

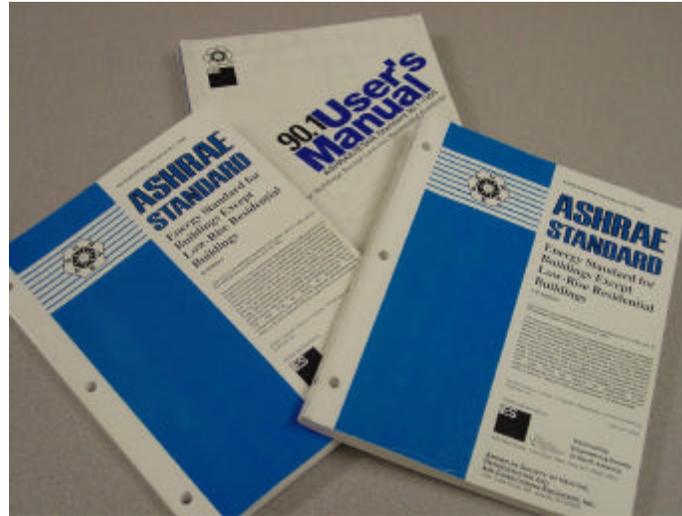
ASHRAE/IESNA Standard 90.1-1999

# Lighting Requirements

**Joseph G. Howley Jr., IESNA**  
GE Lighting

Immediate Past Chair of ASHRAE  
SSPC 90.1 Lighting Subcommittee

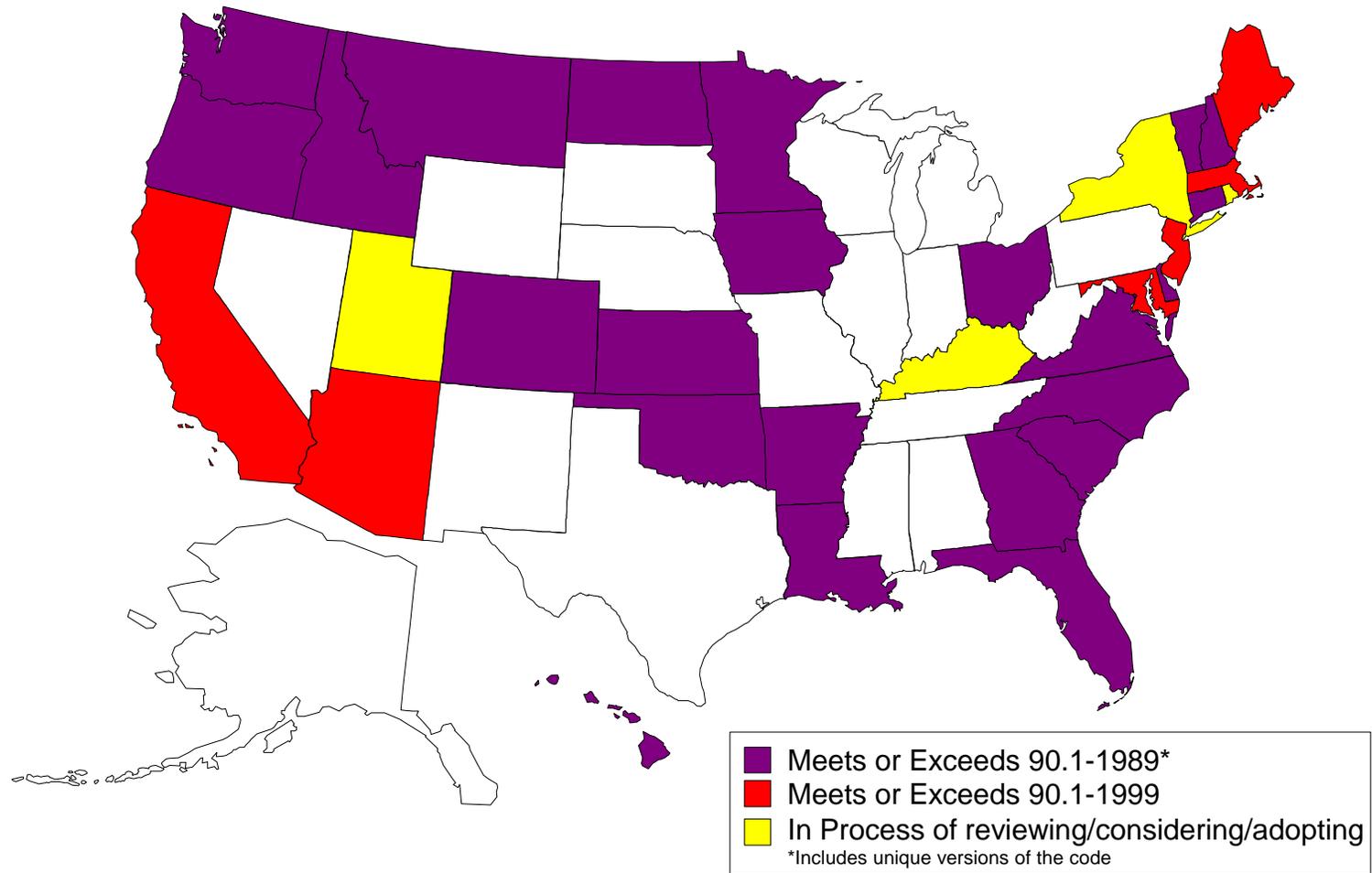
# How to Get the Standard



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<http://xp10.ashrae.org/bookstore/section.html> or call  
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# Status of State Adoption

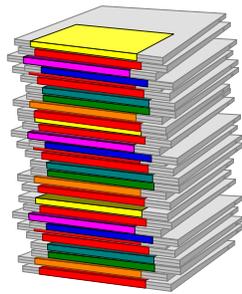


# Section 9 - Lighting

- 1989 vs. 1999 Comparison
- Existing Buildings
- Overview of 1999 Standard
  - Interior Lighting Requirements
    - Whole Building Compliance Approach
    - Space-by-Space Compliance Approach
  - Exterior Lighting Requirements
- Addenda

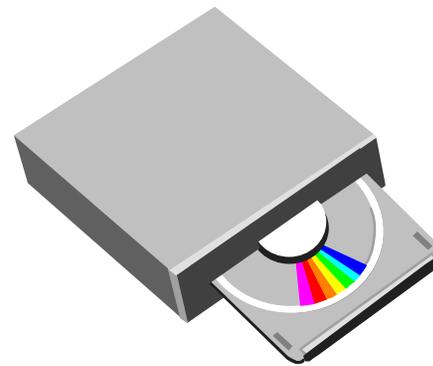


# Lighting Section Comparison



1989

vs.



