Texas Training

Commercial Energy Code

Lighting

Presented by

Energy Systems Laboratory

Texas A&M University System

Tom Fitzpatrick, ESL

Charles Thompson, Archillume Lighting Design

at

National Workshop on State Energy Codes

U.S. Department of Energy

June 27, 2005

Sponsor

- This training is sponsored by the Texas State Energy Conservation Office, Comptroller of Public Accounts

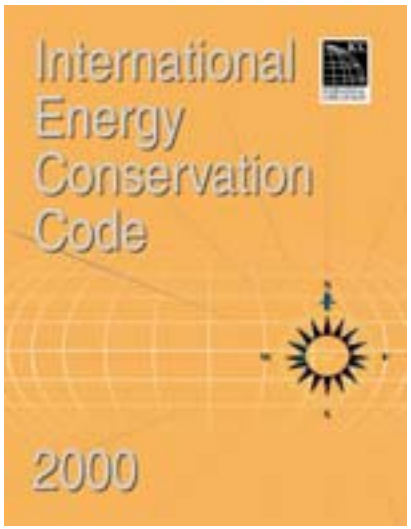
Instructors

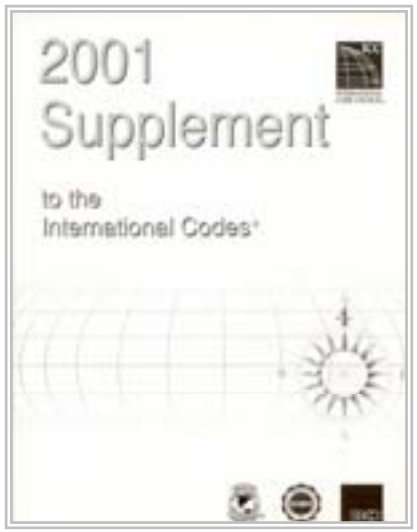
- **Tom Fitzpatrick**, Architect
  - Energy/Codes Specialist at Energy Systems Laboratory, TAMUS
  - SB 5 Liaison
  - 30 years experience in planning, design and construction
  - 5+ years involvement in code implementation and training in Texas
- **Charles K. Thompson**, AIA, LC, IALD, IESNA
  - Founder (1985) and President, ARCHILLUME LIGHTING DESIGN, INC.
  - Architect member of the AIA and an interior designer
  - Corporate member of the International Association of Lighting Designers
  - member of the Illuminating Engineering Society of North America.
  - one of the first lighting professionals to receive LIGHTING CERTIFICATION (LC) from the NCQLP.

Overview

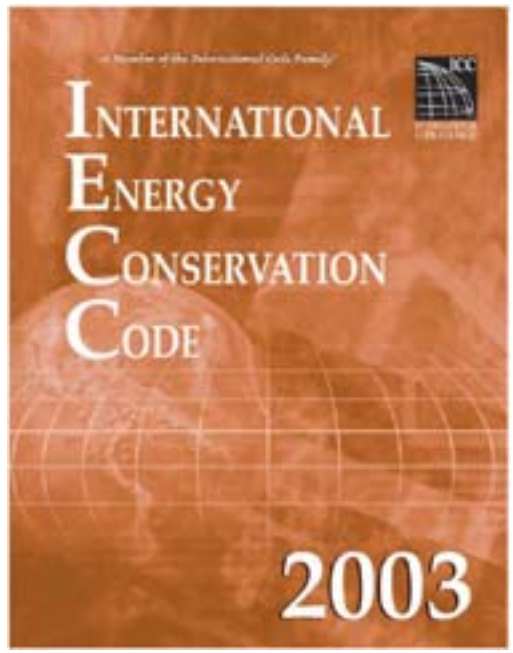
- Quick look at Texas energy code status
- Lighting requirements IECC 2001-2003
- ASHRAE 90.1-2004
- Compliance Documentation
- Design Considerations

Status of Energy Codes in Texas



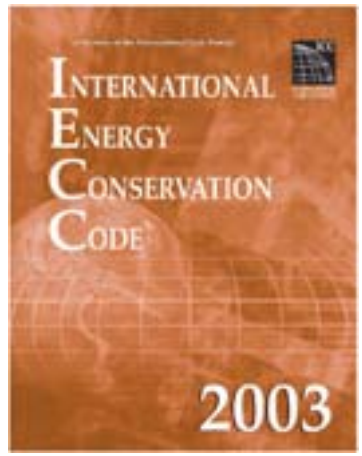


- Senate Bill 5 adopted latest codes published at 5-1-01 (2000 inc. Mar ’01 Supplement)



- *ICC* Certified Commercial Energy Plans Reviewer and Inspector exams now based on 2003 IECC

2003 IECC



- Minor organizational changes
- New edition of 90.1 referenced
- Variety of changes or clarification in lighting controls
- Significant increase in stringency of lighting power allowances

IECC Chapter 7

- 2001 Supplement (Texas) references ASHRAE/IESNA 90.1-1999
- 2003 IECC references ASHRAE/IESNA 90.1-2001
- ASHRAE/IESNA 90.1-2001 amendment “g” and 90.1-2004 have significantly more stringent lighting power density requirements

Local Amendments

- Local amendments allowed in Texas.
- In non-attainment areas and affected counties, may not result in less stringent energy efficiency requirements.
  - Texas A&M Energy Systems Laboratory (ESL) to review local amendments and submit annual report of savings impacts to TNRCC.

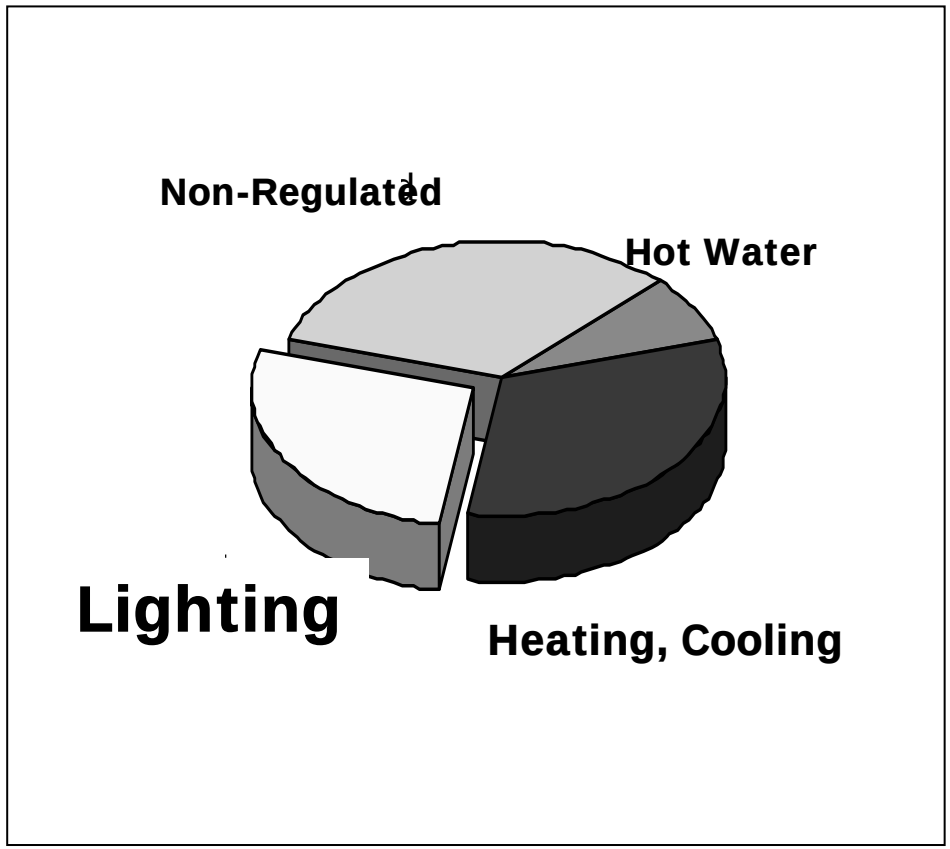
NCTCOG Amendments

- IECC 2003 with regional amendments, plus
- Cool roofing
- Dry-type distribution transformers
- Variable speed motor control
- Lighting (sync with 90.1-2001 amend. “g”)

Lighting

Energy for Lighting in Buildings:

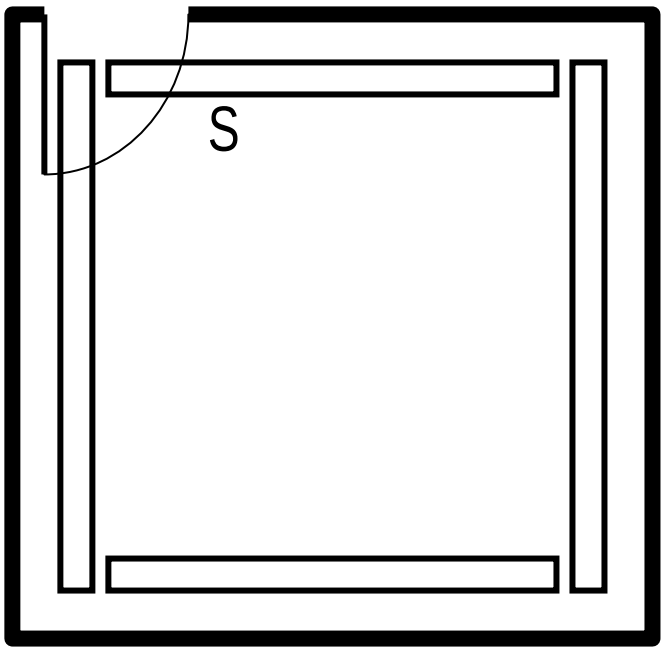
- Accounts for approximately 27% of energy use
- Contributes to cooling load



