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**Building Energy Codes**

# ANSI/ASHRAE/IESNA Standard 90.1-2007

## An Overview of the Lighting and Power Requirements

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**Building Energy Codes**

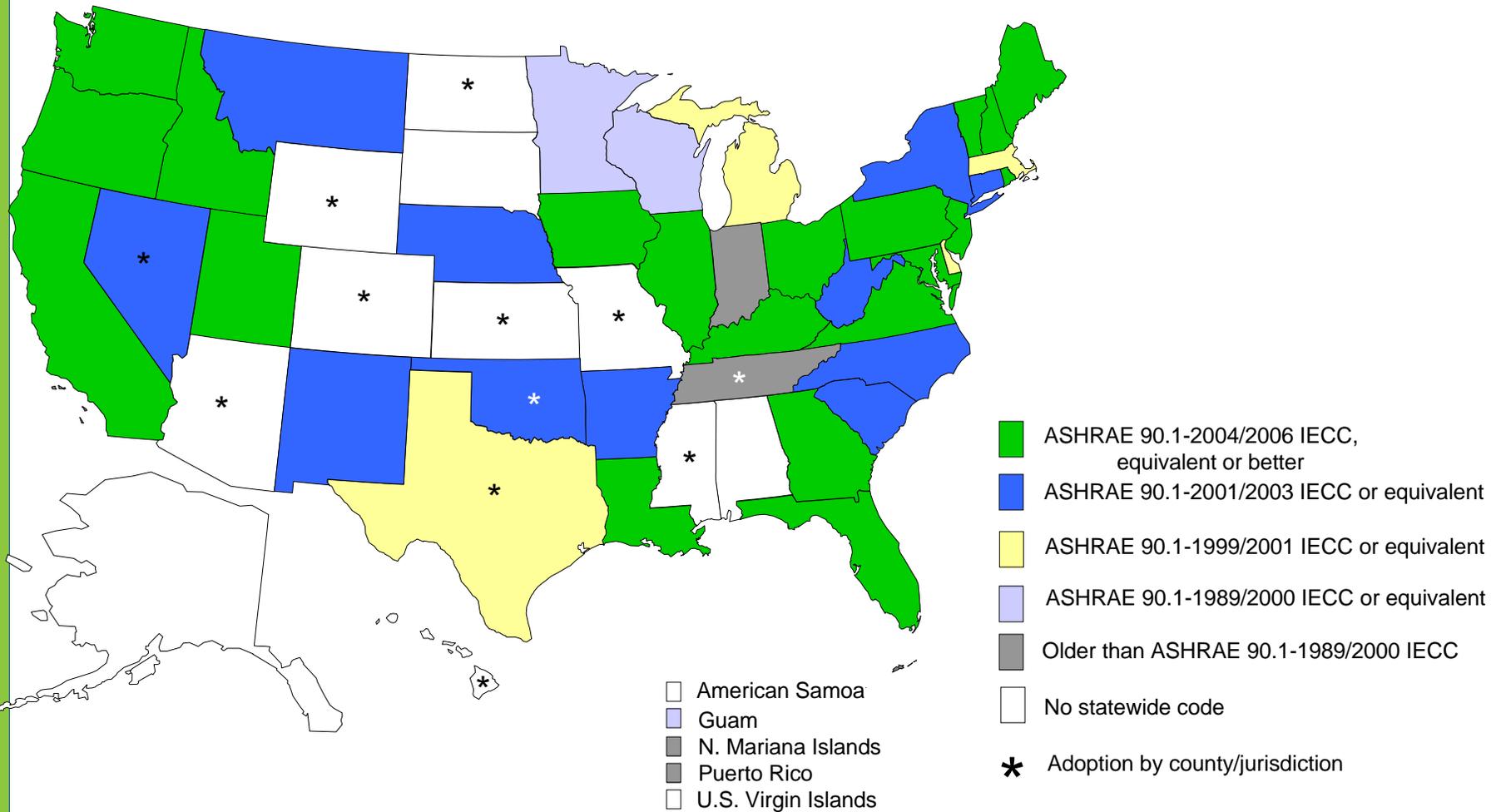
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# The Basis for Energy Requirements

- Energy Conservation and Production Act, as amended by EPC Act, 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
- 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!