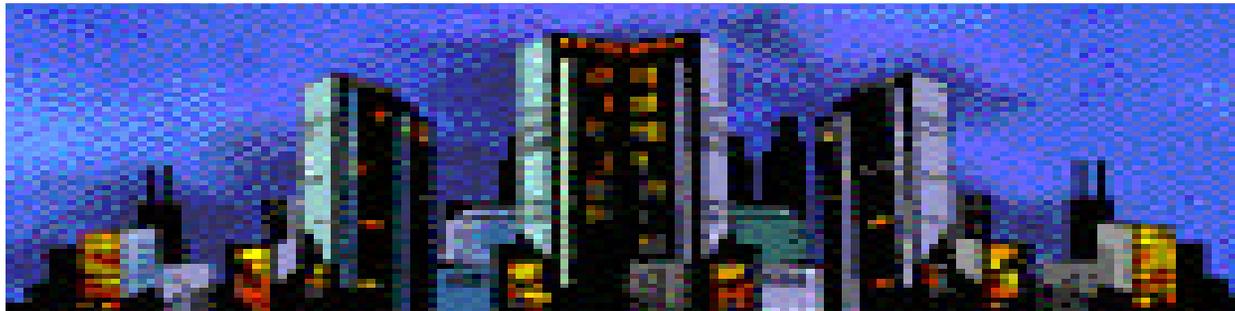
1999

# 1989 vs. 1999

- Lighting control credits eliminated
  - Credits for installing automatic control devices replaced with mandatory control requirements
- Control points for spaces are no longer used
  - Spaces no longer require a certain number of control points
- Building area power allowances (W/ft<sup>2</sup>) no longer depend on the size of the buildings
- Area factor, a function of ceiling height and floor area, is no longer calculated

## 1989 vs. 1999 (cont'd)

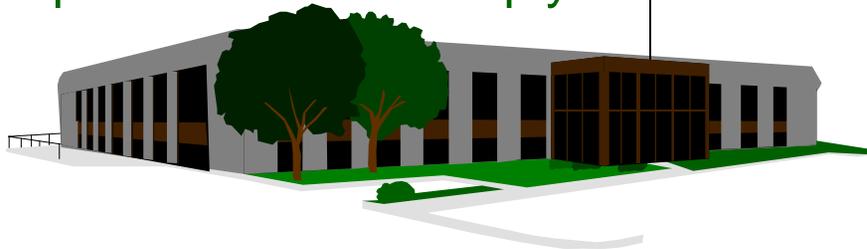
- Exterior lighting power requirements are simplified
  - Most replaced with minimum efficacy (lumens/watt) for outdoor lighting fixtures



- More Stringent Lighting power requirements
  - Requirements based on real lighting models

# Lighting Alterations to Existing Buildings

- Replacement lighting systems space comply with the lighting power density requirements of Section 9 applicable to that space
- Any new control devices as a direct replacement of existing control devices shall control of max. square footage as specified in Section 9 and be readily accessible (auto shutoff not required)
- Exception:
  - Alterations that replace less than 50% of the luminaires in a space need not comply with these requirements

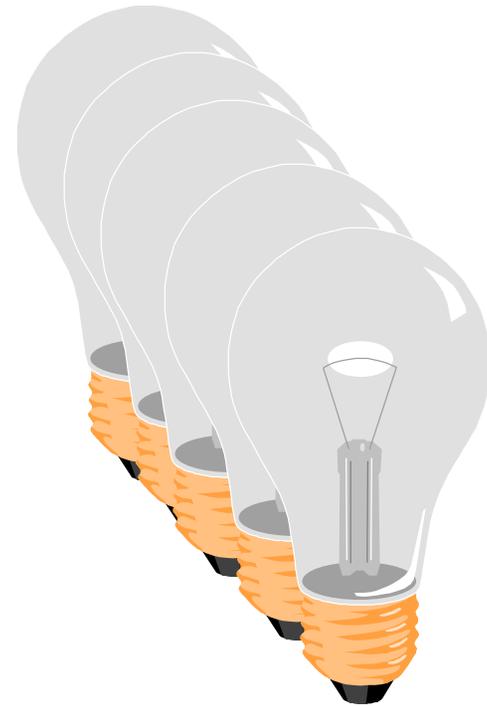


# 90.1–1999 Lighting Section Review



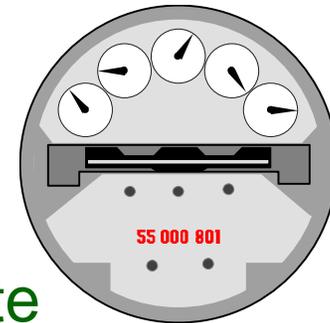
# Section 9 - Lighting

- General Application 9.1
- Mandatory Provisions 9.2
- Prescriptive Path 9.3



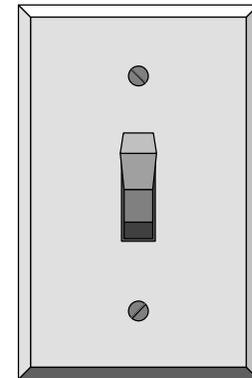
# 9.1 Lighting General Application

- Interior spaces of buildings
- Exterior building features
- Exterior grounds lighting powered through building
- Exceptions
  - Emergency lighting
  - Lighting required by life safety statute
  - Lighting within living units of buildings
  - Decorative gas lighting



