U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Building Energy Codes

Commercial Lighting Requirements of the 2006 International Energy Conservation Code

U.S. Department of Energy
Building Energy Codes Program

Eric Richman, PNNL

Materials developed by: Eric Richman, PNNL and Britt/Makela Group, Inc.

What We Plan to Cover…

- Some history and basis for energy codes and standards
  - Why we have them
  - Where they apply
- Specific Requirements
  - Focus on IECC 2006
  - Comparisons with other codes/standards where applicable
- Intent and application
  - The intent of major requirements
  - What the requirements mean in actual practice

Some History: The Basis for Energy Requirements

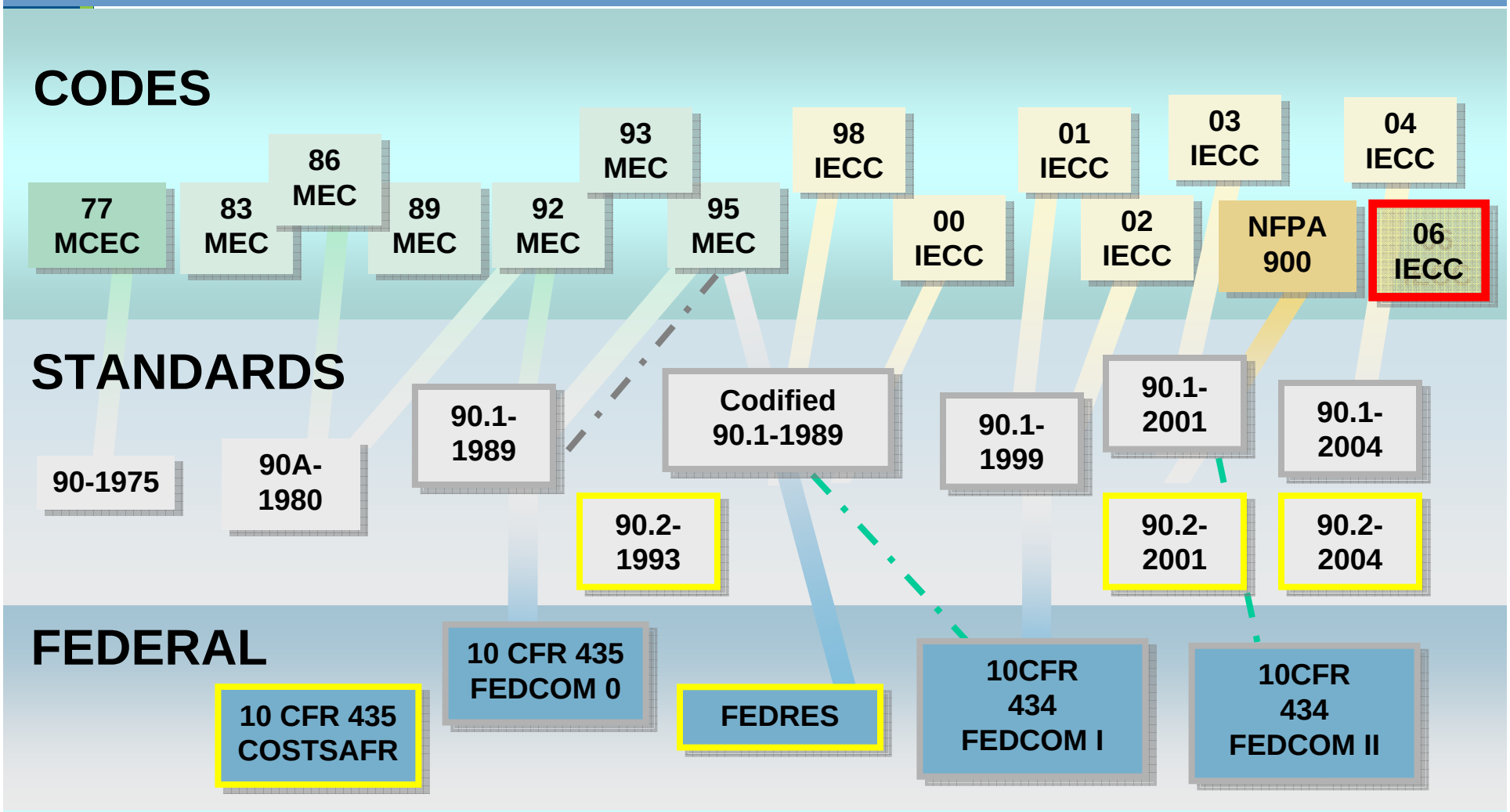
- Energy Conservation and Production Act, as amended, requires States to adopt a commercial energy code

  ……This drives state adoption of energy codes

- DOE determines the effective stringency level to meet or exceed – currently set at ASHRAE/IESNA 90.1-1999.

- Many code/standard versions available and currently adopted – varies by state:
  - Some adopt nationally available codes/standards
  - Some develop state-specific codes
  - Some have no code!