# Status of Commercial Energy Codes as of Jan. 1, 2008



# Standard 90.1-2007 Basics

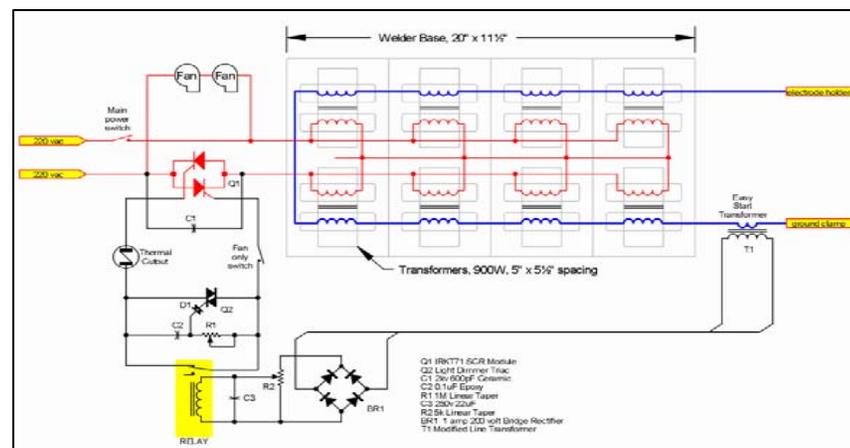
- Jointly sponsored by ASHRAE and IESNA
- 2007 is the brand new version...but many states have other versions of 90.1 in place (2004, 2001, 1999, 1989)
- Many State-specific codes and the IECC are based on 90.1. IECC references 90.1 as compliance option



The  
LIGHTING  
AUTHORITY

# Building Power Requirements

- Voltage Drop:
  - Feeder conductors
    - Run between the service entrance and the branch circuit
    - 2% maximum voltage drop allowed
  - Branch circuit conductors
    - Run from the final circuit breaker to the outlet or load
    - 3% maximum voltage drop allowed



# Building Power Requirements

- Document submittals: owner gets information about the building's electrical system
  - Record drawings of actual installation within 30 days
    - Single-line diagram of electrical distribution system
    - Floor plans showing location of distribution equipment and areas served by equipment
  - Manuals
    - Submittal data stating equipment nameplate rating
    - O&M manuals for equipment
    - Qualified service agency
    - Complete narrative and schematic of system as it's normally intended to operate



# Standard 90.1 Lighting Scope

- New Construction and Additions
  - All commercial type buildings including residential structures of 4 or more stories above grade
  - Interior and exterior lighting
  - Some exceptions to all requirements:
    - Lighting in dwelling units
    - Emergency lighting that is normally off
    - Lighting required by life, health, safety statute
    - Historic buildings (whole code exemption)
  
- Alterations/Renovations
  - Generally treated as new construction
  - Some exemptions apply

