

ANSI/ASHRAE/IESNA Standard 90.1

For: Boston ASHRAE Chapter

By Larry Spielvogel, PE
Consulting Engineer
© October 2007 L. Spielvogel
spielvogel@comcast.net

One Basic Premise Of The Standard

- It provides and requires a variety of means to enable efficient building operation
- Especially controls and limits

One Consequence Of The Standard

- It provides and requires a variety of means to waste energy efficiently
- This is why so many green and LEED® buildings have high energy use
- For example, see the September 2004 ASHRAE Journal article "Lessons Learned High Performance Buildings"

What the Standard Is

- Often complex and confusing
- The worst possible building that your peers say is acceptable
 - Some times it is cost effective
 - Some times it is not cost effective
 - Examples

What the Standard Is Not

- The most energy efficient solution
- A guarantee of efficient performance
- The most cost effective solution
 - Sometimes too little
 - Sometimes too much
 - Examples

Modeling Assumptions for Life-Cycle Criteria Development



- Building Types
 - Retail
 - Office
- HVAC
 - Roof Top Units
 - Gas Fired
 - Air Cooled
- Fuel & Energy Prices
 - National Averages
 - Heating \$0.66/therm
 - Cooling \$0.08/kWh
- Locations
 - 11 Cities from across all U.S. census divisions and regions

Now A Look at Standard 90.1

- Organization of Standard
- Administration and Enforcement
- Envelope
- Mechanical
- Lighting and Power
- Trade-offs
- Benchmarks and Applications

Organization of Standard 90.1

- | | |
|--|------------------------------|
| 1 Purpose | 7 Service Water Heating |
| 2 Scope | 8 Power |
| 3 Definitions | 9 Lighting |
| 4 Administration and Enforcement | 10 Other Equipment |
| 5 Building Envelope | 11 Energy Cost Budget Method |
| 6 Heating, Ventilating, and Air-Conditioning | 12 Normative References |

Appendices

NORMATIVE

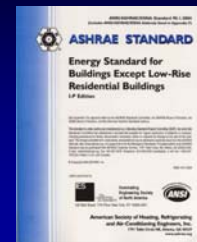
- A Assembly U-, C-, and F-Factor Determination
- B Building Envelope Criteria
- C Envelope Trade-Off Methodology
- D Climate Data

INFORMATIVE

- E Informative References
 - F Addenda Description Information
 - G Performance Rating Method
- Items in red apply to Standard 90.1-2001 and 2004 only

Section 1 - Purpose

The purpose of this standard is to provide minimum requirements for the energy-efficient design of buildings except low-rise residential buildings



Section 2 - Scope

- New buildings and their systems
- New *portions* of buildings and their systems (additions)
- New systems and equipment in *existing* buildings (alterations)



Scope Exemptions

- Single-family houses, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes), and manufactured houses (modular)
- Buildings that do not use either electricity or fossil fuel

More Scope Exemptions

- Equipment and portions of building systems that use energy primarily to provide for industrial, manufacturing, or commercial purposes.
- Envelope may be exempt if building has small enough heating and cooling systems

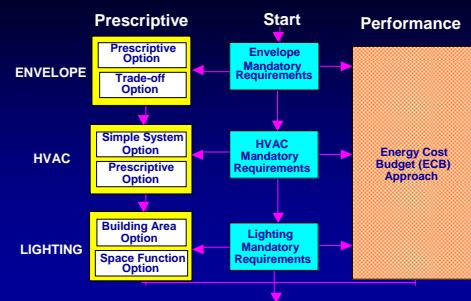
Administration and Enforcement Requirements

- Section 4 covers compliance for new buildings, existing buildings, additions to existing buildings, alterations to existing buildings, and changes in space conditioning in existing buildings
- **ALL** of these events are meant to trigger the requirements of Standard 90.1

Compliance

- Technical Chapters Have:
 - All Have Mandatory Requirements
 - Must Be Done
 - Cannot Be Traded
 - Prescriptive Requirements
 - Can Be Traded
 - Within that Chapter, or
 - Among Chapters in the Energy Cost Budget (ECB)
 - Trade Off Provisions
 - Energy Cost Budget Method
 - Hourly Simulation Required

Alternate Compliance Paths



Overview – Standard 90.1 Envelope Requirements

- Section 5 (Building Envelope) regulates the construction and performance of the exterior building envelope
- Section 5 explicitly does not address moisture control or provide guidance on moisture migration that may lead to condensation, mold, mildew, or insulation or equipment deterioration

