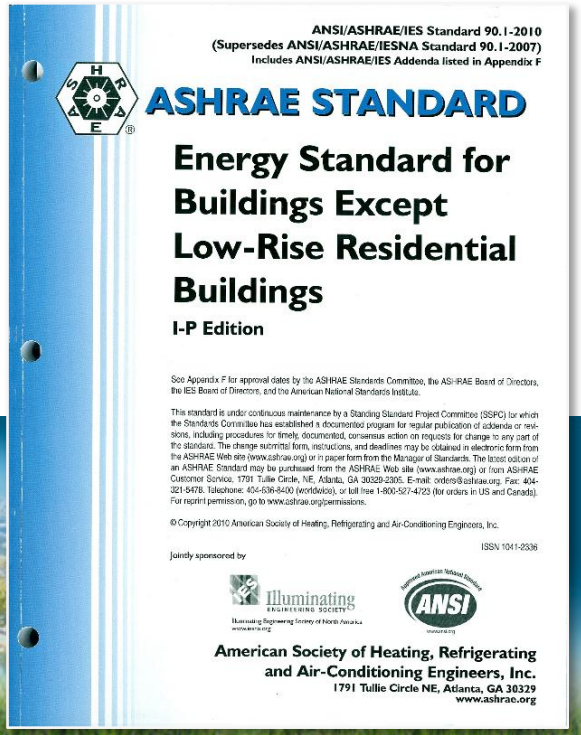
ANSI / ASHRAE / IESNA Standard 90.1 – 2010

Part 5 - Lighting Provisions (Section 9)



Presented by

Energy Systems Laboratory
Texas Engineering Experiment Station
The Texas A&M University System

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Acknowledgments

Thanks to:

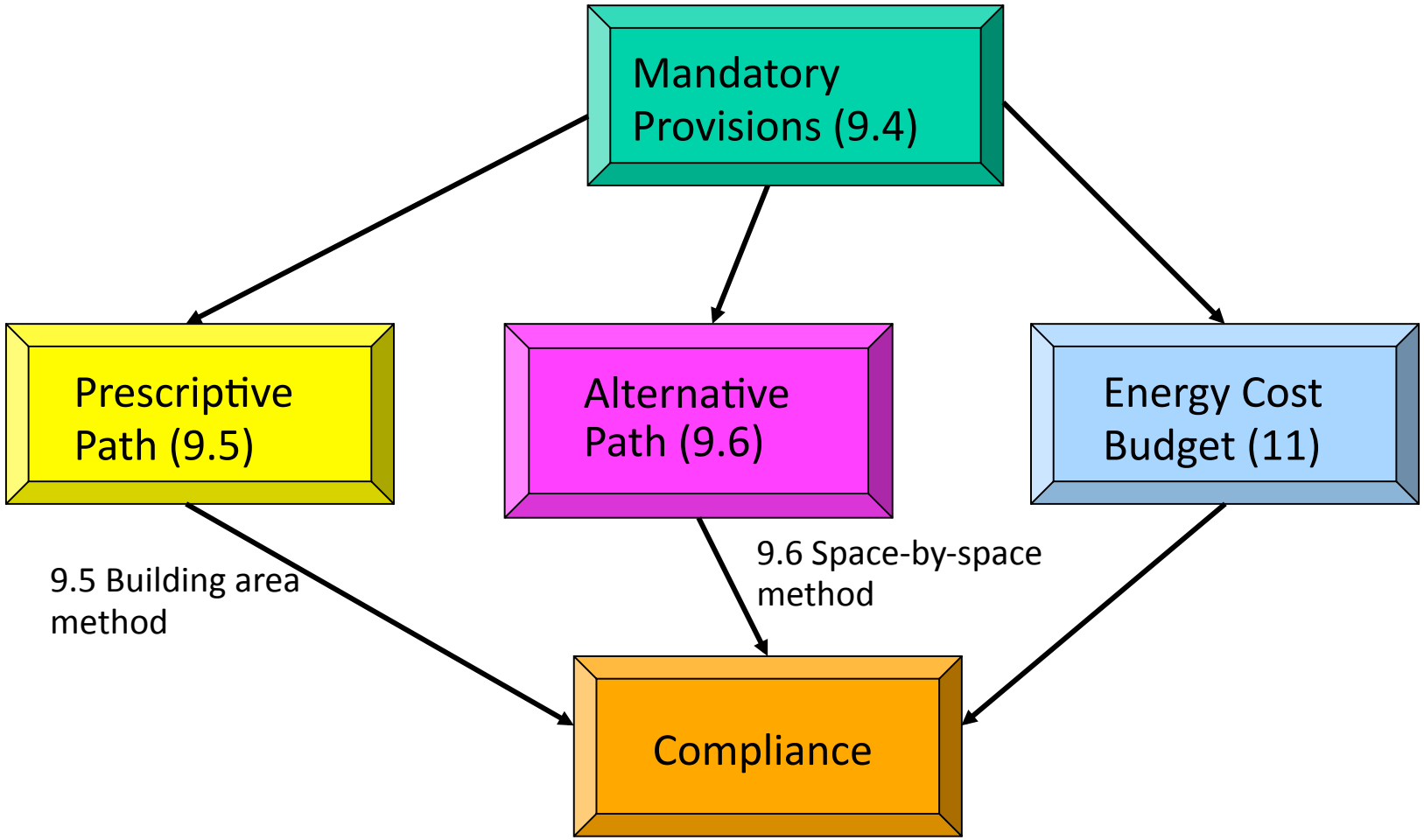
- The American Recovery & Reinvestment Act (ARRA)