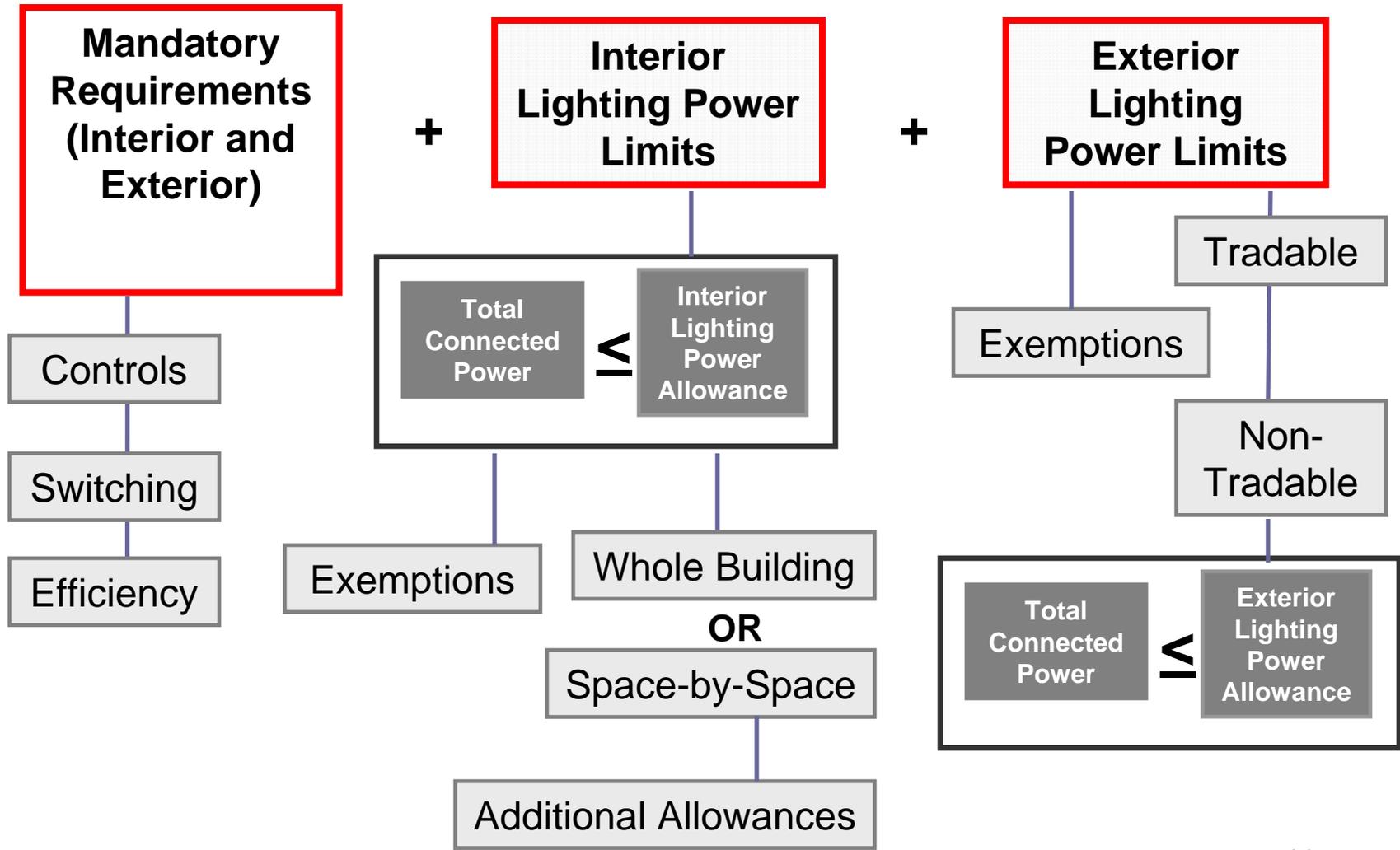


# A Few Words About Alterations/ Renovations

- The requirements are effectively the same as for new construction or additions:
  - The replacement of lighting systems in building spaces must comply
  - Any new or replacement control devices must comply
- Exception: Replacement of less than 50% of the luminaires in a space need not comply (if no increase in power density)

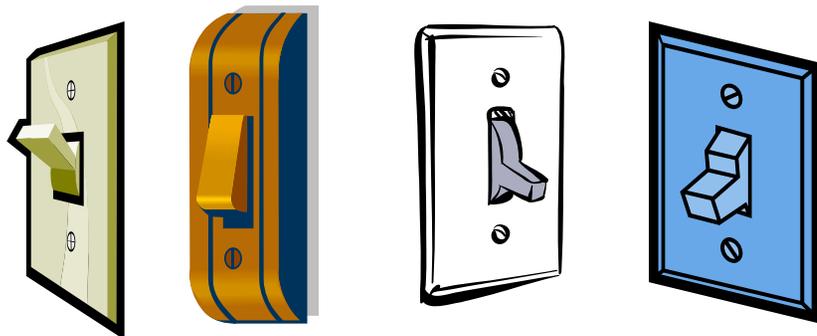


# Basic Lighting Requirements



# Mandatory: Individual Space Control

- At least one for each room or space enclosed by ceiling-height partitions
  - in spaces  $\leq 10,000$  ft<sup>2</sup>, each control serves 2500 ft<sup>2</sup> maximum and in spaces  $> 10,000$  ft<sup>2</sup>, serves 10,000 ft<sup>2</sup> maximum
- Readily accessible to occupants
- Remote location is allowed to accommodate areas where safety or security is a concern



Intent: Allow occupants to control unneeded lighting

# Mandatory: Additional Space Controls

- Hotel/motel guest room lighting must be controlled at room entry

Intent: Allow occupant to turn off lights at exit point



- Occupancy sensors are required in:
  - Classrooms (except shop, lab, K-12)
  - Conference/meeting rooms
  - Employee lunch/break rooms

Intent: Capture major occupied hours wasted light

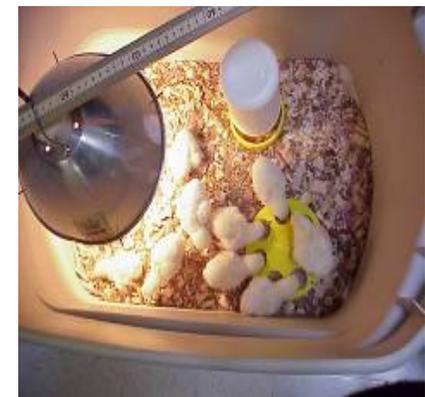


# Mandatory: Individual Space Control

- Additional control required for:
  - Display/accent lighting
  - Case lighting
  - Task lighting
  - Nonvisual lighting
  - Demonstration lighting



Intent: Provide opportunity to turn off special application lighting



# Mandatory: Automatic Shutoff

- Automatic lighting shutoff control device required in all buildings larger than 5,000 ft<sup>2</sup>
- Override of automatic shutoff required for not more than 4 hours
- Exceptions to automatic shutoff:
  - Lighting for 24-hour operation
  - Patient care spaces
  - Areas with safety or security concerns