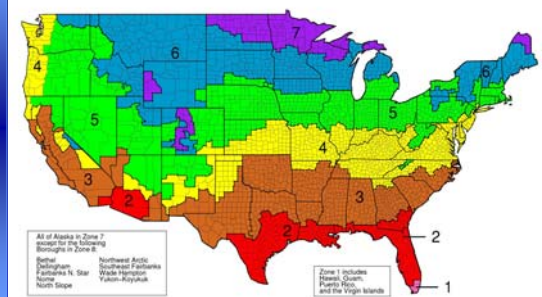
General Design Considerations

- Building envelope does not use energy
- Design affects heating and cooling loads
- Insulation affects the temperature of inside surfaces and comfort
- Daylighting can reduce electric lighting
- Integrated design approach saves energy

Prescriptive Building Envelope Option (Section 5.5)

You need to know 4 things

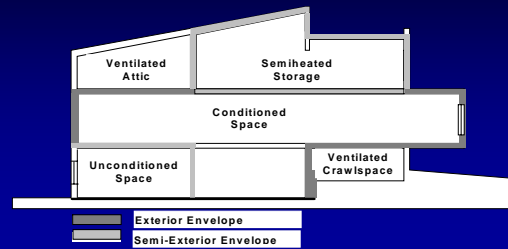
#1 Climate Zones



#2 Occupancy Type Prescriptive Building Envelope Option (Section 5.5)

- Nonresidential
- Residential
- Semi-Heated

#3 Space Type Prescriptive Building Envelope Option (Section 5.5)



#4 Construction Type Prescriptive Building Envelope Option (Section 5.5)

- Prescriptive tables

OPAQUE ELEMENTS	NONRESIDENTIAL		RESIDENTIAL		SEMIHEATED	
	Assembly Maximum	Insulation Min. R-value	Assembly Maximum	Insulation Min. R-value	Assembly Maximum	Insulation Min. R-value
Roofs	U-factor	R-value	U-factor	R-value	U-factor	R-value
Walls Above Grade	U-factor	R-value	U-factor	R-value	U-factor	R-value
Walls Below Grade	U-factor	R-value	U-factor	R-value	U-factor	R-value
Floors	U-factor	R-value	U-factor	R-value	U-factor	R-value
Slab-on-Grade Floors	F-factor	R-value	F-factor	R-value	F-factor	R-value
Opaque Roofs	U-factor	R-value	U-factor	R-value	U-factor	R-value
FENESTRATION	Assembly Max. U-Factor	Assembly Max. SHGC (ANSI Standard)	Assembly Max. U-Factor	Assembly Max. SHGC (ANSI Standard)	Assembly Max. U-Factor	Assembly Max. SHGC (ANSI Standard)

ENVStd Software

- Comes with Users Manual
- Cannot be used to by-pass Mandatory requirements
- Cannot be used to make trade-offs between building envelope and lighting or mechanical systems
- Considers both heating and cooling energy

Overview – Standard 90.1 Mechanical Requirements

- Section 6 (Heating, Ventilating, and Air Conditioning) regulates all mechanical equipment serving building HVAC needs and sets Federal Legal minimum standards.
- Section 7 (Service Water Heating) regulates all SWH systems and equipment

Section 6 - Heating, Ventilating and Air Conditioning

- The 1992 Federal Energy Policy Act says that the ASHRAE 90.1 Committee sets the national mandatory minimum efficiency standards for 26 classes of commercial heating and air conditioning equipment.
- This covers almost all products in the marketplace for commercial buildings
- The Law says the Government can, but they have not yet overridden any of the ASHRAE minimum efficiencies

1992 EPACT; P.L. 102-486 Commercial HVAC & SWH Efficiencies

"If ASHRAE/IES Standard 90.1, as in effect on the date of enactment of the Energy Policy Act of 1992, is amended with respect to any small commercial package air conditioning and heating equipment, large commercial package air conditioning and heating equipment, packaged terminal air conditioners, packaged terminal heat pumps, warm-air furnaces, packaged boilers, storage water heaters, instantaneous water heaters, or unfired hot water storage tanks, the Secretary [of Energy] shall establish an amended uniform national standard for that product at the minimum level for each effective date specified in the amended ASHRAE/IES Standard 90.1, unless the Secretary determines, by rule published in the Federal Register and supported by clear and convincing evidence, that adoption of a uniform national standard more stringent than such amended ASHRAE/IES Standard 90.1 for such product would result in significant additional conservation of energy and is technologically feasible and economically justified."