ENERGY SAVING PRODUCTS

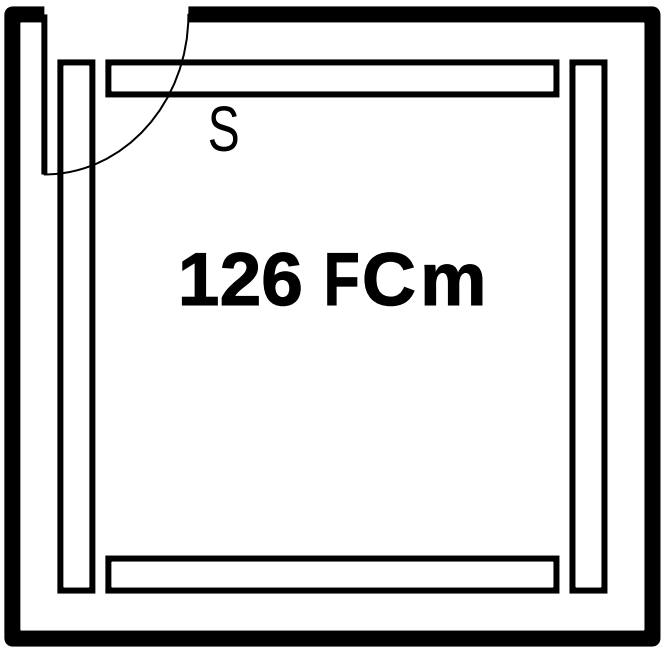
- **A T5HO STORY**
  - GOOD PRODUCTS GONE BAD
- **2 x FO32T8 5,900 LUMENS 61 WATTS**
  - 89 LUMENS PER WATT
- **1 x FP54T5HO 5,000 LUMENS 61 WATTS**
  - 93 LUMENS PER WATT (IF KEPT HOT)
  - SMALLER LAMP SIZE

ENERGY SAVING PRODUCT?



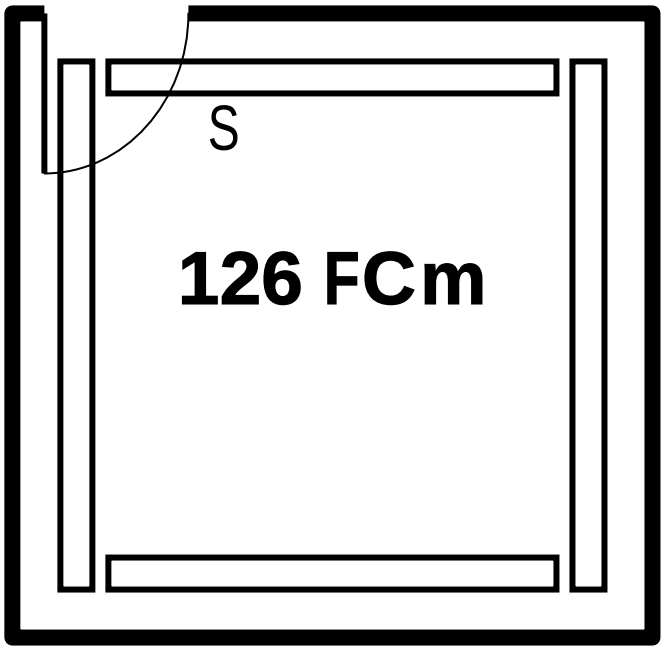
ORIGINAL PLAN

ENERGY SAVING PRODUCT?



ORIGINAL PLAN

ENERGY SAVING PRODUCT?

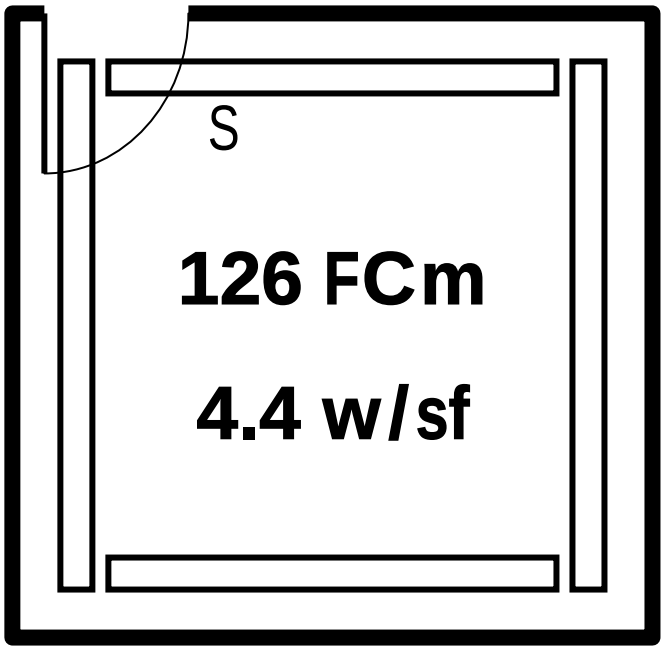


ORIGINAL PLAN

IESNA RECOMMENDATIONS FOR LASER PRINTING IS CATEGORY D or

30 FOOTCANDLES

ENERGY SAVING PRODUCT?



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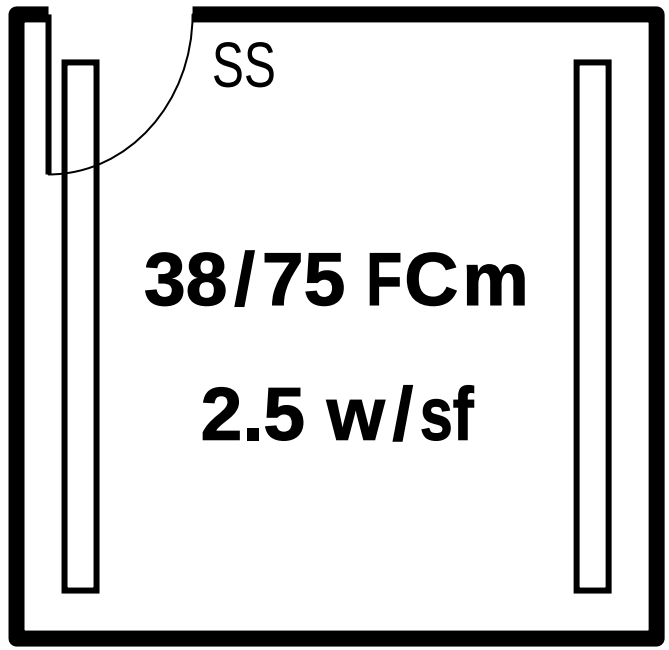
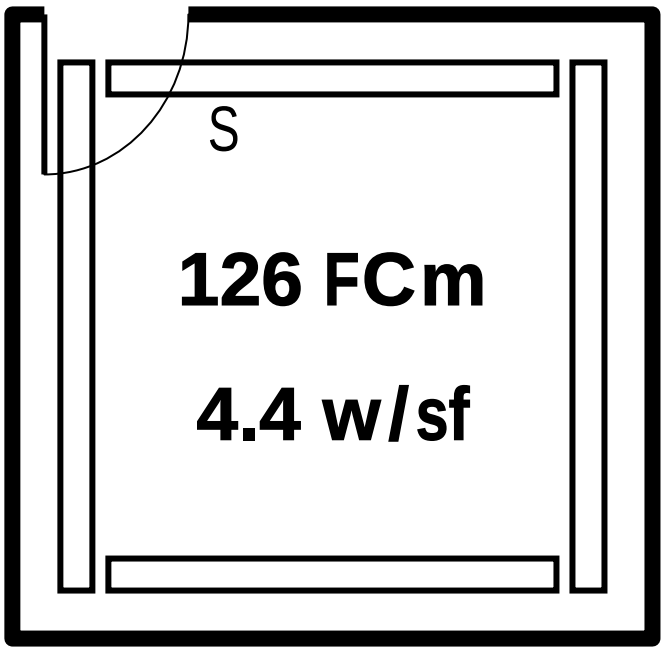