- Department of Energy (U.S.DOE)

- Texas State Energy Conservation Office (SECO)

Lighting Compliance

Section 9



Lighting Sections

Section 9

- General Information ***(Section 9.1)***
- Mandatory Provisions ***(Section 9.4)***
  - Lighting controls
  - Tandem wiring
  - Exit signs
  - Installed interior lighting power
  - Daylighting controls
  - Luminaire wattage
  - Exterior building grounds lighting

- Building Area Compliance Path ***(Section 9.5)***
- Space-by-Space Compliance Path (***Section 9.6***)

Luminaire Wattage Determination

Section 9.1.4

a. Luminaires w/o ballasts = maximum labeled wattage of the luminaire.

b. Luminaires with ballasts = wattage of the lamp/ballast combination.

c. Line-voltage track = minimum 30 W per foot or wattage of circuit breaker or other current-limiting device(s).

d. Low-voltage track = transformer wattage.

e. All other misc. lighting equipment, as specified.

Luminaire Wattage Calculations

Section 9.1.4

Example:

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

A. Eight 2'x 4' Fluorescent Fixtures
- ❑ Three 4' fluorescent T8 lamps per fixture, 32 Watts
- ❑ 1 three-lamp electronic ballast
- ❑ Ballast Input Wattage - 90 watts

B. 6 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 Watt Halogen PAR38 lamps

Luminaire Wattage Calculations

Section 9.1.4

Solution: 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
- ❑ Total Wattage = 1578 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
- ❑ Total Wattage = 1650 Watts

LPD Exceptions

Section 9.2.2.3

Interior Lighting Power Density Exceptions:

a. Display or accent lighting for galleries, museums, and monuments.

b. Lighting integral to equipment installed by the manufacturer.

c. Lighting used only during medical or dental procedures.

d. Integral to both open and glass-enclosed refrigerator and freezer cases.

e. Integral to food warming & prep.

f. Plant growth or maintenance.

g. Spaces specifically designed for visually impaired or other medical.

h. Retail display windows if display area is enclosed by ceiling-height partitions.

i. Interior spaces designated as registered historic landmarks.

j. Integral part of advertising or directional signage.

k. Exit signs.

l. Sale or lighting educational demonstration systems.

m. Lighting for theatrical performance, stage, film & video.

n. Lighting for television broadcasting in sporting activity areas.

o. Casino gaming areas

p. Furniture-mounted supplemental task lighting controlled by automatic shutoff, per section 9.4.1.6(d).

q. Mirror lighting in dressing rooms and accent lighting in pulpit & choir areas.

r. Parking garage transition lighting for covered vehicle entrances.