Section 6 - Heating, Ventilating and Air Conditioning

- Offers a simplified approach option for small (less than 25,000 ft²), short (less than two stories) buildings with single zone HVAC systems
- This option limits HVAC systems and equipment so that stringency is equal to all other requirements of Chapter 6

Section 6 [HVAC for Not-So-Simple Buildings] I

- Requires load calculations
- Regulates equipment efficiency
- Requires controls
 - Zone thermostatic, off-hour, ventilation system, heat pump auxiliary heat, humidifier preheat, humidification and dehumidification, freeze protection and snow/ice melting systems, ventilation controls for high-occupancy areas

Section 6 [HVAC for Not-So-Simple Buildings] II

- Regulates HVAC system construction and insulation
 - Duct, plenum, and piping insulation
 - Duct and plenum leakage
- Requires that construction documents and manuals be provided to the owner
- Requires system balancing in all buildings and commissioning in large buildings

Section 6 [HVAC for Not-So-Simple Buildings] III

- Requires, limits, and/or regulates:
 - Economizers (with lots of exceptions)
 - Simultaneous heating and cooling
 - Air system design and control
 - Hydronic system design and control
 - Heat rejection equipment
 - Energy recovery (with exceptions)
 - Exhaust hoods
 - Radiant heating systems

Section 7 - Service Water Heating

- Requires load calculations
- Regulates equipment efficiency
- Requires SWH piping insulation
- Requires SWH temperature controls
- Requires pool heater shut-off controls, pool covers, and pool heater/pump shut-off controls
- Requires heat traps

Section 8 - Power

- Regulates voltage drop in feeders and branch circuits
- Requires construction drawing and manuals be supplied to owner
- Section was carefully constructed to regulate only aspects of building power systems that are NOT covered in electrical codes

Section 9 - Lighting I

- Requires interior lighting controls
- Requires tandem wiring of ballasts
- Regulates exit signs
- Defines installed interior lighting power
- Defines luminaire wattage
- Regulates exterior lighting efficacy

Section 9 - Lighting II

- Provides two options for regulating interior lighting power
 - Building Area Method
 - Space-By-Space Method
- Provides additional interior lighting power allowances for specific situations

Section 10 - Other Equipment

- Sole requirement is to require the use of motors that meet the requirements of the Energy Policy Act of 1992. Since this Act sets manufacturing standards for motors, all motors in the US meet this requirement.
- Requirements function is primarily to provide a motor baseline for the ECB trade-off

Standard 90.1 Tradeoffs – ENVSTD and ECB

- These are the only two formal tradeoffs within Standard 90.1
 - **ENV**elope **ST**andard for tradeoffs among envelope components
 - **E**nergy **C**ost **B**udget for whole building tradeoffs
- Less formally, lighting power may be traded off within spaces in a building

Section 11 - Energy Cost Budget Method

- The ultimate trade-off method allowing you 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.
- The basis for the energy portion of LEED® rating
- Limits allowable energy costs of the design to those of a building meeting the Standard
- Buildings must still meet all mandatory requirements

Section 11 - Energy Cost Budget Method

If you are attempting to show that your building goes “above code” (say, for instance, for LEED® energy points) as opposed to simply using ECB as a flexible and complex code compliance tradeoff option, be sure to see Informative Appendix G, which contains many of the same elements as Section 11, but with modifications to accommodate the needs of “above code” programs

Appendix G -Performance Rating Method

Instructions for using the ANSI/ASHRAE/IESNA Standard 90.1-2004 Energy Cost Budget Method in conjunction with the U.S. Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED®) and other similar programs

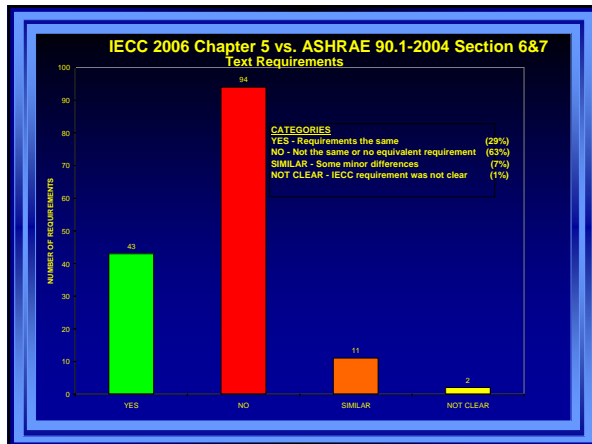
1992 Federal Energy Policy Act



- States Must Certify Compliance
 - But no enforcement capability
- Comparisons with IECC
- Use of COMCheck EZ