Energy Codes/Standards

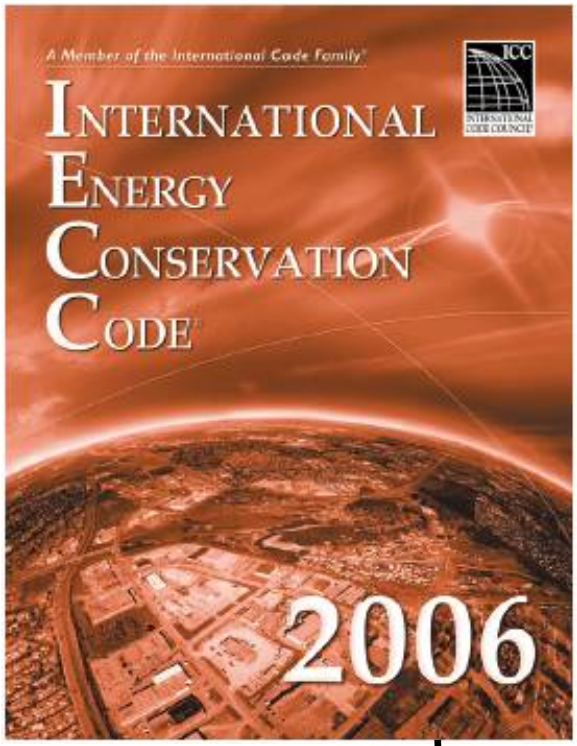


STATE SPECIFIC (Unique or based on a Code/Standard)

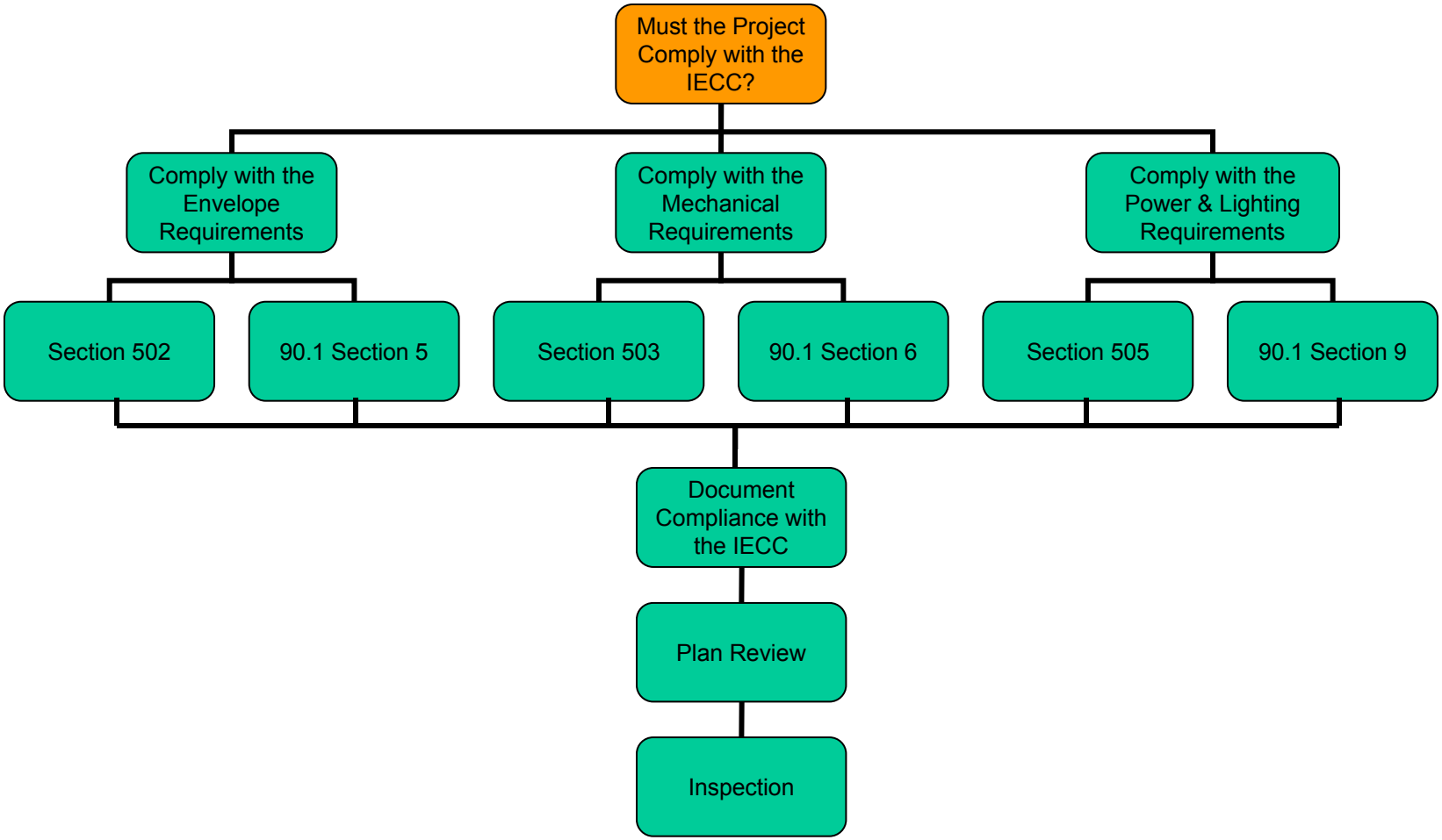
Commercial Lighting Requirements in IECC 2006

- Commercial provisions contained in Chapter 5…with reference to ASHRAE 90.1-2004
- Covers lighting controls and power density for interior and exterior

  Exception: Lighting within dwelling units
- Major changes in the 2006 version
  - Revised Interior Lighting Power Allowances
  - New Lighting Power Densities for Building Exteriors



The IECC Code Compliance Process



Does My Project Need to Comply with the Commercial Requirements of IECC ?

First: Is IECC (2006) the applicable code in your state or jurisdiction?

…If yes, is the building **commercial** or **high-rise residential** other than:

- One- and two-family residential
- R-2, R-3, R-4 three stories or less in height

When do the Lighting and Power Requirements Apply?