Automatic Lighting Shutoff

Section 9.4.1.1

Mandatory Provisions

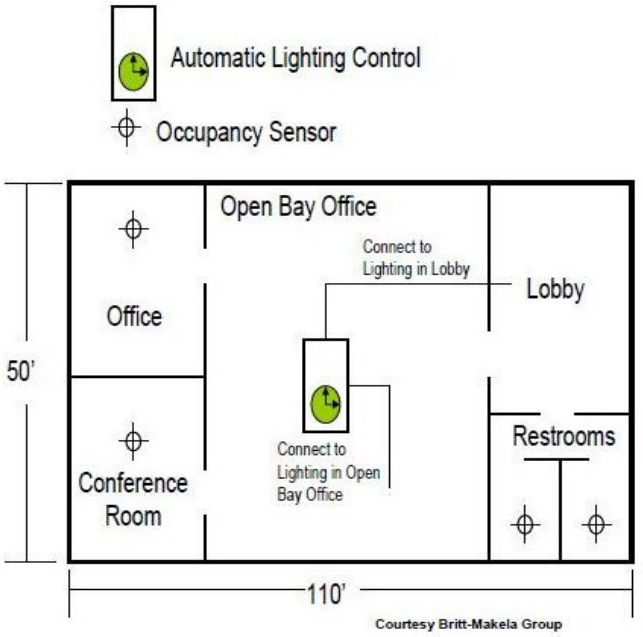
Automatic control options:

a. Time-scheduling devices that accommodate separate schedules for each floor or each space > 25,000 $ft^{2,}$ or

b. Occupant-sensing devices that turn off lights in each controlled space within 30 minutes of last occupant detection, or

c. Signal from another control or alarm system that indicates area is unoccupied.

Exceptions: Lighting for 24-hour operation, where patient care is rendered, and where safety or security of occupants could be endangered.



Space Lighting Control

Section 9.4.1.2

At least one independent, readily accessible, control that can be seen by the occupants must be in each room or space (given these stipulations):

a. **Must have at least one control step between 30% and 70% of full lighting power in addition to full on and full off. Exceptions – corridors, mech. rooms, lobbies, restrooms, stairways, storage rooms, spaces with only one luminaire with power < 100W., and all other spaces with LPD < 0.6 W/ft^2.**

b. **An occupant sensor or timer that turns lights off within 30 minutes of vacating the space shall be installed in: classrooms, lecture halls, conference meeting rooms, training rooms, lunch/break rooms, storage rooms (50 to 1000 ft^2), copy/printing rooms, offices ≤ 250 ft^2, restrooms, dressing/locker rooms. Exceptions – spaces with multi-scene controls, shop & lab classrooms, lighting for 24-hr operation, and spaces where shutoff would endanger safety or security of occupants.**

c. **All other spaces, manual or automatic controls shall control a maximum of 2500 ft^2 area in spaces ≤ 10,000 ft^2, and a maximum of 10,000 ft^2 in spaces > 10,000 ft^2. Automatic controls to allow occupant to override for no more than 2 hours.**

Daylighting Controls for Sidelighting

Section 9.4.1.4

When daylight sidelighted area exceeds 250 ft^2, the lamps for general lighting shall be separately controlled by at least one multilevel photocontrol with these features:

a. Light sensor for the photocontrol shall be remote from where the calibration adjustments are made,

b. The calibration adjustments shall be readily accessible, and

c. Multilevel photocontrol shall reduce the electric lighting in response to available daylight with at least one control step between 50% and 70% of design lighting power and another control step that is ≤ 35% (including off) of design power.

Exceptions:

a. Tops of adjacent structures are twice as high above the windows as their distance from the window. (i.e., 65º angle)

b. Sidelighting effective aperture (EA) < 10%.

c. Retail spaces.

Daylighting Controls for Toplighting

Section 9.4.1.5

When daylight toplighted area exceeds 900 ft^2, the lamps for general lighting shall be separately controlled by at least one multilevel photocontrol with these features:

a. Light sensor for the photocontrol shall be remote from where the calibration adjustments are made,

b. The calibration adjustments shall be readily accessible, and

c. Multilevel photocontrol shall reduce the electric lighting in response to available daylight with at least one control step between 50% and 70% of design lighting power and another control step that is ≤ 35% (including off) of design power.

Exceptions:

a. Adjacent structures block direct beam sunlight for more than 1500 hours per year between 8 a.m. and 4 p.m.

