



Plan Review Of The 2003 International Energy Conservation Code - Commercial

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Britt/Makela Group, Inc

Class Overview

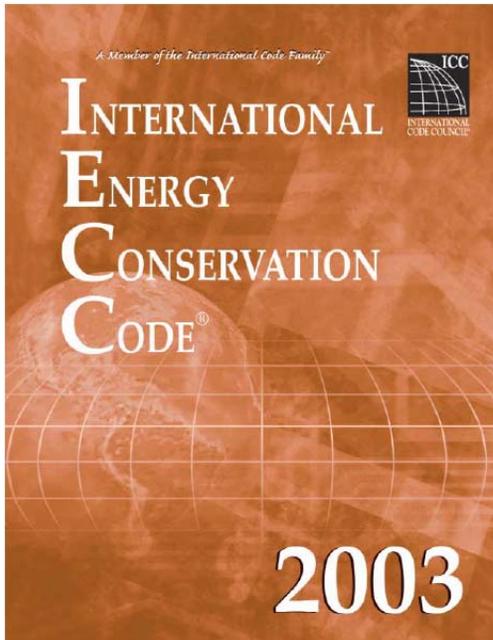
- Scope and Application
- Building Envelope
- Mechanical
- Service Water Heating
- Lighting
- Building Performance
- Additional Sources of Information

What is the IECC ?

International Energy Conservation Code

- Establishes minimum regulations for the design of energy efficient buildings and structures
- Regulates design and selection of :
 - Building envelope
 - Mechanical systems
 - Electrical power and lighting systems
 - Service water heating systems

Structure of the IECC



- Chapter 1 Administrative & Enforcement
- Chapter 2 Definitions
- Chapter 3 Design Conditions
- Chapter 4 Residential - Systems Analysis
- Chapter 5 Residential - Component Performance
- Chapter 6 Simplified Prescriptive Requirements
- Chapter 7 ASHRAE 90.1-2001 Energy Code Reference
- Chapter 8 Design by Acceptable Practice for Commercial Buildings
- Chapter 9 Climate Maps
- Chapter 10 Referenced Standards

Application

When does the IECC apply?

- Newly-conditioned space
- New construction in existing buildings
- Additions, alterations and repairs to existing buildings
- Mixed use buildings
- Change in occupancy

Exceptions

Section 101.2.1

- Very low energy use buildings
($<3.4 \text{ Btu/h-ft}^2$ or 1 watt/ft^2) *for all purposes*
- Buildings (or portions) not heated or cooled
- Buildings designated as historic



Exempt Commercial Buildings

(Not Exactly)

Section 101.2.1

.....Regardless of this exempt status, lighting and service water heating shall meet the applicable provisions.....

Newly Conditioned Space (New Buildings)

Section 101.2



- Envelope, mechanical and lighting systems must comply



Newly Conditioned Space (Previously Unconditioned)

Section 101.2.2



- Envelope, mechanical and lighting systems must be brought into compliance
- Potential problem areas
 - Building envelope
 - Lighting system
- Recommendations
 - Demonstrate compliance at the time of permit

New Construction in Existing Buildings (Alterations and Repairs)

Section 101.2.2

- New system(s) must comply
 - Envelope (should already comply)
 - Mechanical
 - Lighting
 - Service Water Heating
 - Tenant Improvements

Additions

Section 101.2.2.2

- Construction of new conditioned space
- Treat new systems as if the addition were a new building
- Compliance options for additions
 - Treat as a stand-alone building
 - Bring entire building into compliance



Additions

(Section 101.2.2.2)

- Construction of new conditioned space or the conditioning of previously unconditioned space
- Treat the envelope, lighting, and mechanical systems as if the addition were a new building

Mixed Use Buildings

Section 101.2.3

- Minor occupancy
 - If <10% of floor area
 - Then treat as major occupancy



- Different commercial occupancies
 - Treat as single occupancy building

Mixed Use Buildings *(cont'd)*

Section 101.2.3

- Mixed hotel/motel and commercial

- Treat as Different Commercial Occupancies

- Mixed residential and commercial **if ≤ 3 stories**

- Treat the residential occupancy under the residential code

- Treat the commercial occupancy under the commercial code

- **If ≥ 4 stories**

- Treat all as commercial under the commercial code

Mixed Use Buildings *(cont'd)*

Section 101.2.3



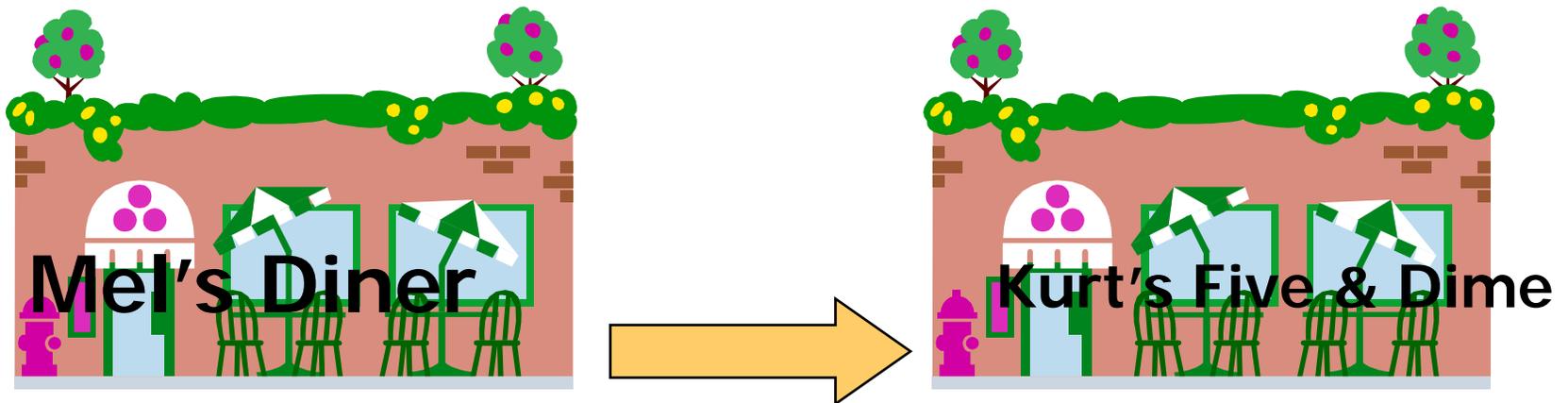
Residential

Retail

Change in Occupancy

Section 101.2.2.4

- No action is required if alterations are not made to the building systems



Change In Occupancy

Section 101.2.2.4

- Alterations to Existing Spaces
- Applies to only portions of the systems being altered
- Applies if alteration increases energy use
- Alterations must meet the requirements applying to the altered component
- New systems in the alterations must comply

What is 90.1 (IECC Chapter 7)?

- ASHRAE/IESNA Standard 90.1 - 2001
- Standard of stringency established by EPA Act '92
- States required to update their nonresidential energy standards to be at least as stringent

Structure of 90.1 (Relevant Sections)

- Section 5 Building Envelope
- Section 6 Heating, Ventilating, and Air-Conditioning
- Section 7 Service Water Heating
- Section 8 Power (voltage drop & completion req'ts.)
- Section 9 Lighting
- Appendix A Assembly U-factor, C-factor, and F-factor determination
- Appendix B Building Envelope Criteria
- Appendix C Trade-off Option
- Appendix D Climate Data

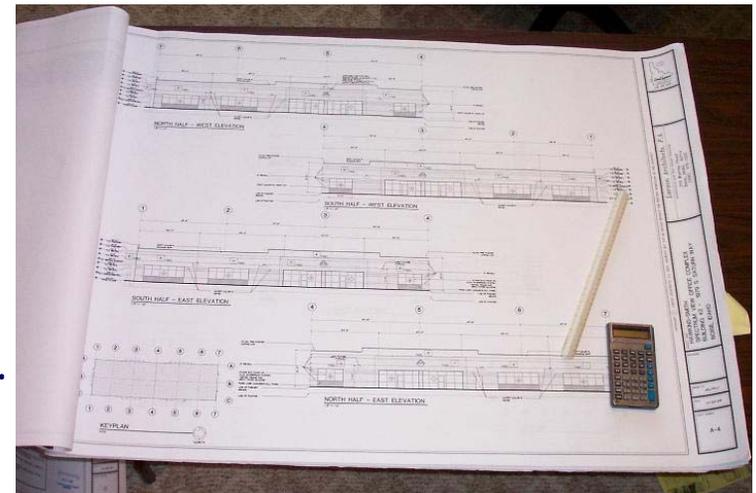
Structure of 90.1 (Component Chapters 5-10)

- X.1 General
- X.2 Mandatory provisions
- X.3 Prescriptive options
- X.4 Trade-off options

Construction Documents

Section 104

- What's required?
 - Plans and documents must indicate the work that is proposed
 - Levels of efficiency for building envelope, mechanical system and lighting system identified in the construction documents
 - Example – R-value, U-factor,
 - SHGC, EER, lighting controls, etc.

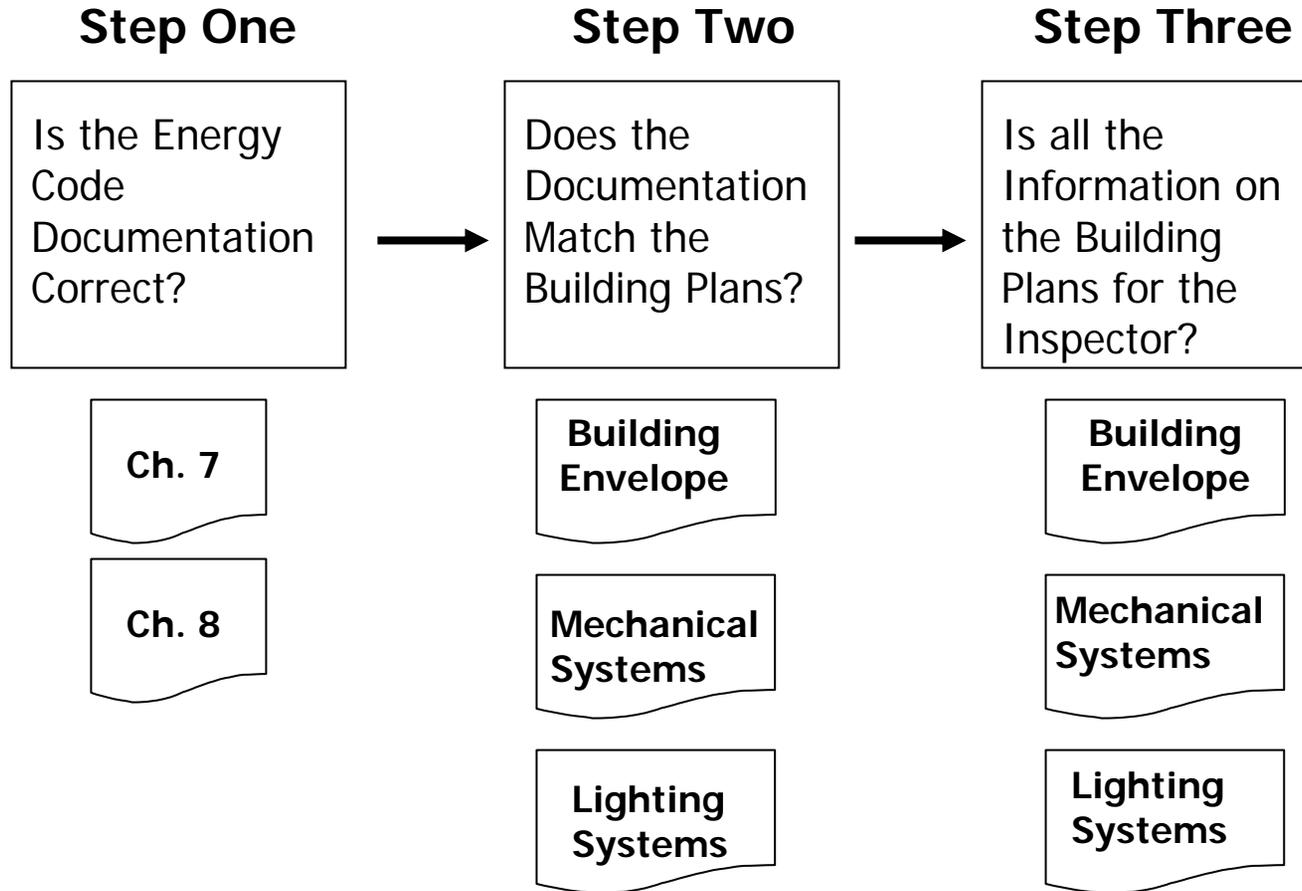


Inspections

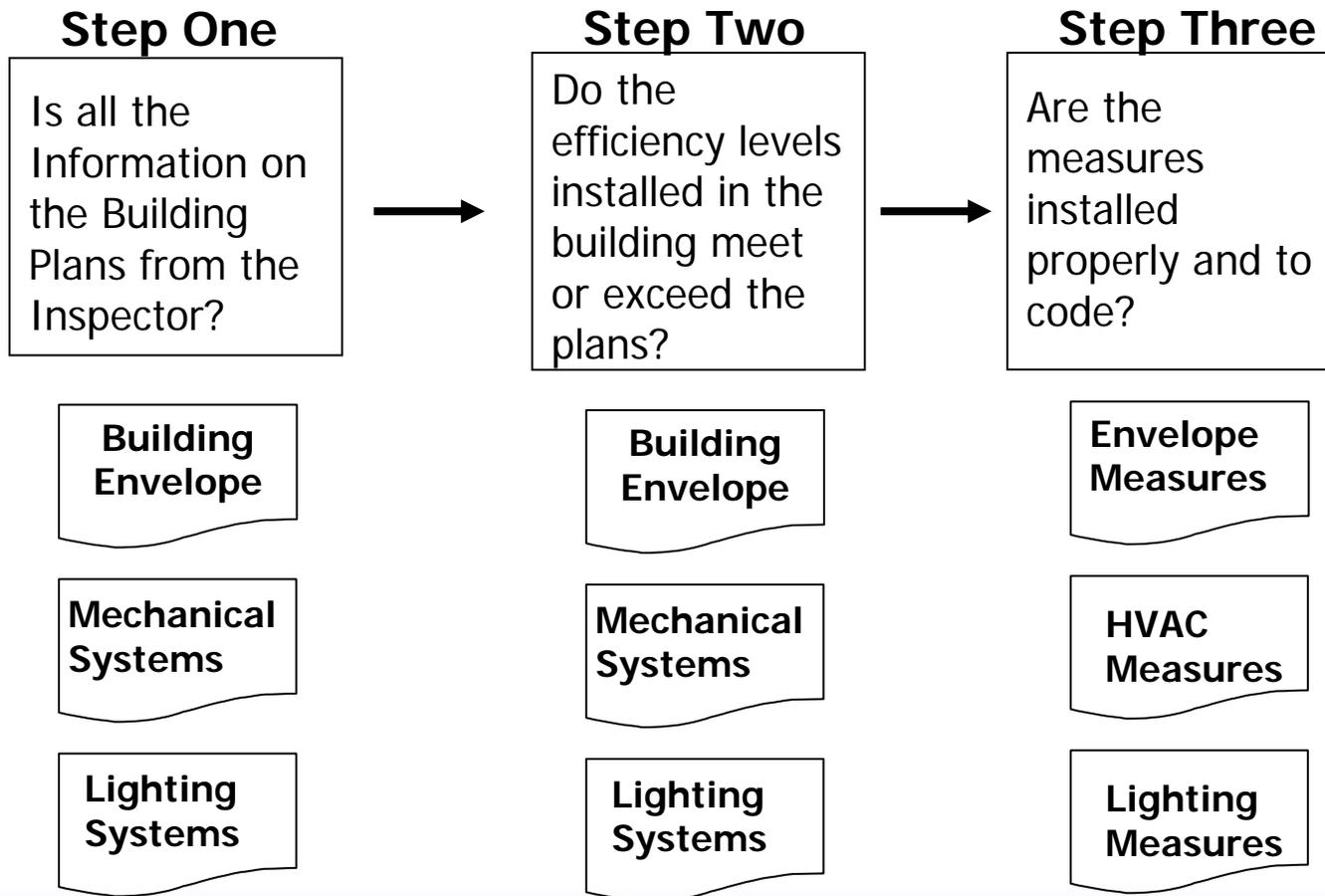
Section 105

- What's required?
 - All construction is subject to inspection
 - No construction shall be concealed without inspection approval
 - A final inspection is required
 - A reinspection is allowed when determined by the code official