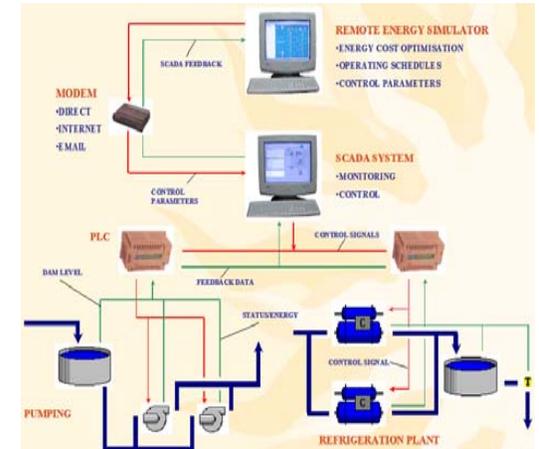
Intent: Eliminate after hours lighting waste

# Mandatory: Automatic Shutoff

Compliance options:

1. Control lights on a scheduled basis (automatic time switch)
  - Time-of-day controller
  - Controls  $\leq 25,000$  ft<sup>2</sup> and not more than one floor
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

**NOTE:** earlier versions include faulty “occupant intervention” phrase



# Application of Automatic Shutoff

Intent is to apply to business entities or structures where whole building control is practical

Example application:

- Strip mall – individual business unit

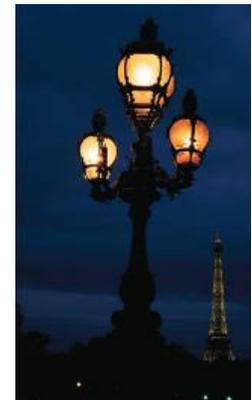


# Mandatory: Exterior Lighting Control

- For dusk-to-dawn lighting: astronomical time switch or photosensor
- For all other: astronomical time switch **OR photosensor + time switch [REVISED!]**
- All time switches must have 10 hour battery backup
- Exceptions:
  - Covered vehicle entrances
  - Exits from buildings or parking structures  
(where required for safety, security, or eye adaptation)



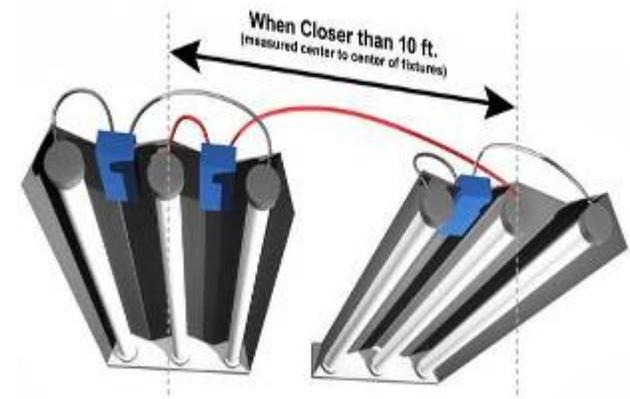
Intent: Eliminate exterior lighting left on during the day



# Mandatory: Tandem Wiring/Exit Signs

- Tandem wiring: eliminate use of single lamp, low-frequency ballast where possible

Intent: Eliminate use of low-frequency ballasts driving single lamps



- Exit signs: limited to 5 watts per face maximum



# Prescriptive: Interior Lighting Power

- Prescriptive Option
  - Whole Building or Space-by-space method
  - Compare actual **Installed Power** (wattage) to **Lighting Power Allowance** (lighting power density LPD) limits
  - Additional power allowances and exemptions available
  
- A few words about the Performance Option “Energy Cost Budget”
  - Whole building energy use modeling
  - Compare prescriptively compliant base building with proposed building
  - Can provide flexibility but requires detailed modeling inputs



Intent: Eliminate waste by promoting thoughtful design and application

# Prescriptive: Determine Installed Power

- Calculate installed lighting wattage for all interior lighted space(s)
- Include all permanent and portable interior lighting designed for general, ambient, or task illumination
  - Exception: for 2 or more mutually exclusive lighting systems only count the system with highest wattage