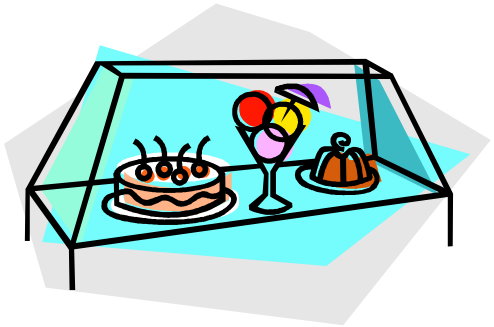
b. Skylight effective aperture (EA) < 0.6%.

c. Buildings with daylighted space < 1500 ft^2 in climate zone 8.

Additional Control

Section 9.4.1.6

- **Additional *separate* control required for:**
  - **Display/accent lighting**
  - **Case lighting**
  - **Task lighting**
  - **Hotel/motel guest room lighting**
  - **Nonvisual lighting (e.g., plants)**
  - **Demonstration lighting**



Exterior Lighting Control – Requirements

Section 9.4.1.7

a. Controller turns off lights when adequate daylight is available.

b. Building façade and landscape lighting to shut off between midnight or business closing (whichever is later) and 6 a.m. or business opening (whichever comes first.)

c. Advertising and other outdoor lighting shall reduce the power by ≥ 30% during at least one of the following periods:

   1. Midnight or within one hour after business closing (whichever is later) until 6 a.m. or business opening (whichever is earlier), or
   2. When no activity has been detected for 15 minutes.

Exceptions – lighting for:

- *Covered vehicle entrances*
- *Exits from buildings or parking structures*
- *(where required for safety, security, or eye adaptation.)*

Exit Signs

Section 9.4.2

- **Internally illuminated exit signs shall not exceed 5W per face**
- **LED lamps are quickly becoming the norm.**
- **A vast majority of incandescent lamps will not meet the LPD requirements. (A new Federal Energy Act phases incandescents out by 2014.)**

Exterior Lighting Power

Section 9.4.3

The total exterior lighting power allowance for all exterior building applications is the sum of the base site allowance plus the individual allowances for areas that are designated to be illuminated and are permitted in Table 9.4.3B. Trade-offs are allowed only among exterior lighting applications listed as "Tradable Surfaces".

For the lighting zone designations in the Table,

Zone 0 = Undeveloped areas in national and state parks and rural areas.

Zone 1 = Developed areas in national and state parks and rural areas.

Zone 2 = Residential, neighborhood business, & light industrial zoning.

Zone 3 = All other areas.

Zone 4 = High activity commercial districts in major metropolitan areas.

Exceptions are: traffic signal lights, advertising signage, and equipment or instrumentation installed by the manufacturer.

Lighting Power Densities for Building Exteriors

Table 9.4.3B

Site *	Zone 1	Zone 2	Zone 3	Zone 4
Examples of tradable surfaces:				
Uncovered parking	0.04W/ft^2	0.06 W/ft^2	0.10 W/ft^2	0.13 W/ft^2
Walkways & plazas	0.14 W/ft^2	0.14 W/ft^2	0.16 W/ft^2	0.2 W/ft^2
Building entry canopies	0.25 W/ft^2	0.25 W/ft^2	0.4 W/ft^2	0.4 W/ft^2
Outdoor vehicle sales	0.25 W/ft^2	0.25 W/ft^2	0. 5 W/ft^2	0. 7 W/ft^2
Examples of non-tradable surfaces:				
Bldg façades	none	0.1 W/ft^2	0.15 W/ft^2	0.2 W/ft^2
ATM machines	270 W per location plus 90 W for each additional.			
Guarded entrances	0.75 W/ft^2 of uncovered area. (covered canopies addressed above.)			
Parking @ 24-hr retail entrances	800 W per main store entry			

Footnotes: * No allowances for Zone 0

Exterior Lighting Exceptions

Section 9.4.3

Exempt when equipped with an independent control device:

a. Specialized signal, directional, and marker lighting associated with transportation
b. Advertising signage
c. Lighting integral to equipment or instruments
d. Theatrical lighting
e. Athletic lighting, amusement park lighting
f. Temporary lighting
g. Industrial production
h. Amusement parks
i. Highlighting public monuments or registered historic landmark structures or buildings
j. Hazardous locations
k. Swimming pools
l. Searchlights

Building Area Method

Section 9.5 (Alternative path 1)