## Space Control – 9.2.1.2

- Control devices can't control more than
  - 2,500 ft<sup>2</sup> in spaces < 10,000 ft<sup>2</sup>
  - 10,000 ft<sup>2</sup> in spaces > 10,000 ft<sup>2</sup>
- Control must be readily accessible and located so occupants can see the controlled lighting
  - Except for safety or security
- At least one for each room or space enclosed by ceiling-height partitions



# Lighting Control – 9.2.1

- Automatic lighting shutoff
  - Applies to buildings  $> 5,000 \text{ ft}^2$ 
    - Time-scheduling devices
    - Occupant-sensing devices



## Exterior Lighting Control – 9.2.1.3

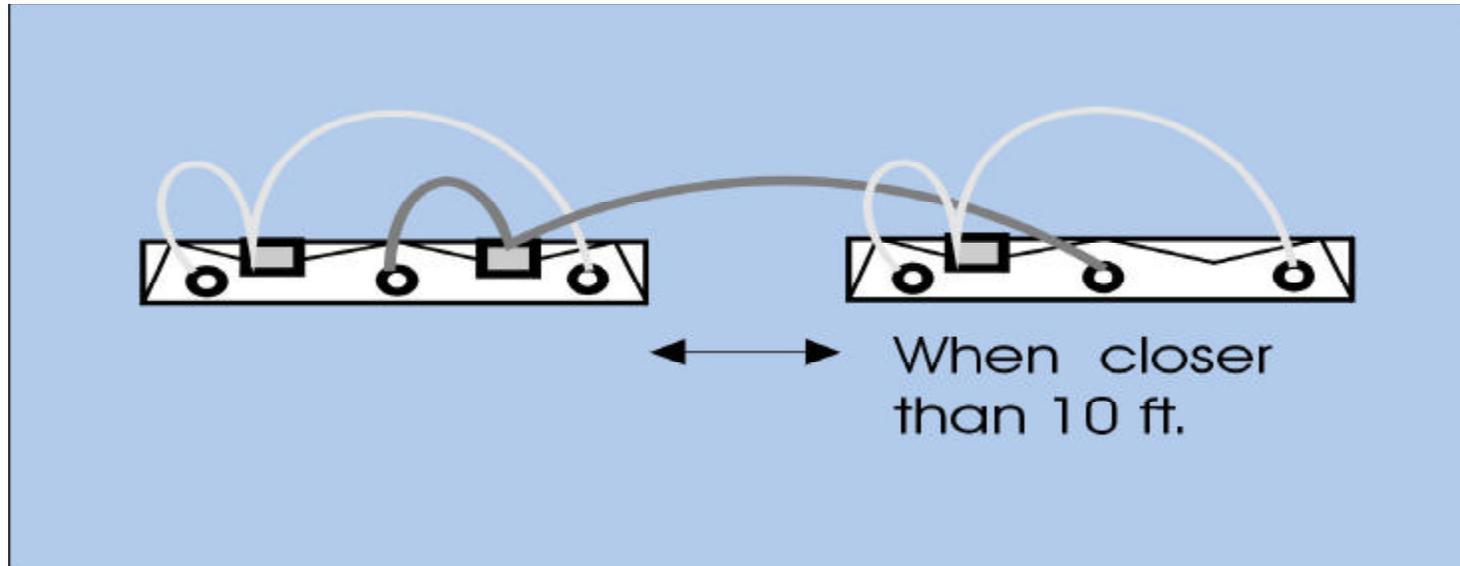
- Photocells or astronomical time switch required
- Seven-day electrically-driven, mechanical clocks with trippers, astronomical dial, and four-hour spring-wound storage
- Seven-day or calendar year, electronic programmable time switches with astronomic correction and battery backup
- Any of the timers above with a photocell (in place of astronomical correction)
- Exceptions