# Prescriptive: Determine Installed Power

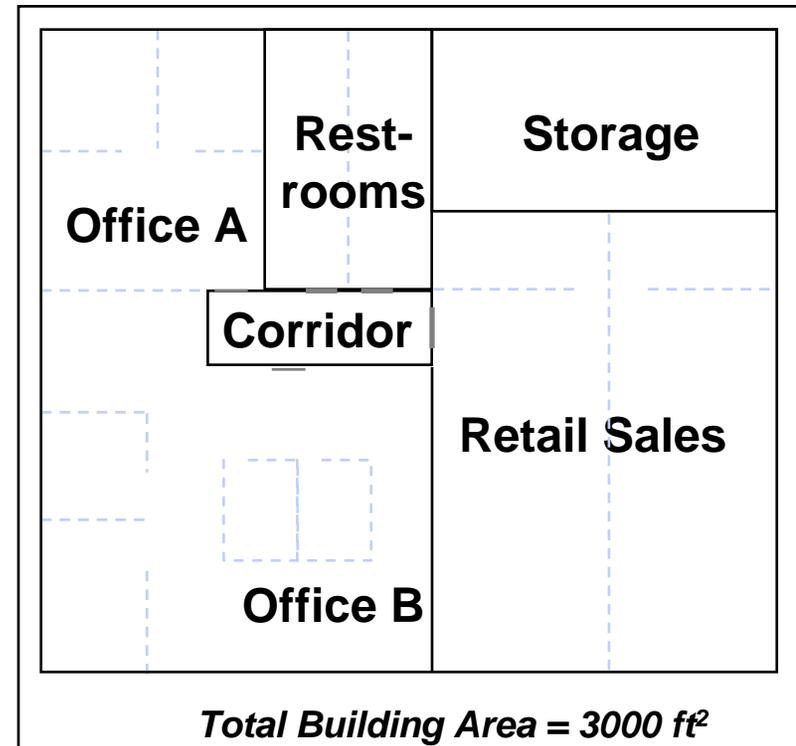
- Wattage “Calculation Rules”
  - Standard incandescent = maximum labeled wattage of the luminaire
  - Luminaires with ballasts or transformers = wattage of the maximum lamp/ballast combination – not just nominal lamp wattage!  
**OR the maximum labeled wattage of the luminaire [NEW!]**
  - Line voltage track = actual wattage with minimum 30 W per foot  
**OR the wattage limit of the system’s circuit breaker [NEW!]**  
**OR the wattage limit of other permanent current limiting device(s) on the system [NEW!]**
  - Low voltage track = transformer wattage
  - All others as specified on equipment

# Prescriptive: Wattage Exemptions

- Lighting for the following can be excluded:
  - Theatrical, stage, film, and video production
  - Used only during medical and dental procedures
  - Display/accent in exhibits/displays for museums, monuments, and galleries
  - Plant growth or maintenance
  - Integral to equipment or instrumentation installed by manufacturer
  - Integral to both open and glass-enclosed refrigerator and freezer cases
  - Food warming and food prep equipment
  - In retail display windows when the display is enclosed by ceiling-height partitions
  - **Lighting in spaces specifically designed for use by occupants with special lighting needs including visual impairment and other medical and age related issues. [REVISED!]**
  - In spaces specifically designated as registered interior historic landmarks
  - Integral part of advertising or directional signage
  - Exit signs
  - Sale or lighting educational demonstration systems
  - For television broadcasting of sporting activities
  - Casino gaming areas
  - **Furniture-mounted supplemental task lighting controlled by automatic shutoff – [NEW!]**

# Prescriptive: Lighting Power Allowance

- Choose appropriate Lighting Power Density (LPD)
  - Whole Building Path
    - Easier
    - Less flexibility
  - Space-by-Space Path
    - More math
    - Often higher potential total allowance
- Multiply LPD by square footage
  - Whole building LPD times total building area
  - Space-by-space LPD times space area(s) and sum values



