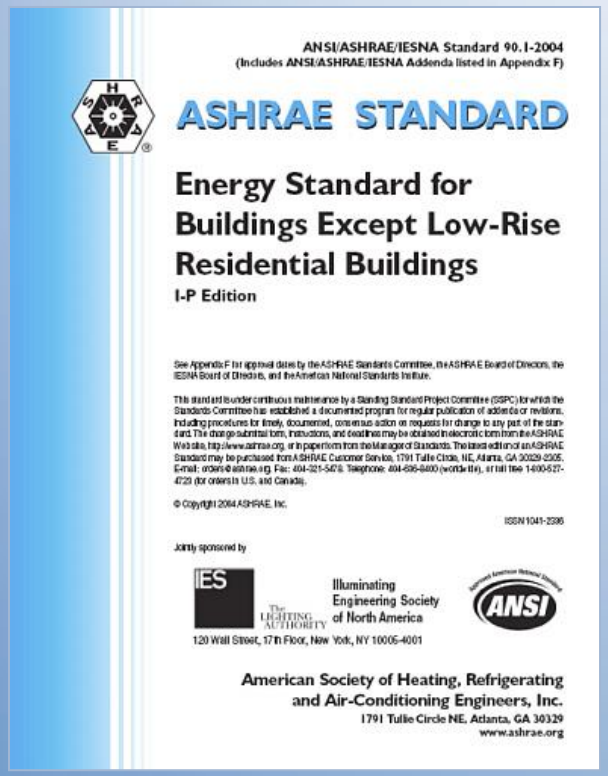
ASHRAE Standard 90.1



90.1 Past, Present and Future

ASHRAE Oryx Chapter, Doha Seminar – March 23, 2013

Ronald E. Jarnagin

Presidential Member 2011-2012

Credits for material due to Mick Schwedler (Trane), Jeff Boldt (KJWW Engineering), Steve Skalko (Consultant), Merle McBride (Owens Corning)

ASHRAE Standard 90.1

- Provide background on Standard 90.1
- The “30%” Goal for 2010
- The “50%” Goal for 2013

ASHRAE Standard 90.1

- In the 1970's energy design and building operation conducted in a "business as usual" fashion
- Inexpensive energy, ample supplies
- 1/3 of U.S. energy used in buildings
- National Council of States on Building Codes and Standards (NCSBCS) formed in 1967 to address non-uniformity of U.S. building codes and standards

ASHRAE Standard 90.1

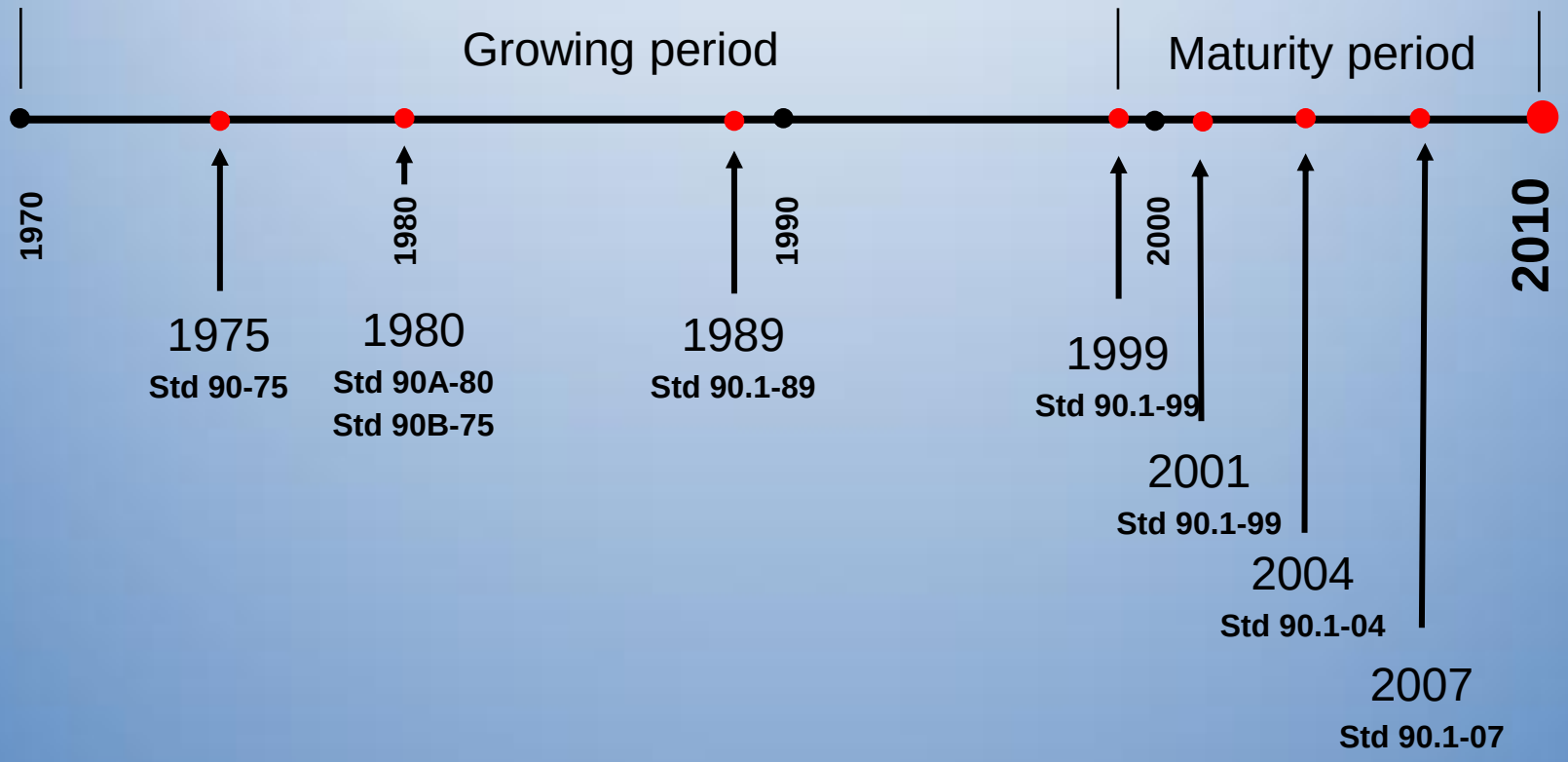
- 1973 OPEC oil embargo changed everything!
- Long lines at service stations – supplies ran out in many areas
- Curtailment/rationing of fuel oil and gasoline
- New York State instituted gas every other day dependent on last digit on license plate
- Electrical brownouts in many states

ASHRAE Standard 90.1

- *“ASHRAE’s membership is concerned about utilization of energy, not with its production. We, as engineers, designers, manufacturers and technicians, can help to reduce the shortage of energy by using our technology to assure that the utilization of energy is optimized. If we don’t take the forefront in this, we must expect others to take over.”*
- **– Presidential Member Rod Kirkwood, presidential speech, 1973 to Board of Directors urging approval of development of standard and requesting a dues increase to cover the costs**