## Additional Control – 9.2.1.4

- Many special lighting applications must be controlled separately
  - Display/accent lighting
  - Case lighting
  - Hotel/motel guest room lighting
  - Task lighting
  - Nonvisual lighting
  - Demonstration lighting

# Tandem Wiring – 9.2.2



# Tandem Wiring Exceptions

- Separated surface or pendant luminaires
- Recessed luminaires more than 10 ft apart
- Other luminaires
  - With three-lamp ballasts
  - On emergency lighting circuits
  - With no available pair
  - With one lamp, high frequency, electronic ballast

## Exit Signs – 9.2.3



- Exit signs operating at  $> 20$  W must have a source efficacy  $> 35$  Lumens
- LED lamps okay
- CF lamps with electronic ballasts usually okay
- Majority of incandescent lamps not okay

# Efficacy

- The ratio of light output to watts input
  - lumens per watt
- The higher the efficacy, the more efficient the light source
  - 40 watt incandescent = 495 lumens
  - 40 watt fluorescent = 3,150 lumens

# Installed Interior Lighting Power – 9.2.4

- Includes all permanent and portable interior lighting intended for general, ambient, or task illumination
- Includes lamp, power used by ballast, the control (when applicable), current regulators, and any other lighting power draws
- Exception

# Luminaire Wattage – 9.2.5

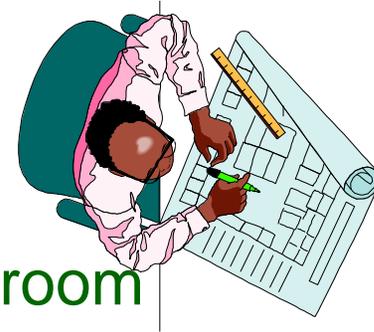


- Standard incandescent = max. labeled wattage of the luminaire
- Luminaires with ballasts = wattage of the lamp/ballast combination
- Line voltage track = min. 30 W per foot
- Low voltage track = transformer wattage
- All others as specified

# Lighting Power Allowance Exemptions

- Theatrical, stage, film, and video production
- Medical and dental procedures
- Monuments, Museum and Gallery Exhibits
- Plant growth or maintenance
- Equipment lighting or instrumentation installed by manufacturer
- Refrigerator and Freezer cases
- Retail display windows
- Registered Historic Landmarks
- Advertising or directional signage
- Exit signs
- Sale or lighting educational demonstration systems
- Athletic playing areas with permanent facilities for TV broadcasting
- Casino gaming areas
- For use in areas specifically designed for the visually impaired

# Example #1



Calculate the total lighting wattage of a room containing the following fixtures:

- A. Eight 2'-4' Fluorescent Fixtures
  - Three 4' fluorescent T8 lamps per fixture, 32 Watts
  - One three-lamp electronic ballast
  - Ballast Input Wattage – 90 Watts
- B. Six Incandescent Downlights
  - Specified Lamps – 60 Watt, A-line, Medium Screw Base
  - Maximum labeled wattage of fixture – 75 Watts
- C. 16 Feet of Line Voltage Track
  - Specified – 5 Track Heads
  - 90 Watts Halogen PAR38 Lamps

# Solution #1: Total Lighting Wattage Calculation

## Wrong Way!

|   |   |             |
|---|---|-------------|
| 8 Fixtures x 3 Lamps x 32 Watts per Lamp  | = | 768 Watts   |
| 6 Downlights x 60 Watts/A-line lamp       | = | 360 Watts   |
| 5 Track Heads x 90 Watts/Halogen Par Lamp | = | 450 Watts   |
|   |   | <hr/>       |
| Total Wattage                             | = | 1,578 Watts |