REVISED PLAN

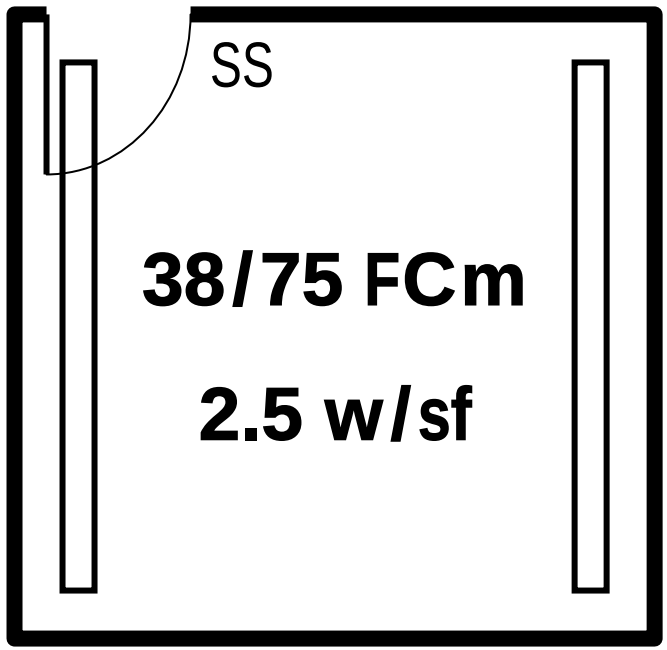
IESNA RECOMMENDATIONS FOR LASER PRINTING IS CATEGORY D or

30 FOOTCANDLES

ENERGY SAVING **DESIGN**



ORIGINAL PLAN



REVISED PLAN

IESNA RECOMMENDATIONS FOR LASER PRINTING IS CATEGORY D or

30 FOOTCANDLES

Types of Requirements

- Control systems and spaces
- Limit interior lighting power loads
- Limit exterior lighting to more efficient products
- Provide sufficient information to document compliance

General Application

- Interior spaces of buildings
- Exterior building features
- Exterior grounds lighting powered through building
- Exceptions
  - Lighting within dwelling units
- Control exceptions
  - Continuously lit security or emergency areas
  - Means of egress

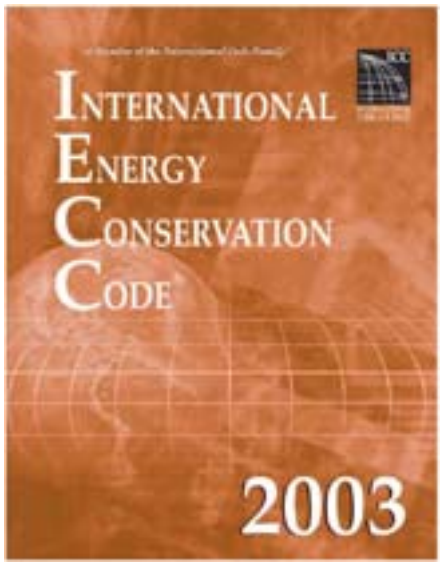
INTERIOR IMPACT TO THE PROJECT

- Greater variety in contrast in the space
- Lower lighting levels
- Greater variety in product types
- Increased maintenance
- More reliance on task light
- More lighting controls

SPECIFIC LIGHTING DESIGN STRATEGIES

- Careful consideration of lighting design goals
- Careful consideration of construction costs
- Careful consideration of lamp & ballast systems
- Exercise design process
- Play well with others
- Clear communication about user expectations

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

Exempt Buildings

(Not exempt from lighting)

Section 101.2.1

…Regardless of this exempt status from **envelope** provisions, mechanical, lighting and service water heating shall meet the applicable provisions….

•Provisions apply to all occupancies

Applicability

Section 101.2.2

- New buildings
- New [lighting] system(s)
- Tenant improvements
- Additions and alterations
- Removal, alteration or abandonment of existing building systems not required by code -- if not altered by project

Product Information

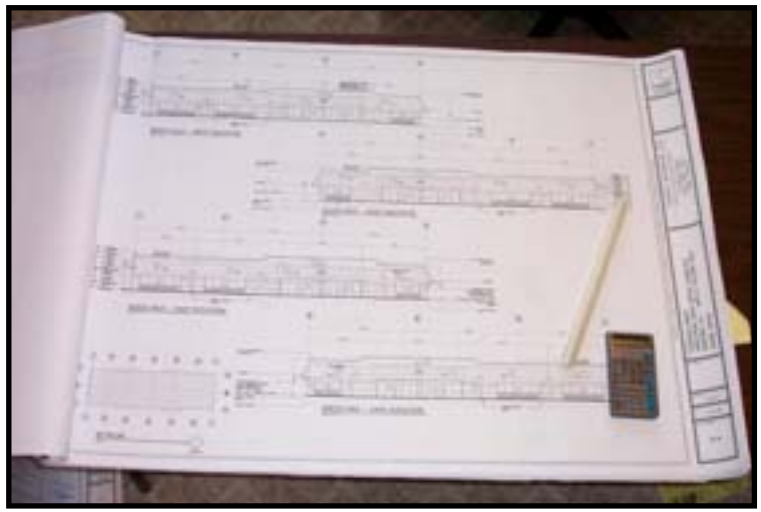
Section 102.1

- Materials, equipment and systems shall be identified in a manner that will allow a determination of their compliance with the applicable provisions of this code

Construction Documents

Section 104

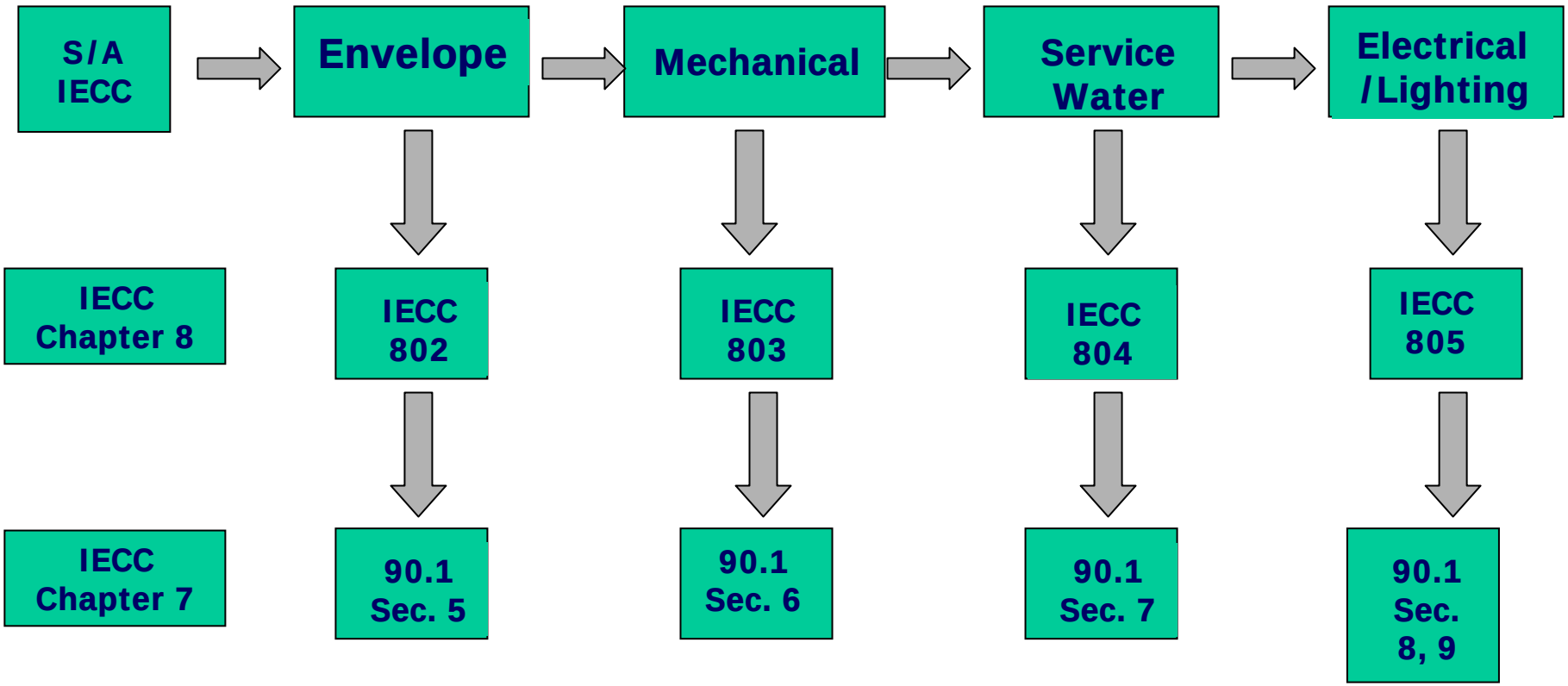
- What's required?
  - Plans and documents must indicate the work that is proposed
  - Levels of efficiency for building envelope, mechanical system and lighting system identified in the construction documents
    - Example – R-value, U-factor,
    - SHGC, EER
    - Lighting types, layouts, controls,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



Chapter 8 Design By Acceptable Practice for Commercial Buildings

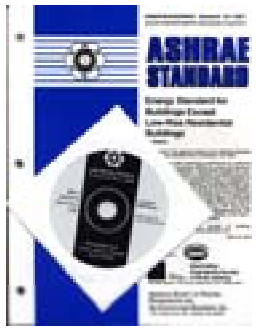
IECC Energy Code Layout

Section 801.2



ASHRAE 90.1

90.1 Chapter 8 (Power)

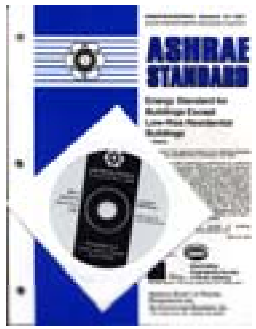


- Regulates voltage drop in feeders and branch circuits
- Requires construction drawing and manuals be supplied to owner