- **Used for projects involving**
  - An entire building
  - A single, independent, and separate occupancy in a multi-occupancy building
- **Gross lighted area is multiplied by allowance from Table 9.5.1**
- **Limitations**
  - Insensitive to specific space functions and room configurations
  - Generally is more restrictive
  - Does not apply to all building types - but "selection of a reasonably equivalent type" is permitted

Interior LPD Requirements

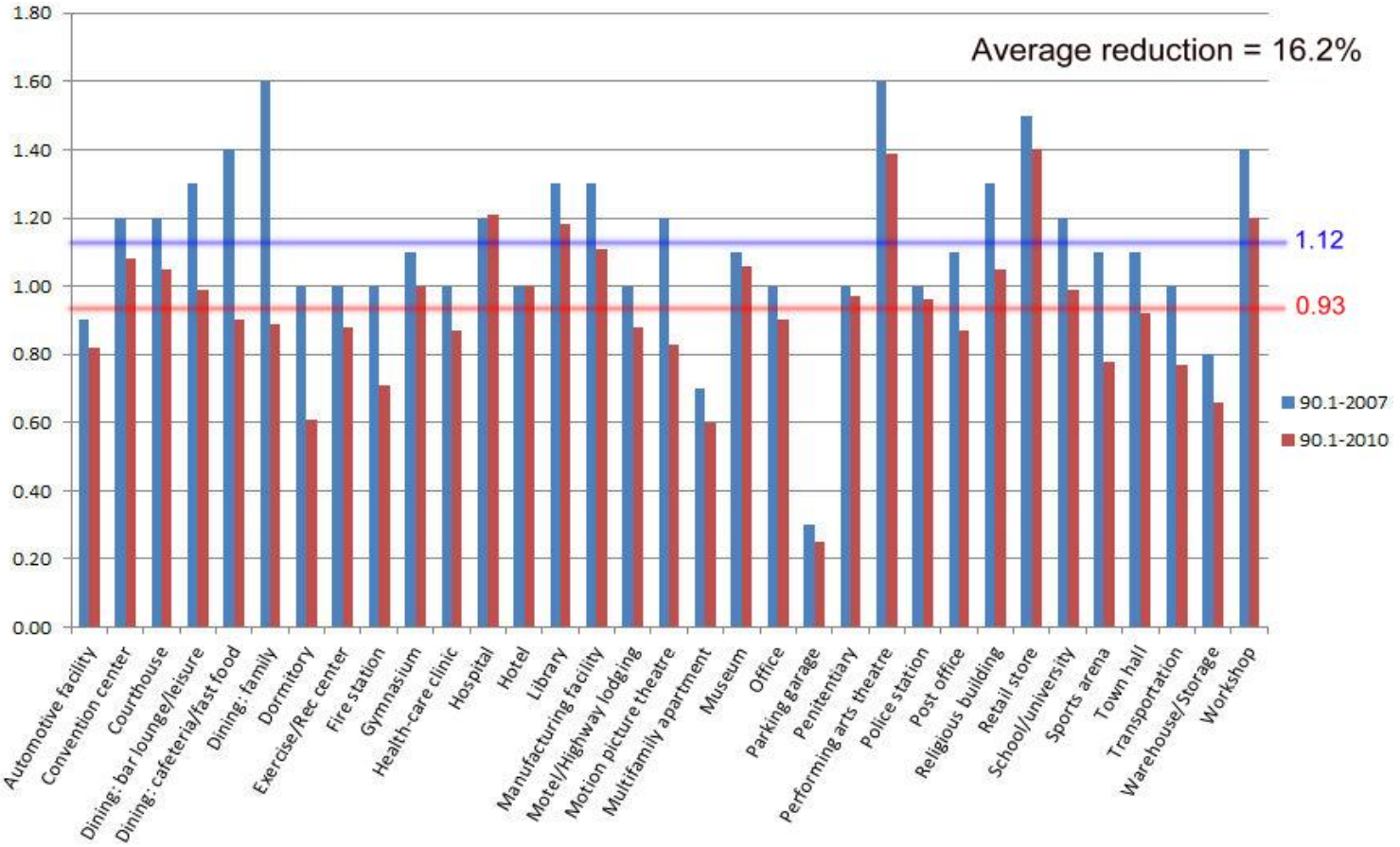
Table 9.5.1

Lighting Power Densities (LPD), W/ft² – Building Area Method							
Bldg Type	2007	2010	Diff.	Bldg Type	2007	2010	Diff.
Automotive facility	0.9	0.82	9 %	Multifamily	0.7	0.60	14 %
Convention center	1.2	1.08	10 %	Museum	1.1	1.06	4 %
Courthouse	1.2	1.05	13 %	Office	1.0	0.90	10 %
Dining: bar/lounge	1.3	0.99	24 %	Parking garage	0.3	0.25	17 %
Dining: cafeteria	1.4	0.90	36 %	Penitentiary	1.0	0.97	3 %
Dining: family	1.6	0.89	44 %	Performing arts theater	1.6	1.39	13 %
Dormitory	1.0	0.61	39 %	Police station	1.0	0.96	4 %
Exercise center	1.0	0.88	12 %	Post office	1.1	0.87	21 %
Fire station	1.0	0.71	29 %	Religious building	1.3	1.05	19 %
Gymnasium	1.1	1 %	9 %	Retail	1.5	1.40	7 %
Health-care clinic	1.0	0.87	13 %	School / University	1.2	0.99	18 %
Hospital	1.2	1.21	-1 %	Sports arena	1.1	0.78	29 %
Hotel	1.0	1.00	0 %	Town hall	1.1	0.92	16 %