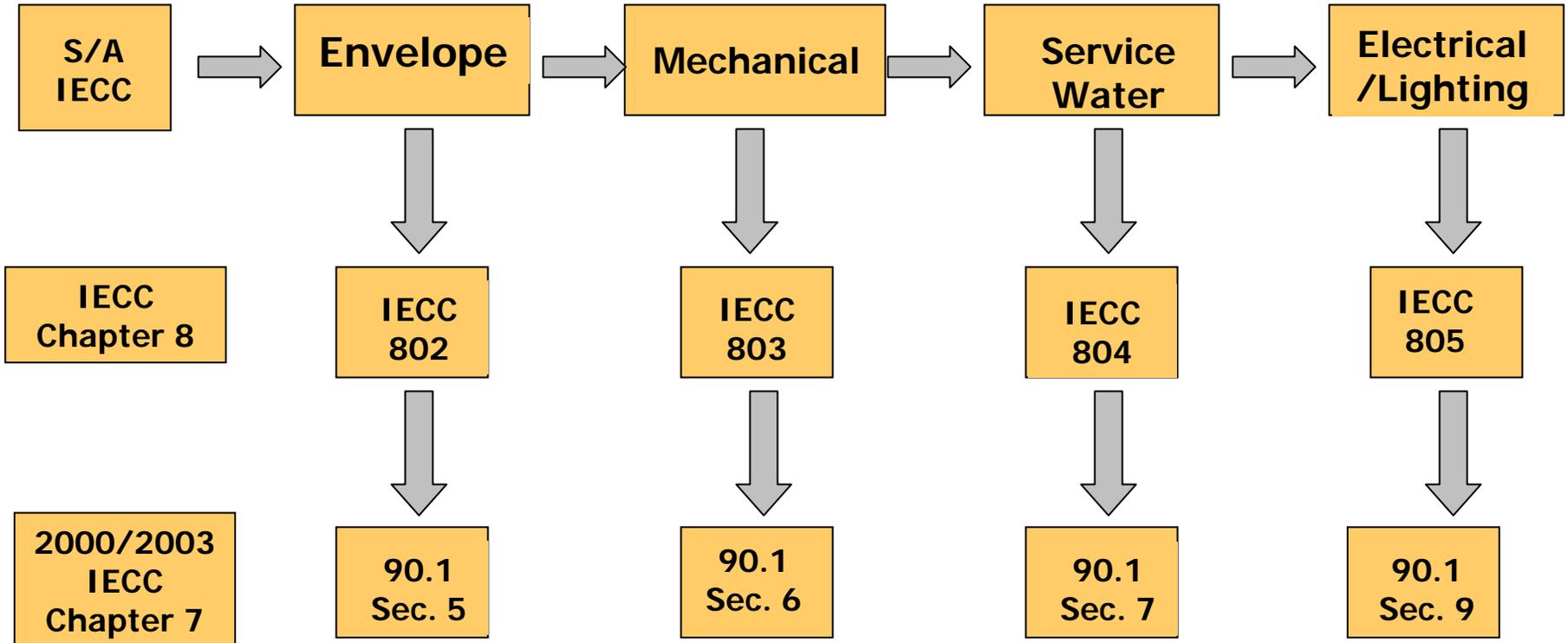
The Role of the Energy Plans Examiner



The Role of the Energy Field Inspector



IECC Energy Code Layout



IECC Scope

Envelope Requirements:

- Mandatory Requirements
- Air Leakage
- Materials & Equipment Information
- Vapor Retarders

Building Envelope Requirements

Infiltration Controls

Section 802.3.1

- Manufactured window and door air leakage rates
 - Labeled windows and doors enforced at point of manufacturer
 - Site constructed windows/doors to be caulked, gasketed, weatherstripped

Infiltration Controls

Section 802.3.2

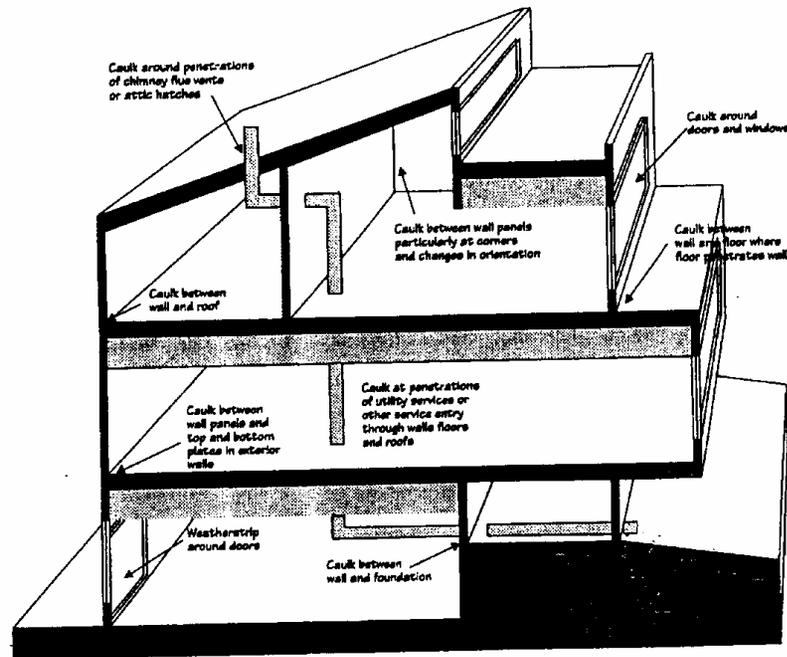
- Curtain Wall, Storefront Glazing and Commercial Entrance Doors
 - Tested for air leakage at 1.57 psi per ASTM E283
 - Curtain walls and storefront glazing rated at 0.3 cfm/ft²
 - Swinging entrance doors and revolving doors rated at 1.0 cfm/ft²



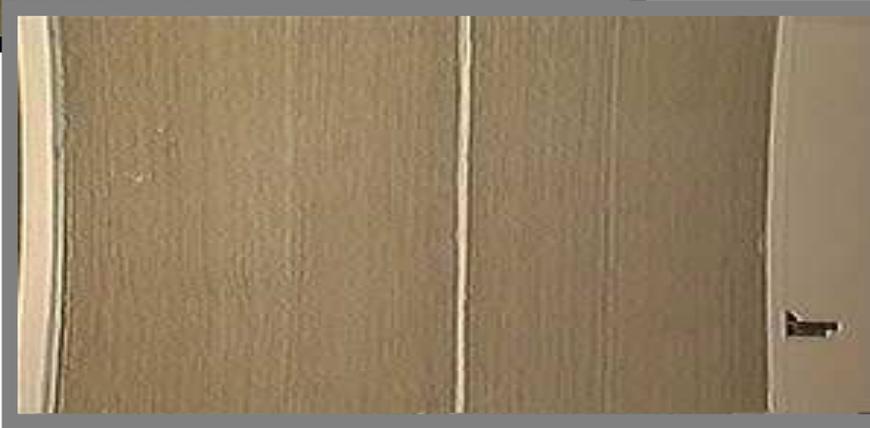
Infiltration Controls

Section 802.3.3

- Caulk, gasket, weatherstrip or otherwise seal all joints and penetrations in the building envelope



Infiltration Controls



Infiltration Controls



- Fiberglass batt insulation is not an air sealer
 - Great air filter

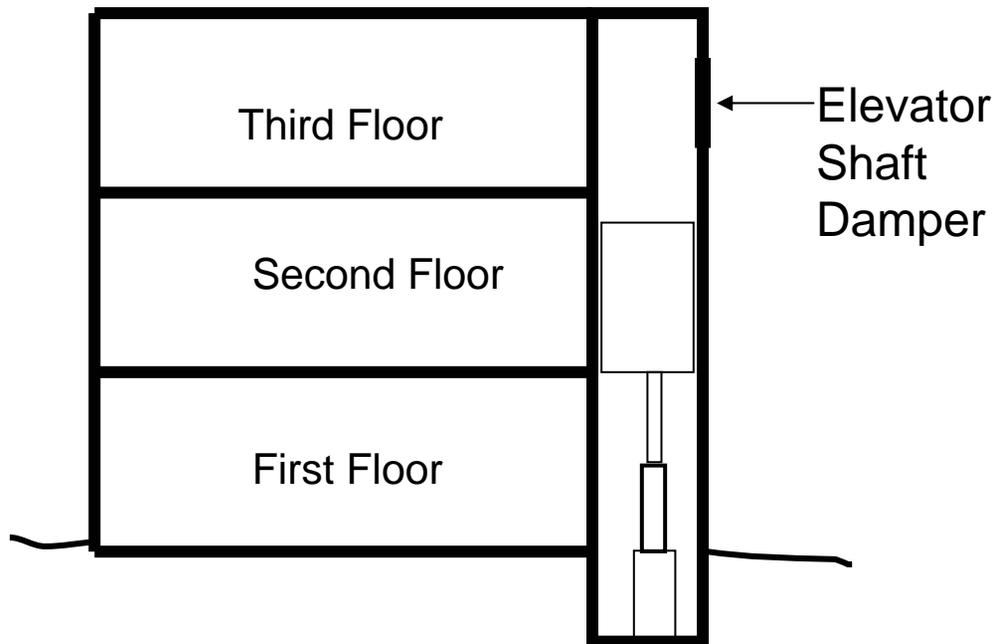
No

Infiltration Controls

Section 802.3.4



Dampers Integral to Building Envelope



- Motorized dampers required on vents for
 - Stairs
 - Elevator shafts
 - Other dampers
- Gravity dampers permitted on buildings < 3 stories

Infiltration Controls

Section 802.3.5

Loading Dock Weatherseals

- Equip cargo doors and loading dock doors with weatherseals
- Restrict infiltration



Infiltration Controls

Section 802.3.5

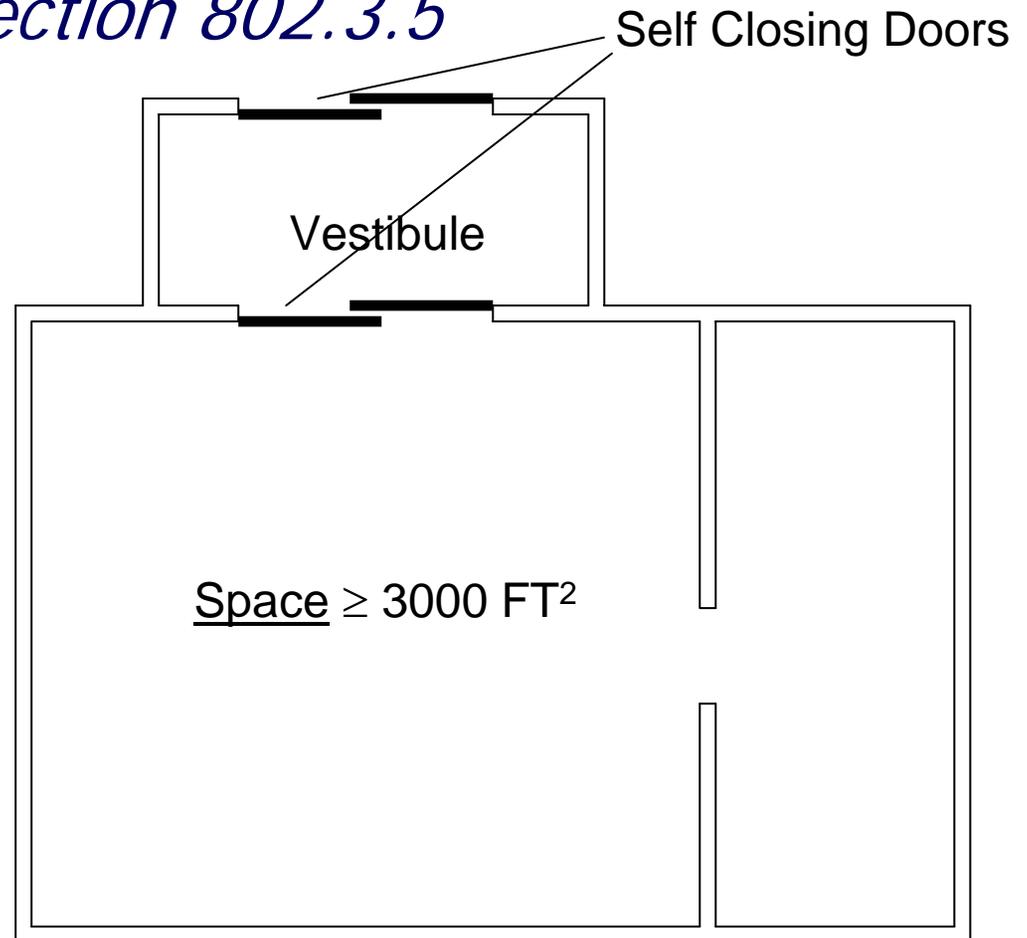
Enclosed Vestibule

Required for:

- Spaces $\geq 3,000$ Ft²
- Entrance doors
- Must have self-closing devices

Exceptions

- Doors from guest room or dwelling unit
- Revolving doors
- Doors used primarily for vehicular movement, material handling and adjacent personnel doors



Vestibules



Vestibules



Infiltration Controls

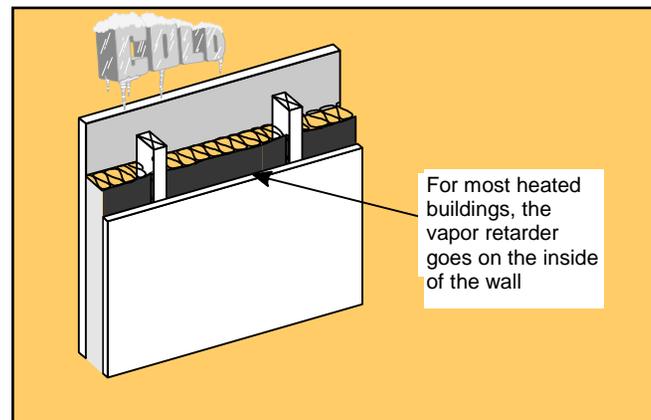
Section 802.3.7



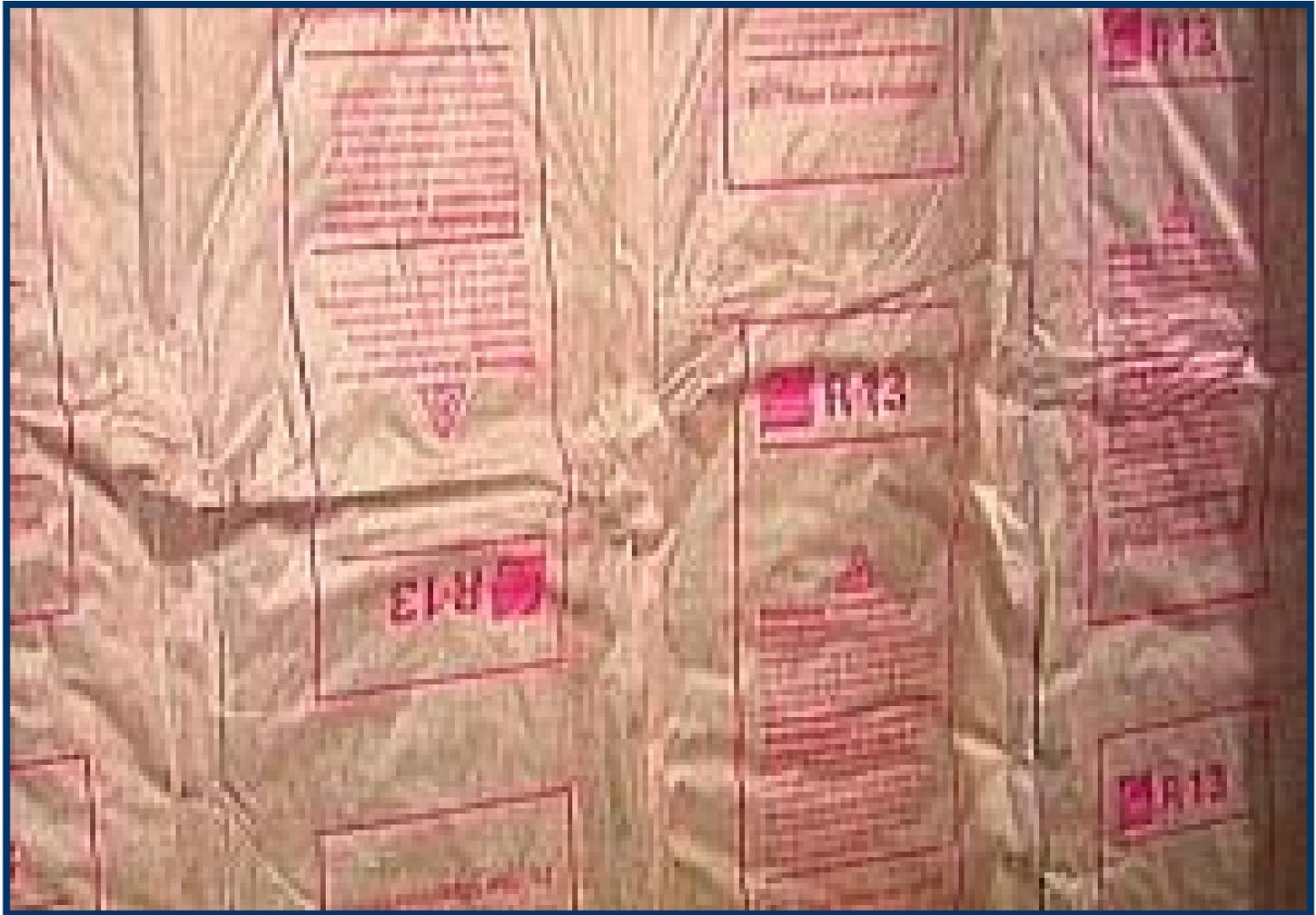
Vapor Retarder

Section 802.1.2

- Install in nonvented framed ceilings, walls, floors
- Must have a Perm Rating of ≤ 1.0
- Install on the “warm-in-winter” side of insulation