- Chapter was carefully constructed to regulate only aspects of building power systems that are NOT covered in electrical codes

ASHRAE 90.1

90.1 Chapter 9 (Lighting)



- Requires interior lighting controls
- Requires tandem wiring of ballasts
- Regulates exit signs
- Defines installed interior lighting power
- Defines luminaire wattage
- Regulates exterior lighting efficacy

90.1 Chapter 9 (Lighting)

- Provides two options for regulating interior lighting power
  - Building Area Method
  - Space-By-Space Method

- Provides additional interior lighting power allowances for specific situations

90.1 Lighting power density development concept

- ASHRAE/IESNA create building space models to calculate power densities with:
  - Current product performance data
  - Updated efficacy and loss factors
  - New building construction data
  - IES-recommended light levels
  - Professional lighting design consensus

IECC Mandatory Provisions

Sec. 801.2

- Provisions listed in the Exception to 801.2 must be met even when compliance is being demonstrated by Sec. 806, the Total Building Performance approach (annual energy cost comparison) including (for lighting):
  - 805.2. Lighting controls
  - 805.3. Tandem Wiring
  - 805.4. Exit Signs
  - 805.6. Exterior Lighting
  - 805.7. Electrical Energy Consumption (metering)

Section 805 Electrical Power and Lighting Systems

Section 805 Electric Power and Lighting Systems

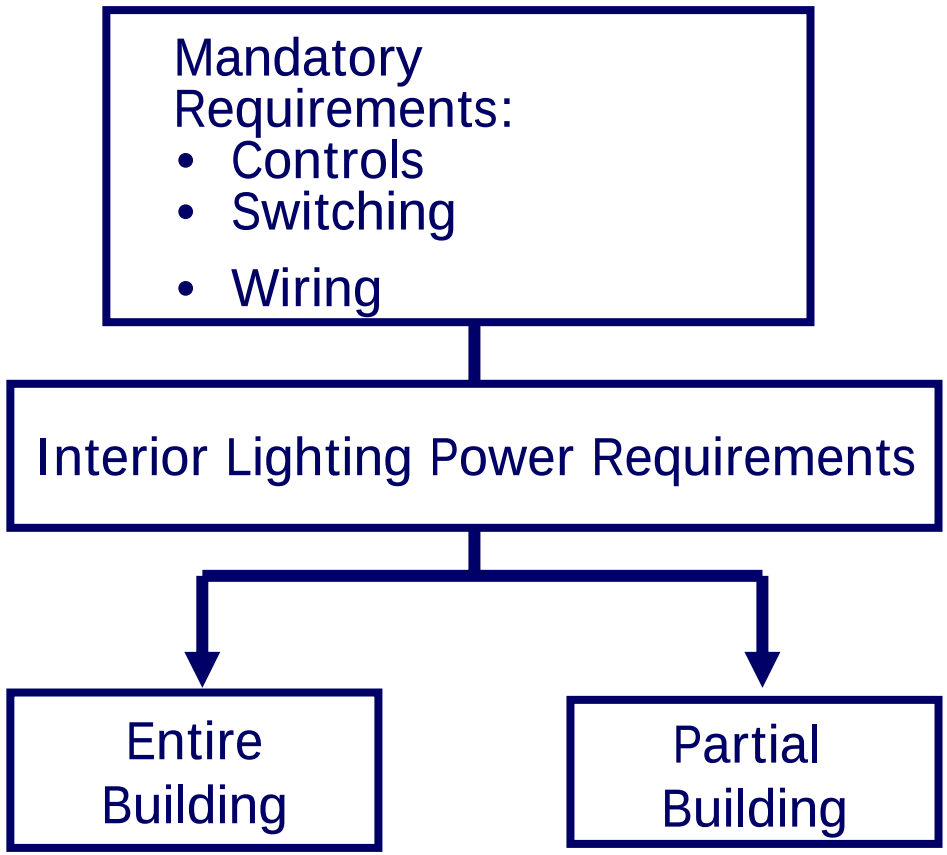
- **805.1 General**
- **805.2 Lighting controls**
  - 805.2.1 Interior lighting controls
  - 805.2.2 Additional controls
    - *805.2.2.1 Light reduction controls*
    - 805.2.2.2 Automatic lighting shutoff
      - *805.2.2.2.1 Occupant override*
      - *805.2.2.2.2 Holiday scheduling*
    - 805.2.2.3 Guestrooms
  - 805.2.3 Exterior lighting controls
- ***805.3 Tandem wiring***
- ***805.4 Exit signs***
- **805.5 Interior lighting power requirements**
  - 805.5.1 Total connected interior lighting power
    - 805.5.1.1 Screw lamp holders
    - 805.5.1.2 Low-voltage lighting
    - 805.5.1.3 Other luminaires
    - 805.5.1.4 Line-voltage lighting track and plug-in busway
  - *805.5.2 Interior lighting power*
    - *805.5.2.1 Entire building method*
    - *805.5.2.2 Tenant area or portion of building method*
- **805.6 Exterior lighting**
- ***805.7 Electrical energy consumption***

Lighting Systems Scope

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

Scope

Interior Lighting Requirements:



Scope

Exterior Lighting Requirements:

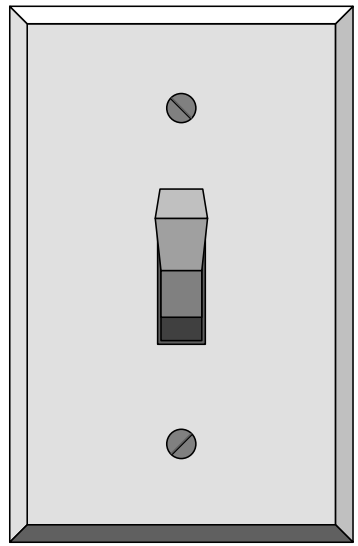
Mandatory Requirements:
- Controls

Exterior Lighting Requirements:
- Energy Efficient Sources
- Use Limitations

Independent Switching

Section 805.2.1

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



Independent Switching *(cont'd)*

Section 805.2.1

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

Light Reduction Controls

2001 Supplement

Section 805.2.2

- Reduce Lighting Load
  - Area < 250 ft^2
    - Additional control to reduce lighting load by 50% (this is also called “bi-level switching”)
- Automatic control device
  - Area > 250 ft^2 in buildings larger than 5000 ft^2
    - Scheduled basis to control areas $\leq$ 25,000 ft^2 or no more than one floor
    - Unscheduled basis by occupant intervention

Light Reduction Controls

2003 IECC

Section 805.2.2

- Reduce Connected Lighting Load
  - All areas [removed 250 ft^2 limit]that are required to have a manual control
    - Additional control to reduce lighting load by 50%
- Automatic Lighting Shutoff
  - Buildings larger than 5000 ft^2 [instead of spaces > 250 ft^2 in those buildings]
    - Scheduled basis to control areas $\leq$ 25,000 ft^2 or no more than one floor
    - Unscheduled basis by occupant intervention

Light Reduction Controls

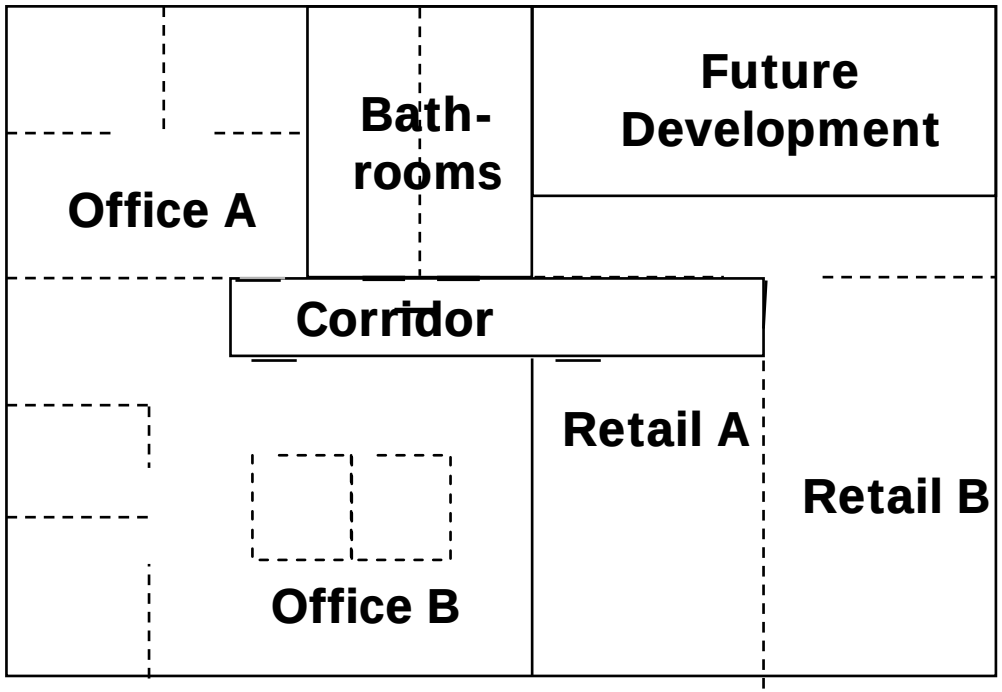
2003 IECC

Sections 805.2.2.2.1, 805.2.2.2.2

- If automatic lighting shutoff is a time switch control device, it must have
  - Occupant override
    - Readily accessible
    - In view of the lights
    - Manually operated
    - Two-hour override limit
    - Controls area $\leq$ 5000 Ft^2
  - Holiday scheduling feature