## Right Way!

|   |   |             |
|---|---|-------------|
| 8 Fixtures x 90 Ballast Input Watts           | = | 720 Watts   |
| 6 Downlights x 75 Watt Labeled A-line Fixture | = | 450 Watts   |
| 16' Track x 30 Watts/Foot                     | = | 480 Watts   |
|   |   | <hr/>       |
| Total Wattage                                 | = | 1,650 Watts |

# Two Compliance Paths



# Building Area Method – 9.3.1.1

- Used for projects involving
  - An entire building
  - A single, independent, and separate occupancy in a multi-occupancy building
- Most Building Types listed
  - “Selection of a reasonably equivalent type” is permitted
- Gross lighted area is multiplied by allowance from Table 9.3.1.1

# Gross Lighted Area

- Sum of total lighted area of a building
  - Measured from the exterior faces of the exterior walls or from the centerline of walls separating buildings
- Used in the building area method of determining interior lighting power allowance

## Lighting Power Densities - 9.3.1.1

- Building space models were developed to calculate power densities limits using:
  - Current product performance data
  - Updated efficacy and loss factors
  - New building construction data
  - IES-recommended light levels
  - Professional lighting design consensus

# Building Area Method Lighting Power Densities – 9.3.1.1



|                |                         |
|----------------|-------------------------|
| Hospital       | - 1.6 W/ft <sup>2</sup> |
| Library        | - 1.5 W/ft <sup>2</sup> |
| Manufacturing  | - 2.2 W/ft <sup>2</sup> |
| Museum         | - 1.6 W/ft <sup>2</sup> |
| Office         | - 1.3 W/ft <sup>2</sup> |
| Parking Garage | - 0.3 W/ft <sup>2</sup> |
| Retail         | - 1.9 W/ft <sup>2</sup> |
| School         | - 1.5 W/ft <sup>2</sup> |

## Example #2

Calculate Total Lighting Power Allowance  
using the Building Area Method:

### A. An Office Building

- Six floors
- Outside Dimensions 200' x 350'
- Office Building Power Allowance = 1.3 Watts/ft<sup>2</sup>



### **Solution #2**

†  $200' \times 350' = 70,000 \text{ ft}^2$  per floor

†  $6 \text{ Floors} \times 70,000 \text{ ft}^2 \text{ per floor} = 420,000 \text{ ft}^2$

†  $420,000 \text{ ft}^2 \times 1.3 \text{ watts per ft}^2 = 546,000 \text{ watts}$

† **Total Lighting Power Allowance = 546 kilowatts**

# Space-to-Space Method – 9.3.1.2

- Identify different building types in your project
- Divide gross lighted area of the building into each of the space types
- Calculate lighting power allowance
- Sum all the allowances
- Advantages
  - More flexible
  - Applicable to all building types