Vapor Retarders



Materials and Equipment Information

Section 104.2



- Identify materials and equipment used for compliance
 - Building Plans
 - U-factors of windows and doors
 - SHGC of windows
 - R-values of all insulation
 - Window dimensions on floor plans or window schedule

Materials and Equipment Information

Section 102.5

- Building Site
 - Labels on insulation and windows
 - Contractor certification statements
 - Blown-in insulation
 - Initial installed and settled thickness
 - Coverage area and number of bags
 - Insulation thickness markers

Material Identification

- Certificates for blown in insulation



Building Envelope Requirements

- For buildings \leq 50% glazing to gross wall area
- Minimal calculations
- Based on:
 - Climate zone
 - Window wall ratio
 - Construction assembly
- All components must meet or exceed building envelope requirements
 - Projection Factors

Chapter 9 Climate Zone Maps

Zone	County	Zone	County	Zone	County	Zone	County	Zone	County	Zone	County	Zone	County	Zone	County		
11B	Adams	13B	Blair	13B	Carbon	13B	Columbia	14A	Erie	12B	Huntingdon	14A	Lawrence	14A	Mercer	14A	Mercer
12A	Allegheny	15	Bradford	13B	Centre	14A	Crawford	12A	Fayette	13B	Indiana	12B	Lebanon	12B	Mifflin	12B	Mifflin
13B	Armstrong	11B	Bucks	11B	Chester	12B	Cumberland	15	Forest	15	Jefferson	12B	Lehigh	13B	Monroe	13B	Monroe
12A	Beaver	14A	Butler	14A	Clarion	12B	Dauphin	11B	Franklin	12B	Junata	13B	Luzerne	11B	Montgomery	11B	Montgomery
13B	Bedford	13B	Cambria	15	Clearfield	10B	Delaware	12B	Fulton	14A	Lackawanna	13B	Lycoming	13B	Montour	13B	Montour
12B	Berks	15	Cameron	13B	Clinton	15	Elk	12A	Greene	11B	Lancaster	15	McKean	12B	Northampton	12B	Northampton
												13B	Northumberland	13B	Northumberland		
												12B	Perry	12B	Perry		
												10B	Philadelphia	10B	Philadelphia		
												13B	Pike	13B	Pike		
												15	Potter	15	Potter		
												13B	Schuylkill	13B	Schuylkill		
												13B	Snyder	13B	Snyder		
												13B	Somerset	13B	Somerset		
												14A	Sullivan	14A	Sullivan		
												15	Susquehanna	15	Susquehanna		
												15	Tioga	15	Tioga		
												13B	Union	13B	Union		
												14A	Venango	14A	Venango		
												14A	Warren	14A	Warren		
												12A	Washington	12A	Washington		
												15	Wayne	15	Wayne		
												13B	Westmoreland	13B	Westmoreland		
												14A	Wyoming	14A	Wyoming		
												11B	York	11B	York		

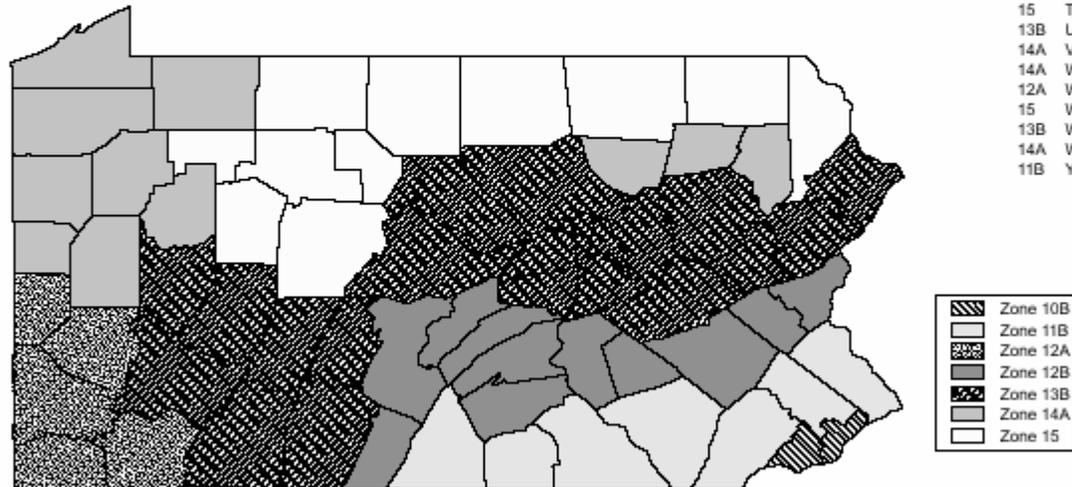


FIGURE 302.1(39)
PENNSYLVANIA

IECC Table

TABLE 802.2(24)—continued
BUILDING ENVELOPE REQUIREMENTS^a through ^e - CLIMATE ZONE 10b

WINDOW AND GLAZED DOOR AREA OVER 25 PERCENT BUT NOT GREATER THAN 40 PERCENT OF ABOVE-GRADE WALL AREA			
ELEMENT	CONDITION/VALUE		
Skylights (<i>U</i> -factor)	0.8		
Slab or below-grade wall (<i>R</i> -value)	R-0		
Windows and glass doors	SHGC	<i>U</i> -factor	
PF < 0.25	0.4	0.5	
0.25 ≤ PF < 0.50	0.5	0.5	
PF ≥ 0.50	0.6	0.5	
Roof assemblies (<i>R</i> -value)	Insulation between framing	Continuous insulation	
All-wood joist/truss	R-25	R-19	
Metal joist/truss	R-25	R-20	
Concrete slab or deck	NA	R-19	
Metal purlin with thermal block	R-30	R-20	
Metal purlin without thermal block	X	R-20	
Floors over outdoor air or unconditioned space (<i>R</i> -value)	Insulation between framing	Continuous insulation	
All-wood joist/truss	R-19	R-12	
Metal joist/truss	R-19	R-13	
Concrete slab or deck	NA	R-13	
Above-grade walls (<i>R</i> -value)	No framing	Metal framing	Wood framing
Framed			
<i>R</i> -value cavity	NA	R-11	R-11
<i>R</i> -value continuous	NA	R-0	R-0
CMU, ≥ 8 in, with integral insulation			
<i>R</i> -value cavity	NA	R-11	R-11
<i>R</i> -value continuous	R-5	R-0	R-0
Other masonry walls			
<i>R</i> -value cavity	NA	R-11	R-11
<i>R</i> -value continuous	R-5	R-0	R-0

Prescriptive Packages

Section 802.2

- Window percentage to wall area (WWR)
 - Gross window area / gross wall area
 - Gross wall area includes
 - Above-grade walls
 - Band joist and subfloor between floors
 - Area of all doors and windows

Prescriptive Packages

Section 802.2.5

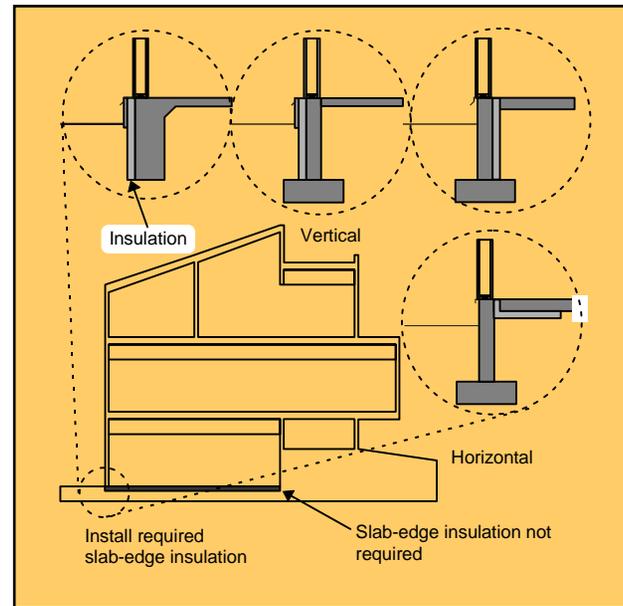
- Skylights
 - Restricted to $< 3\%$ of roof area
 - Requirements based on
 - U-factor ~ NFRC tested or default U-factor table



Prescriptive Packages

Section 802.2.7

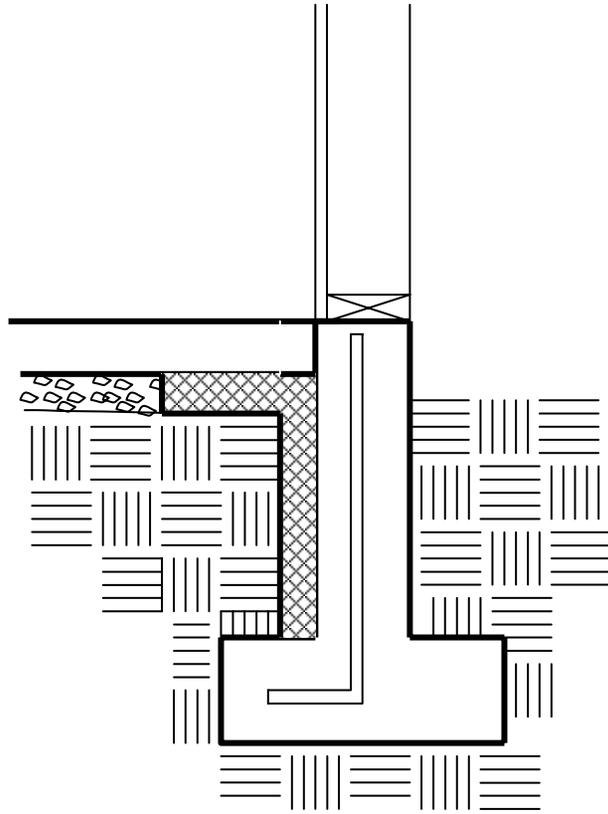
- Slabs-on-grade
 - Slab edge insulation
 - Proposed R-value must meet or exceed



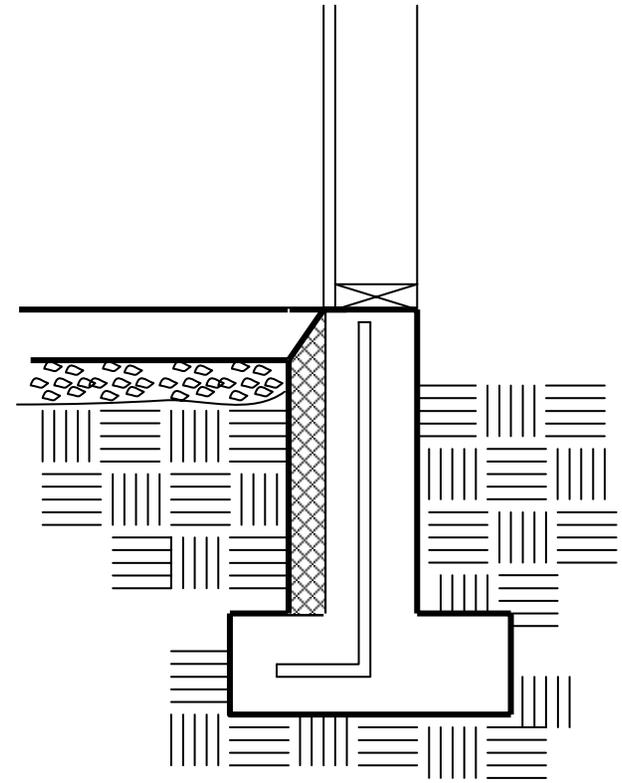
Prescriptive Packages

Section 802.2.7

- Slabs-on-grade Insulation Installation



No!!!!!!