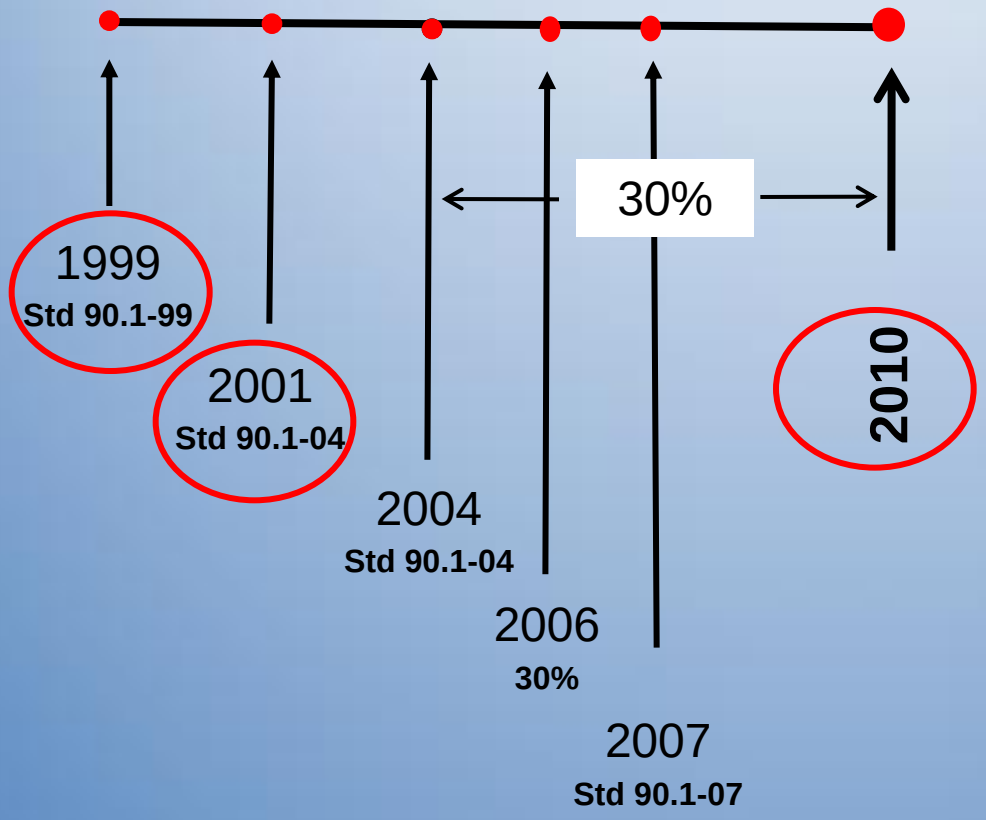
ASHRAE Standard 90.1

Timeline



ASHRAE Standard 90.1

Timeline



MILESTONES

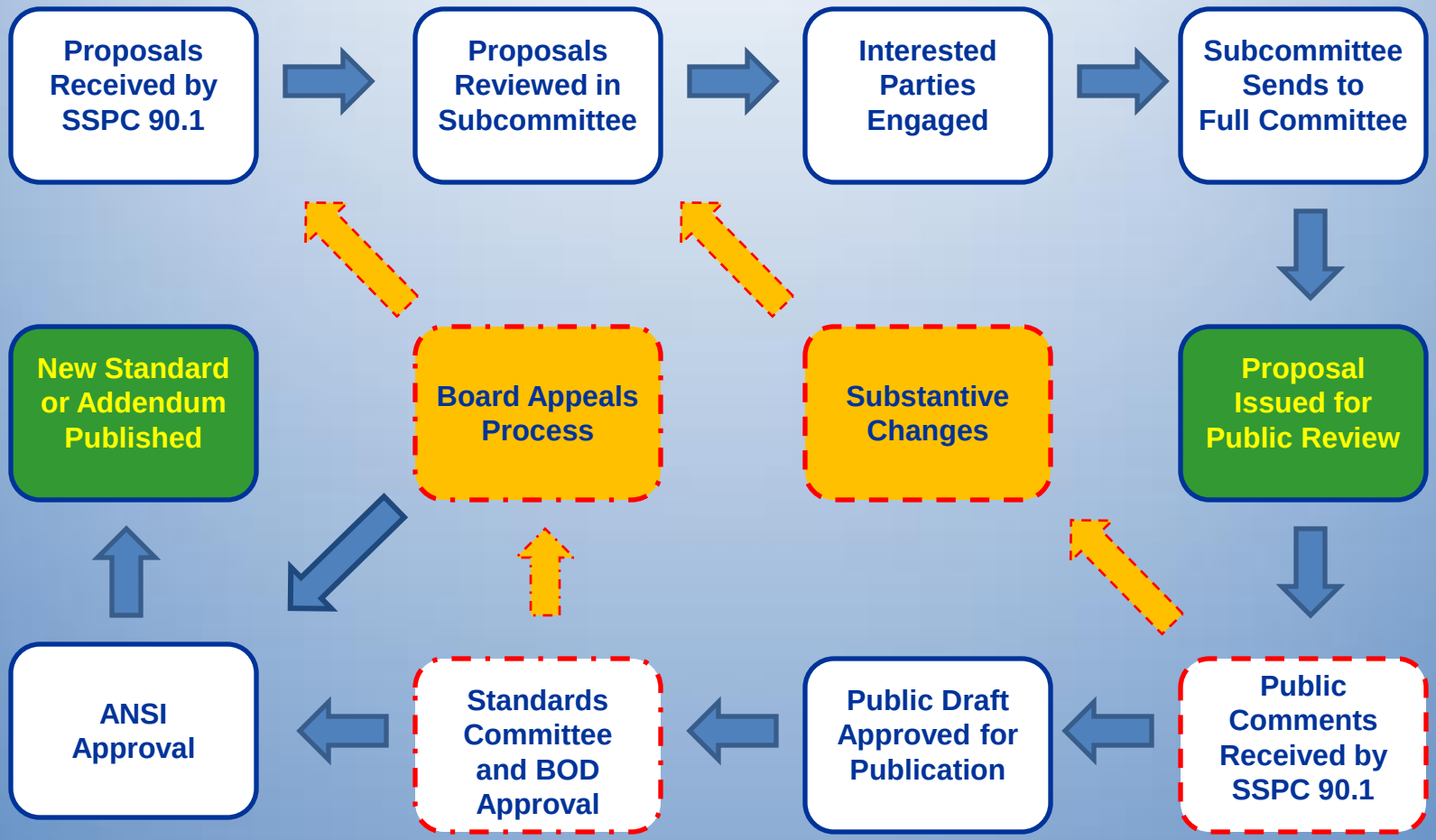
- 1999 – Major rewrite, economic basis & CM
- 2001 – 3 Year cycles
- 2006 – BOD 30% challenge
- 90.1 Work Plan – 30% energy cost savings
- Expand TPS

