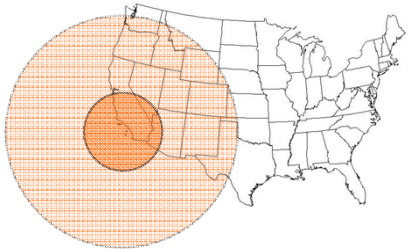
  - Indoor air quality
    - Ventilation rates per ASHRAE Standard 62.1
    - Outdoor air flow rate monitoring of min. outside air
    - MERV 8 filter (MERV 13 in PM2.5 non-attainment areas)
    - No smoking inside building
    - Source contaminant control
  - Daylighting
  - Acoustical control

ASHRAE Standard 189.1

- The Building's Impact on the Atmosphere

MR Highlights

  - Construction waste management
  - Reduced impact materials
  - Wood products
  - Refrigerants
  - Storage and collection of recyclables and discarded goods

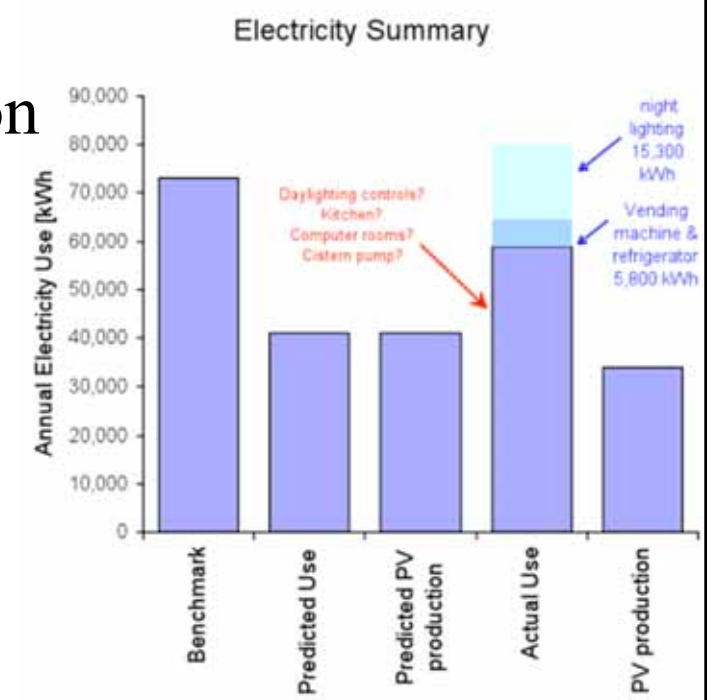


ASHRAE Standard 189.1

- Construction and Operation Highlights

CO

  - Acceptance testing / commissioning
  - IAQ construction management plan
  - Plans for Operation
    - High-performance building operation
    - Maintenance
    - Service life
    - Transportation management



THANK YOU 謝謝