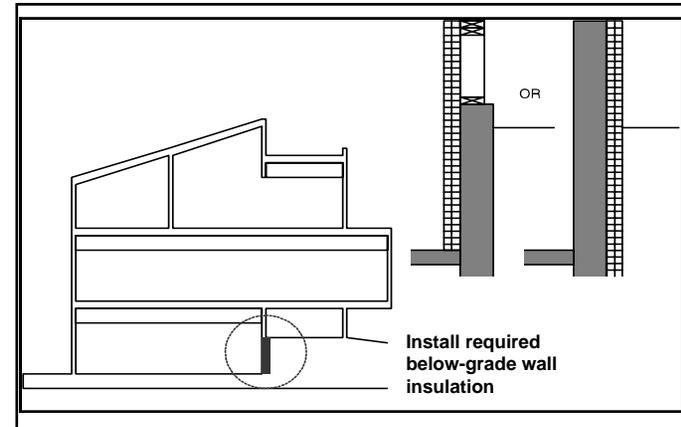


One Option

Prescriptive Packages

Section 802.2.8

- Below-grade walls
 - Surface area in direct contact with the Earth
 - Proposed R-value(s) must meet or exceed required R-value
 - Cavity insulation
 - Insulating sheathing



Prescriptive Packages

- Windows
 - Requirements based on
 - Solar Heat Gain Coefficient
 - Maximum U-factor

Prescriptive Packages

Section 802.2.3

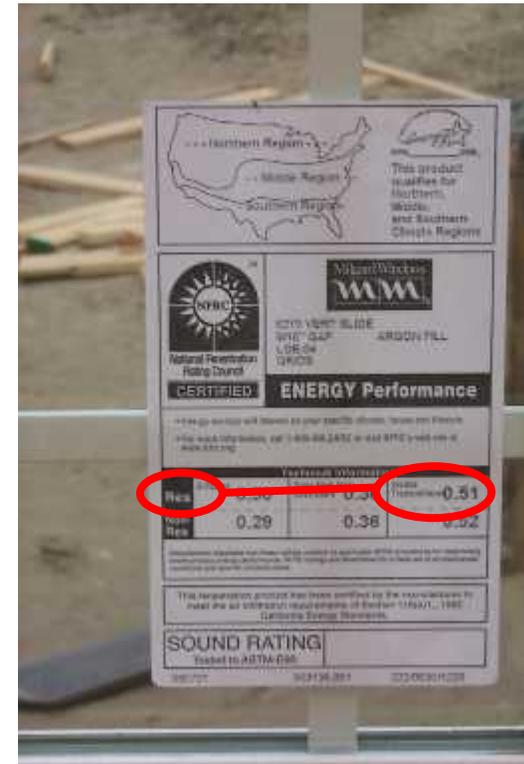
- Windows
 - Solar Heat Gain Coefficient (SHGC)
 - National Fenestration Rating Council (NFRC) tested or use SHGC Default Table

TABLE 102.5.2(3)
SHGC DEFAULT TABLE FOR FENESTRATION

PRODUCT DESCRIPTION	SINGLE GLAZED				DOUBLE GLAZED			
	Clear	Bronze	Green	Gray	Clear + Clear	Bronze + Clear	Green + Clear	Gray + Clear
Metal frames								
Operable	0.75	0.64	0.62	0.61	0.66	0.55	0.53	0.52
Fixed	0.78	0.67	0.65	0.64	0.68	0.57	0.55	0.54
Nonmetal frames								
Operable	0.63	0.54	0.53	0.52	0.55	0.46	0.45	0.44
Fixed	0.75	0.64	0.62	0.61	0.66	0.54	0.53	0.52

Fenestration SHGC Requirements

- NFRC 200 Rated for all Manufactured Fenestration
- $SHGC = 0.87 \times SC$



SHGC Examples

* Values from SHGC default table. NFRC rated values lower



SHGC = 0.57*



SHGC = 0.55*

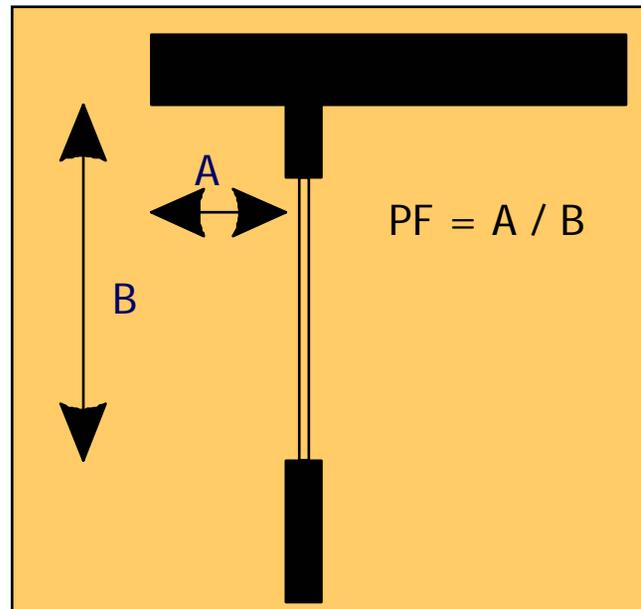
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SHGC = 0.54*

Prescriptive Packages

- Windows
 - Solar Heat Gain Coefficient (SHGC)
 - Requirements dependent on projection factor



Projection Factor



Projection Factor



Prescriptive Packages

Section 802.2.3

- Windows
 - U-factor
 - NFRC tested and certified or default window U-factor range

TABLE 102.5.2(1)
U-FACTOR DEFAULT TABLE FOR WINDOWS,
GLAZED DOORS AND SKYLIGHTS

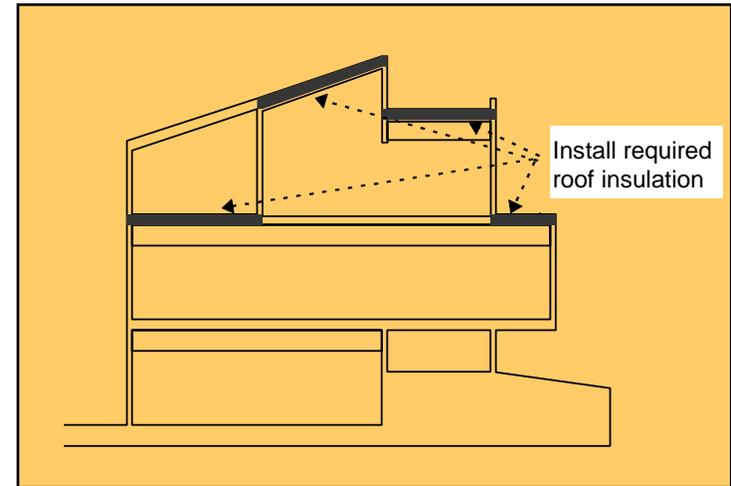
FRAME MATERIAL AND PRODUCT TYPE ^a	SINGLE GLAZED	DOUBLE GLAZED
Metal without thermal break		
Operable (including sliding and swinging glass doors)	1.27	0.87
Fixed	1.13	0.69
Garden window	2.60	1.81
Curtain wall	1.22	0.79
Skylight	1.98	1.31
Site-assembled sloped/overhead glazing	1.36	0.82
Metal with thermal break		
Operable (including sliding and swinging glass doors)	1.08	0.65
Fixed	1.07	0.63
Curtain wall	1.11	0.68
Skylight	1.89	1.11
Site-assembled sloped/overhead glazing	1.25	0.70
Reinforced vinyl/metal clad wood		
Operable (including sliding and swinging glass doors)	0.90	0.57
Fixed	0.98	0.56
Skylight	1.75	1.05
Wood/vinyl/fiberglass		
Operable (including sliding and swinging glass doors)	0.89	0.55
Fixed	0.98	0.56
Garden window	2.31	1.61
Skylight	1.47	0.84

a. Glass block assemblies with mortar but without reinforcing or framing shall have a U-factor of 0.60.

Prescriptive Packages

Section 802.2.4

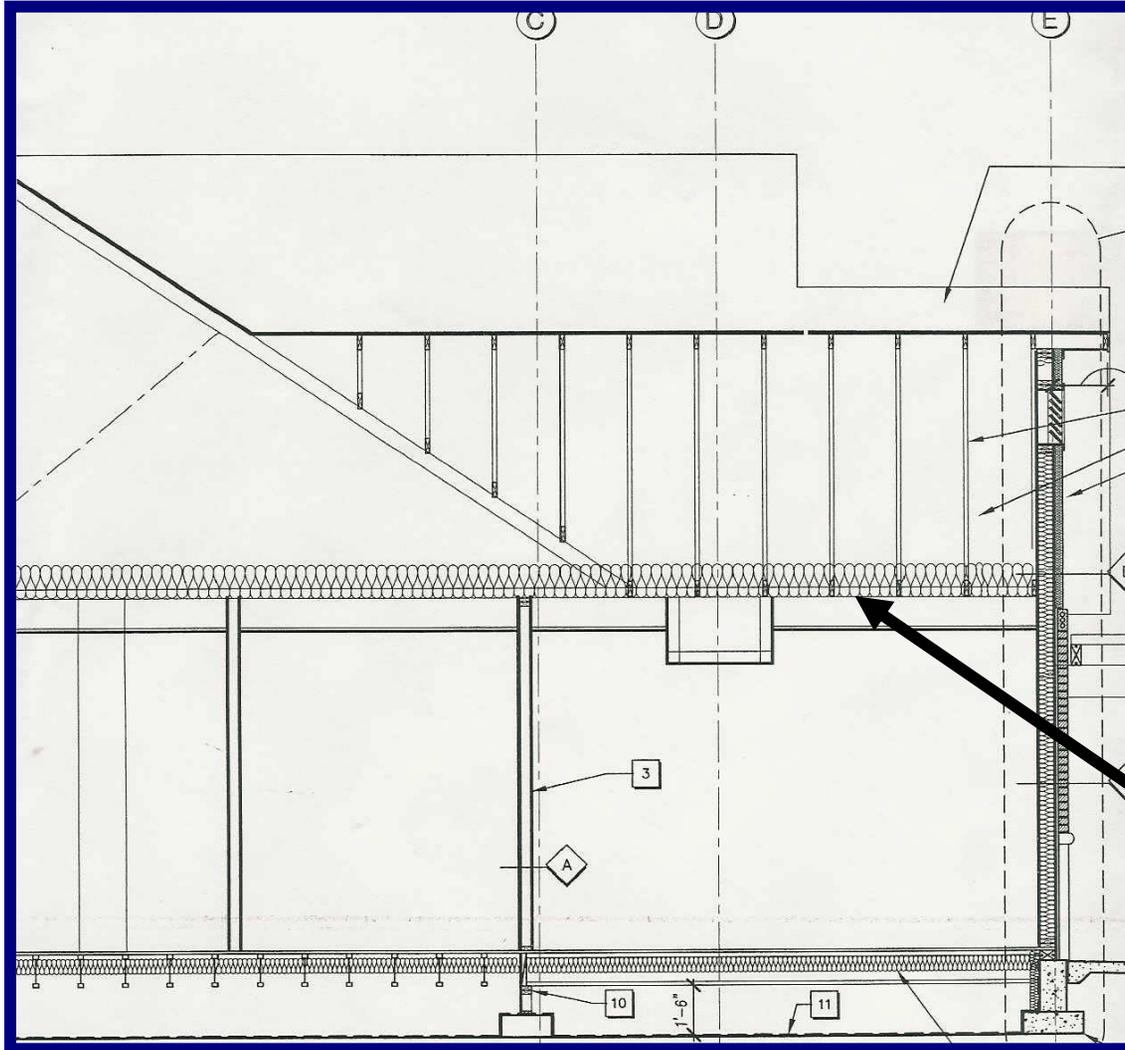
- Roofs
 - Requirements based on
 - Assembly type
 - Continuous insulation
 - Cavity insulation
 - All R-values must meet or exceed



Roof Insulation

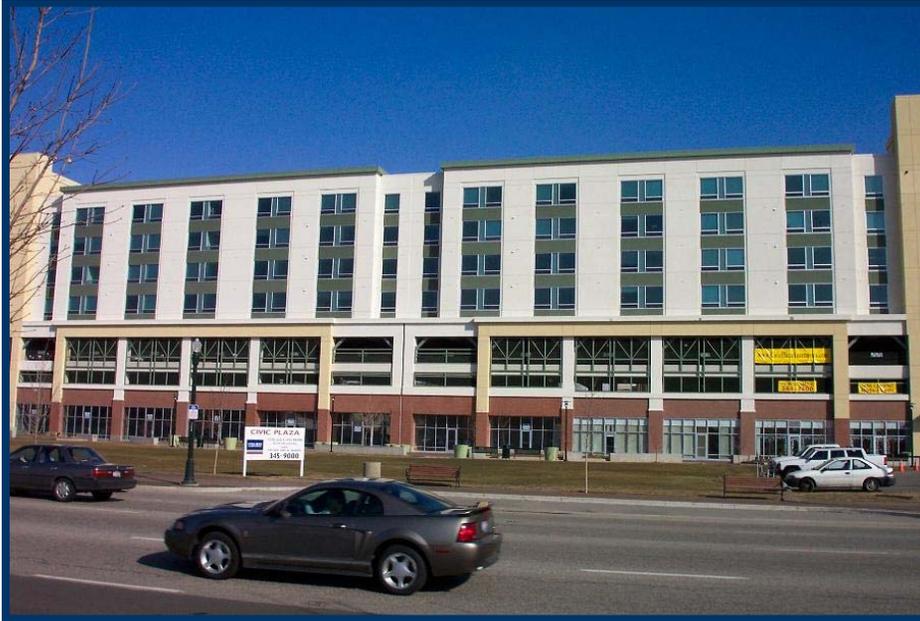


Roof Insulation – Air Barrier?



Prescriptive Packages

Section 802.2.6

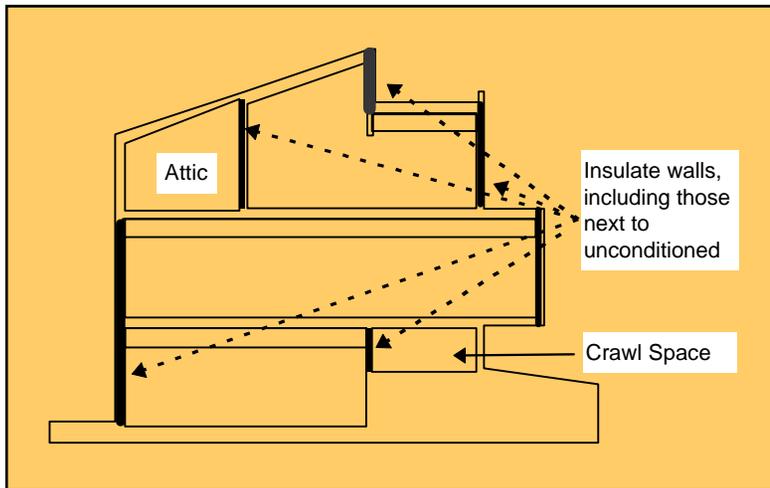


- Floors
 - Requirements based on
 - Assembly type
 - Continuous insulation
 - Cavity insulation
 - Raised floor insulation
 - Meet or exceed

Prescriptive Package

Section 802.2.1

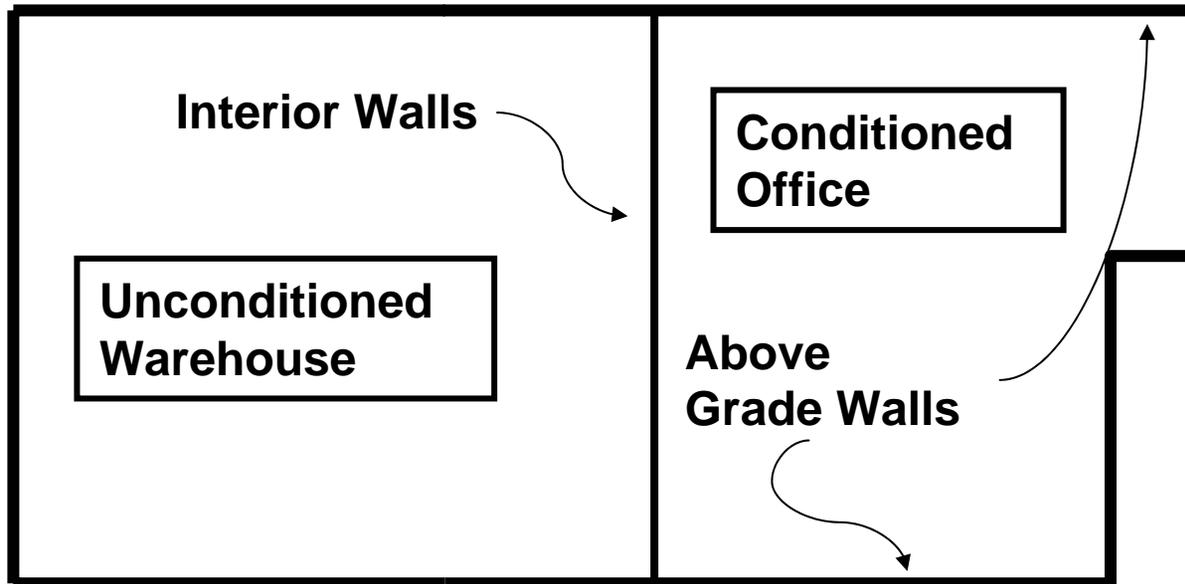
Walls



- Meet or exceed R-value requirement
- Walls next to unconditioned space
 - "Low fenestration area"
- Cavity R-value
- Continuous R-value

Wall Classification

Section 802.1.1



Prescriptive Packages

Section 802.2.2

- Doors
 - Nonglazed doors
 - Meet U-factor requirement for windows
 - Glazed doors
 - Meet U-factor and SHGC requirement for window

ASHRAE Standard 90.1-2001 Envelope

- Options
 - Section 802 of the IECC
 - Chapter 5 and Appendices A and B of ASHRAE Standard 90.1-2001
- ASHRAE Standard 90.1-2001 will be covered in more detail in a post-workshop session on Thursday afternoon

ASHRAE Standard 90.1-2001 Envelope Differences

- Typically, ASHRAE Standard has more detail
 - More sets of requirements (3 versus 1)
 - More window types (fixed/operable versus 1)
 - More skylight types (3 versus 1)
 - More slab types (heated/unheated versus 1)
 - Explicit treatment of steel building walls and roofs