ASHRAE Standard 90.1

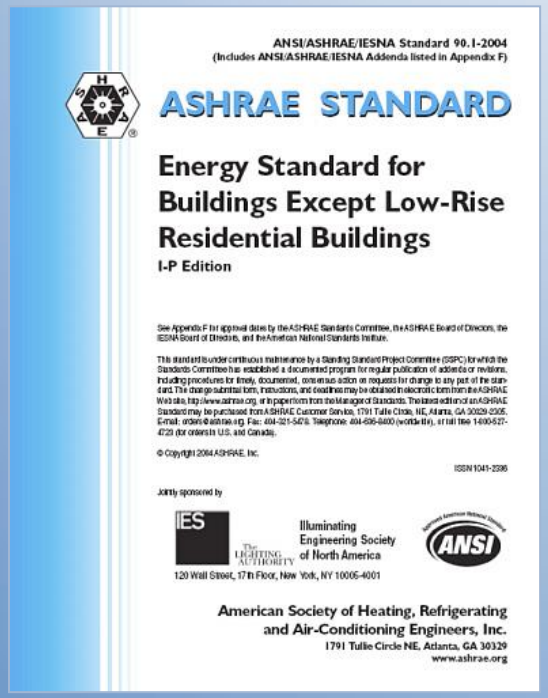
Significance

- In 1992 Standard 90.1 became “the law of the land” for the U.S. when the federal government passed the Energy Policy Act
- Legislation required all states to adopt 90.1
- Equipment efficiencies of commercial heating and cooling equipment would become mandated by the standard at the point of manufacturing
- 90.1 became the basis for many of the standards in other countries (e.g. Singapore, China)
- 90.1 is referenced in a number of above-code programs

ASHRAE Standard 90.1 Revision Process



ASHRAE Standard 90.1 Revision Goals



- **Technically justified**
- **Simplicity**
- **Flexibility**
- **Enforceable**

ASHRAE Standard 90.1 Workplan

- Goal: A 2010 standard that results in 30% total energy cost savings improvement compared to Standard 90.1-2004. Measurement is aggregated, may not be met for every building in every location

- 90.1-2010 = 90.1-2007 + All IES and ASHRAE BOD approved addenda

ASHRAE Standard 90.1

Accomplishments for Standard 90.1-2010

- Completed upgrade from 2007 version
- Incorporated 109 addenda in the process
- Produced 90.1-2010 Users Manual
- Met the target energy savings goals

ASHRAE Standard 90.1

Sections

- Section 1: Purpose
- Section 2: Scope
- Section 3: Definitions Abbreviations
- Section 4: Admin. And Enforcement
- Section 5: Building Envelope
- Section 6: HVAC
- Section 7: SWH
- Section 8: Power
- Section 9: Lighting
- Section 10: Elec. Motors
- Section 11: ECB
- Section 12: References
- Appendices
  - Appendix C – Envelope
  - Appendix G - ECB

ASHRAE Standard 90.1

Purpose of 90.1 – 2010

"To establish the minimum energy efficiency requirements of buildings, other than low rise residential buildings, for:

1. design, construction, and a plan for operation and maintenance, and
2. utilization of on-site, renewable energy resources "

ASHRAE Standard 90.1

Scope of 90.1 – 2010

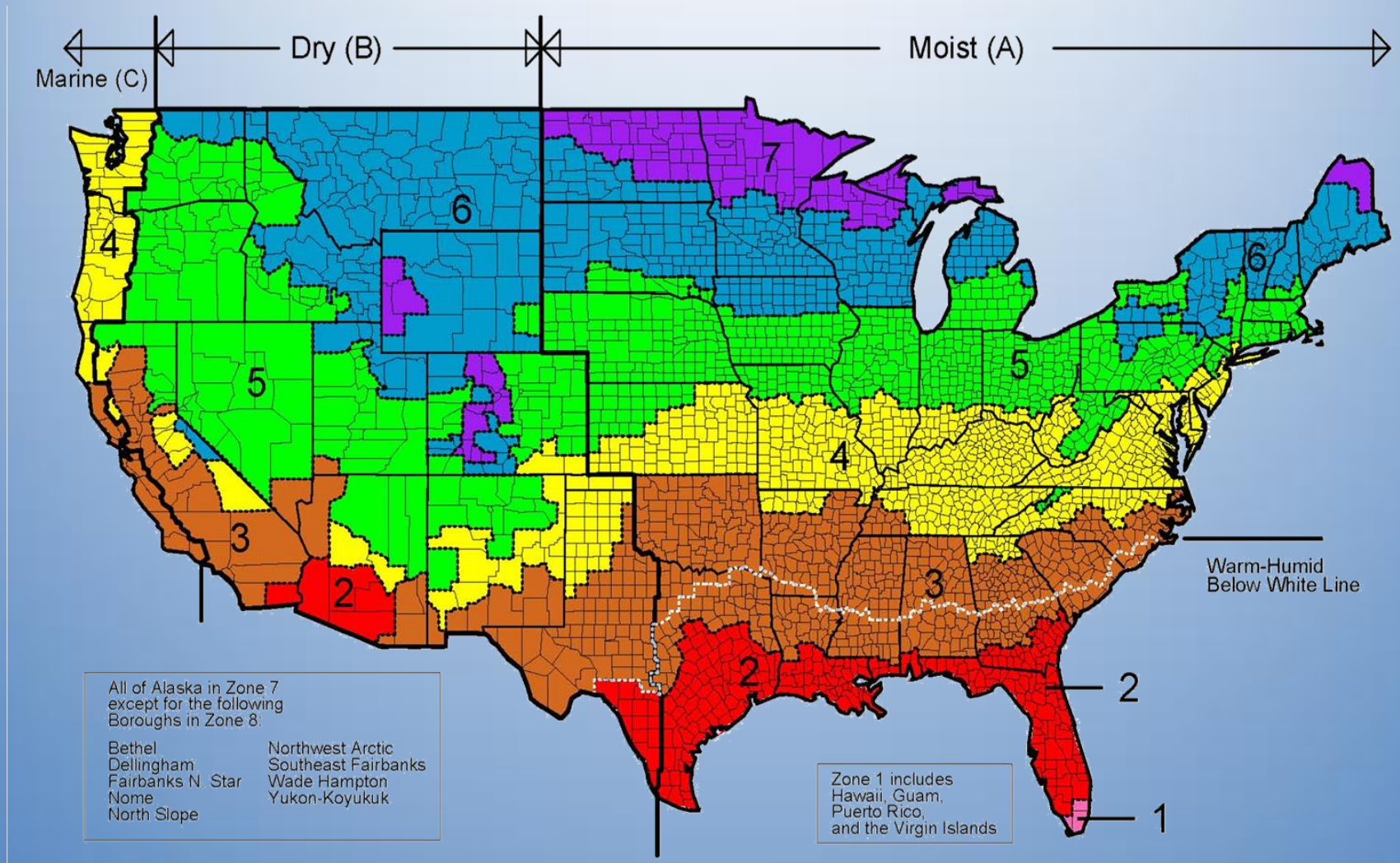
- New buildings and their systems
- New portions of buildings and their systems
- New systems and equipment in existing buildings
- New equipment or building systems specifically identified in the standard that are part of industrial or manufacturing processes