- Original Installed Lighting System in a New Building, Addition, or Tenant Build-out
- Existing Lighting System that is Altered
- Change in Occupancy that Increases Energy

Exceptions:

- Historic buildings
  - State or National listing
  - Eligible to be listed
- Lighting within dwelling units

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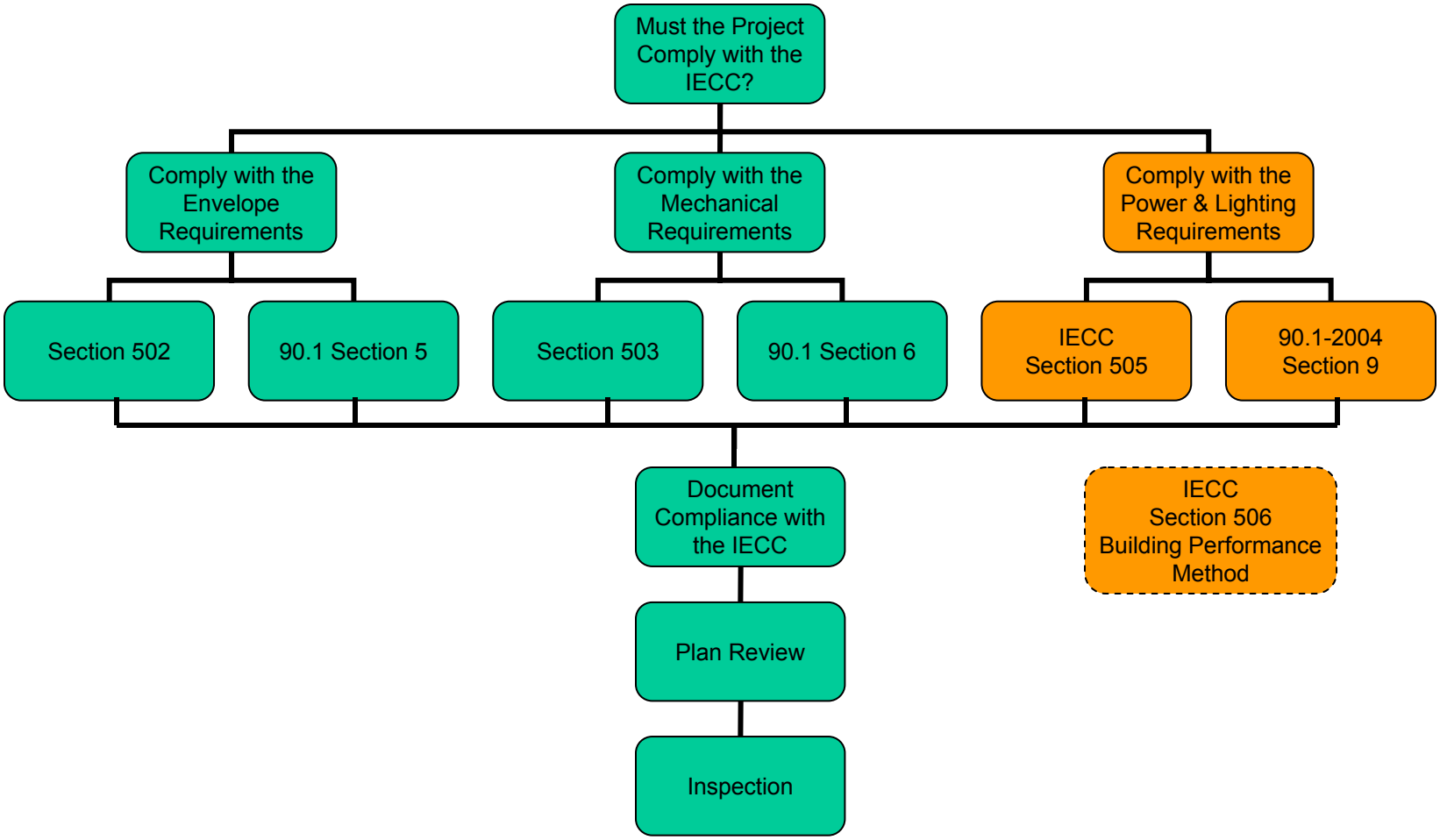


What's Covered Under Electrical Power and Lighting System Requirements?

- Mandatory Interior Lighting requirements
  - Required Controls
  - Wattage/Efficiency Limits
- Interior Lighting Power Allowances (watts/ft^2)
- Exterior Lighting Controls
  - Required Controls
  - Lamp Efficiency
- Exterior Lighting Power Allowances (watts/ft^2)
- Electric Metering

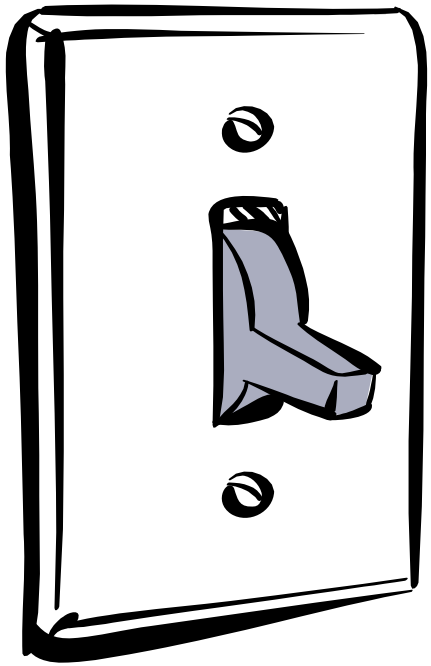
Interior Lighting Control (505.2): Basic Control

Independent Lighting Control required for each space surrounded by floor-to-ceiling partitions

- Must be located in the space served,

  - or -

- Switched from a remote location
  - Must have indicator that identifies the lights served and their status (off or on)
- Exemptions
  - Security or emergency areas that must be continuously lighted
  - Lighting in stairways or corridors that are elements of the means of egress



Intent: Allow occupants to control unneeded lighting!