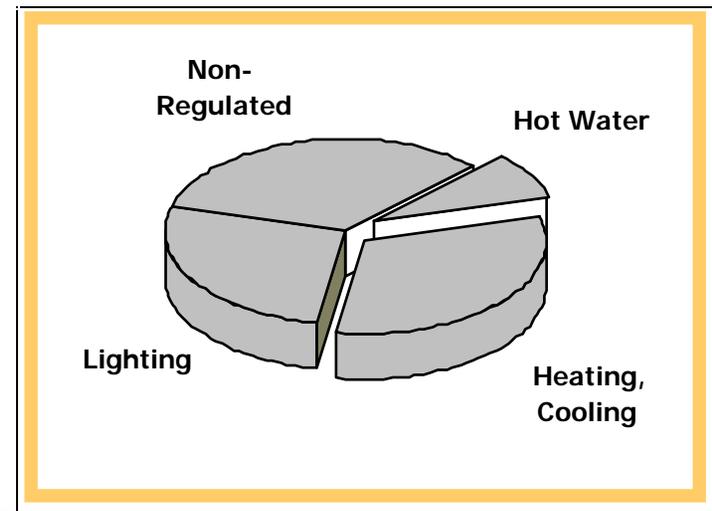
ASHRAE Standard 90.1-2001

More Envelope Differences

- ASHRAE Standard 90.1 also has some additional requirements
 - No insulation on top of suspended ceilings
- ASHRAE Standard 90.1 uses different assembly descriptions (mass walls versus CMU > 8 inches and other masonry)
- Stringency differences depend on building type, design, and location

Mechanical Systems (Application)

- Systems that provide heating, cooling or ventilation **primarily** for human comfort
- Exception: Systems that serve an industrial process

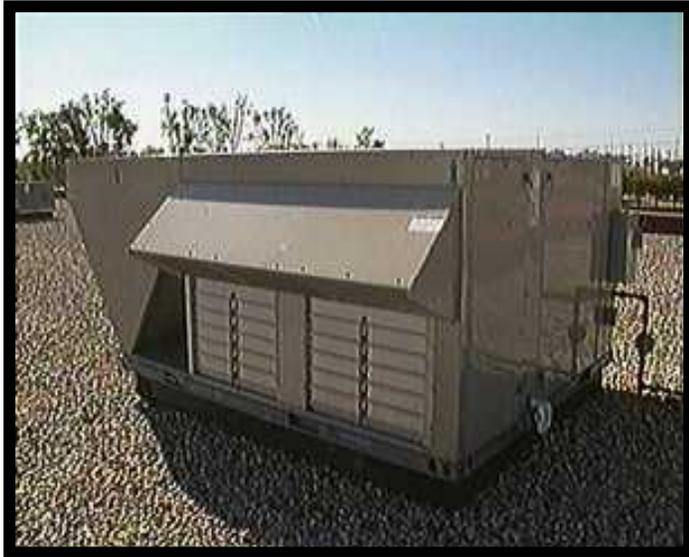


Energy Efficient Mechanical Design

IECC accomplishes by:

- Requiring minimum equipment performance
- Minimizing distribution losses
- Optimizing system controls
- Taking advantage of free cooling

Simple HVAC System Types



- Unitary or packaged, single zone controlled by a single thermostat in the zone served. Includes:
 - Unitary Air Conditioners and Condensing Units
 - Unitary and Applied Heat Pumps, Electrically Operated
 - Packaged Terminal Air Conditioners
 - Packaged Terminal Heat Pumps
 - Warm Air Furnaces
 - Warm Air Duct Furnaces
 - Unit Heaters
 - Two-pipe Heating Systems w/no Cooling Installed

Complex HVAC System Types



All systems not covered under Simple HVAC Systems. Includes:

- Systems serving multiple zones
- Water chilling packages
- Variable Air Volume (VAV) Systems
- Two-pipe Changeover
- Four-pipe Systems
- Hydronic (water loop) heat pump systems

Equipment Efficiency

Section 803.2.2 / 803.3.2



- New Efficiency Requirements Listed in Table 803.2.2 and 803.3.2
- Took effect as of 10/29/01
- Must meet full- and part-load values

Equipment Efficiency - Example

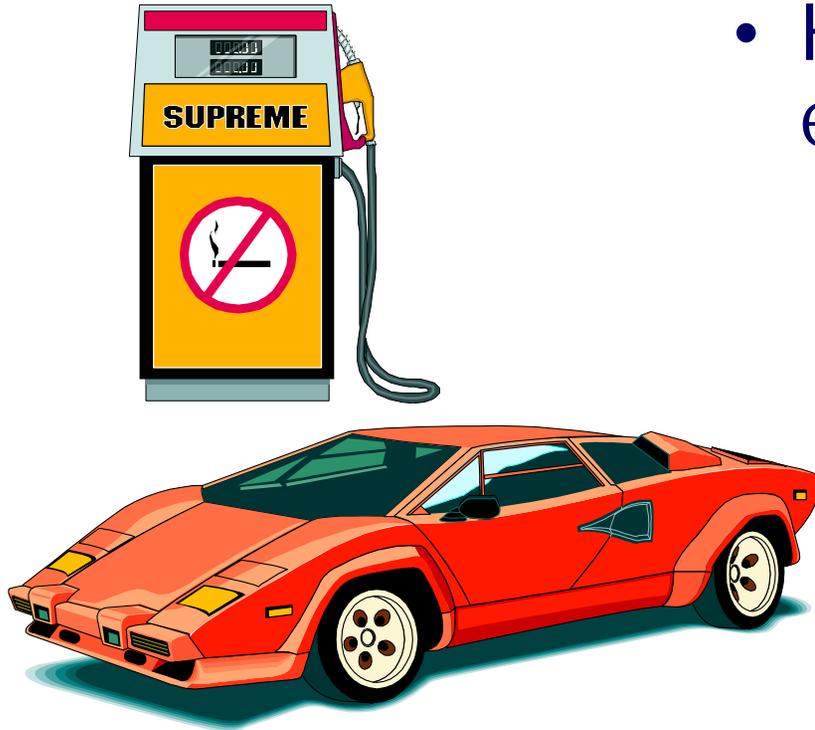
TABLE 803.3.2(2)
WATER CHILLING PACKAGES, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY	MINIMUM EFFICIENCY ^b	TEST PROCEDURE ^a
Air cooled, with condenser, Electrically operated	< 150 tons	2.80 COP 2.80 IPLV	ARI 550/590
	≥ 150 tons	2.50 COP 2.50 IPLV	
Air cooled, without condenser, Electrically operated	All capacities	3.10 COP 3.10 IPLV	
Water cooled, Electrically operated, Positive displacement (reciprocating)	All capacities	4.20 COP 4.65 IPLV	
Water cooled, Electrically operated, Positive displacement (rotary screw and scroll)	< 150 tons	4.45 COP 4.50 IPLV	
	≥ 150 tons and < 300 tons	4.90 COP 4.95 IPLV	
	≥ 300 tons	5.50 COP 5.60 IPLV	
Water cooled, Electrically operated, centrifugal	< 150 tons	5.00 COP 5.00 IPLV	
	≥ 150 tons and < 300 tons	5.55 COP 5.55 IPLV	
	≥ 300 tons	6.10 COP 6.10 IPLV	
Air cooled, absorption single effect	All capacities	0.60 COP	ARI 560
Water cooled, absorption single effect	All capacities	0.70 COP	
Absorption double effect, indirect-fired	All capacities	1.00 COP 1.05 IPLV	
Absorption double effect, direct-fired	All capacities	1.00 COP 1.00 IPLV	

Equipment Efficiency

- NAECA
 - National Appliance Energy Conservation Act
 - Specifies equipment performance of heating and cooling equipment, water heaters, and other equipment
 - Applicable equipment must meet NAECA before it can be sold in the United States - *No need to enforce at the building department counter*

Equipment Efficiency



(MPG) - Miles Per Gallon

- Heating and cooling efficiency terminology
 - (EER) – Energy Efficiency Ratio
 - (COP) – Coefficient of Performance
 - (IPLV) – Integrated Part Load Value
 - (AFUE) - Annual Fuel Utilization Efficiency

HVAC Load Calculations

Section 803.2.1 / 803.3.1

- HVAC system designers must perform heating and cooling load calculations before selecting HVAC equipment

Equipment Selection

- Simple Systems (*Section 803.2.1.1*)
 - Package Systems
 - Select system for greatest load (either heating or cooling)
 - Select other capacity as small as possible
 - Other Systems
 - Select for load
- Complex Systems (*Section 803.3.1.1*)
 - Select System to meet loads
 - Exceptions
 - Standby Equipment with Required Controls
 - Multiple Units with Combined Capacities Exceeding Loads
 - Sequencing Controls Required

Mechanical Ventilation

Section 803.2.5 / 803.3.5

IMC Chapter 4

TABLE 403.3
REQUIRED OUTDOOR VENTILATION AIR

OCCUPANCY CLASSIFICATION	ESTIMATED MAXIMUM OCCUPANT LOAD, PERSONS PER 1,000 SQUARE FEET ^a	OUTDOOR AIR [cubic feet per minute (cfm) per person] UNLESS NOTED ^b
Correctional facilities		
Cells	20	20
Dining halls	100	15
Guard stations	40	15
Dry cleaners, laundries		
Coin-operated dry cleaner	20	15
Coin-operated laundries	20	15
Commercial dry cleaner	30	30
Commercial laundry	10	25
Storage, pick up	30	35
Education		
Auditoriums	150	15
Classroom	50	15
Corridors	—	0.10 cfm/ft. ²
Laboratories	30	20
Libraries	20	15
Locker rooms	—	0.50 cfm/ft. ²
Music rooms	50	15
Smoking lounges ^b	70	60
Training shops	30	20
Food and beverage service		
Bars, cocktail lounges	100	30
Cafeteria, fast food	100	20
Dining rooms	70	20
Kitchens (cooking) ^f	20	15
Hospitals, nursing and convalescent homes		
Autopsy rooms ^g	—	0.50 cfm/ft. ²
Medical procedure rooms	20	15
Operating rooms	20	30
Patient rooms	10	25
Physical therapy	20	15
Recovery and ICU	20	15
Hotels, motels, resorts and dormitories		
Assembly rooms	120	15
Bathrooms ^h	—	35 cfm per room
Bedrooms	—	30 cfm per room
Conference rooms	50	20
Dormitory sleeping areas	20	15
Gambling casinos	120	30
Living rooms	—	30 cfm per room
Lobbies	30	15
Offices		
Conference rooms	50	20
Office spaces	7	20
Reception areas	60	15
Telecommunication centers and data entry	60	20

(continued)

TABLE 403.3—continued
REQUIRED OUTDOOR VENTILATION AIR

OCCUPANCY CLASSIFICATION	ESTIMATED MAXIMUM OCCUPANT LOAD, PERSONS PER 1,000 SQUARE FEET ^a	OUTDOOR AIR [cubic feet per minute (cfm) per person] UNLESS NOTED ^b
Private dwellings, single and multiple		
Living areas ^c	—	0.35 air changes per hour ^e or 13 cfm per person, whichever is greater
Kitchens	—	100 cfm intermittent or 25 cfm continuous
Toilet rooms and bathrooms	—	Mechanical exhaust capacity of 50 cfm intermittent or 20 cfm continuous
Garages, separate for each dwelling	—	100 cfm per car
Garages, common for multiple units ^b	—	1.5 cfm/ft. ²
Public spaces		
Corridors and utilities	—	0.05 cfm/ft. ²
Elevators ^g	—	1.00 cfm/ft. ²
Locker and dressing rooms ^h	—	0.5 cfm/ft. ²
Toilet rooms ^{h,e}	—	75 cfm per water closet or urinal
Smoking lounges ^b	70	60
Retail stores, sales floors and showroom floors		
Basement and street	—	0.30 cfm/ft. ²
Dressing rooms	—	0.20 cfm/ft. ²
Malls and arcades	—	0.30 cfm/ft. ²
Shipping and receiving	—	0.15 cfm/ft. ²
Smoking lounges ^b	70	60
Storage rooms	—	0.15 cfm/ft. ²
Upper floors	—	0.20 cfm/ft. ²
Warehouses	—	0.05 cfm/ft. ²
Specialty shops		
Automotive service stations	—	1.5 cfm/ft. ²
Barber	25	15
Beauty	25	25
Clothing, furniture	—	0.30 cfm/ft. ²
Florists	8	15
Hardware, drugs, fabrics	8	15
Pet shops	—	1.00 cfm/ft. ²
Reducing salons	20	15
Supermarkets	8	15

(continued)

TABLE 403.3—continued
REQUIRED OUTDOOR VENTILATION AIR

OCCUPANCY CLASSIFICATION	ESTIMATED MAXIMUM OCCUPANT LOAD, PERSONS PER 1,000 SQUARE FEET ^a	OUTDOOR AIR [cubic feet per minute (cfm) per person] UNLESS NOTED ^b
Theaters		
Auditoriums	150	15
Lobbies	150	20
Stages, studios	70	15
Ticket booths	60	20
Transportation		
Platforms	100	15
Vehicles	150	15
Waiting rooms	100	15
Workrooms		
Bank vaults	5	15
Darkrooms	—	0.50 cfm/ft. ²
Duplicating, printing	—	0.50 cfm/ft. ²
Meat processing ^c	10	15
Pharmacy	20	15
Photo studios	10	15
Sports and amusement		
Ballrooms and discos	100	25
Bowling alleys (seating areas)	70	25
Game rooms	70	25
Ice arenas	—	0.50 cfm/ft. ²
Playing floors (gymnasiums)	30	20
Spectator areas	150	15
Swimming pools (pool and deck area)	—	0.50 cfm/ft. ²
Storage		
Repair garages, public garages (enclosed) ^d	—	1.5 cfm/ft. ²
Warehouses	—	0.05 cfm/ft. ²

HVAC System Controls

- Temperature Control (*Section 803.2.3*)
- Each heating and cooling system must be controlled by:
 - Solid-state programmable thermostat
 - Capability to setback or shut down
 - Time of day and day of week
 - Manual override
 - Exceptions
 - HVAC systems serving hotel/motel guestrooms
 - PTAC / PTHP and room air conditioner systems



Mechanical Ventilation and Exhaust

(Section 803.2.7 / 803.3.3.4)

Shutoff Dampers

- Required for outdoor-air-supply and exhaust systems > 3000 CFM
- Must automatically close during periods of non-use

Exceptions

- Where restricted by health and life safety codes
- Where serving areas designed for continuous operation
- Systems with *readily accessible* manual dampers

Economizers

(Section 803.2.6)