ASHRAE Standard 90.1

90.1 Does Not Apply To:

- Single-family houses, multi-family structures of three stories or fewer above grade, manufactured houses (mobile homes), and manufactured houses (modular), or
- Buildings that use neither electricity nor fossil fuel

ASHRAE Standard 90.1 Climates



ASHRAE Standard 90.1

90.1-2010 Envelope Changes

- bn, fenestration orientation
- bf, continuous air barrier
- f, cool roofs
- Envelope/lighting interactions

ASHRAE Standard 90.1

Lighting levels were generally reduced or remained the same for 90.1-2010

TABLE 9.5.1 Lighting Power Densities Using the Building Area Method

Building Area Type[a]	LPD (W/ft²)	
Automotive facility	~~0.9~~	0.82
Convention center	~~1.2~~	1.08
Courthouse	~~1.2~~	1.05
Dining: bar lounge/leisure	~~1.3~~	0.99
Dining: cafeteria/fast food	~~1.4~~	0.90
Dining: family	~~1.6~~	0.89
Dormitory	~~1.0~~	0.61
Exercise center	~~1.0~~	0.88
Gymnasium	~~1.1~~	1.00
Health-care clinic	~~1.0~~	0.87
Hospital	~~1.2~~	1.21
Hotel	~~1.0~~	1.00
Library	~~1.3~~	1.18
Manufacturing facility	~~1.3~~	1.11
Motel	~~1.0~~	0.88
Motion picture theater	~~1.2~~	0.83
Multifamily	~~0.7~~	0.60
Museum	~~1.1~~	1.06
Office	~~1.0~~	0.90
Parking garage	~~0.3~~	0.25

ASHRAE Standard 90.1

Lighting Addenda

- Envelope/lighting interaction
  - D, AB, AL – daylighting control
  - Ct, dd – modify the area thresholds for top and side daylighting
- AV – changes alteration threshold (10%) at which replacement lighting and controls must comply
- Ce – requires bi-level switching
- CZ – parking garage lighting control
- BS – control of 50% of receptacles

ASHRAE Standard 90.1

Mechanical Addenda

- Equipment efficiency
- System design requirements

ASHRAE Standard 90.1

Equipment Efficiency

- Unitary
- Chillers
- Heat rejection
- Fans and pumps

ASHRAE Standard 90.1

Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency[a]	Test Procedure[b]
≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.2 EER 11.4 IEER	ARI 340/360
	All other	Split System and Single Package	11.0 EER 11.2 IEER	
≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	11.0 EER 11.2 IEER	
	All other	Split System and Single Package	10.8 EER 11.0 IEER	
≥240,000 Btu/h and <760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	10.0 EER 10.1 IEER	
	All other	Split System and Single Package	9.8 EER 9.9 IEER	
≥760,000 Btu/h	Electric Resistance (or None)	Split System and Single Package	9.7 EER 9.8 IEER	
	All other	Split System and Single Package	9.5 EER 9.6 IEER	
< 65,000 Btu/h	All	Split System and Single Package	12.1 EER 12.3 IEER	ARI 210/240
≥65,000 Btu/h and	Electric Resistance	Split System and	11.5 EER	

ASHRAE Standard 90.1

What is IEER vs. EER?

- a new metric, the *Integrated Energy Efficiency Ratio*
- used on unitary products to replace IPLV
- designed to encourage better real world part load performance by putting different spices in the soup (i.e. manufacturers are rewarded for designs that save energy but were not reflected in the IPLV metric)

ASHRAE Standard 90.1

Unitary Changes – addendum n

- In 2012 (DX) and 2010 (chilled water)
- Single zone systems
  - DX ≥ 110,000 Btu/h (9.2 tons)
  - Chilled water AHUs with fan motors ≥ 5hp
- Two-speed motors or VFDs
- Required for implementing
  - Discharge temperature sensors or multiple stages of compression
  - Care needed to meet ventilation codes
    - Damper position compensation for fan speed
    - Airflow measurement and variable OA dampers

ASHRAE Standard 90.1

Unitary Equipment Efficiency

- Water- and evaporatively cooled AC and HP
- Water- and evap-cooled condensing units are now two different categories
- 3 to 5% more stringent than 2001-2007 levels
  Effective 6/1/2011

ASHRAE Standard 90.1

Minimum Efficiency Requirements *(continued)*

Water source water to water (cooling mode)	<135,000 Btu/h	All	86°F entering water	10.6 EER	ISO-13256-2
Groundwater source water to water (cooling mode)	<135,000 Btu/h	All	59°F entering water	16.3 EER	ISO-13256-2
Ground source Brine to water (cooling mode)	<135,000 Btu/h	All	77°F entering water	12.1 EER	ISO-13256-2
Water source water to water (heating mode)	<135,000 Btu/h (cooling capacity)	---	68°F entering water	3.7 COP	ISO-13256-2
Groundwater source water to water (heating mode)	<135,000 Btu/h (cooling capacity)	---	50°F entering water	3.1 COP	ISO-13256-2

ASHRAE Standard 90.1

Computer room air conditioners (CRAC)

- ASHRAE 127 test procedure
  conditions reflect sensible (mostly) data center cooling
  SCOP is defined (sensible coefficient of performance)

- Minisplits have been covered under 210-240
- Multi-splits (VRF, VRV)
  Coverage beginning July 1, 2012

ASHRAE Standard 90.1

Equipment Type	Size Category	Heating Section Type	Sub-Category or Rating Condition	Minimum Efficiency	Test Procedure
VRF Air Cooled, (cooling mode)	<65,000 Btu/h	All	VRF Multi-split System	13.0 SEER	AHRI 1230
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	11.0 EER 12.3 IEER 12.9 IEER (as of 7/1/2012)	
	≥65,000 Btu/h and <135,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System with Heat Recovery	10.8 EER 12.1 IEER 12.7 IEER (as of 7/1/2012)	
	≥135,000 Btu/h and <240,000 Btu/h	Electric Resistance (or none)	VRF Multi-split System	10.6 EER 11.8 IEER 12.3 IEER (as of 7/1/2012)	
	≥135,000 Btu/h	Electric	VRF Multi-split	10.4 EER	