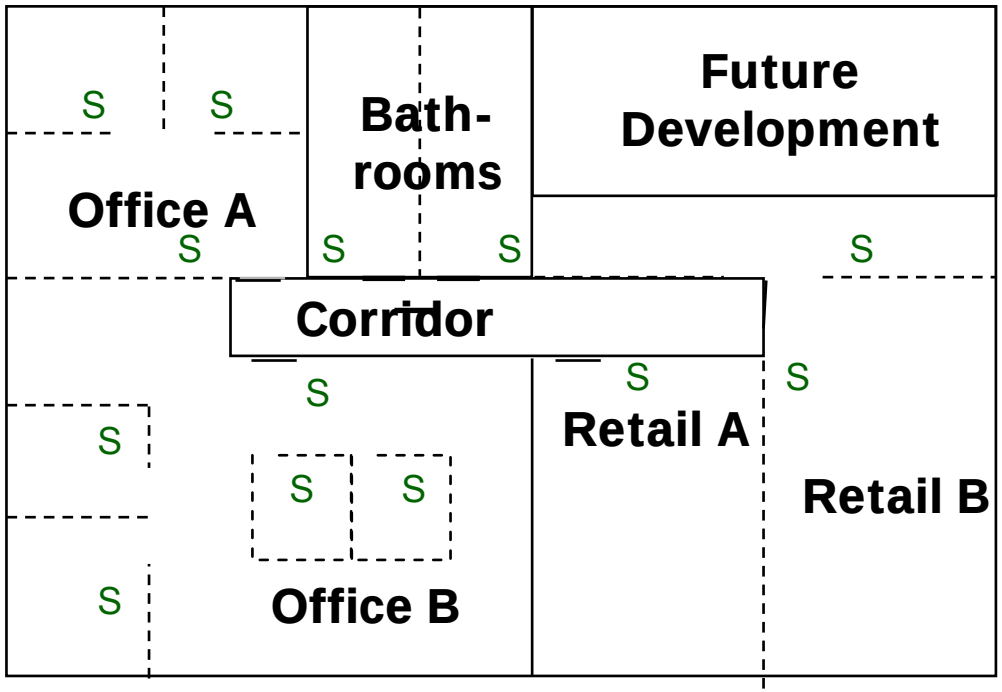
Switching Example

- Example



Switching Example

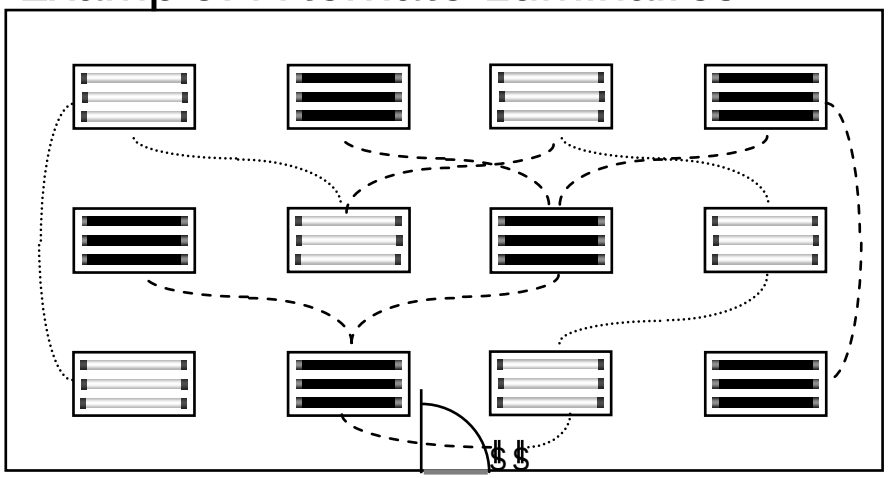
- Example



Bi-Level Switching

- Compliance Examples

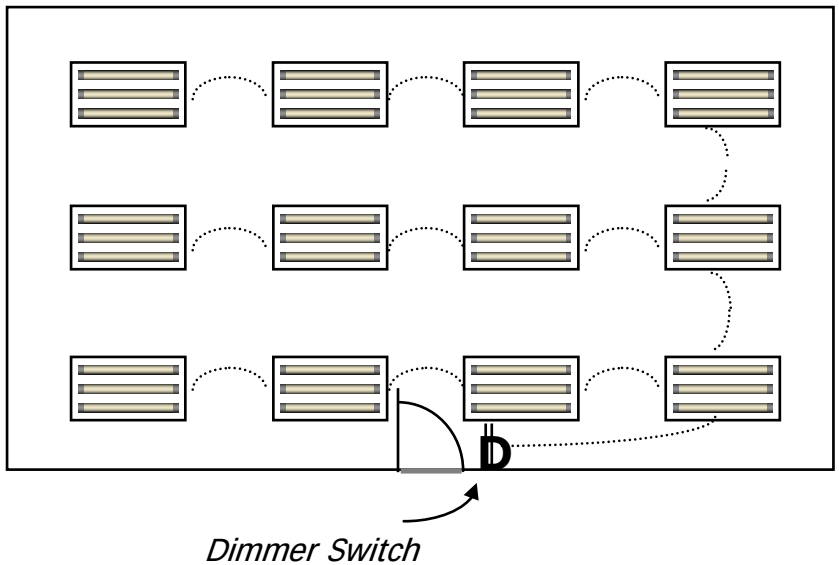
Example: Alternate Luminaires



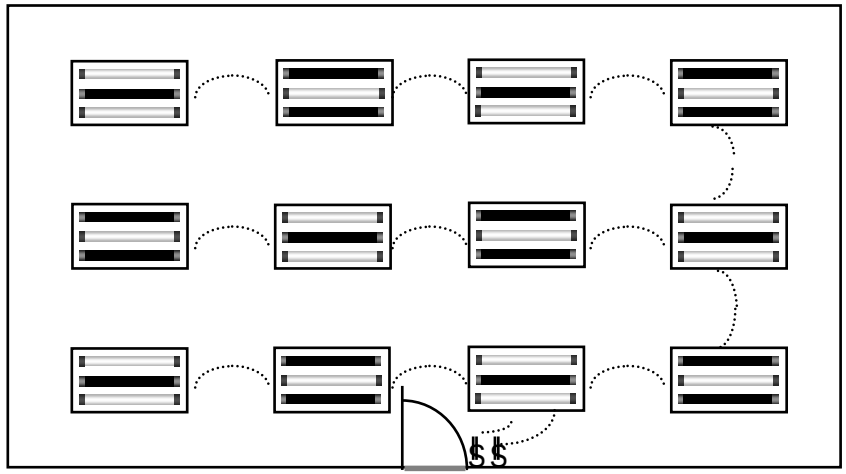
Bi-Level Switching

- Compliance Examples

Example: Dimmer Control Option



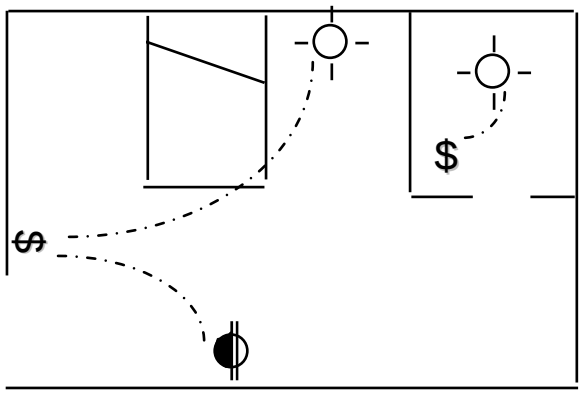
Example: Alternate Lamps (a/b)



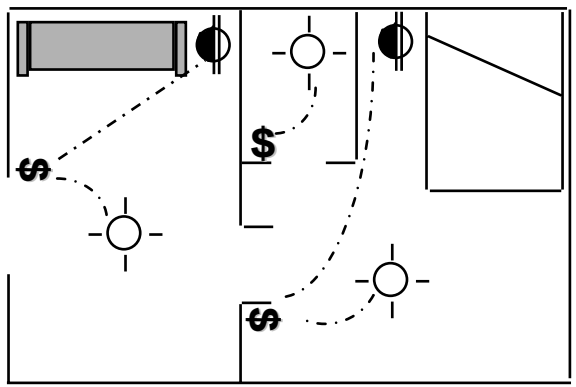
Hotel/Motel Guest Rm. Switching

Section 805.2.2.3

- Master switch required at entry



Standard Room

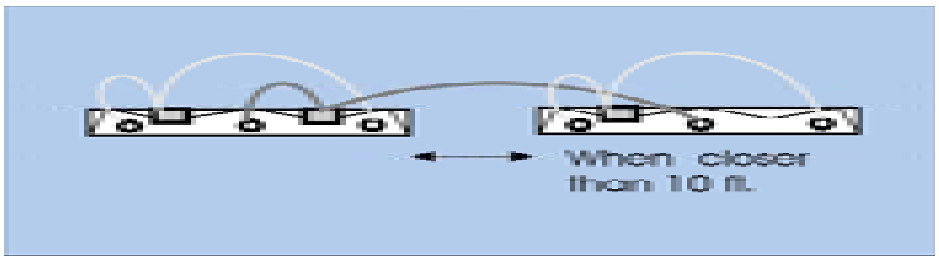


Suite

Tandem Wiring

Section 805.3

- one-, three- or other odd numbered lamp configurations
- If recessed, within 10 feet of each other