Interior Lighting Control: Light Reduction

Light Reduction Controls must allow the occupant to reduce connected lighting

- By at least 50%
- In a reasonably uniform illumination pattern

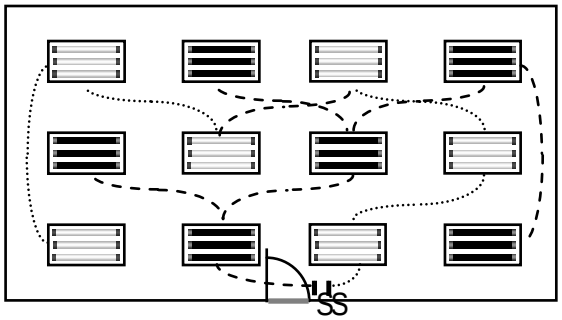
Note: Alternate Standard ASHRAE/IESNA 90.1-2004 does not require Light Reduction Control

Intent: Allow occupants to moderate light levels to save energy!

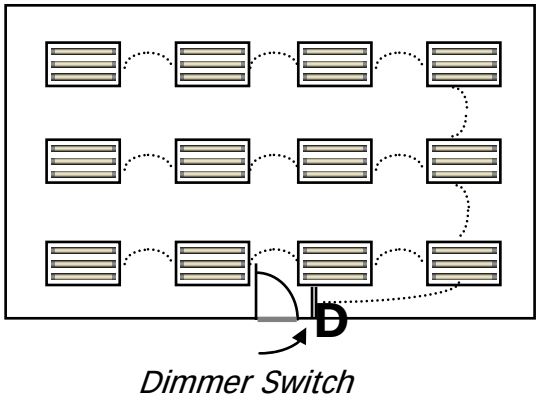
Light Reduction Control Options

- Controlling all lamps or luminaires
- Dual switching of alternate rows of luminaires, alternate luminaires or lamps
- Switching middle lamp luminaires independently from the outer lamps
- Each luminaire or each lamp

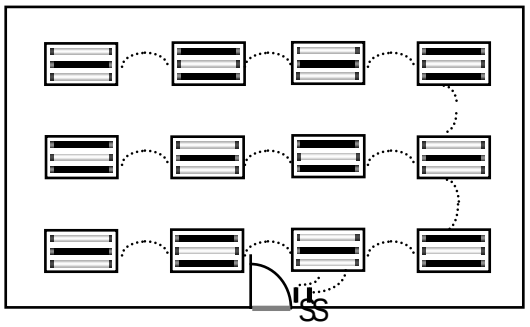
Alternating Luminaires



Dimming



Alternating lamps



Interior Lighting Control: Light Reduction Exemptions

Light Reduction Control **Not** required for the following:

- Areas with only one luminaire
- Areas controlled by occupancy sensor
- Corridors, storerooms, restrooms or public lobbies
- Sleeping units
- Spaces with <0.6 w/ft^2

Interior Lighting Control: Automatic Shutoff

Automatic lighting shutoff control device required in all buildings larger than 5,000 ft^2

Building Defined:

- "Any structure used or intended for supporting or sheltering any use or occupancy"
- Building area surrounded by exterior walls and fire walls

Exempted spaces

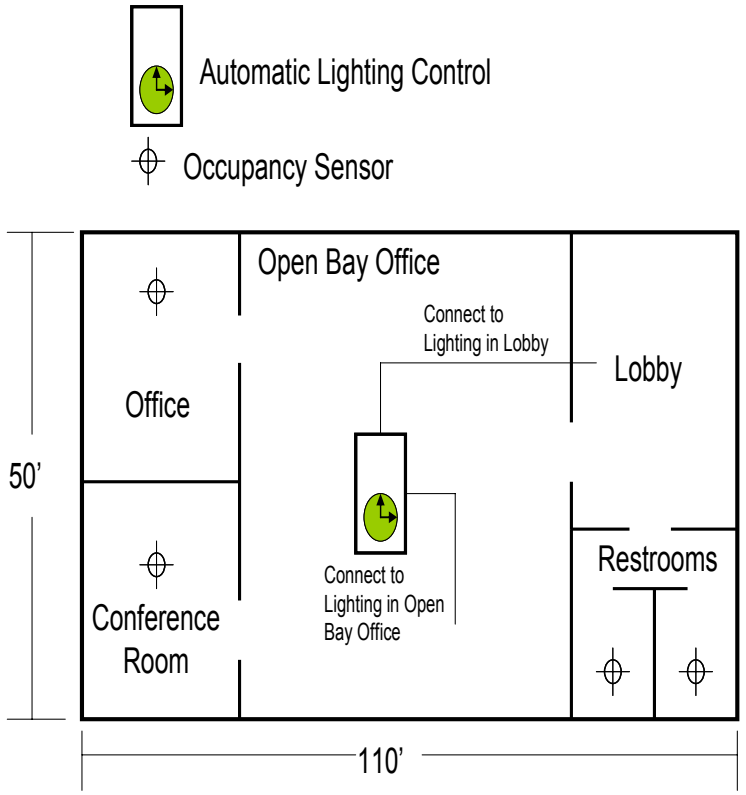
- Sleeping units
- Lighting for patient care
- When an automatic shutoff would endanger occupant safety or security

Intent: Eliminate after hours lighting waste!