ASHRAE Standard 90.1

Chiller Energy Efficiency

- Two compliance paths for water-cooled chillers
  - Full load and part load metrics in both paths
  - Water-cooled positive displacement classed together
- Air-cooled chillers part load improvement
- New categories
  - Less than and 150+ tons air-cooled categories
  - 600+ tons water-cooled centrifugal category
- Removed categories
  - Air-cooled chillers without condensers
  - Reciprocating chillers now with screw and scroll

ASHRAE Standard 90.1

Heat Rejection Energy Efficiency

- Limits on centrifugal fan cooling tower use
  - Above 1,100 gpm, centrifugal fan towers have to meet axial fan power levels (≥ 38.2 gpm/hp)
  - Some exceptions
- Closed circuit cooling towers
  - Requirements added (14 gpm/hp axial, 7 gpm/hp prop)
  - Rating conditions 90-102°F water, 75°F entering wb
- Liquid-liquid heat exchanger certification
  - No efficiency requirements, test procedure AHRI 400
  - More heat exchanger manufacturers are choosing to certify, rather than pay for independent lab testing

ASHRAE Standard 90.1

Summary – Equipment Efficiency

- Equipment efficiencies are more stringent
  - Chillers: once a path is chosen both full and part load requirements must be met
  - Unitary equipment now uses Integrated Energy Efficiency Ratio (IEER)
- New coverage
  - Computer room air conditioners
  - Variable refrigerant flow (VRF) equipment
  - Closed-circuit cooling towers
  - Water-water heat pumps

ASHRAE Standard 90.1

System Design

- Hydronics
- Outdoor air
- System fan power

ASHRAE Standard 90.1

Hydronics System Design

- Water-cooled unitary
  Shut-off valves required in all (formerly only required in water source hp, now also water cooled self contained)
  If system power >5hp, have to have VFD pump
- Lower threshold for VFD on pump motors
  Formerly only on 50hp pumps with 100’ head, now each 5+hp pump when system power is at least 10hp
- Booster pumps (limits on pressure-reducing valves)
  Measure pressure and vary pump speed or stage pumps

ASHRAE Standard 90.1

Hydronics System Design

- Pump pressure optimization
  - DP setpoint no more than 110% of design flow's DP
  - Reset DP setpoint until one valve nearly wide open
- Pipe and pump sizing
  - Based on pressure limits and economics
  - Applies to both chilled water and condenser water
  - Pump head must be calculated for sizing pumps

ASHRAE Standard 90.1

Systems Design Hydronics

- Pipe insulation
  - Biggest changes are in steam and hot water piping
  - when pipes are in the interior walls between conditioned spaces.
  - Non-metallic pipe optional path if > schedule 80

ASHRAE Standard 90.1

System Design Hydronics - Summary

- VSD-like performance required on much smaller systems
- Pump pressure optimization is required
- Maximum flow rates defined
- Pipe insulation more stringent

ASHRAE Standard 90.1

System Design – Airside

- Economizers
- Energy recovery
- Dampers
- Ventilation and exhaust

ASHRAE Standard 90.1

System Design – Economizers

- Integrated economizers now required in all but a few climate zones at 54,000 Btuh or greater

- Excluded zones:
  - Zone 1a (hot and humid) South Florida, Hawaii, Caribbean, India, Indonesia
  - Zone 1b (hot and dry) Dubai, Saudi Arabia

ASHRAE Standard 90.1

Airside System Design

- Energy recovery ventilation system
  Threshold changes
  Climate specific
  Exempted from ventilation optimization control

- Expanded use of low leakage air dampers in colder climates and taller buildings

ASHRAE Standard 90.1

Airside System Design – Other Changes

- Motor efficiency (general purpose)
- Elevator lighting and ventilation allowances
- Garage ventilation controls
- Duct leakage to seal class A
- Kitchen exhaust hoods— large ones listed
- Radiant panels—insulate ineffective surfaces
- Heat pump pool heaters
- Furnace and water heating cleanup

ASHRAE Standard 90.1

Controls Requirements

- Existing controls requirements
  - Fan pressure optimization
  - Demand control ventilation (DCV)
- Changes to controls requirements
  - Ventilation reset
  - Pump pressure optimization
  - Supply air temperature reset
  - VAV minimum airflow/reheat minimums

ASHRAE Standard 90.1

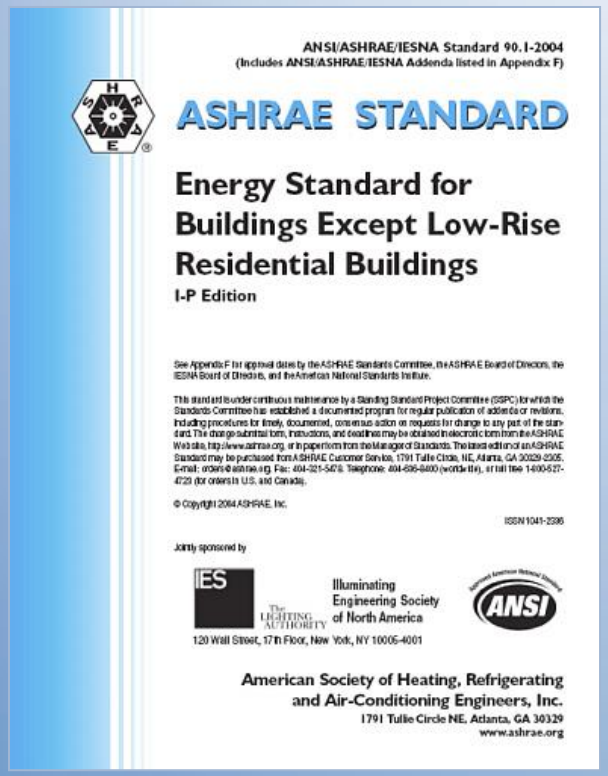
Summary of Energy Savings for 90.1-2010

Target Energy Savings – 30%

Achieved Energy Savings

- 30.1% energy cost savings
- 32.6% energy savings

ASHRAE Standard 90.1-2013



ANSI/ASHRAE/IESNA Standard 90.1-2004
(Includes ANSI/ASHRAE/IESNA Addenda listed in Appendix F)

ASHRAE STANDARD

Energy Standard for Buildings Except Low-Rise Residential Buildings

I-P Edition

See Appendix F for approval dates by the ASHRAE Standards Committee, the ASHRAE Board of Directors, the IESNA Board of Directors, and the American National Standards Institute.

This standard is under continuous maintenance by a Standing Standard Project Committee (SSPC) for which the Standards Committee has established a documented program for regular publication of addenda or revisions, including procedures for timely, documented, consensus action on requests for change to any part of the standard. The change submittal form, instructions, and deadlines may be obtained in electronic form from the ASHRAE Web site, http://www.ashrae.org, or in paper form from the Manager of Standards. The latest edition of an ASHRAE Standard may be purchased from ASHRAE Customer Service, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. E-mail: orders@ashrae.org. Fax: 404-321-5478. Telephone: 404-636-8400 (worldwide), or toll free 1-800-527-4723 (for orders in U.S. and Canada).