Simple Systems

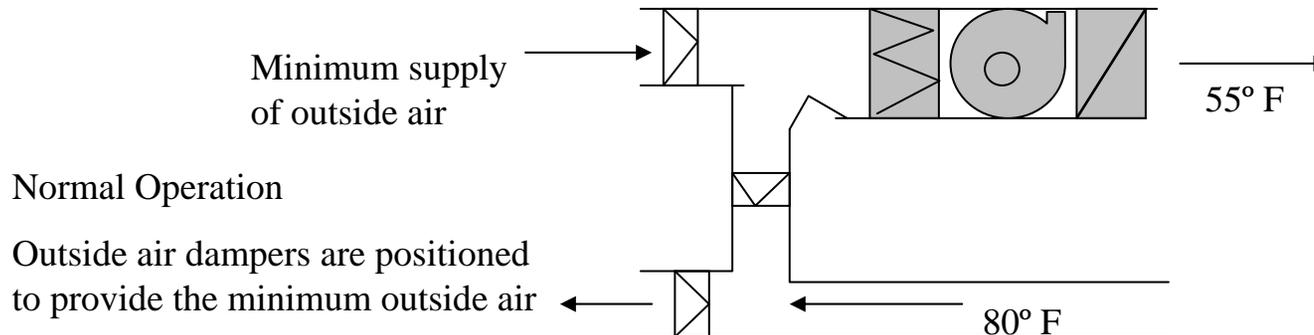
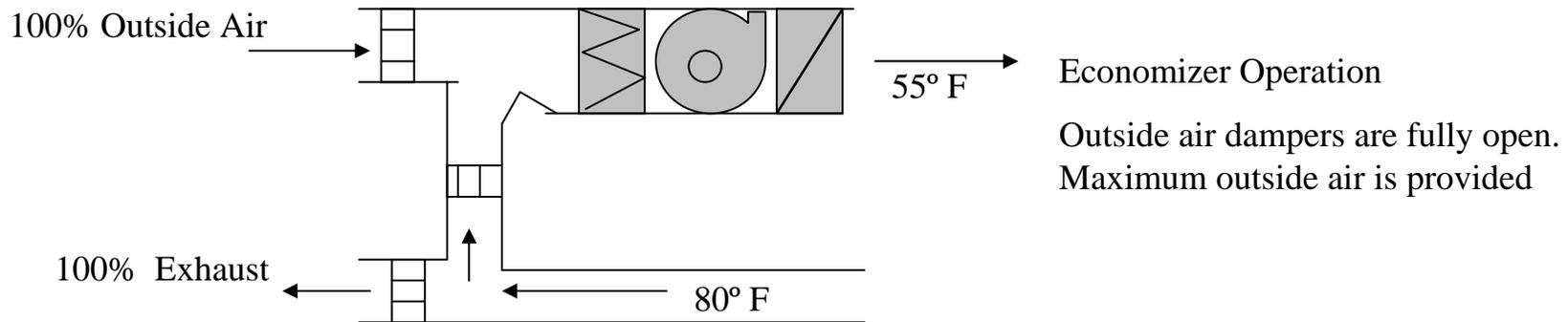
- Air economizers required on systems with a cooling capacity 65,000 Btu/h
- Not required in climate zones 1, 2, 3b, 5a, 6b
- Not required for <135,000 Btu/h in climate zones 3c, 5b, 7, 13b and 14
- Equipment efficiency trade-off



Economizer Types

Air-Side Economizers

- Use dampers to increase outside air when outside air cool system requires cooling



Equipment Economizer Exception

- Based on:
 - Total cooling capacity
 - Climate zones
 - Equipment efficiency (EER)

TABLE 803.2.6
MINIMUM EQUIPMENT EFFICIENCY ECONOMIZER EXCEPTION

TOTAL COOLING CAPACITY OF EQUIPMENT	BUILDING LOCATION		
	Zones 6a, 9a, 10a, 11a, 12a, 12b, 13a, 13b, 14a, 14b, 15-19	Zones 3a, 3b, 4a, 7a, 8, 9b, 10b, 11b	Zones 4b, 5a, 5b, 6b, 7b
90,000 Btu/h to 134,999 Btu/h	Not Applicable	11.4 EER	10.4 EER
135,000 Btu/h to 759,999 Btu/h	Not Applicable	10.9 EER	9.9 EER
760,000 Btu/h or more	Not Applicable	10.5 EER	9.6 EER

For SI: °C = [(°F)-32]/1.8, 1 British thermal unit per hour = 0.2931 W.

Duct Systems

- Duct Systems Are Defined As a Continuous Passageway for the Transmission of Air that Includes:
 - Ducts
 - Duct Fittings
 - Dampers
 - Plenums
 - Fans, and
 - Accessory Air-Handling Equipment and Appliances



Duct Insulation

*Section 803.2.8 /
803.3.6*

- Required for supply and return ducts
 - Located in unconditioned space - R5
 - Located outside the building - R8

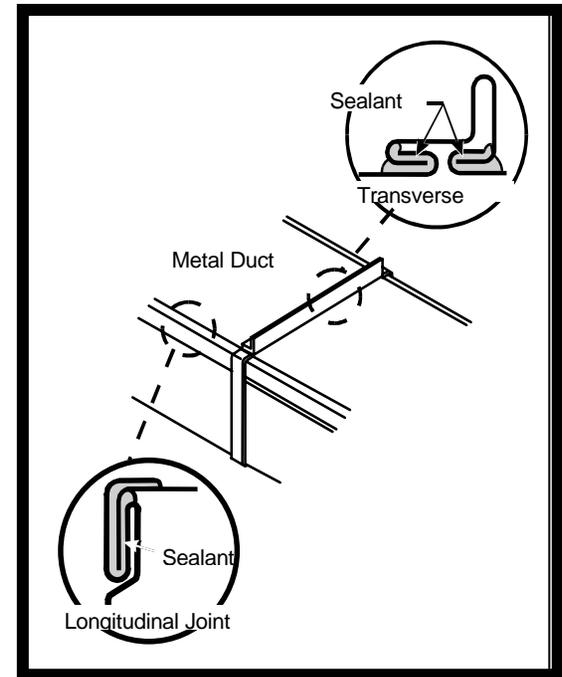
Duct Sealing and Leak Testing

Section 803.2.8.1 / 803.3.6

Seal and securely fasten all joints, longitudinal and transverse seams and connections with

- welds
- mastic-plus-embedded fabric system
- gaskets
- mastics
- tapes

Ducts > 3" w.g. shall be leak tested



HVAC Piping Insulation

Section 803.3.7

- Piping Serving as Part of Heating or Cooling System Must be Insulated

FLUID	Nominal Pipe Diameter	
	$\leq 1.5''$	$> 1.5''$
Steam	1.5	3.0
Hot Water	1.0	2.0
Chilled Water, brine or refrigerant	1.0	1.5

ASHRAE Standard 90.1-2001 Mechanical

- Options
 - Sections 803 and 804 of the IECC
 - Chapters 6 and 7 of ASHRAE Standard 90.1-2001
- ASHRAE Standard 90.1-2001 will be covered in more detail in a post-workshop session on Thursday afternoon

ASHRAE Standard 90.1-2001

Mechanical Differences

- **ASHRAE has some additional requirements for specific systems**
- Humidification/dehumidification controls
- Freeze and snow melting system controls
- Fan pressure optimization
- Commissioning (for some systems)
- Radiant heating
- Hot gas bypass
- Optimum start
- Fan power limitation
- Exhaust hoods
- Motorized dampers instead of gravity dampers

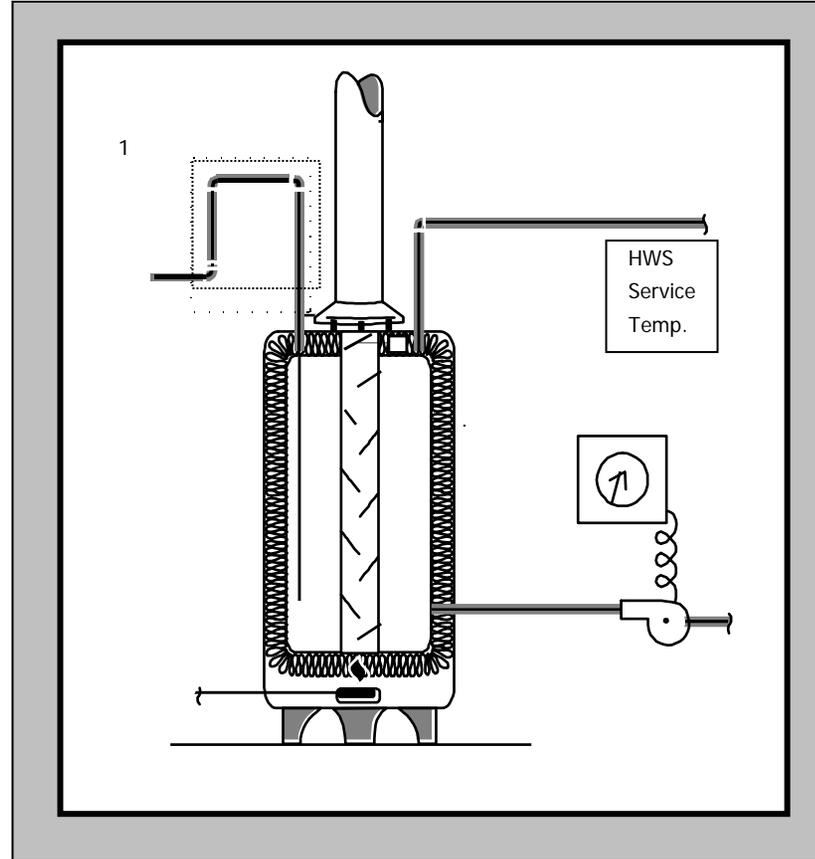
ASHRAE Standard 90.1-2001 More Mechanical Differences

- ASHRAE may have additional exemptions or exceptions that are not found in the IECC
 - Setpoint overlap restrictions
 - Design for future expansion
 - Heat rejection equipment

Service Water Heating

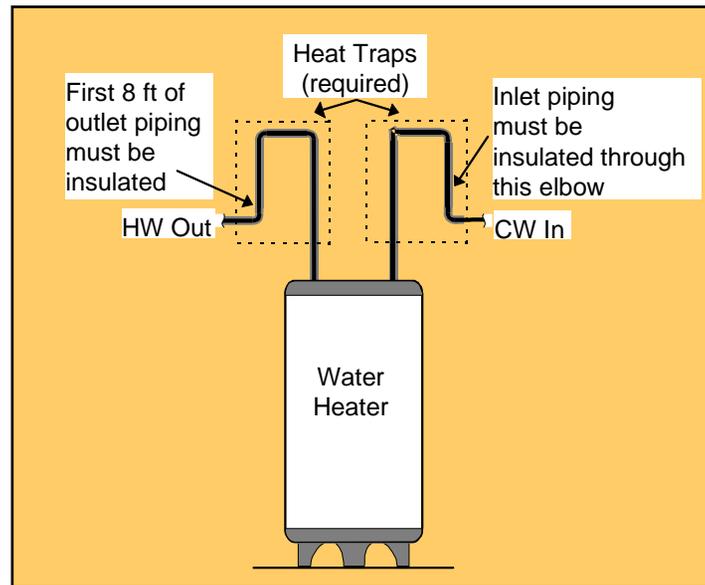
Summary of Requirements:

- Heat traps to reduce standby losses
- Pipe insulation to reduce distribution and standby losses
- Circulation loop temperature controls to reduce distribution losses



Heat Traps

- Required on noncirculating hot water systems (*Section 804.4*)



Pipe Insulation

(Section 804.4)

- Circulating systems
 - 1" of insulation on piping
 - R-3.5/inch minimum
- Non circulating systems
 - No integral heat traps installed
 - 1/2" for first 8 feet
 - R-3.5/inch minimum

Circulation Loop Controls

(Section 804.6)

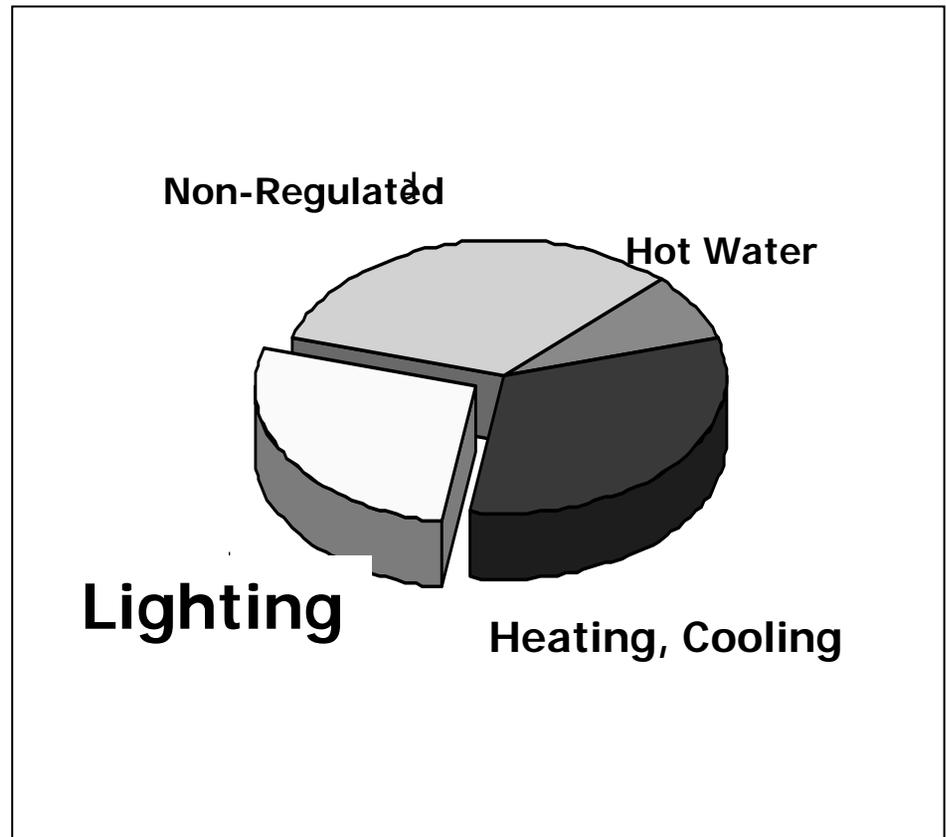


- Application: circulating hot water systems
 - Automatic time switches required to turn off the pump and heat tracer tape when it is not in use

Lighting System Scope

Energy for Lighting in Buildings:

- Accounts for approximately 27% of energy use



Lighting Systems Scope

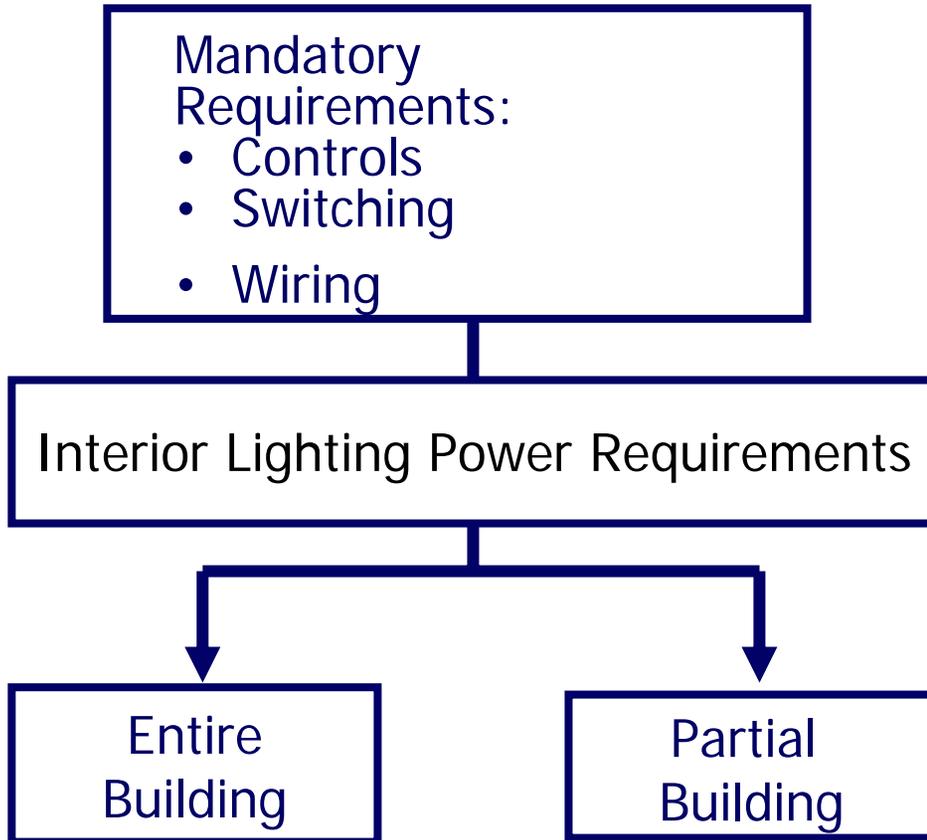


- Applies to the design of:
 - First installed lighting systems in conditioned or unconditioned spaces
 - Altered systems as part of alteration
 - Altered system that increases the lighting load if change of occupancy
 - Exterior lighting systems