Library	1.3	1.18	9 %	Transportation	1.0	0.77	23 %
Manufacturing facility	1.3	1.11	15 %	Warehouse	0.8	0.66	18 %
Motel	1.0	0.88	12 %	Workshop	1.4	1.20	14 %
Motion picture theatre	1.2	0.83	31 %	Overall Average	1.12	0.93	16.2 %

Lighting LPD Comparisons

From Table 9.5.1, 2010 vs. 2007

Significant reduction (16.2%) in LPDs since the 2007 version



Building Area Allowances

Section 9.5.1

There are 33 bldg types. Eight examples are shown here:

Hospital	**- 1.21 W/ft^2**
Library	**- 1.18 W/ft^2**
Manufacturing	**- 1.11 W/ft^2**
Museum	**- 1.06 W/ft^2**
Office	**- 0.90 W/ft^2**
Parking Garage	**- 0.25 W/ft^2**
Retail	**- 1.40 W/ft^2**
School / Univ.	**- 0.99 W/ft^2**

Building Area Method

Section 9.5.1

Example:

Calculate Total Lighting Power Allowance using the Building Area Method:

A. An Office Building:

- ❑ **6 Floors**
- ❑ **Outside Dimensions 200' x 350'**
- ❑ **Office Building Power Allowance = 0.9 W/sq.ft.**

Solution

- ✓ 200' x 350' = 70,000 sq. ft. per floor
- ✓ 6 Floors x 70,000 sq. ft per floor = 420,000 sq. ft.
- ✓ 420,000 sq. ft. x 0.9 watts per sq. ft = 378,000 Watts
- ➢ **Total Lighting Power Allowance = 378 kiloWatts ***

*** 420,000 W when using 90.1-2007 (42,000 W saved.)**

Space-by-Space Method

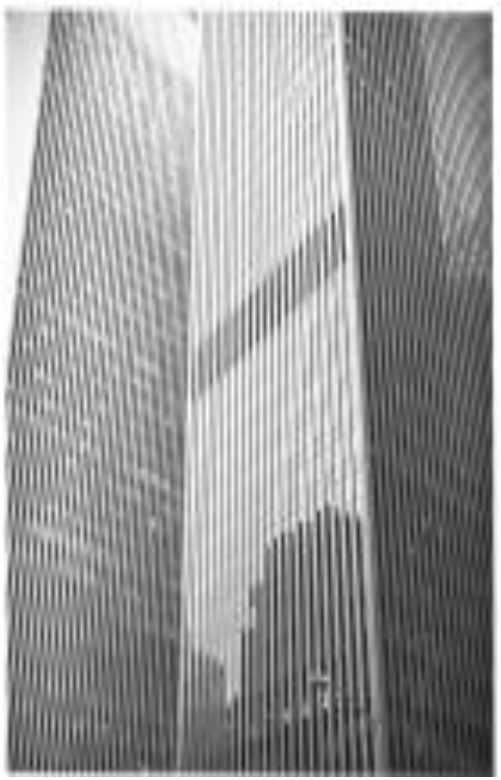
Section 9.6 (Alternative Path 2)