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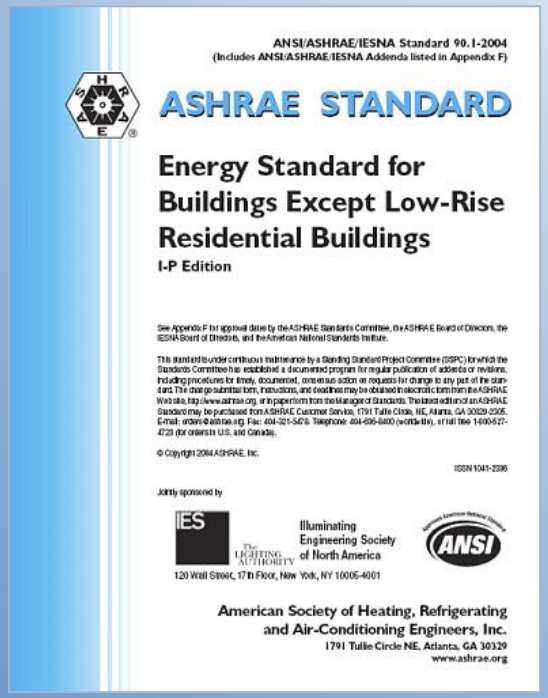
Aiming at 50% Energy Savings For 90.1-2013

90.1-2010 – 2013

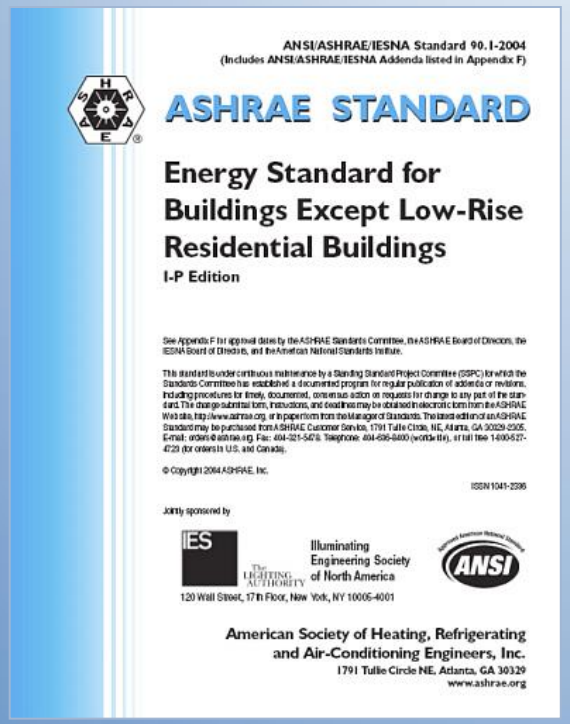
- ASHRAE Technology Committee - Ad-Hoc Committee on Energy Targets – June 2010
  - Promote EUI as measurement
  - Encourage use of ASHRAE Stds 62.1 & 55
  - SSPC 90.1 responsible for our energy targets
  - Standard 90.1 IS NOT the foundation for meeting Vision 2020 or NZEB
  - AEDGs are mechanism for NZEB

ASHRAE Standard 90.1 Revision Goals



- **Technically justified**
- **Simplicity**
- **Flexibility**
- **Enforceable**

90.1-2010 – Major Step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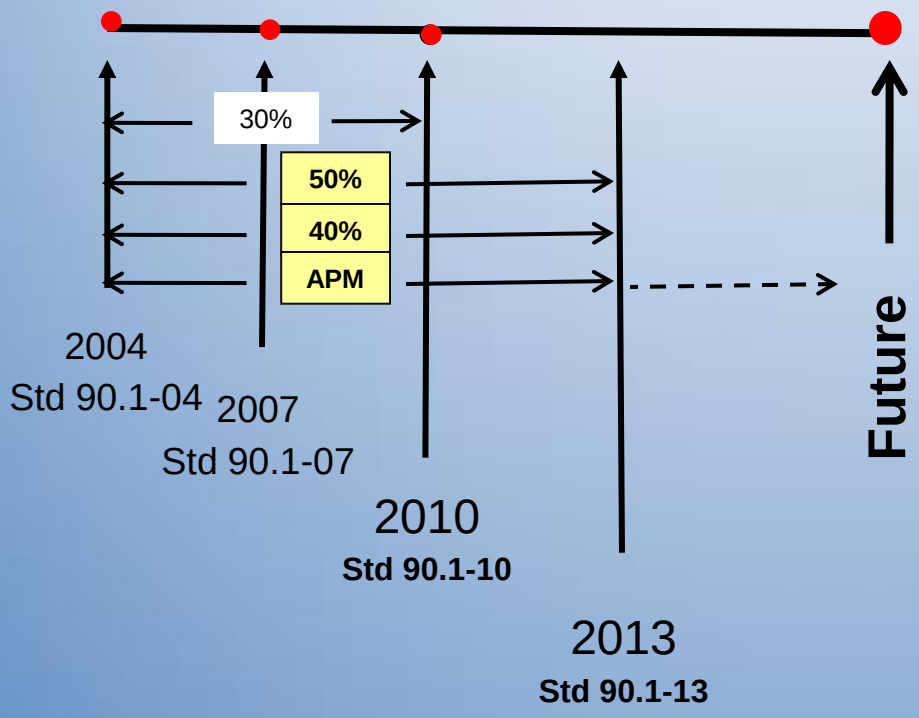
Title, Purpose & Scope change

- Expand to new areas
  - Commercial/industrial equipment/processes
  - Identify & engage stakeholders