# Space-to-Space Method – 9.3.1.2

| Building Type   | Common Space Types and LPDs (watts/ft <sup>2</sup> ) |                   |                                   |                               |                        |       |                            |                                |                   |             |                  |           |                     |                 |                |                  | Building Specific Space Types and LPD's (watts/ft <sup>2</sup> ) |               |                        |     |
|-----------------|--|-------------------|-----------------------------------|-------------------------------|------------------------|-------|----------------------------|--------------------------------|-------------------|-------------|------------------|-----------|---------------------|-----------------|----------------|------------------|--|---------------|------------------------|-----|
|                 | Office--enclosed                                     | Office--open plan | Conference Meeting / Multipurpose | Class room/ Lecture/ Training | Audience/ Seating Area | Lobby | Atrium--first three floors | Atrium-- each additional floor | Lounge/Recreation | Dining area | Food Preparation | Restrooms | Corridor/Transition | Stairs - active | Active Storage | Inactive storage |  |               | Electrical/ mechanical |     |
| GYMNASIUM       | 1.5  | 1.3               | 1.5                               |                               | 0.5                    | 1.8   | 1.3                        | 0.2                            | 1.4               | 1.4         | 2.2              | 1.0       | 0.7                 | 0.9             | 1.1            | 0.3              | 1.3  | Playing Area  | 1.9                    |     |
|                 |  |                   |                                   |                               |                        |       |                            |                                |                   |             |                  |           |                     |                 |                |                  |  | Dressing Room | 0.8                    |     |
|                 |  |                   |                                   |                               |                        |       |                            |                                |                   |             |                  |           |                     |                 |                |                  |  |               | Exercise Area          | 1.1 |
| EXERCISE CENTER | 1.5  | 1.3               | 1.5                               |                               | 0.5                    | 1.8   | 1.3                        | 0.2                            | 1.4               | 1.4         | 2.2              | 1.0       | 0.7                 | 0.9             | 1.1            | 0.3              | 1.3  | Exercise Area | 1.1                    |     |
|                 |  |                   |                                   |                               |                        |       |                            |                                |                   |             |                  |           |                     |                 |                |                  |  |               | Dressing Room          | 0.8 |
| COURTHOUSE      | 1.5  | 1.3               | 1.5                               | 1.6                           | 1.6                    | 1.8   | 1.3                        | 0.2                            | 1.4               | 1.4         | 2.2              | 1.0       | 0.7                 | 0.9             | 1.1            | 0.3              | 1.3  | Courtroom     | 2.1                    |     |
|                 |  |                   |                                   |                               |                        |       |                            |                                |                   |             |                  |           |                     |                 |                |                  |  |               | Confinement Cells      |     |
|                 |  |                   |                                   |                               |                        |       |                            |                                |                   |             |                  |           |                     |                 |                |                  |  |               | Judges Chamber         |     |
| Police Station  |  |                   |                                   |                               |                        |       |                            |                                |                   |             |                  |           |                     |                 |                |                  |  |               | Police Station         |     |

# Additional Interior Lighting Power – 9.3.1.2

- Decorative luminaires -
  - 1.0 W/ft<sup>2</sup> in space where used
- Use of fluorescent luminaires designed to eliminate computer screen glare (Defined by IES RP1 requirements.) - 0.35 W/ft<sup>2</sup>
- Accent Lighting
  - Additional 1.6 W/ft<sup>2</sup>, or
  - Additional 3.9 W/ft<sup>2</sup> for fine merchandise



## Example #3

Calculate Total Lighting Power Allowance  
using the Space by Space Method:

### A. A Retail Building:

- 5,000 ft<sup>2</sup> of Sales Area – General Accent Lighting
- 1,000 ft<sup>2</sup> of Active Storage Area
- Three Enclosed Office – 200 ft<sup>2</sup> each
- One Conference Room – 400 ft<sup>2</sup>
- Two Rest Rooms – 150 ft<sup>2</sup> each
- Corridors – 6' wide x 25' long



# Solution - Step #1

## Identify the Watts per Square Foot Allowed for Each Space

### A. A Retail Building:

- Sales Area - 2.1 W/ft<sup>2</sup>
  - Additional Power Allowance
    - ✍ Accent Lighting - 1.6 W/ft<sup>2</sup>
- Active Storage Area - 1.1 W/ft<sup>2</sup>
- Enclosed Offices - 1.5 W/ft<sup>2</sup>
- Conference Room - 1.5 W/ft<sup>2</sup>
- Rest Rooms - 1.0 W/ft<sup>2</sup>
- Corridors - 0.7 W/ft<sup>2</sup>



## Solution - Step #2

Multiply W/ft<sup>2</sup> allowance by the area of each space. Add to calculate total power allowance