Interior Lighting Control: Automatic Shutoff Options

Automatic Lighting Shutoff Compliance Options

1. Control lights on a scheduled basis (automatic time switch)
   - Time-of-day controller
   - Controls ≤ 25,000 ft^2 and not more than one floor, or
2. Occupant sensor
   - Turn lights off within 30 minutes of occupant leaving the space
3. Signal from another control or alarm that indicates the area is unoccupied



Interior Lighting Control: Automatic Shutoff Override

- Automatic Time Switch Override Requirements
  - Readily accessible
  - Within view of the lights or area controlled
  - Manually operated
  - ≤ 2 hour override
  - Controls an area ≤ 5,000 ft^2
- Exemptions to Override Requirements
  - Can be over 2 hour override in malls and arcades, auditoriums, single-tenant retail space, industrial facilities and arenas when using captive key override
  - Override in malls and arcades, auditoriums, single-tenant retail space, industrial facilities and arenas can cover up to 20,000 ft^2

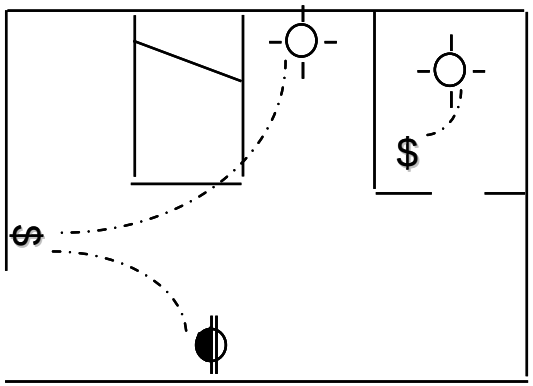
Interior Lighting Control: Holiday Scheduling

- Automatic Time Switch Holiday Scheduling
  - Must have feature that turns off all loads for 24 hours then resumes the normally scheduled operation
  - Retail stores and associated malls, restaurants, grocery stores, places of religious worship and theaters are exempt

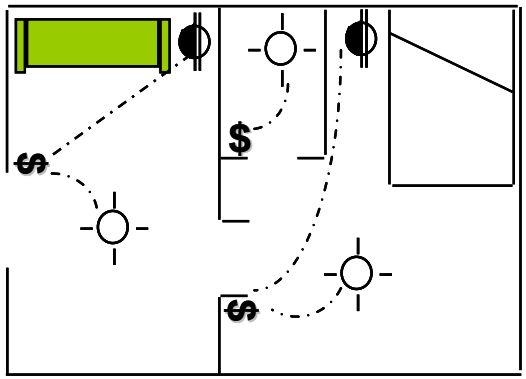
Interior Lighting Control: Sleeping Unit Lighting Control

- Sleeping Unit Control
  - Applies to Hotel/Motel Guest Room, boarding houses, or similar
  - Master switch required at each room or main room entry
  - Must control all permanently wired luminaires or switched receptacles

Intent: Allow occupant to turn off lights at exit point!



Standard Room



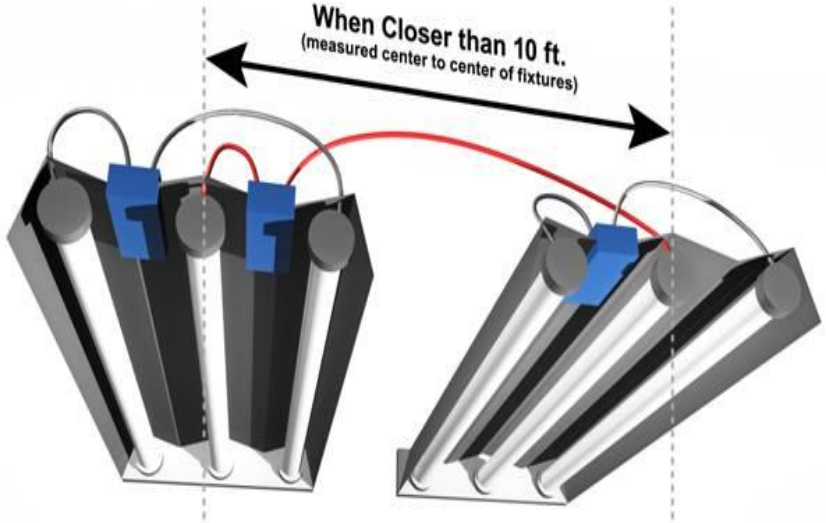
Suite

Tandem Wiring (505.3)

- Tandem Wiring for all Odd Numbered Lamp Configurations

Exceptions:

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



Intent: Eliminate the use of magnetic ballasts driving single lamps!

Exit Signs (505.4)

- Exit Signs
  - Internally illuminated exit signs shall not exceed 5 watts per side

Interior Lighting Power Limits (505.5)

Connected Interior Lighting Power must not exceed Interior Lighting Power Allowance

1. Calculate Interior Lighting Power Allowance
   - Building Area type allowance
   - Additional allowances
2. Calculate proposed connected lighting power
   - Wattage calculation “rules”
   - Exempted lighting
3. Compare values: proposed wattage must be less than or equal to allowed wattage

Intent: Eliminate waste from sloppy lighting design and application!

Interior Lighting Power Allowances

- New for the 2006 version:
  - Building Area Type Only!
  - Retail Additional Allowance Only!

  This is a simplification of the previous 2003 version that included building and tenant area allowances plus decorative and medical additional allowances

Note: Alternate Standard ASHRAE/IESNA 90.1-2004 provides whole building and space-by-space options

TABLE 505.5.2
INTERIOR LIGHTING POWER ALLOWANCES

LIGHTING POWER DENSITY	
Building Area Type[a]	(W/ft²)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare-Clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multi-Family	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail[b]	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².

a. In cases where both a general building area type and a more specific building area type are listed, the more specific building area type shall apply.

b. Where lighting equipment is specified to be installed to highlight specific merchandise in addition to lighting equipment specified for general lighting and is switched or dimmed on circuits different from the circuits for general lighting, the smaller of the actual wattage of the lighting equipment installed specifically for merchandise, or 1.6 W/ft² times the area of the specific display but not to exceed 50% of the floor area, or 3.9 W/ft² times the actual case or shelf area for displaying and selling jewelry, china or silver, shall be added to the interior lighting power determined in accordance with this line item.