ASHRAE Standard 90.1-2013

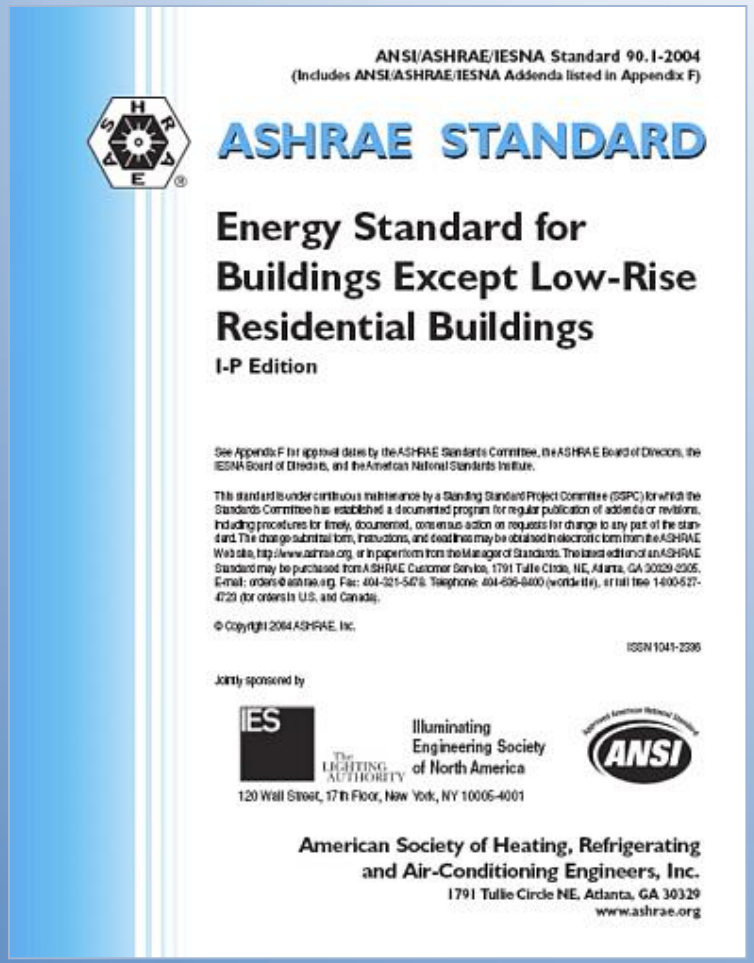
Timeline



MILESTONES

- 90.1-10 Work Plan – 30%
- 90.1-13 Work Plan – 50% on regulated end use loads
- 90.1-13 Work Plan – 40% whole building (all end uses)
- 90.1-13 Work Plan – EUI
- 90.1-13 Work Plan – Alternate Performance Methodology (APM)

ASHRAE Standard 90.1



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Since

July 1, 2010

- 112 Addenda in process or complete
- 4 from previous cycle

ASHRAE Standard 90.1

Sections

- Section 1: Purpose
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- Section 6: HVAC 43
- Section 7: SWH 1
- Section 8: Power 2
- Section 9: Lighting 16
- Section 10: Elec. Motors 2
- Section 11: ECB 16
- Section 12: References 3
- Appendices
  - Appendix C – Envelope 1
  - Appendix G - PRM 11

ASHRAE Standard 90.1 Complete

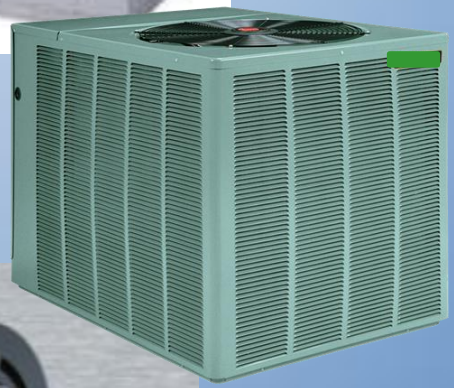
ENVELOPE

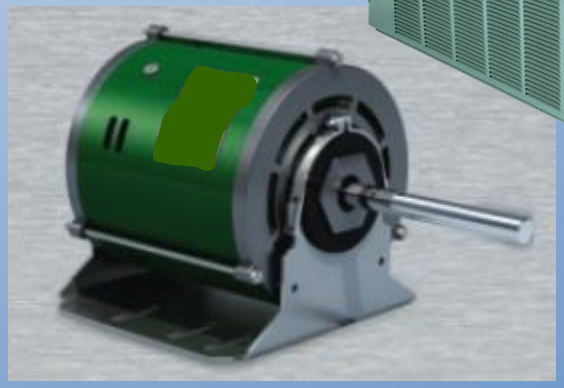
- Building envelope (Addendum “bb”)
- Door leakage
- Cool Roof standards
- Fenestration labeling

ASHRAE Standard 90.1 Complete

MECHANICAL

- Commercial refrigeration and freezers
- Heat pump efficiencies
- SPVAC & SPVHP efficiencies
- Small motor efficiencies
- Transformer testing





ASHRAE Standard 90.1 Complete

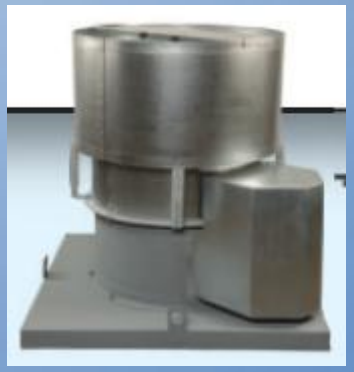
LIGHTING

- Elevator lighting
- LPD revisions
- Electrical Monitoring
- Branch circuit controls

ASHRAE Standard 90.1 Complete

Energy Cost Budget

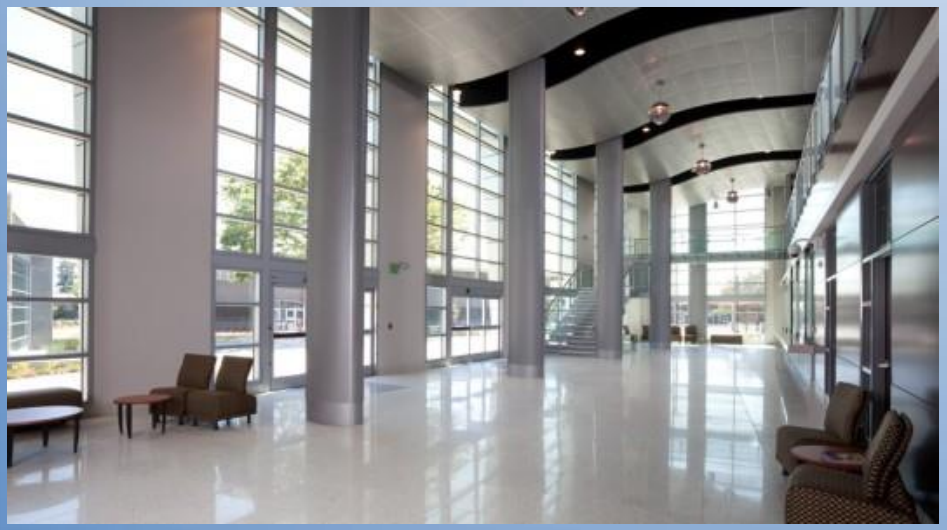
- Daylighting – Chapter 11 & Appendix G
- Cooling Towers – App G
- Laboratory Exhaust



ASHRAE Standard 90.1
In Progress

ENVELOPE

- Dynamic glazing – Addendum “cm”



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MECHANICAL

- Commercial refrigeration
- Chiller efficiencies
- Cooling tower controls and efficiencies
- Laboratory exhaust

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Mechanical - Continuous Maintenance Proposal (CMP)

Data Centers complying with the PUE_0 values listed below shall be exempted from the prescriptive requirements of Section 6 of this code.