### A. A Retail Building:

$$\text{Sales: } 2.1 \text{ W/ft}^2 \times 5000 \text{ ft}^2 = 10,500 \text{ Watts}$$

$$\text{Active Storage Area: } 1.1 \text{ W/ft}^2 \times 1000 \text{ ft}^2 = 1,100 \text{ Watts}$$

$$\text{Enclosed Offices: } 1.5 \text{ W/ft}^2 \times (3) 200 \text{ ft}^2 = 900 \text{ Watts}$$

$$\text{Conference Room: } 1.5 \text{ W/ft}^2 \times 400 \text{ ft}^2 = 600 \text{ Watts}$$

$$\text{Rest Rooms: } 1.0 \text{ W/ft}^2 \times (2) 150 \text{ ft}^2 = 300 \text{ Watts}$$

$$\text{Corridors: } 0.7 \text{ W/ft}^2 \times 6' \times 25' = 105 \text{ Watts}$$

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$$\text{TOTAL POWER ALLOWANCE} = 13,505 \text{ WATTS}$$

### B. Additional Power Allowance - Accent Lighting Only

$$1.6 \text{ W/ft}^2 \times 5000 \text{ ft}^2 = 8,000 \text{ WATTS}$$

# The Great Outdoors



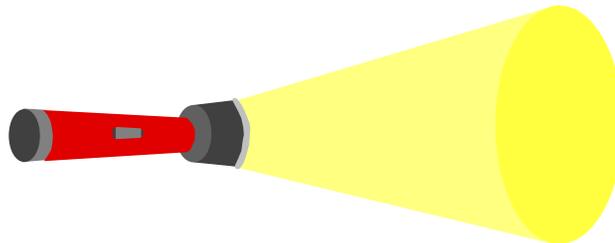
# Exterior Building Grounds Lighting – 9.2.6

- Luminaires that operate at  $> 100$  W must use a lamp with a source efficacy  $> 60$  lumens/W
- Exceptions
  - Traffic signals
  - Lighting within outdoor signs
  - Lighting used to illuminate public monuments or registered historic landmarks
  - If a motion sensor controls the lighting application



# Exterior Building Lighting Power – 9.3.2

- Sum of all lighting power allowances for applicable exterior applications
  - Building Entrance w/canopy -  $3\text{W}/\text{ft}^2$
  - Building Entrance -  $33\text{ W}/\text{linear ft.}$
  - Building Exit -  $20\text{ W}/\text{linear ft.}$
  - Building Facades -  $0.25\text{ W}/\text{ft}^2$



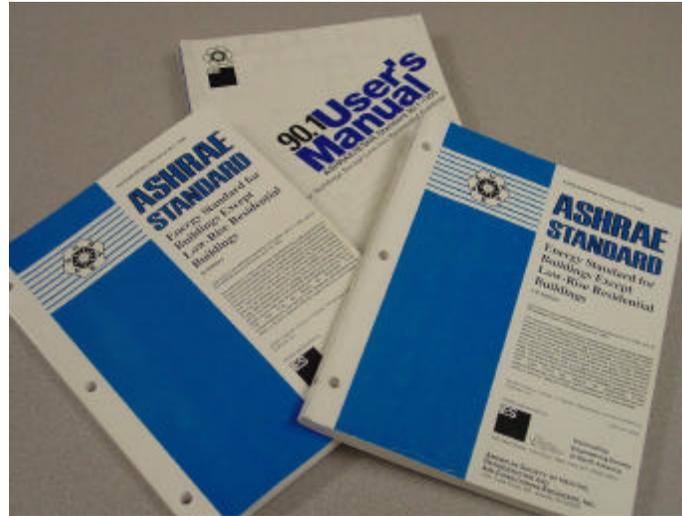
# Recent Addendum to Lighting Section

- Automatic lighting control shut-off required for buildings > 5,000 ft<sup>2</sup>, allowed to function in the following ways:
  - Scheduled basis
  - Occupancy sensor basis
  - Using a signal from another control or alarm system that indicating the area is unoccupied
  - Occupant override basis

# Questions?



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