- Identify different building types in your project
- Divide gross lighted area of the building into each of the space types
- Calculate lighting power allowance by multiplying area of space type by lighting power density for that specific space type
- Sum all the allowances
- Advantages
  - More flexible
  - Applicable to all building types
  - Accounts for room geometry (e.g., lighting needs of enclosed office vs. open office)

Space-by-Space Method

Section 9.6.1

There are 95 space types. Eleven examples are shown here:



Office Building Spaces:

Office Enclosed	- 1.11 W/ft^2
Office Open	- 0.98 W/ft^2
Conference	- 1.23 W/ft^2
Training	- 1.24 W/ft^2
Lobby	- 0.90 W/ft^2
Lounge	- 0.73 W/ft^2
Dining	- 0.65 W/ft^2
Food Prep.	- 0.99 W/ft^2
Corridor	- 0.66 W/ft^2
Restroom	- 0.98 W/ft^2
Active Storage	- 0.63 W/ft^2

Additional Interior Lighting Power

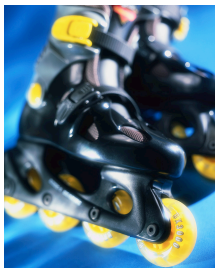
Section 9.6.2

Additional interior lighting power is allowed for specific space functions when using the space-by-space method:

a. Decorative – 1.0 W/ft^2 in space used

b. Lighting equipment installed in retail spaces specifically to highlight merchandise in specific space used, as follows:

- **Sales area for general consumer goods, 0.6 W/ft^2**
- **Vehicles, sporting goods, small electronics , 0.6 W/ft^2**



- **Furniture, clothing, cosmetics, artwork, 1.4 W/ft^2**
- **Fine jewelry, crystal & china, 2.5 W/ft^2**

Space-by-Space Method

Section 9.6.2

Example:

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

Project is a Retail Building:

- ❑ 5000 sq. ft of Sales Area including
- ❑ 1000 sq. ft of jewelry counters
- ❑ 1000 sq. ft. of Active Storage Area
- ❑ 3 Enclosed Offices - 200 sq. ft. each
- ❑ 1 Conference Room - 400 sq. ft.
- ❑ 2 Rest Rooms - 150 sq. ft. each
- ❑ Corridors - 6’ wide x 25’ long

Space-by-Space Method

Section 9.6.2

Solution, Step #1:

Identify the Watts per Square Foot allowed for Each Space

Retail Building:

- Sales Area – 1.68 W/ft^2
- Additional power allowances for jewelry cases lighting – 2.5 W/ft^2 of display
- Active Storage Area – 0.63 W/ft^2
- Enclosed Offices - 1.11 W/ft^2
- Conference Room - 1.23 W/ft^2
- Rest Rooms – 0.98 W/ft^2
- Corridors - 0.66 W/ft^2

Space-by-Space Method

Section 9.6.2

Solution, Step #2:

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

Retail Building:

❑ Sales: 1.68 W/ft^2 x 5000 ft^2	= 8,400 Watts
❑ Active Storage Area: 0.63 W/ft^2 x 1000 ft^2	= 630 Watts
❑ Enclosed Offices: 1.11 W/ft^2 x (3) 200 ft^2	= 666 Watts
❑ Conference Room: 1.23 W/ft^2 x 400 ft^2	= 492 Watts
❑ Rest Rooms: 0.98 W/ft^2 x (2) 150 ft^2	= 294 Watts
❑ Corridors: 0.66 W/ft^2 x 6' x 25'	= 99 Watts
LIGHTING POWER ALLOWANCE	**= 10,581 Watts**
Additional Power Allowance - Jewelry areas Only	
2.5 W/ft^2 x 1000 ft^2	**= 2,500 Watts**
TOTAL Int. Ltg. POWER ALLOWANCE	**= 13,081 Watts ***

*** 15,025 Watts when using 90.1-2007 (1,944 W saved.)**

Lighting Alteration Exceptions

- Replacement of less than 10% of luminaires in a “space”….but must not increase the installed LPD.
- Note: Replacement of luminaire components only (lamp, ballast) also constitutes an alteration for compliance purposes, but routine maintenance or repairs are exempt.

This Concludes:
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