- If pendant or surface, within 1 ft. end-to-end

Tandem Wiring

Section 805.3

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

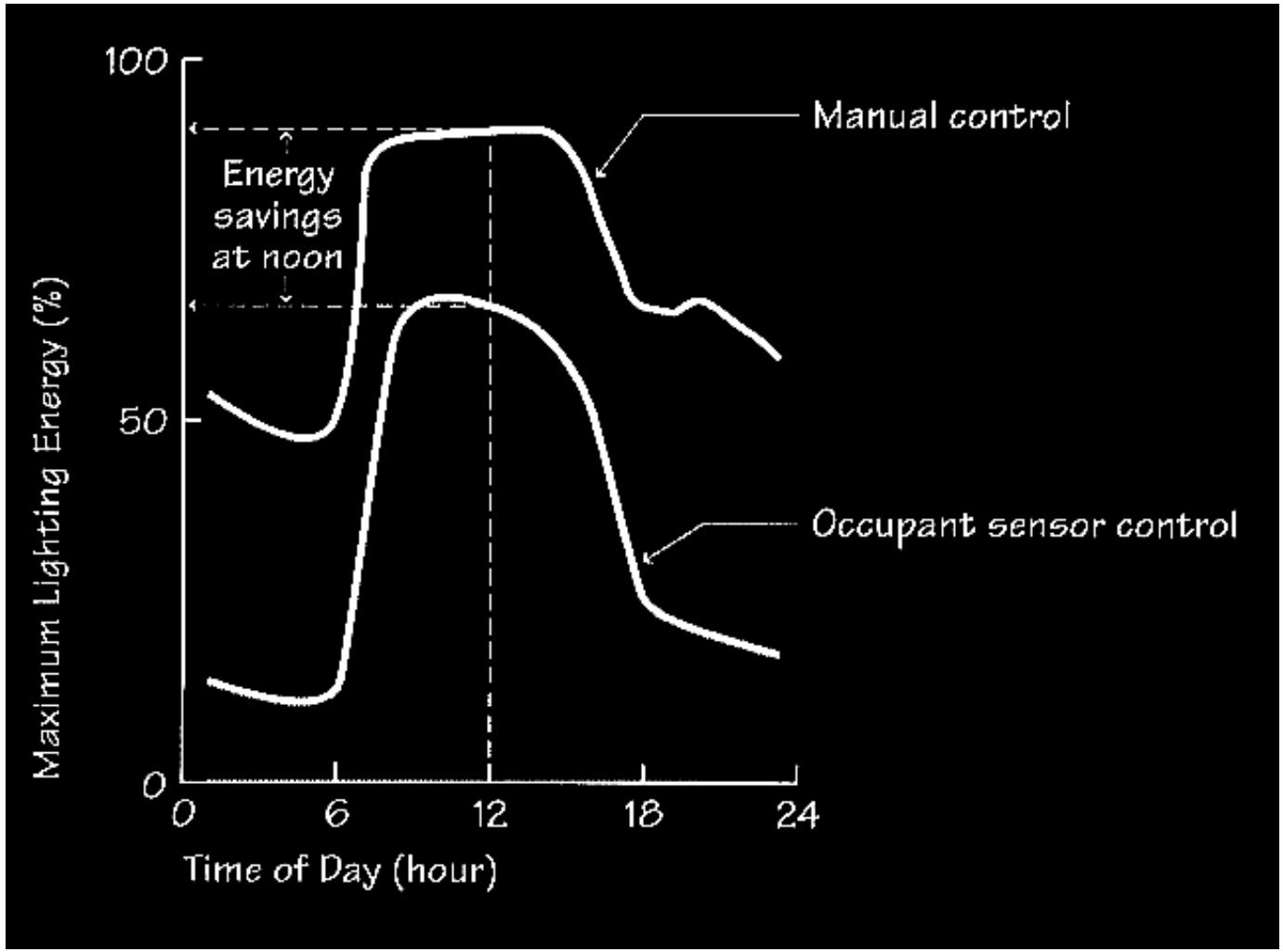
INTERIOR LIGHTING CONTROL STRATEGY

- Sensible use of lighting controls
  - Integration of electric and natural lighting is key
  - Dimming is always more satisfactory than switching when automatically compensating for daylight
- Occupants want to be in control

INTERIOR LIGHTING CONTROL OPTIONS

- Wall box occupancy control (user intervention)
- Ceiling occupancy control (power pack)
- Panel based relay system / stand alone
- Panel based relay system / integrated
- Distributed lighting controls / integrated

INTERIOR LIGHTING CONTROLS



Exit Signs

Section 805.4

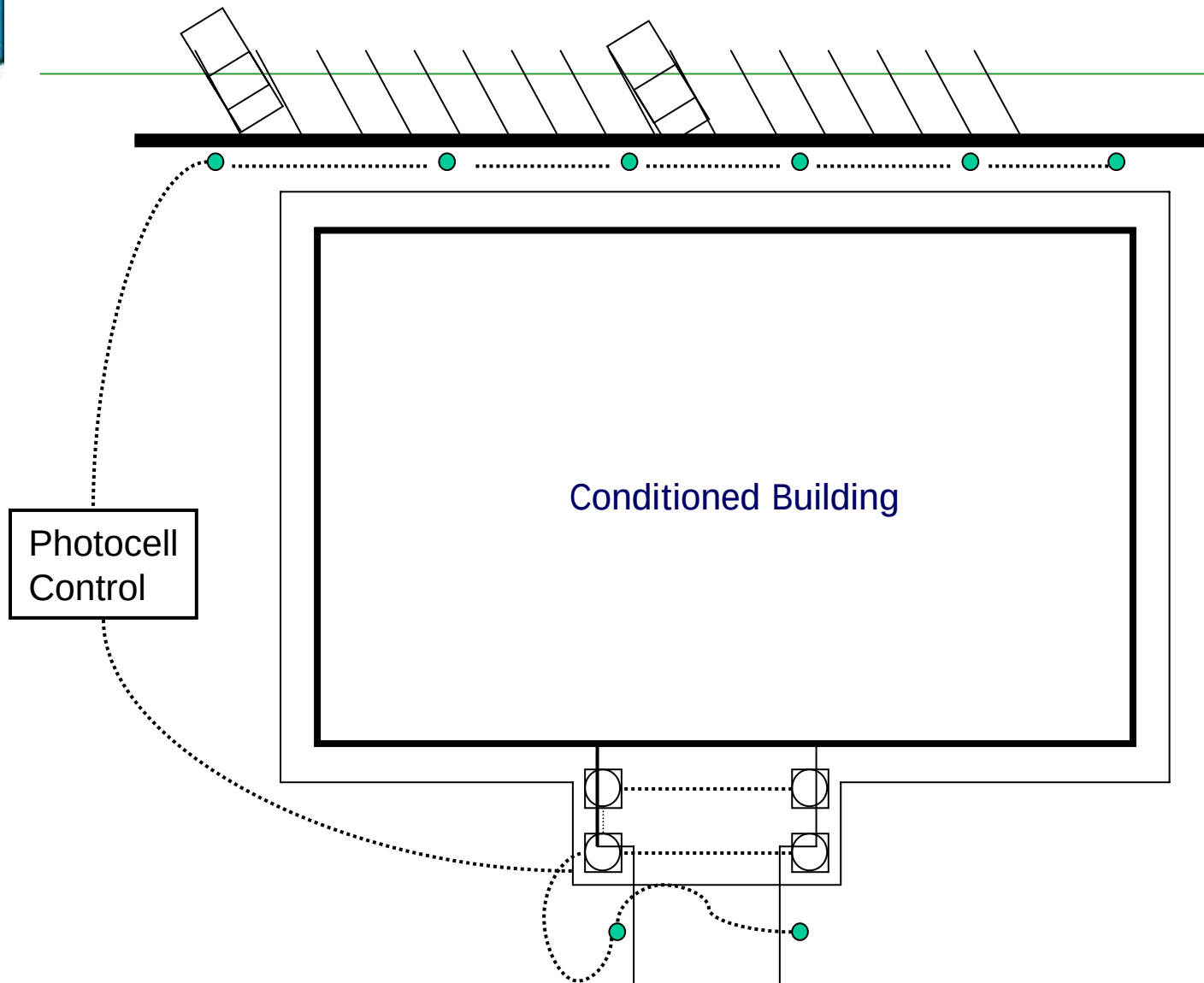
- Internally illuminated exit signs shall not exceed 5 Watts per side

Exterior Lighting Controls

Section 805.2.3

- 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
  - Notes on automatic lighting shutoff devices (bldgs. > 5,000 s.f.)
  - 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

Note: There is a significant increase in stringency of allowances between the 2001 and the 2003 IECC.