Interior Lighting Power Allowance Calculation

- First, choose an appropriate “Building Area Type” from the allowance table (505.5.2).
  - “Building Area” includes all spaces that are associated with that business or function type. For example a space with:
    - Corridors,
    - Restrooms,
    - A lobby, and
    - Office space

      …would be considered an office Building Area Type
  - Then...multiply the lighting power density (W/ft^2) by the building square footage to get allowed watts for compliance

Office - Example

A 200,000 ft^2 office building that contains corridor, restrooms, break rooms and a lobby is given 1.0 watt/ft^2 for the entire building

Office: 200,000 ft^2

1.0 w/ft^2 =

200,000 w

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Interior Lighting Power Allowance for Multiple Occupancy Building

How is an allowance determined if the building has more than one Building Area Type?

Example – A building contains the following area types

- Museum: 40,000 ft^2
- Retail: 5,000 ft^2
- Cafeteria: 10,000 ft^2

- Use the more specific building area type where more than one area type exists in the building
- Sum the individual (lighting power density X area square footage) values for Total Power Allowance

Multiple Occupancy Building - Example

Museum: 40,000 ft^2

at 1.1 w/ft^2 = 44,000 w

Cafeteria: 10,000 ft^2

at 1.4 w/ft^2 = 14,000 w

Retail: 5,000 ft^2

at 1.5 w/ft^2 = 7,500 w

Total watts allowed =

65,500 w

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Additional Retail Lighting Power Allowance (Table 505.5.2 – Footnote "a")

- Lighting installed to "highlight specific merchandise…in addition to…general lighting"
  - Additional lighting is added to the general lighting allowances
  - Lighting for merchandise display
    - Add additional 1.6 w/ft^2 X display area
    - Display area cannot exceed 50% of the floor area
  - Lighting for displaying and selling jewelry, china and silver
    - 3.9 w/ft^2 X the actual case or shelf area

  Note: Display lighting must be switched or dimmed on separate circuit from general lighting

Intent: Allow flexibility in design for critical retail applications!

With Retail - Example

Museum: 40,000 ft^2

at 1.1 w/ft^2 = 44,000 w

Cafeteria:10,000 ft^2

at 1.4 w/ft^2 = 14,000 w

Retail: 5,000 ft^2

at 1.5 w/ft^2 = 7,500 w

+ retail allowance:

Wall Display (10X40) = 400 ft^2

at 1.6 w/ft^2 = 640 w

New Total Allowance =

66,140 w

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Proposed Lighting Power Calculation

- Sum the wattage of all proposed connected lighting power

- This must include all lighting that is part of the design for the space including:
  - Overhead lighting
  - Task lighting
  - Decorative lighting

Note: Wattage must be calculated based on actual power draw…not just nominal lamp rating

Proposed Lighting Calculation: Example

Lighting wattage must be documented in accordance with Section 505.5.1

- Screw lamp holders: maximum rated wattage of the luminaire
- Low voltage lighting: transformer wattage
- Line voltage track: Use the GREATER of 30 w/linear foot or the actual wattage proposed for line-voltage track or plug-in busway lighting
- Other: manufacturer's rated wattage of lamp and associated ballast

Luminaire	Description	Ballast Type	Lamp (+Ballast) Wattage	# Lamps per Luminaire	Luminaire Quantity	Luminaire Wattage
A	Inc. Downlight	NA	75	1	24	1800
B	Fl. 2X4 Recesse	Elec	30	3	110	9900
C	Biax 2X2	Elec	24	2	12	576
D	CFL Wallwash	Elec Dim	14	2	16	448
E	Fl. Cove	Elec	30	2	22	1320
F	MH Downlight	Mag.	81	1	8	648
				TOTAL WATTAGE:		14692

Exemptions to Proposed Lighting Power Calculation

- What lighting can I exempt from the Proposed Lighting Power Calculation?
  - Specialized medical, dental and research lighting
  - Professional sports arena playing field lighting
  - Display lighting for exhibits in galleries, museums and monuments
  - Sleeping unit lighting in hotels, motels, boarding houses or similar buildings
  - Emergency lighting automatically off during normal building operation

What if My Proposed Design Does Not Meet Code?

- Check calculations and design
  - Appropriate building types used?
  - Actual lighting equipment wattages used?

  …and design
  - Reasonable illuminance levels provided?
  - Efficient light sources used?
- Use alternate 90.1-2004 Standard
- Use total Building Performance Method

Exterior Lighting Control Requirements (505.2.4)

- Lighting designated for dusk to dawn operation
  - Control by astronomical time switch or photocell
- Lighting not designated for dusk to dawn operation
  - Control by astronomical time switch
- Exceptions:
  - Lighting for covered vehicle parking entrances or exits from buildings or parking structures if required by safety, security or eye adaptation

Exterior Efficiency Requirement (505.6.1)

Building grounds lighting luminaires over 100 watts must have source efficacy of at least 60 lumens per watt

Light Source	Typical System Efficacy Range in LPW (varies depending on wattage and lamp type)
Incandescent	10-18
Halogen incandescent	15-20
Compact fluorescent (CFL)	35-60
Linear fluorescent	50-100
Metal halide	50-90

Exceptions:

- Controlled by motion sensor
- Any of the exterior lighting power allowance exceptions
- As approved for a historical, safety, signage, or emergency consideration

Exterior Lighting Power Limits (505.6.2)

Connected Exterior Lighting Power must not exceed Exterior Lighting Power Allowance

- Calculate exterior Lighting Power Allowance
  - Lighting power densities by exterior function
  - Additional 5% added to total allowance
- Calculate proposed connected lighting power
  - Wattage calculation “rules”
  - Exempted lighting
- Compare values: proposed wattage must be less than or equal to allowed wattage

Intent of 5% adder: Allow flexibility in design for critical or unusual applications!