Scope

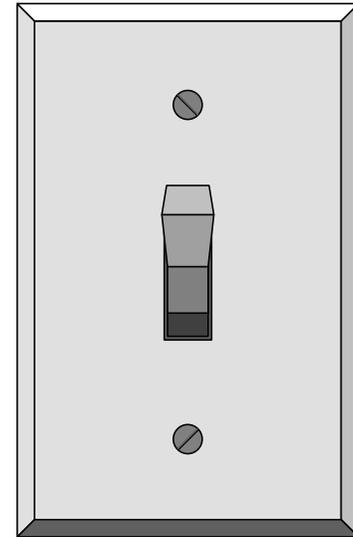
Interior Lighting Requirements:



Independent Switching

Section 805.2.1

- Lighting controls required for each area enclosed by ceiling height partitions
- Switch locations
 - In view of lights
 - "On" or "off" indication from remote location
 - Occupancy sensor



Independent Switching



- Exceptions
 - Emergency/Security Lighting
 - Stairway or corridor lighting for egress

Light Reduction Controls

2003 IECC

Section 805.2.2.1.1

- Reduce Connected Lighting Load
 - All areas required to have a manual control
 - Additional control to reduce lighting load by 50%
 - Buildings larger than 5000 ft²
 - Automatic control device
 - Scheduled basis to control areas \leq 25,000 ft² or no more than one floor
 - Unscheduled basis by occupant intervention

Light Reduction Controls

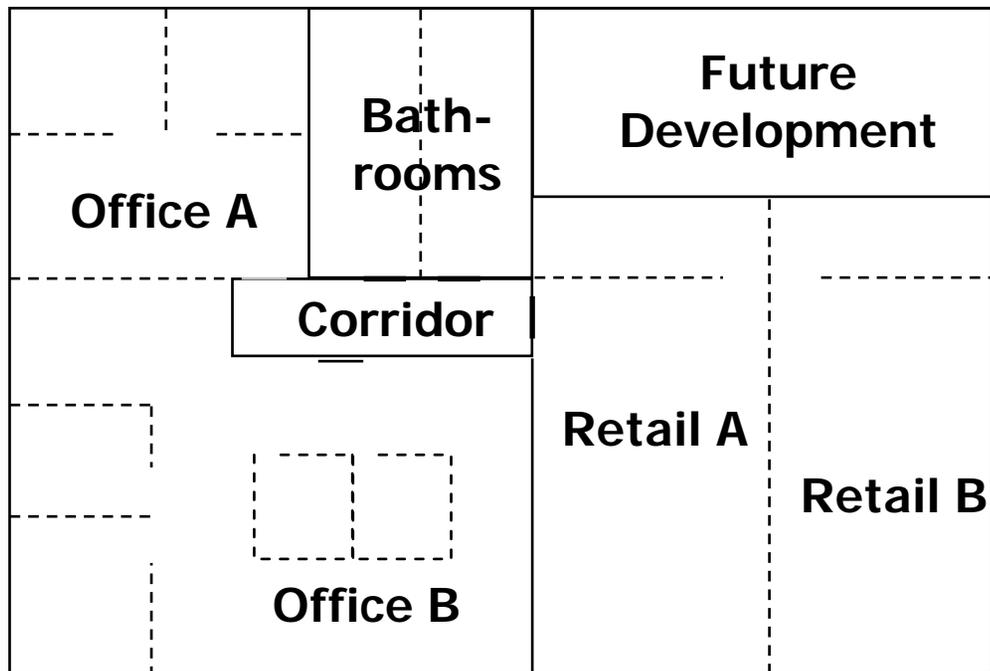
2003 IECC

Section 805.2.2.1.1

- Automatic Lighting Shutoff
 - Occupant override
 - Readily accessible
 - In view of the lights
 - Manually operated
 - Two-hour override limit
 - Controls area $\leq 5000 \text{ Ft}^2$
 - Holiday scheduling feature required for automatic time switch

Switching Example

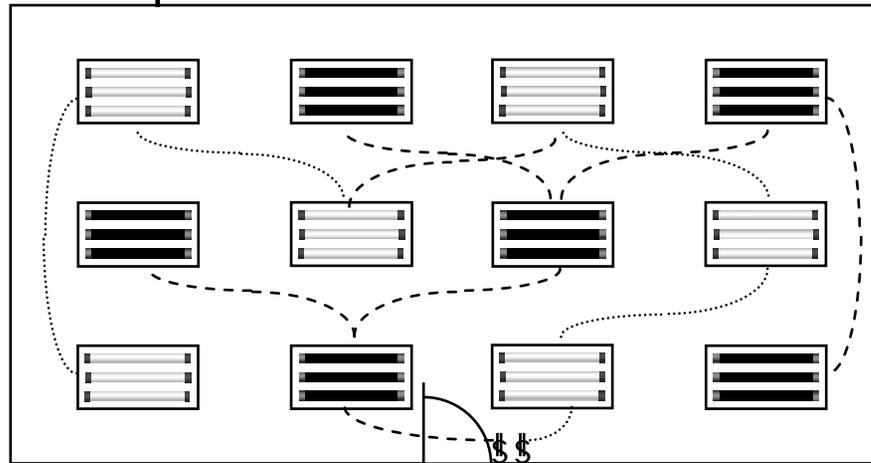
- Example



Bi-Level Switching

- Compliance Examples

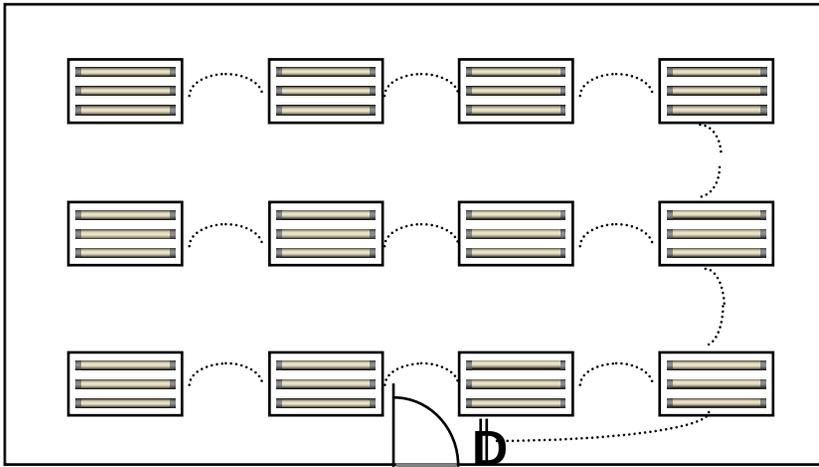
Example: Alternate Luminaires



Bi-Level Switching

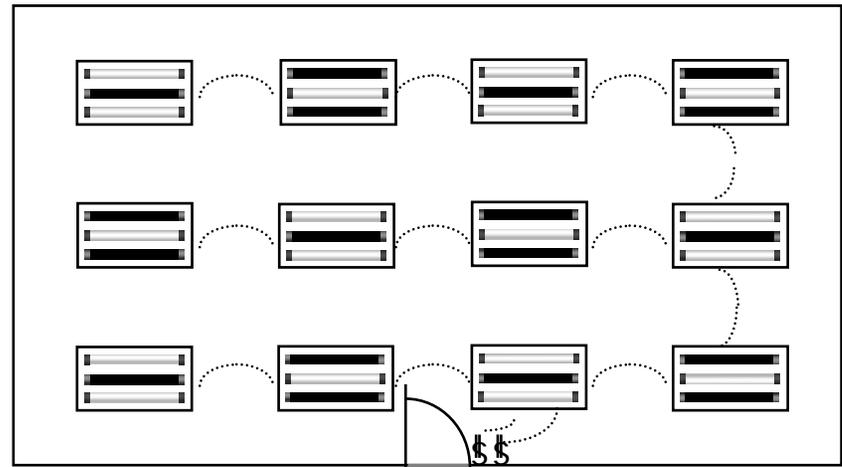
- Compliance Examples

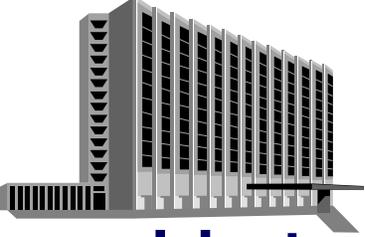
Example: Dimmer Control Option



Dimmer Switch

Example: Alternate Lamps (a/b)

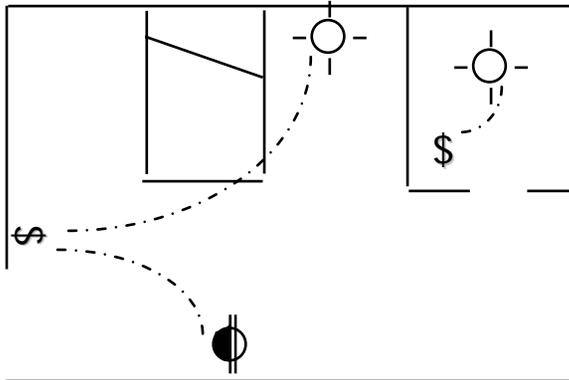




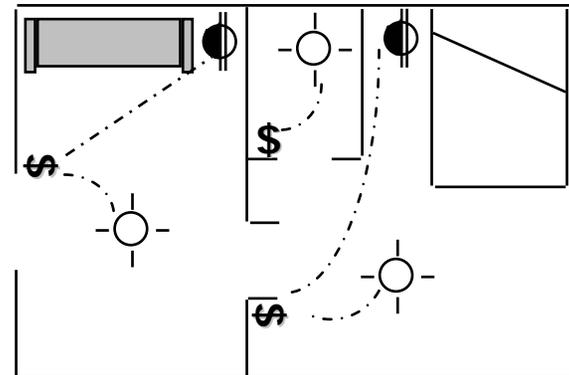
Hotel/Motel Guest Room Switching

Section 805.2.2.3

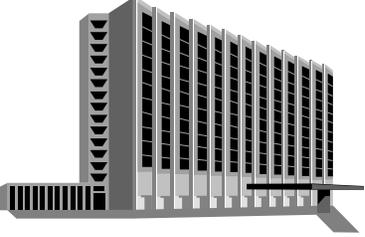
- Master switch required at entry



Standard Room



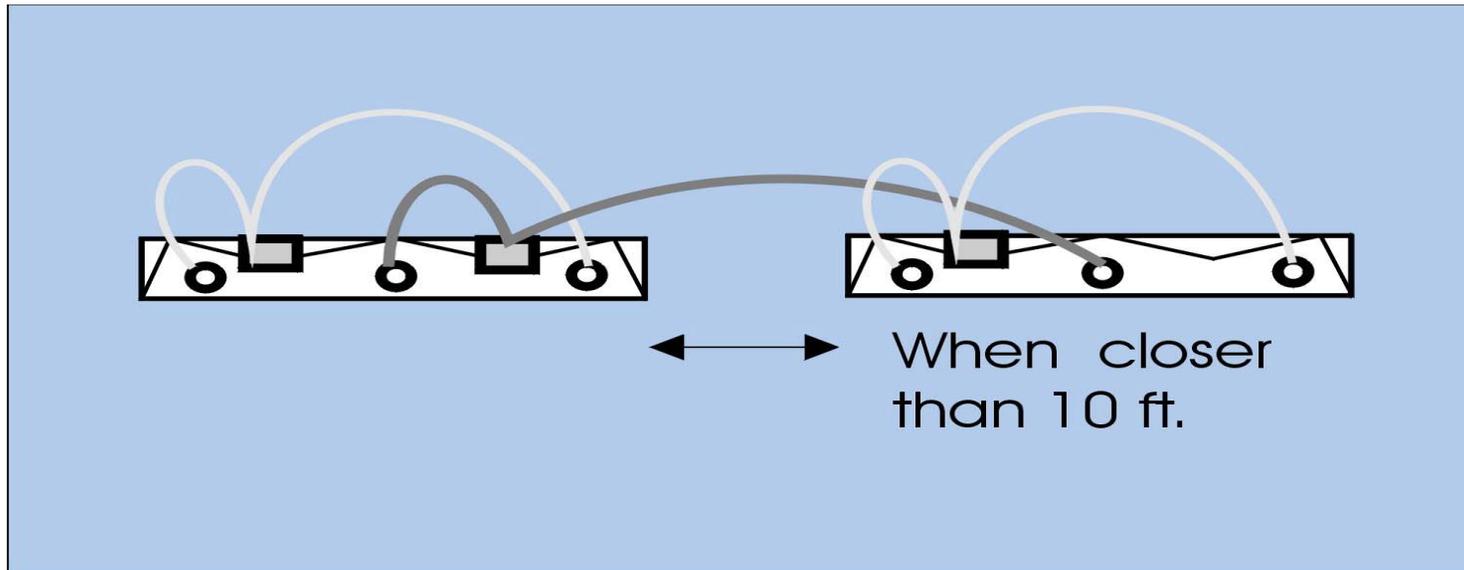
Suite



Hotel/Motel Guest Room Switching



Tandem Wiring *(Section 805.3)*



Tandem Wiring

- Exceptions
 - Luminaires with electronic high-frequency ballasts
 - Luminaires on emergency circuits
 - Luminaires with no available pair in the same area

Exit Signs



- Internally illuminated exit signs shall not exceed 5 Watts per side

Scope

Exterior Lighting Requirements:

Mandatory Requirements:

- Controls



Exterior Lighting Requirements:

- Energy Efficient Sources
- Use Limitations

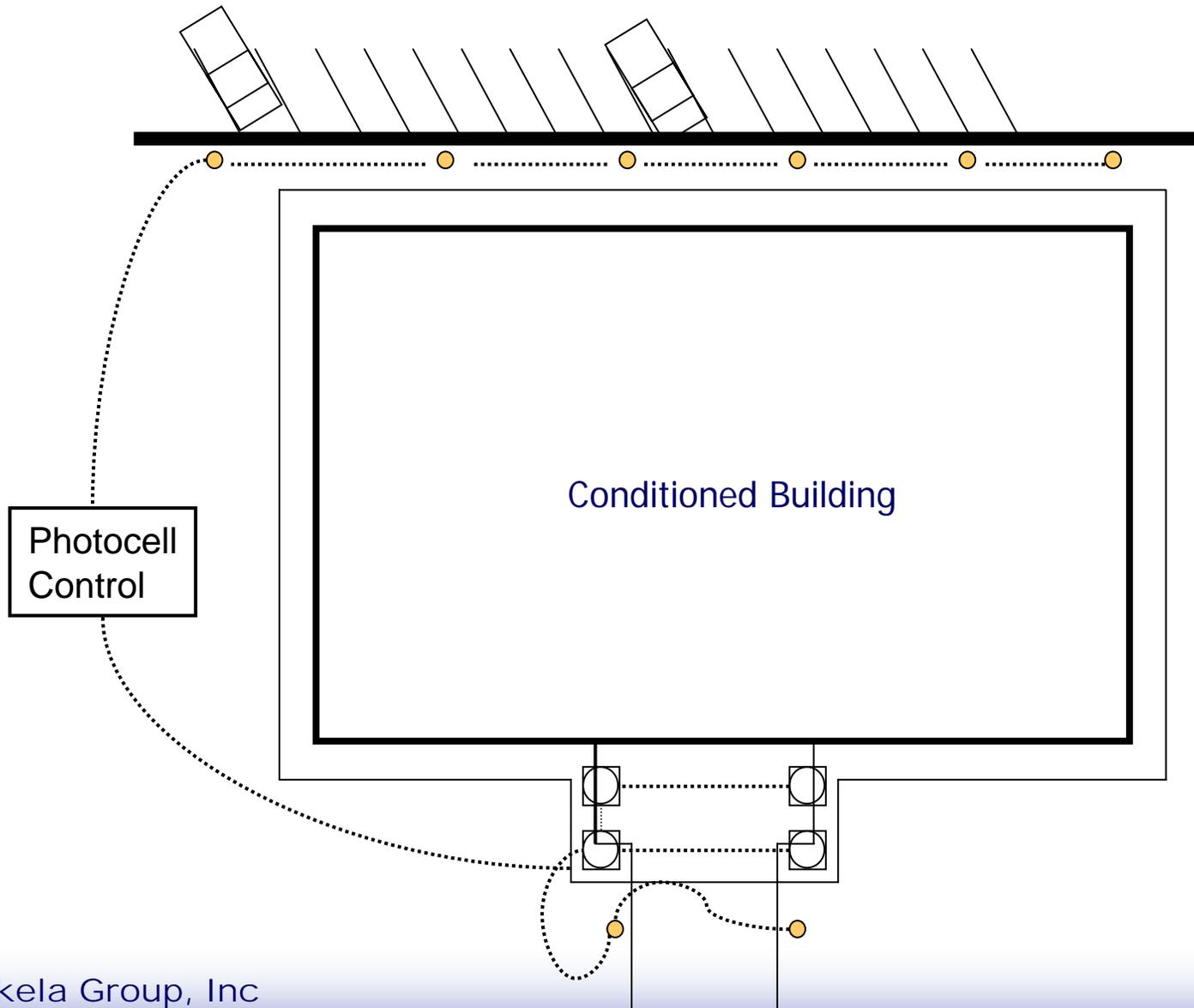


Exterior Lighting Controls



- Turn Lights off During Daylight Hours
 - Photo Cell
 - Automatic Time Switches
 - Seven Day/Seasonal Daylight Program
 - 4 hour Minimum Backup
 - Exception
 - Lights Intended for 24-hour Operation