# Space LPDs

90.1-2007 Space type  
LPD sample



| 90.1-2007 Space Type (LPD) Allowance - Partial List |                                 |            |
|---|---------------------------------|------------|
| Building Type                                       | Space Type description          | Watts/sqft |
| Common Space Type                                   | Corridor/Transition             | 0.5        |
| Common Space Type                                   | Classroom/Lecture/Training      | 1.4        |
| Common Space Type                                   | Electrical/Mechanical           | 1.4        |
| Common Space Type                                   | Dining Area                     | 0.9        |
| Common Space Type                                   | Food Preparation                | 1.2        |
| Common Space Type                                   | Lounge/Recreation               | 1.2        |
| Common Space Type                                   | Stairs - Inactive               | 0.4        |
| Common Space Type                                   | Stairway                        | 0.6        |
| Common Space Type                                   | Restrooms                       | 0.9        |
| Common Space Type                                   | Lobby                           | 1.3        |
| Common Space Type                                   | Atrium - first three floors     | 0.6        |
| Common Space Type                                   | Atrium - each additional floor  | 0.2        |
| Common Space Type                                   | Office - enclosed               | 1.1        |
| Common Space Type                                   | Office - open plan              | 1.1        |
| Common Space Type                                   | Conference Meeting/Multipurpose | 1.3        |
| Common Space Type                                   | Inactive storage                | 0.3        |
| Common Space Type                                   | Active storage                  | 0.8        |
| Auditorium  | Lobby                           | 1.0        |
| Convention Center                                   | Exhibit space                   | 1.3        |
| Court House   | Courtroom                       | 1.9        |
| Exercise Center                                     | Dressing/Locker/Fitting Room    | 0.6        |
| Hospital/Healthcare                                 | Exam/Treatment                  | 1.5        |
| Hospital/Healthcare                                 | Emergency                       | 2.7        |
| Hospital/Healthcare                                 | Recovery                        | 0.8        |
| Library   | Stacks                          | 1.7        |
| Library   | Reading Area                    | 1.2        |
| Manufacturing Facility                              | General Low Bay                 | 1.2        |
| Manufacturing Facility                              | General High Bay                | 1.7        |
| Museum  | General exhibition              | 1.0        |
| Parking Garage                                      | Parking Area - Pedestrian       | 0.2        |
| Performing Arts Theatre                             | Audience/Seating Area           | 2.6        |
| Police/Fire Station                                 | Fire Station Engine room        | 0.7        |
| Post Office   | Sorting Area                    | 1.2        |
| Transportation                                      | Airport - Concourse             | 0.6        |
| Transportation                                      | Terminal - Ticket counter       | 1.5        |

# Whole Building LPDs

90.1-2007 whole building LPD values as shown



| 90.1-2007 Whole Building (LPD) Allowance |                       |
|--|-----------------------|
| Building Type                            | Watts per Square Foot |
| RETAIL                                   | 1.5                   |
| OFFICE                                   | 1                     |
| POST OFFICE                              | 1.1                   |
| DINING: BAR LOUNGE/LEISURE               | 1.3                   |
| CONVENTION CENTER                        | 1.2                   |
| MUSEUM                                   | 1.1                   |
| PARKING GARAGE                           | 0.3                   |
| COURTHOUSE                               | 1.2                   |
| POLICE STATIONS                          | 1                     |
| HEALTHCARE/CLINIC                        | 1                     |
| HOSPITAL                                 | 1.2                   |
| MANUFACTURING                            | 1.3                   |
| PERFORMING ARTS THEATER                  | 1.6                   |
| SCHOOL/UNIVERSITY                        | 1.2                   |
| TOWN HALL                                | 1.1                   |
| PENITENTIARY                             | 1                     |
| TRANSPORTATION                           | 1                     |
| WORKSHOP                                 | 1.4                   |
| FIRE STATIONS                            | 1                     |
| LIBRARY                                  | 1.3                   |
| HOTEL                                    | 1                     |
| MOTEL                                    | 1                     |
| MOTION PICTURE THEATRE                   | 1.2                   |
| DINING: CAFETERIA/FAST FOOD              | 1.4                   |
| DORMITORY                                | 1                     |
| MULTI-FAMILY                             | 0.7                   |
| EXERCISE CENTER                          | 1                     |
| SPORTS ARENA                             | 1.1                   |
| DINING: FAMILY                           | 1.6                   |
| GYMNASIUM                                | 1.1                   |
| AUTOMOTIVE FACILITY                      | 0.9                   |
| RELIGIOUS BUILDINGS                      | 1.3                   |
| WAREHOUSE                                | 0.8                   |

# How Were the Space Type LPDs Developed?

- Developed within the ANSI/ASHRAE/IESNA 90.1 Lighting subcommittee with IESNA committee support
- Similar general process for 90.1-1999, 2001, 2004, 2007
- Apply:
  - Current lighting product performance data
  - Current lamp/ballast efficacy and light loss factors
  - Latest IESNA recommended light levels
  - Professional consensus of quality lighted environments
- Combine these elements into building space models to calculate lighting power densities