Does the Building Comply?

- Determine the total connected power in watts for the proposed lighting
- Determine the interior lighting power budget for the entire building or space from Table 9.3.1.1 or Table 9.3.1.2
- Building complies if:
  - Interior lighting power budget - total connected power $\geq$0 watts

Connected Interior Lighting Power

Sec. 805.5.1

- Total connected interior lighting power is the sum (Watts) of all interior lighting equipment except
  - Medical, dental and research lighting
  - Professional sports playing field lighting
  - Display lighting for exhibits in galleries, museums and monuments
  - Guestroom lighting in hotels, motels, etc.
  - Emergency lighting automatically off during normal operation

Connected Interior Lighting Power

Sec. 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

Interior Lighting Power

Table 805.5.2

Building or Area Type	Entire Building (W/ft^2)	Tenant Area or Portion of Building (W/ft^2)
Auditorium	Not Applicable	1.6/1.8
Automotive facility	0.9	Not Applicable
Bank/financial institution	Not Applicable	2.0/1.5
Classroom/lecture hall	Not Applicable	1.6/1.4
Convention, Conference or meeting center	1.2	1.5/1.3
Corridor, restroom, support area	Not Applicable	0.8/0.9
Courthouse/town hall	1.2	Not Applicable
Dining	Not Applicable	1.4/0.9

Interior Lighting Power

Table 805.5.2

Building or Area Type	Entire Building (W/ft^2)	Tenant Area or Portion of Building (W/ft^2)
Dormitory	1.0	NA
Exercise Center	1.4/1.0	1.1/0.9
Grocery Store	1.9/1.5	2.1/1.6
Hotel function	NA/1.0	2.4/1.3
Industrial <20’ clg.	Not Applicable	2.1/1.2
Industrial ≥20’ clg.	Not Applicable	3.0/1.7
Office	1.3/1.0	1.5/1.1
Parking Garage	0.3	Not Applicable
Restaurant	1.7/1.6	1.7/0.9
Retail sales, showroom	1.9/1.5	2.1/1.7

Additional Lighting Allowances

Table 805.5.2

- Decorative Appearances
  - The lesser of (1.0 w/ft2 x Area of Space) or Actual Wattage of Lighting Equipment + General Lighting Allotments for specific types only
- Applies To
  - Bank/Financial Institutions
  - Convention, Conference or Meeting Center
  - Dining
  - Exercise Center
  - Hotel Function
  - Library
  - Lobby
  - Religious Worship
  - Restaurant
  - Theater - Performance

Additional Lighting Allowances

Table 805.5.2

- Visual Display Terminals
  - The lesser of (0.35 w/ft^2 x Area of Space) or Actual Wattage of Lighting Equipment + General Lighting Allotments

- Applies To
  - Classroom / Lecture Hall
  - Medical & Clinical Care
  - Museum
  - Office

Additional Lighting Allowances

Table 805.5.2

- Merchandise Display Lighting
  - The lesser of (1.6 w/ft^2 x Merchandise Display) or Actual Wattage of Lighting Equipment
  - The lesser of (3.9 w/ft^2 x 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

Additional Lighting Allowances

Table 805.5.2

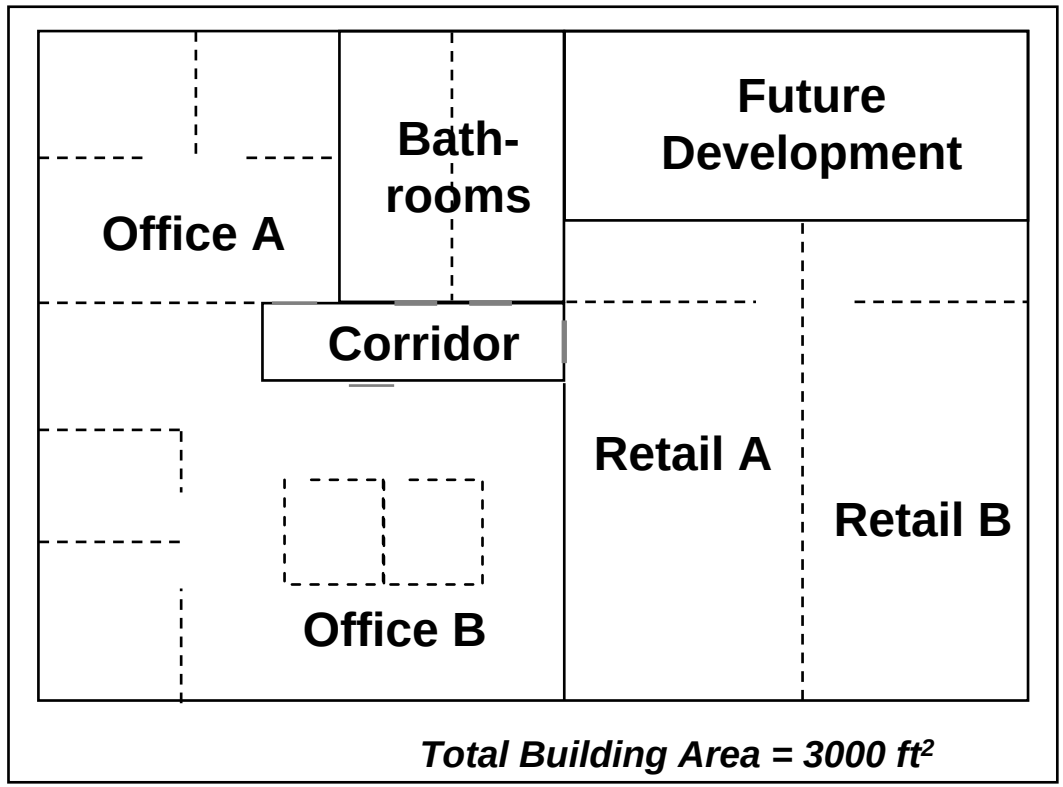
- Emergency, Recovery, Medical Supply, Pharmacy Space
  - The lesser (1.0 w/ft^2 x Area) of Space or Actual Wattage of Lighting Equipment + General Lighting Allotment

- Applies to
  - Medical and Clinic Care

Interior Lighting Power

What is Interior Lighting Power Budget for this Building?

Office A:	**400 ft²**
Office B:	**850 ft²**
Bathrooms:	**350 ft²**
Corridor:	**50 ft²**
Retail A:	**500 ft²**
Retail B:	**500 ft²**
Future:	**350 ft²**



Interior Lighting Power Budgets

Office A: $400ft^2$ x _____ w/ft^2 = _____watts

Office B: $850ft^2$ x _____ w/ft^2 = _____watts

Bathrooms: $350ft^2$ x _____ w/ft^2 = _____watts

Corridor: $50ft^2$ x _____ w/ft^2 = _____watts

Retail A: $500ft^2$ x _____ w/ft^2 = _____watts

Retail B: $500ft^2$ x _____ w/ft^2 = _____watts

Future: ?

TOTAL _____ watts

INTERIOR LIGHTING DESIGN STRATEGIES

- Light where you need it
- Sensible use of lighting techniques
  - General lighting
  - Accent lighting
  - Task lighting

INTERIOR LIGHTING DESIGN STRATEGIES

- Sensible use of sources and equipment
  - Careful consideration of lamp and ballast
  - T8 and T5 debate
  - Compact fluorescent
  - Metal halide
  - Halogen
  - Incandescent
  - Halogen / IR
  - LED and others

CARVER MUSEUM & LIBRARY

AUSTIN, TEXAS

14,700 SF

LEED SILVER

1.2 w/sf	1.6 w/sf	1.6 w/sf	1.1 w/sf	1.1 w/sf
ACTUAL	90.1-1999	IECC-2001	IECC-2003	90.1-2004

SHANGRI LA BOTANICAL GARDEN

ORANGE, TEXAS (BEGINS CONSTRUCTION JULY 2005)

14,400 SF

LEED GOLD/PLATINUM

REQUIRES SPACE-BY-SPACE METHOD

1.1 w/sf	1.4 w/sf			
ACTUAL	**90.1-1999**	**IECC-2001**	**IECC-2003**	**90.1-2004**

SABRE CORPORATE CAMPUS

SOUTHLAKE, TEXAS

415,000 SF

LEED SILVER

1.1 w/sf	1.3 w/sf	1.3 w/sf	1.0 w/sf	1.0 w/sf
ACTUAL	90.1-1999	IECC-2001	IECC-2003	90.1-2004

AUSTIN CITY HALL

AUSTIN, TEXAS

117,000 SF

LEED SILVER

1.2 w/sf	1.4 w/sf	1.4 w/sf	1.1 w/sf	1.1 w/sf
ACTUAL	90.1-1999	IECC-2001	IECC-2003	90.1-2004