Exterior Lighting Controls



Demonstrating Compliance

Section 104



- Include the following information on the electrical plans
 - Switching schemes
 - Make/model of exterior lighting controls
 - Notes for tandem wiring

Interior Lighting Power

Section 805.5.2

- Entire Building
 - Building is all one occupancy or a majority occupancy exists (Section 101.4.3)
- Tenant area or portion of building
 - Use for tenant spaces in larger building or divide whole building into area types

TABLE 805.5.2
INTERIOR LIGHTING POWER

BUILDING OR AREA TYPE	ENTIRE BUILDING (W/ft ²)	TENANT AREA OR PORTION OF BUILDING (W/ft ²)
Auditorium	Not Applicable	1.8
Automotive facility	0.9	Not Applicable
Bank/financial institution ^a	Not Applicable	1.5
Classroom/lecture hall ^b	Not Applicable	1.4
Convention, conference or meeting center ^a	1.2	1.3
Corridor, restroom, support area	Not Applicable	0.9
Courthouse/town hall	1.2	Not Applicable
Dining ^a	Not Applicable	0.9
Dormitory	1.0	NA
Exercise center ^a	1.0	0.9
Exhibition hall	Not Applicable	1.3
Grocery store ^a	1.5	1.6
Gymnasium playing surface	Not Applicable	1.4
Hotel function ^a	1.0	1.3
Industrial work, < 20-foot ceiling height	Not Applicable	1.2
Industrial work, ≥ 20-foot ceiling height	Not Applicable	1.7
Kitchen	Not Applicable	1.2
Library ^a	1.3	1.7
Lobby—hotel ^a	Not Applicable	1.1
Lobby—other ^a	Not Applicable	1.3
Mall, arcade, or atrium	Not Applicable	0.6
Medical and clinical care ^{b,c,d}	1.2	1.2
Motel	1.0	Not Applicable
Multifamily	0.7	Not Applicable
Museum ^a	1.1	1.0
Office ^a	1.0	1.1
Parking garage	0.3	Not Applicable
Penitentiary	1.0	Not Applicable
Police/fire station	1.0	Not Applicable
Post office	1.1	Not Applicable
Religious worship ^a	1.3	2.4
Restaurant ^a	1.6	0.9
Retail sales, wholesale showroom ^a	1.5	1.7
School	1.2	Not Applicable
Storage, industrial and commercial	0.8	0.8
Theaters—motion picture	1.2	1.2
Theaters—performance ^a	1.6	2.6
Transportation	1.0	Not Applicable
Other	0.6	1.0

Interior Lighting Power

Interior Lighting Power Footnotes

- Visual Display Terminals
 - The lesser of $(0.35 \text{ w/ft}^2 \times \text{Area of Space})$ or Actual Wattage of Lighting Equipment + General Lighting Allotments
- Applies To
 - Classroom / Lecture Hall
 - Medical & Clinical Care
 - Museum
 - Office

Interior Lighting Power Footnotes

Merchandise Display Lighting

- The lesser of ($1.6 \text{ w/ft}^2 \times \text{Merchandise Display}$) or Actual Wattage of Lighting Equipment
- The lesser of ($3.9 \text{ w/ft}^2 \times \text{Case or Shelf Area}$) or Actual Wattage of Lighting Equipment
- Add to General Lighting Number
- Applies to
 - Grocery Store
 - Retail Sales
 - Wholesale Showroom
- Must be Switched on Separate Circuit

Interior Lighting Power Footnotes

- Decorative Appearances
 - The lesser of $(1.0 \text{ w/ft}^2 \times \text{Area of Space})$ or Actual Wattage of Lighting Equipment + General Lighting Allotments
- Applies To:
 - Bank/Financial Institutions
 - Convention, Conference or Meeting Center
 - Dining
 - Exercise Center
 - Hotel Function
 - Library
 - Lobby
 - Religious Worship
 - Restaurant
 - Theater - Performance

Interior Lighting Power Footnotes Emergency, Recovery, Medical Supply, Pharmacy Space

- The lesser ($1.0 \text{ w/ft}^2 \times \text{Area}$) of Space or Actual Wattage of Lighting Equipment + General Lighting Allotment
- Applies to Medical and Clinic Care

Calculating Installed Lighting Power

Section 805.5.1

Sum the Watts of All Interior Lighting Equipment Except:

- Specialized Medical, Dental & Research Lighting
- Professional Sports Arena Playing Field Lighting
- Display Lighting of Exhibits in Galleries, Museums & Monuments
- Guest Room Lighting in Hotels, Motels, Boarding Houses or Similar Buildings
- Emergency Lighting Automatically off During Normal Building Operation

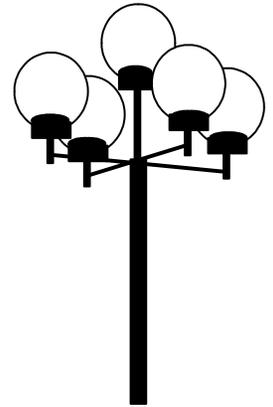
Calculating Installed Lighting Power

Section 805.5.1

- Ballasted Light Sources
 - Include Wattage of Bulb and Ballast
 - Manufactures Literature or Other Approved Resources
- Screw Lamp Holders
 - Use Maximum Labeled Wattage
- Low-Voltage Lighting
 - Specified Wattage of Transformer
- Line-Voltage Lighting Track & Plug-in Busway
 - Greater of 30 Watts/Linear Foot or Calculated Wattage

Exterior Lighting

Section 805.6

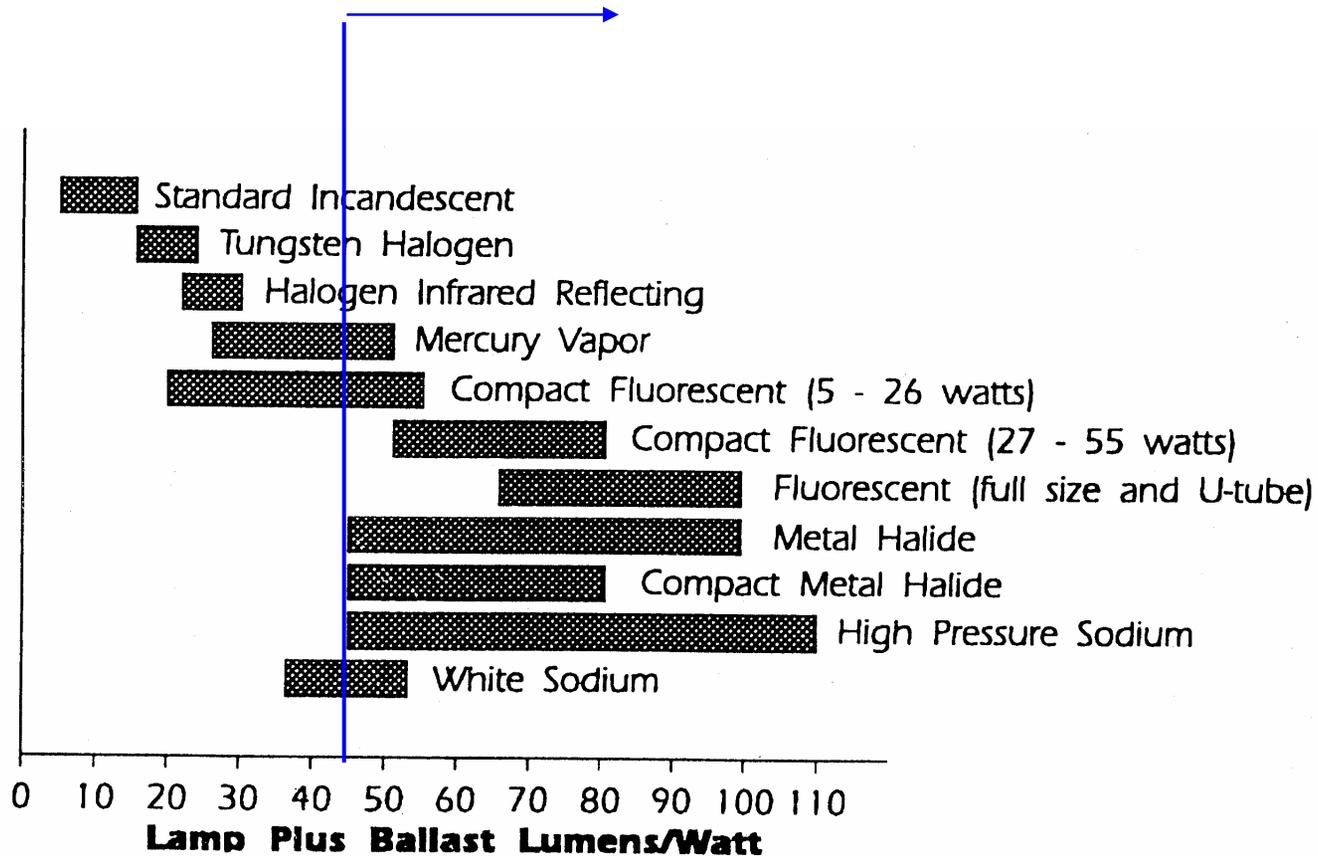


- Criteria
 - Lighting power supplied through building electrical service
 - Must use energy-efficient lighting sources
 - ≥ 45 Lumens/Watt
 - Fluorescent
 - Compact Fluorescent
 - Metal Halide
 - High Pressure Sodium

Exterior Lighting



Energy Efficient Lighting Sources



Exterior Lighting

- Exceptions
 - Where approved because of the following considerations:
 - Historical
 - Safety
 - Signage
 - Emergency

ASHRAE Standard 90.1-2001 Lighting

- Options
 - Section 805 of the IECC
 - Chapter 9 of ASHRAE Standard 90.1
- ASHRAE Standard 90.1-2001 will be covered in more detail in a post-workshop session on Thursday afternoon

ASHRAE Standard 90.1-2001 Lighting Differences

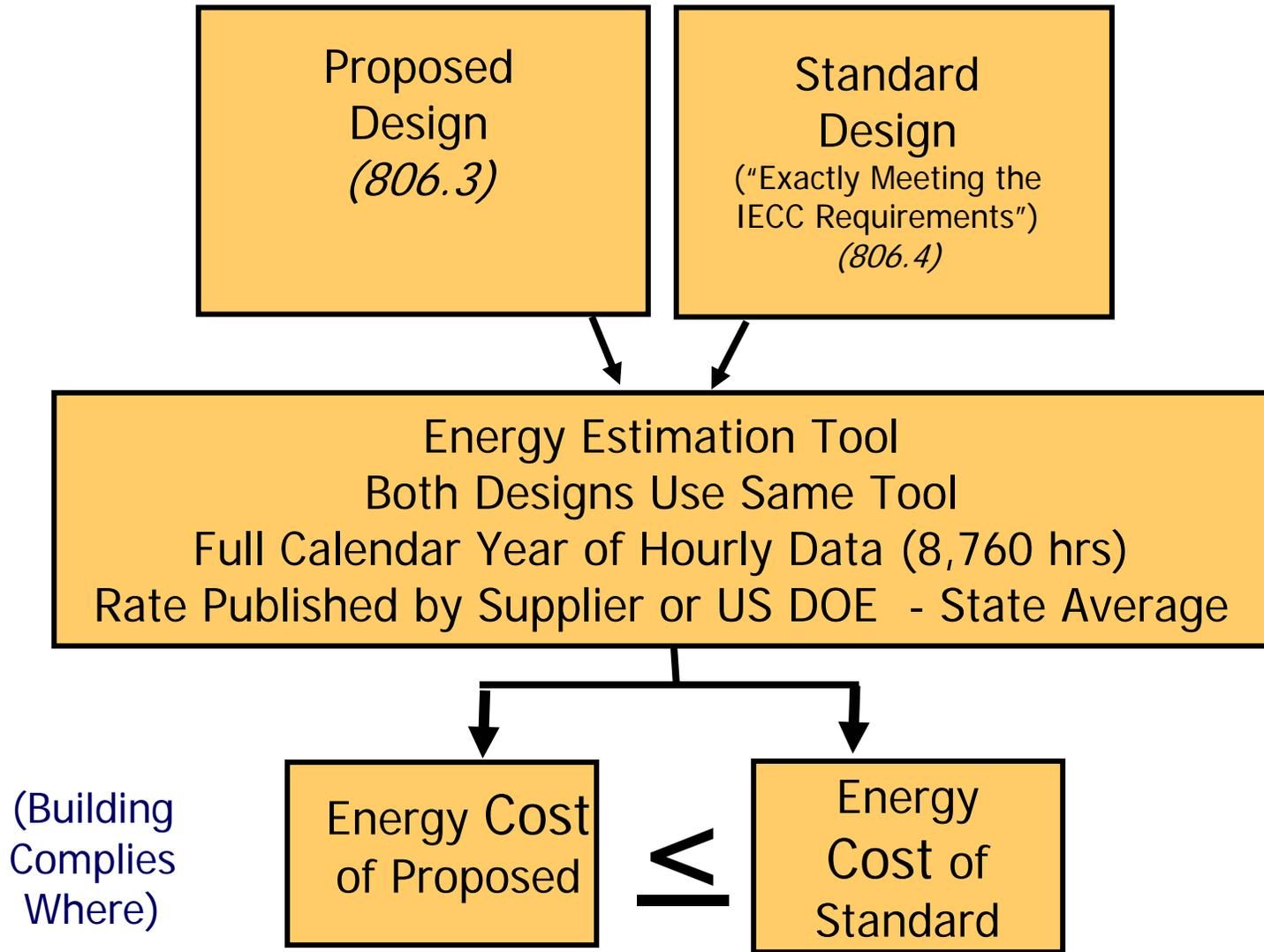
- Biggest single difference is in lighting power density requirements
 - 2003 IECC contains newest (and lowest) lighting power density requirements that will also be in ASHRAE 90.1-2004, but are not in ASHRAE 90.1-2001

Total Building Performance

- When do I use this procedure?
 - > 50% WWR
 - Sophisticated designs requiring more flexibility
 - When you cannot comply with *802, 803, or 804*
- Basic requirements must still be satisfied (*801.2*)



Total Building Performance



Total Building Performance

- Examples of energy using features that can be traded off:
 - HVAC efficiency (*Section 806.4.1*)
 - Window area (*Section 806.4.5*)
 - Skylight area (*Section 806.4.6*)
 - Interior lighting (*Section 806.4.7*)
 - Window shading devices (*Section 806.4.4*)
 - Energy costs (*Section 806.3*)

Additional Resources

Websites

- EnergyCodes.info
- International Codes Council www.icbo.org/
- US Department of Energy www.energycodes.gov/
- National Fenestration Rating Council, Inc www.nfrc.org
- New Buildings Institute www.newbuildings.org

Products

- Inspecting for the Residential Provisions of the International Energy Conservation Code
- Field Inspection video for inspecting on the residential provisions of the 2000 IECC
- Inspecting for the Commercial Provisions of the International Energy Conservation Code
- Field Inspection video for inspecting on the commercial provisions of the 2000 IECC