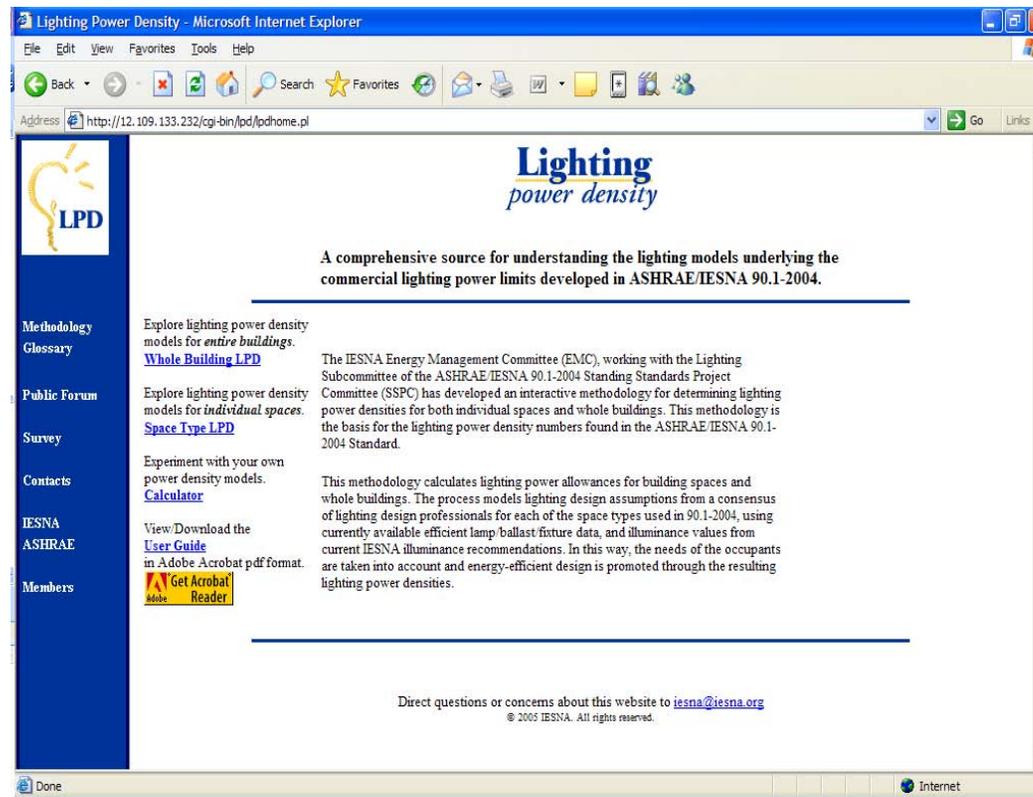
# ...and Whole Building LPDs?

- Develop detailed space-by-space data for commercial buildings
  - Source: DODGE Construction data plans sets - best available current, multiple commercial building data
  - Perform space type area takeoffs for detailed square footage by space type for “typical” buildings
  - Current set at 246 buildings for 31 building types
- Assign applicable space type model LPD for each space
- Calculate whole building LPD



# Process Detail Available at IESNA

- Interactive version of the process is available at IESNA at:
  - <http://12.109.133.232/cgi-bin/lpd/lpdhome.pl>



# Prescriptive: Additional Lighting Power

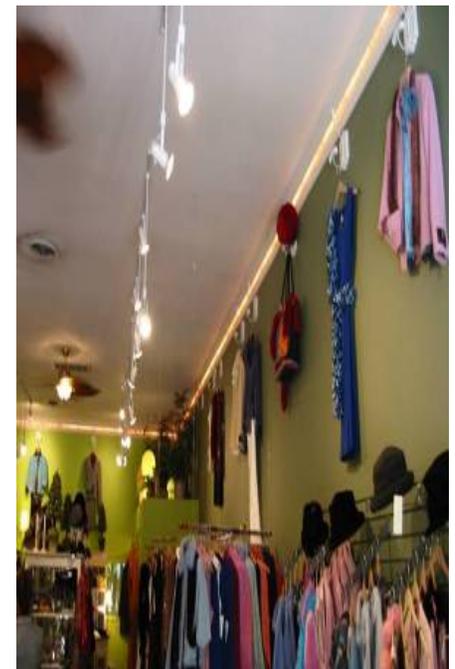
- Additional power allowed for design flexibility and specific needs
- These are use-it-or-lose-it allowances
- They must be used only for specific designed use and not for general illumination
- Should be separately switched from other general lighting



# Prescriptive: Additional Lighting Power

Additional lighting power allowed for specific applications must be **automatically controlled, separately from the general lighting, to be turned off during non-business hours [REVISED!]**:

- Decorative luminaires in addition to the general lighting at 1.0 W/ft<sup>2</sup>
- Use of specific luminaires designed to eliminate computer screen glare at 0.35 W/ft<sup>2</sup>
- **Retail Display Lighting**



# Retail Display Lighting [REVISED!]

Additional Interior Lighting Power Allowance = 1000 watts +  
(Retail Area 1 x 1.0 W/ft<sup>2</sup>) +  
(Retail Area 2 x 1.7 W/ft<sup>2</sup>) +  
(Retail Area 3 x 2.6 W/ft<sup>2</sup>) +  
(Retail Area 4 x 4.2 W/ft<sup>2</sup>),

## Where:

Retail Area 1 = the floor area for all products not listed in Retail Area 2, 3 or 4.