Exterior Lighting Power Limits (505.6.2)

What areas are covered under exterior lighting allowances?

- **Tradable surfaces**

  Common exterior lighted needs that can be traded for other needs.

  For example, wattage allowed for parking lot lighting can be “traded” and used for canopy lighting.

- **Non-tradable surfaces**

  Less common exterior lighted needs that **cannot** be traded for other needs.

  These applications have more specific security or task illuminance needs.

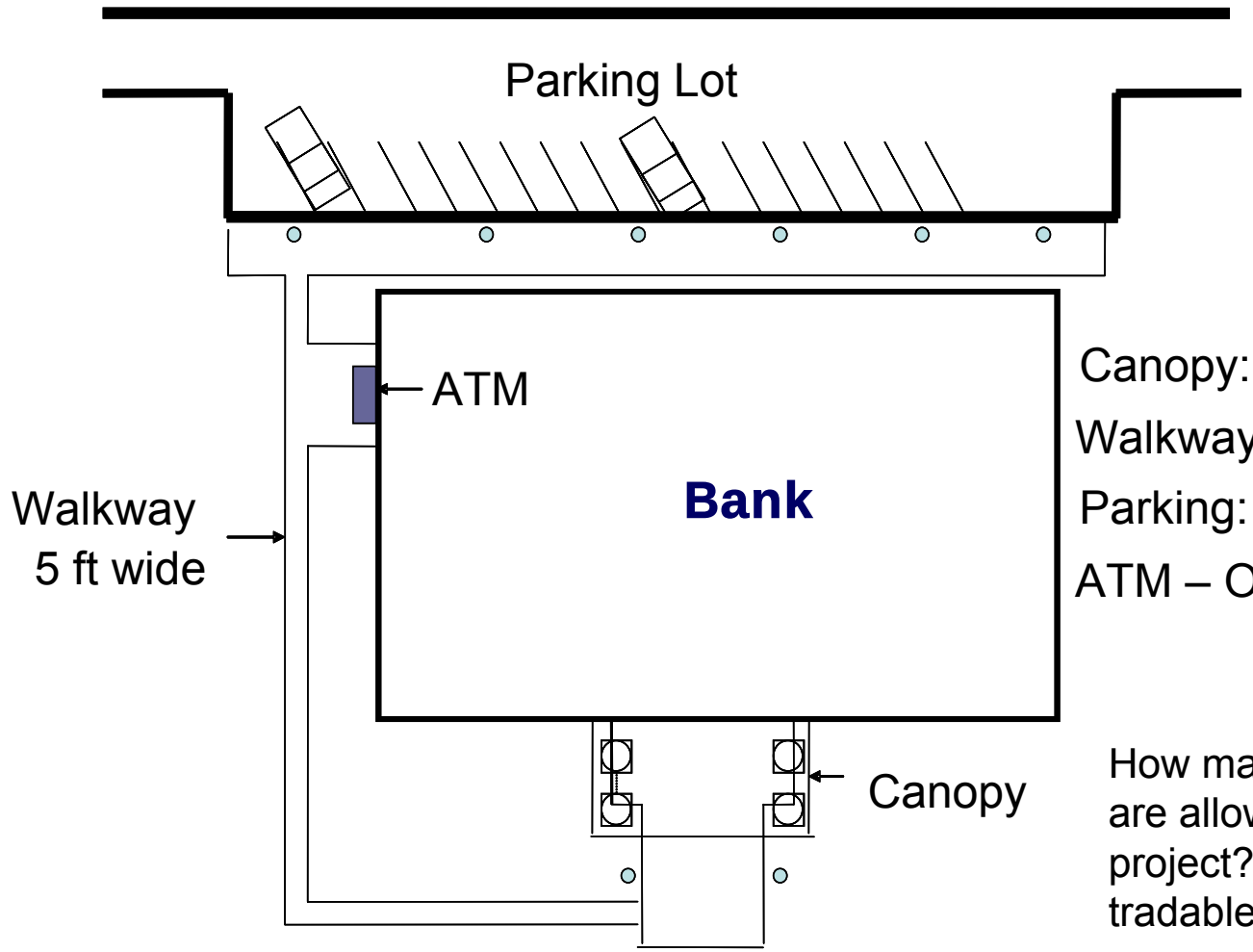
Tradable Surfaces

- Uncovered parking lots and areas
- Walkways (under and over 10 feet wide)
- Stairways
- Main building entrances
- Other doors
- Canopies and overhangs – free standing and attached
- Open sales areas
- Street frontage sales areas

Non-tradable Surfaces

- Building facades
- Automated teller machines and night depositories
- Entrances and gatehouse inspection stations at guarded facilities
- Loading areas for law enforcement, fire, ambulance and other emergency vehicles
- Drive-up windows at fast food restaurants
- Parking near 24-hour retail entrances

Exterior Lighting Power Example



Canopy: 100 ft^2

Walkway: 200 ft long

Parking: 10,000 ft^2

ATM – One location

How many tradable watts are allowed for this project? How many non-tradable watts?