Table 6.6.1 Maximum PUE_0 Requirements of Data Centers to be in compliance with Section 6.6.1

Data Center Zone	Maximum PUE_0 (for IT cooling loads < 250 tons)	Maximum PUE_0 (for IT cooling loads > 250 tons, water available)	Maximum PUE_0 (for IT cooling loads > 250 tons, water not available)
Data Center Zone 1 (ASHRAE Climate Zones 1A, 2A, 3A, 4A)	1.61	1.34	1.51
Data Center Zone 2 (ASHRAE Climate Zones 5A, 6A, 7, 8)	1.40	1.27	1.41
Data Center Zone 3 (ASHRAE Climate Zones 2B, 3B, 4B, 5B, 6B	1.53	1.27	1.43
Data Center Zone 4 (ASHRAE Climate Zones 3C, 4C)	1.49	1.26	1.34

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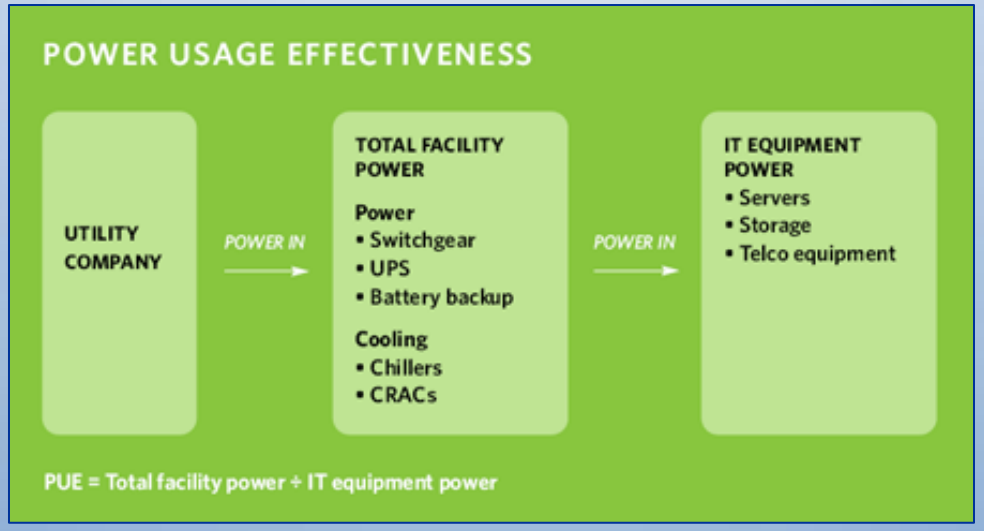
Mechanical – Addendum “ap’ – Data centers



PUE = Total Energy @ Meter ÷ Peak IT Equipment Energy

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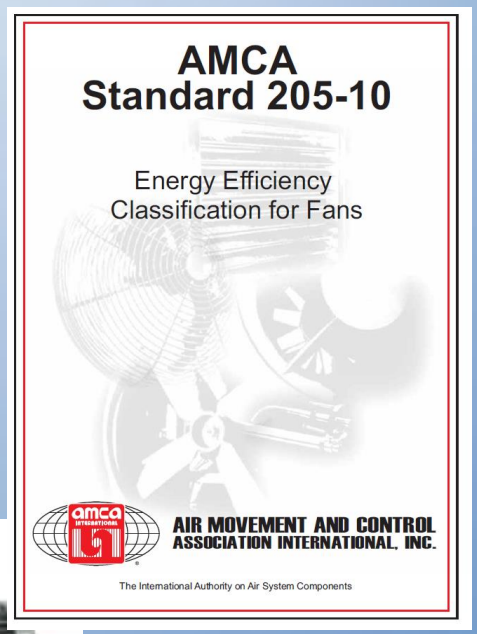
MECHANICAL – Fan Efficiencies

- Advisory Public Review (APR)
  - Engaged interested parties
  - Set min Fan Efficiency Grade (FEG) ≥ 67
  - Based on AMCA 205-10
    - Covers fan motor ratings ≥ 1/6 hp
    - Does not cover fan systems
  - Addendum “u”excludes
    - Fans with bhp ≤ 5
    - Fans covered by 6.4.1.1



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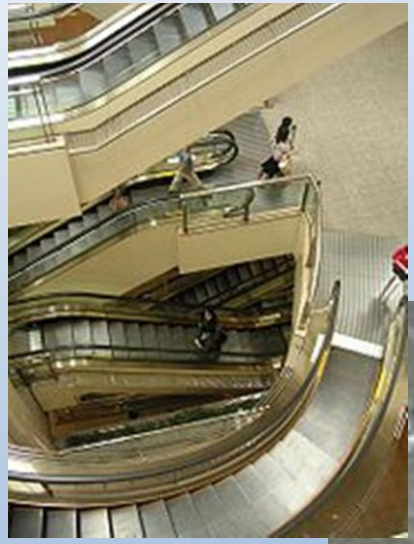
LIGHTING

- Escalator controls
- Lighting controls
- Toplighting



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Energy Cost Budget

- Building Orientation
- Fenestration
- Temp & Humid Schds
- Computer room criteria (Addendum cj)

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Energy Cost Budget – Addendum “w’ - Renewables

- Site-recovered & Site-generated energy credit allowed
- Not considered “*purchased energy*”
- Deducted from “*proposed design*” energy consumption
- Credit ≤ 5% for calculated energy cost budget

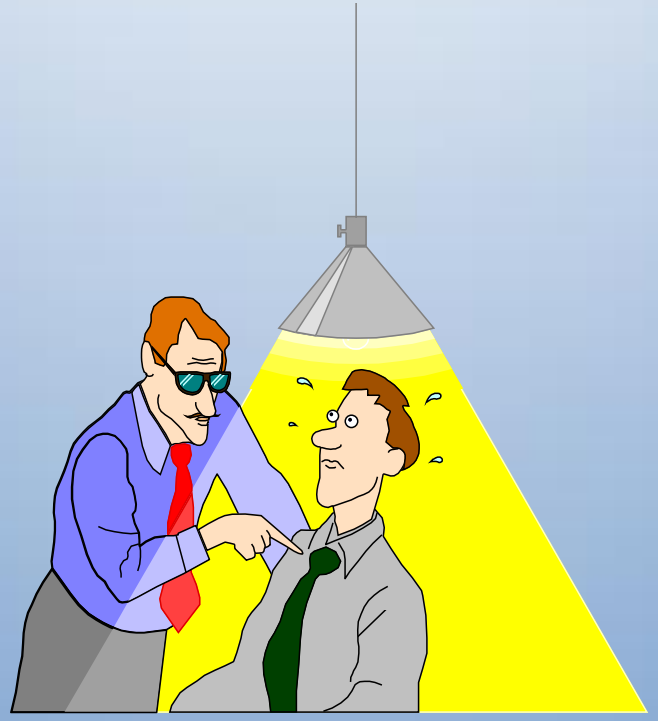
ASHRAE Standard 90.1 Under Discussion

Other Continuous Maintenance Proposals (CMPs)

- Systems testing personnel limitations
- Economizer revisions
- Luminaire limitations
- Definition of cooling design temperature
- Revisions to evaluate systems with Appendix G

ASHRAE Standard 90.1-2013

QUESTIONS?



Stephen V. Skalko, PE,
svskalko@cox.net