Retail Area 2 = the floor area used for the sale of vehicles, sporting goods and small electronics.

Retail Area 3 = the floor area used for the sale of furniture, clothing, cosmetics and artwork.

Retail Area 4 = the floor area used for the sale of jewelry, crystal, and china.

Exception: Other merchandise categories may be included in Retail Areas 2 through 4 above, provided that justification documenting the need for additional lighting power based on visual inspection, contrast, or other critical display is approved by the authority having jurisdiction.

# Exterior Lighting Power

- Building grounds lighting luminaires over 100 watts must have lamp efficacy of at least 60 lumen/Watt
- Exterior Building Lighting Power must meet prescribed wattage limits. Exterior applications divided into 2 categories:

**Tradable:** allowed wattage may be traded among these applications

**Non-Tradable:** allowed wattage **cannot** be traded between surfaces or with other exterior lighting



# Exterior Lighting Power

- The total exterior lighting power allowance is the sum of the individual lighting power densities [LPD]....
- ....plus an additional unrestricted allowance of 5% of that sum. Trade-offs are allowed only among “Tradable Surfaces” applications.
- Some exemptions apply



# Exterior LPDs: 90.1-2007

| Applications  | Lighting Power Densities     |
|---|------------------------------|
| <p><b>Tradable Surfaces</b><br/>           (Lighting Power Densities for open parking areas, building grounds, building entrances and exits, canopies and overhangs, and outdoor sales areas may be traded)</p> |                              |
| <p><b>Uncovered Parking Areas</b></p>   |                              |
| <p>Parking lots and drives</p>  | <p>0.15 W/ft<sup>2</sup></p> |
| <p><b>Building Grounds</b></p>  |                              |
| <p>Walkways less than 10 feet wide</p>  | <p>1.0 W/linear foot</p>     |
| <p>Walkways 10 feet wide or greater, Plaza areas and Special feature areas</p>  | <p>0.2 W/ft<sup>2</sup></p>  |
| <p>Stairways</p>  | <p>1.0 W/ft<sup>2</sup></p>  |

# Exterior LPDs: 90.1-2007

| Applications  | Lighting Power Densities       |
|---|--------------------------------|
| <b>More Tradable Surfaces...</b>  |                                |
| <b>Building Entrances and Exits</b>   |                                |
| Main entries  | 30 W/linear foot of door width |
| Other doors   | 20 W/linear foot of door width |
| <b>Canopies and Overhangs</b>   |                                |
| Canopies (free standing & attached) and overhangs                           | 1.25 W/ft <sup>2</sup>         |
| <b>Outdoor Sales</b>  |                                |
| Open areas (including vehicle sales lots)                                   | 0.5 W/ft <sup>2</sup>          |
| Street frontage for vehicle sales lots in addition to “open area” allowance | 20 W/linear foot               |

# Exterior LPDs: 90.1-2007

| Applications   | Lighting Power Densities   |
|--|--|
| <b>Non-Tradable Surfaces</b> (Lighting Power Density calculations for the following applications can only be used 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 <sup>2</sup> for each illuminated wall or surface or 5.0 W/linear foot for each illuminated wall or surface length      |
| Automated teller machines & night depositories   | 270 W per location plus 90 watts per additional ATM per location   |
| Entrances and gatehouse inspection stations at guarded facilities  | 1.25 W/ft <sup>2</sup> of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces) |

# Exterior LPDs: 90.1-2007

| Applications  | Lighting Power Densities  |
|---|---|
| <b>Non-Tradable Surfaces</b>  |   |
| Loading areas for law enforcement, fire, ambulance and other emergency service vehicles | 0.5 W/ft <sup>2</sup> of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces) |
| Drive-up windows at fast food restaurants   | 400 W per drive through   |
| Parking near 24-hour retail entrances   | 800 W per main entry  |

# Exterior Lighting Power Exemptions

- The following are exempt when equipped with separate control:
  - Specialized signal, directional, and marker lighting associated with transportation;
  - Lighting that is integral to advertising signage or directional signage;
  - Lighting that is integral to equipment or instrumentation and is installed by its manufacturer;
  - Lighting for theatrical purposes, including performance, stage, film, 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.

# More Information?

- More information on Standard 90.1-2007, the Users Manual, and more detailed training opportunities available from:



[www.ashrae.org](http://www.ashrae.org)



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[www.iesna.org](http://www.iesna.org)

- More information on the standard and compliance tools available from:



[www.energycodes.gov](http://www.energycodes.gov)

# Questions

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- If we don't respond to your question live, you will get a response via email later
- If you want to submit a question later, just send us an email at [techsupport@becp.pnl.gov](mailto:techsupport@becp.pnl.gov)