Example Calculation

Parking : 10,000 ft^2
at 0.15 w/ft^2 = 1,500 w
Canopy: 100 ft^2
at 1.25 w/ft^2 = 125 w
Walkway: 200 ft
at 1.0 w/ft = 200 w
ATM (one): = 270 w
Total = 2,095 w

Total watts allowed:
1.05 x 2,095 = 2,200

TABLE 505.6.2
LIGHTING POWER DENSITIES FOR BUILDING EXTERIORS

APPLICATIONS	LIGHTING POWER DENSITIES
Tradable Surfaces (Lighting Power Densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs, and outdoor sales areas may be traded.)	
Uncovered Parking Areas	
Parking Lots and drives	0.15 W/ft^2
Building Grounds	
Walkways less than 10 feet wide	1.0 watts/linear foot
Walkways 10 feet wide or greater, plaza areas and special feature areas	0.2 W/ft^2
Stairways	1.0 W/ft^2
Building Entrances and Exits	
Main entries	30 watts/linear foot of door width
Other doors	20 watts/linear foot of door width
Canopies and Overhangs	
Canopies (free standing & attached and overhangs)	1.25 W/ft^2
Outdoor Sales	
Open areas (including vehicle sales lots)	0.5 W/ft^2
Street frontage for vehicle sales lots in addition to "open area" allowance	20 watts/linear foot
Nontradable Surfaces (Lighting Power Density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the Tradable Surfaces section of this table.)	
Building facades	0.2 W/ft^2 for each illuminated wall or surface or 5.0 Watts/linear foot for each illuminated wall or surface length
Automated teller machines and night depositories	270 watts per location plus 90 watts per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	1.25 W/ft^2 of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)
Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft^2 of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)
Drive-up windows at fast food restaurants	400 watts per drive-through
Parking near 24-hour retail entrances	800 watts per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m^2.

Exemptions from Exterior Calculation

The following lighting does not need to be included in the proposed lighting calculation:

- Specialized signal, directional, and marker lighting associated with transportation
- Advertising signage or directional signage
- Lighting integral to *equipment* or instrumentation and installed by its *manufacturer*
- Lighting for theatrical purposes, including performance, stage, film production, and video production
- Lighting for athletic playing areas
- Temporary lighting
- Lighting for industrial production, material handling, transportation sites, and associated storage areas
- Theme elements in theme/amusement parks
- Lighting used to highlight features of public monuments and registered *historic* landmark structures or *buildings*

What if My Proposed Exterior Lighting Does Not Meet Code?

- Check calculations and design
  - Appropriate surface allowances used?
  - Actual lighting equipment wattages used?

  …and design
  - Reasonable illuminance levels provided?
  - Efficient light sources used?
- Use total Building Performance Method

  Note: Alternate 90.1-2004 Standard has same requirements

Electrical Energy Consumption Mandatory Requirement

- Separate Metering Required for Each Dwelling Unit

Intent: Occupant understanding of actual energy use can promote effective energy use!

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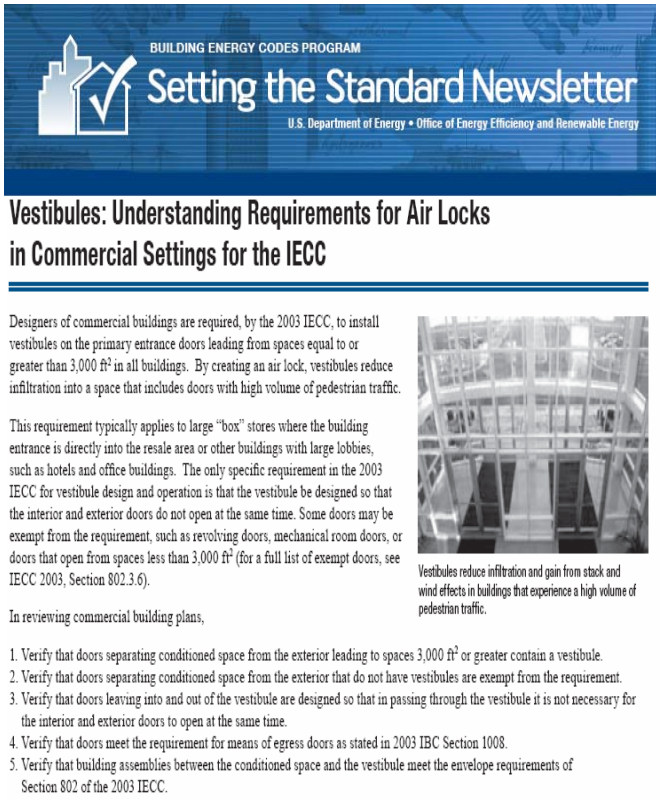
Setting the Standard Newsletter

- Register on-line to receive the latest up-to-date information on energy code related issues



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Vestibules: Understanding Requirements for Air Locks in Commercial Settings for the IECC

Designers of commercial buildings are required, by the 2003 IECC, to install vestibules on the primary entrance doors leading from spaces equal to or greater than 3,000 ft^2 in all buildings. By creating an air lock, vestibules reduce infiltration into a space that includes doors with high volume of pedestrian traffic.

This requirement typically applies to large "box" stores where the building entrance is directly into the resale area or other buildings with large lobbies, such as hotels and office buildings. The only specific requirement in the 2003 IECC for vestibule design and operation is that the vestibule be designed so that the interior and exterior doors do not open at the same time. Some doors may be exempt from the requirement, such as revolving doors, mechanical room doors, or doors that open from spaces less than 3,000 ft^2 (for a full list of exempt doors, see IECC 2003, Section 802.3.6).

Vestibules reduce infiltration and gain from stack and wind effects in buildings that experience a high volume of pedestrian traffic.

In reviewing commercial building plans,

1. Verify that doors separating conditioned space from the exterior leading to spaces 3,000 ft^2 or greater contain a vestibule.
2. Verify that doors separating conditioned space from the exterior that do not have vestibules are exempt from the requirement.
3. Verify that doors leaving into and out of the vestibule are designed so that in passing through the vestibule it is not necessary for the interior and exterior doors to open at the same time.
4. Verify that doors meet the requirement for means of egress doors as stated in 2003 IBC Section 1008.
5. Verify that building assemblies between the conditioned space and the vestibule meet the envelope requirements of Section 802 of the 2003 IECC.

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Questions/Comments

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