DOE Determination

- Under 1992 EPACT DOE must determine if 90.1-2004 saves energy
- If so, states directed to implement and certify codes at least as stringent in 2 years by Federal Register notice
- Determination imminent



- ### 2007 Edition Almost Final
- Stringency compared with 2004
 - May not be published this year
 - Updated Users Manual
 - Major changes from 90.1-2004
 - Compliance with 62.1-2004, not 62-1999
 - Revised lighting allowances
 - Fan & boiler energy reductions
 - Many mostly minor refinements

- ### Presidential & BOD Requests
- 30% stringency increase
 - Relative to 90.1-2004
 - Performance standard
 - Linked criteria
 - Complete by 2010

- ### ASHRAE/USGBC/IESNA SPC 189.1 Standard For The Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings
- **Purpose:** the purpose of this standard is to provide minimum requirements for the design of high-performance, green buildings to:
 - (A) Balance environmental responsibility, resource efficiency, occupant comfort and well being, and community sensitivity, and
 - (B) Support the goal of the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.

- ### EPA Energy Star Buildings
- Getting Energy Star for a building means that its energy performance is better than 75% of all existing buildings of that type of any age.
 - Simply put, that is not very good energy performance, especially for newer buildings, and by today's building energy codes and standards.

Relation To IECC 2006

“When one or more of these sections is not satisfied, compliance for that section(s) shall be demonstrated in accordance with the applicable provisions of ASHRAE/IESNA 90.1”

US Department of Energy-Building Energy Codes – May 4, 2005

"COMcheck-Web is the web-based version of COMcheck-EZ desktop software. It performs just like the desktop version, but you don't need to download or install any software on your computer. This version supports envelope and lighting compliance for ASHRAE Standard 90.1 and IECC. It does have a few limitations: mechanical compliance is not included, lighting allowances are not included, and state codes are not supported. These features will be added in an update scheduled for September 2005." (Emphasis added)

2005 Federal Energy Policy Act (EPACT)

- Tax Deduction for exceeding 90.1 by 50%
 - IRS Rules Not Yet Published
 - Up To \$1.80 per SF With 50% Energy Cost Reduction
- Federal Buildings Must Exceed 90.1 by 30%
 - When Cost Effective

ANSI/ASHRAE/IESNA Standard 90.1 References

Serves as the energy benchmark (minimum) for the:
USGBC Leadership in Energy and Environmental Design LEED® Program
Green Building Initiative Green Globes Program
Green Guide for Health Care
US Government Federal Building Standards
Commercial Building Tax Deductions
Is one option for compliance with IECC
But is rarely used

ASHRAE Advanced Energy Design Guides

- Claim 30% less energy than 90.1-1999
- Only for buildings less than 20,000 square feet
 - Office buildings
 - Schools
 - Warehouses
 - Retail buildings
 - With some exclusions
- 90.1-2004 already has lower energy than 1999
 - So comparisons with 90.1-1999 are not valid

Current Major Proposals But Not Yet Final

- Continuous air barrier
- Envelope stringency
- Fenestration stringency
- HVAC efficiencies
- Lighting controls
- Fuel & energy pricing
- Economic assumptions

Ongoing Major Controversies

- Energy Prices – Local versus Average
- Fuel & Energy Competition
- Product Requirements
- Multiple Sets of Requirements
- Existing Buildings
- Simplified Options

What You Can Do

- Participate in Public Reviews
 - Announced on Free ASHRAE List Server
 - <http://www.ashrae.org/publications/detail/14934>
- Review Proposals From Your Perspective
- Are the Proposed Requirements
 - Reasonable, Justifiable, Economic, Practical
 - Too Complicated
 - Not Enforceable
- Submit Comments
- Submit Continuous Maintenance Proposals

Interpretations for Standard 90.1

- Users Manual
 - Provides much of the background
- Formal Interpretations
 - Formal written interpretations take time
- Informal Interpretations
 - Quick, informal answers to questions
- ASHRAE Manager of Standards (404)636-8400

Training Resources

- ASHRAE Chapters
- ASHRAE Learning Institute Courses
 - Also on the Internet
- ASHRAE's website – www.ashrae.org
 - Interpretations, addenda, errata, mailing lists, videos, free viewing
- DOE's code website – www.energycodes.gov
 - Presentations, status of states, code comparisons, simplified compliance materials (maps, guides, software), videos

Solutions for Efficient Buildings

- Have better trained, more intelligent, and more motivated building operators
- Design buildings that have simple systems and controls
- Design buildings and systems that do not require too much maintenance and service
- Design buildings that do not require commissioning or retro-commissioning
- Design buildings that do not use every trick in the book

Questions?