ASHRAE 90.1

New 90.1 Lighting Table 9.3.1.1

Lighting Power Densities Using the Building Area Method

	Lighting Power Density (W/ft2)		
	1999-2001	**Amend. "g"**	**2003 !ECC**
Automotive Facility	1.5	0.9	0.9
Convention Center	1.4	1.2	1.2
Court House	1.4	1.2	1.2
Dining: Bar Lounge/Leisure	1.5	1.3	--
Dining: Cafeteria/Fast Food	1.8	1.4	--
Dining: Family	1.9	1.6	--
Dormitory	1.5	1.0	1.0
Exercise Center	1.4	1.0	1.0
Gymnasium	1.7	1.1	--
Healthcare-Clinic	1.0	1.0	1.2
Hospital/Healthcare	1.6	1.2	1.2
Hotel	1.7	1.0	1.0
Library	1.5	1.3	1.3
Manufacturing Facility	2.2	1.3	--
Motel	2.0	1.0	1.0

	Lighting Power Density (W/ft2)		
	1999-2001	Amend. “g”	2003 !ECC
Motion Picture Theatre	1.6	1.2	--
Multi-Family	1.0	0.7	0.7
Museum	1.6	1.1	1.1
Office	1.3	1.0	1.0
Parking Garage	0.3	0.3	0.3
Penitentiary	1.2	1.0	1.0
Performing Arts Theatre	1.5	1.6	1.6
Police/Fire Station	1.3	1.0	1.0
Post Office	1.6	1.1	1.1
Religious Building	2.2	1.3	1.3
Retail	1.9	1.5	1.5
School/University	1.5	1.2	1.2
Sports Arena	1.5	1.1	1.
Town Hall	1.4	1.1	1.2
Transportation	1.2	1.0	1.0
Warehouse	1.2	0.8	0.8
Workshop	1.7	1.4	--

AUSTIN CITY HALL/90.1-2004 STRATEGIES

ALL TWO LAMP F32T8	LM/W	WATTS	QTY	TOTAL W
FO32/XP & IS @ 0.89 BF	92	59	900	53,100
FO28/XP/SS & PROG START @ 0.71 BF	97	40	900	36,000
WATTS SAVED				17,100
NEW WATTAGE DENSITY				1.07 w/sf

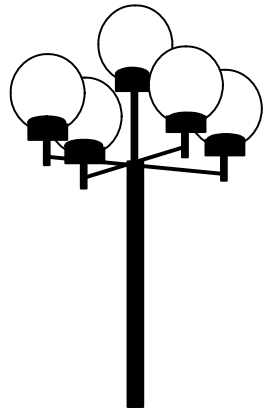
ADDITIONAL COST FOR UPGRADE $6,000

ANNUAL COST SAVINGS AT $0.07/KWH $3,000

1.2 w/sf	1.4 w/sf	1.4 w/sf	1.1 w/sf	1.1 w/sf
ACTUAL	90.1-1999	IECC-2001	IECC-2003	90.1-2004

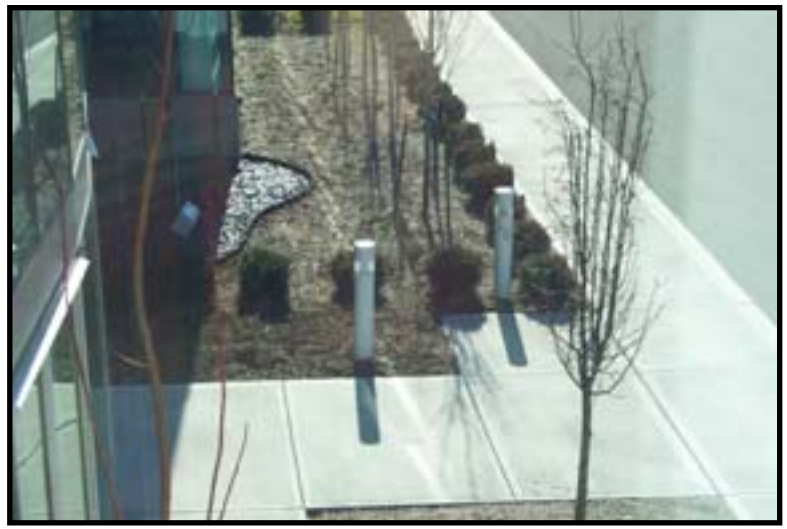
Exterior Lighting

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

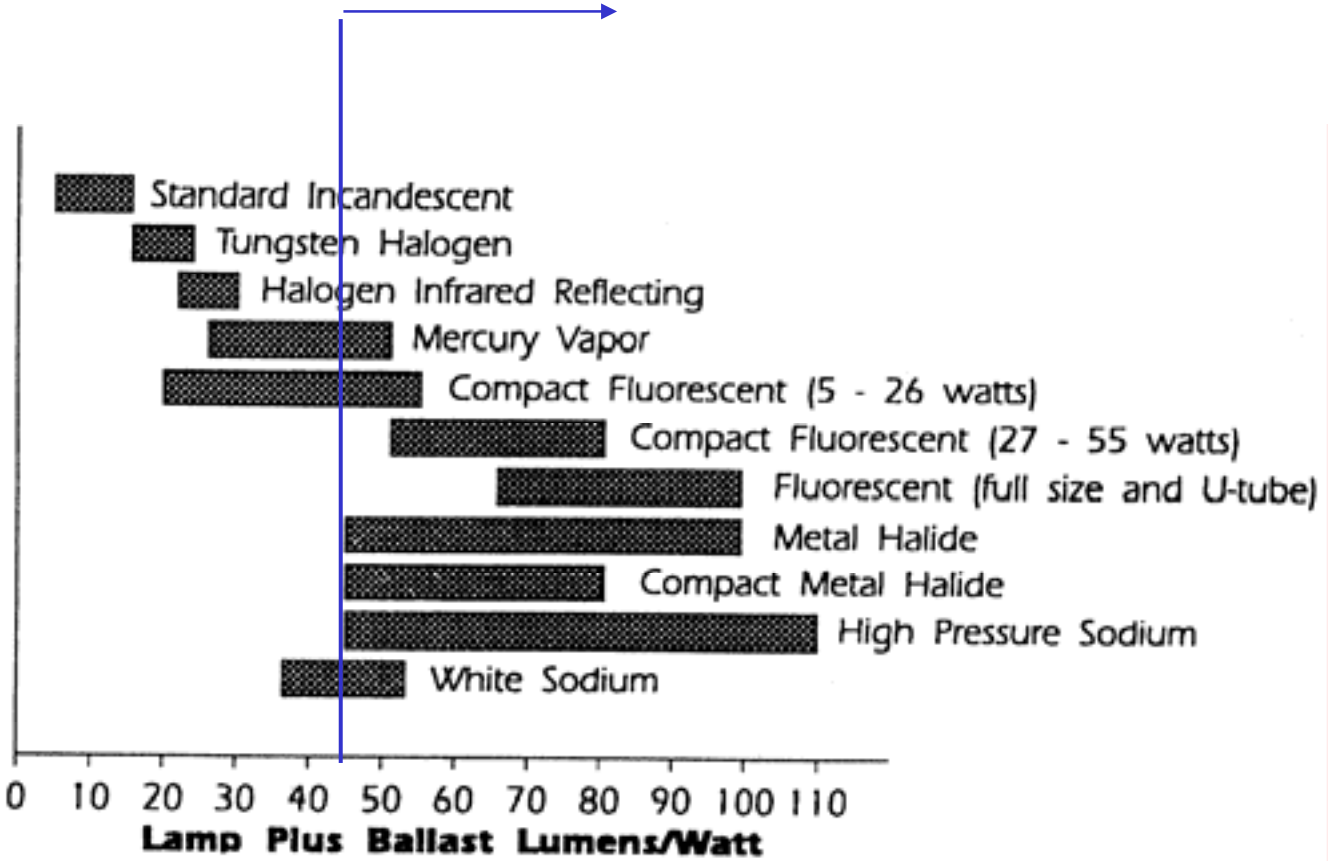
Exterior Lighting



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 = 480 lumens
  - 40 watt fluorescent = 2640 lumens

Energy Efficient Lighting Sources



Exterior Lighting

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

IECC/ASHRAE

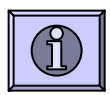
- Can I use one code for the interior and the other for exterior?
- **No.** ALL lighting requirements must be met under whichever code the designer has chosen.

ASHRAE 90.1-1999, 2001

Exterior Building Lighting Power

(Section 9.3.2)

- Façade lighting ≤ .25 W/sf of illuminated area
- Sum of all lighting power allowances for applicable exterior building applications
  - Building entrance with canopy – 3 W/ft^2
  - Building entrance – 33 W/linear ft
  - Building exit – 20 W/linear ft
- Exceptions, when equipped with independent control device…



ASHRAE 90.1Exterior Lighting

Exceptions

- When equipped with a control device
  - Specialized signal, directional, and marker lighting associated with transportation
  - Highlighting Public monuments or Registered historic landmark structures or buildings
  - Lighting integral to advertising signage

NCTCOG Lighting Amendments

Amend Section 805.6:

- Exterior Lighting. All permanently installed outdoor luminaires that operate at greater than 100 watts, shall have a source efficacy of 60 [instead of 45] lumens per Watt.

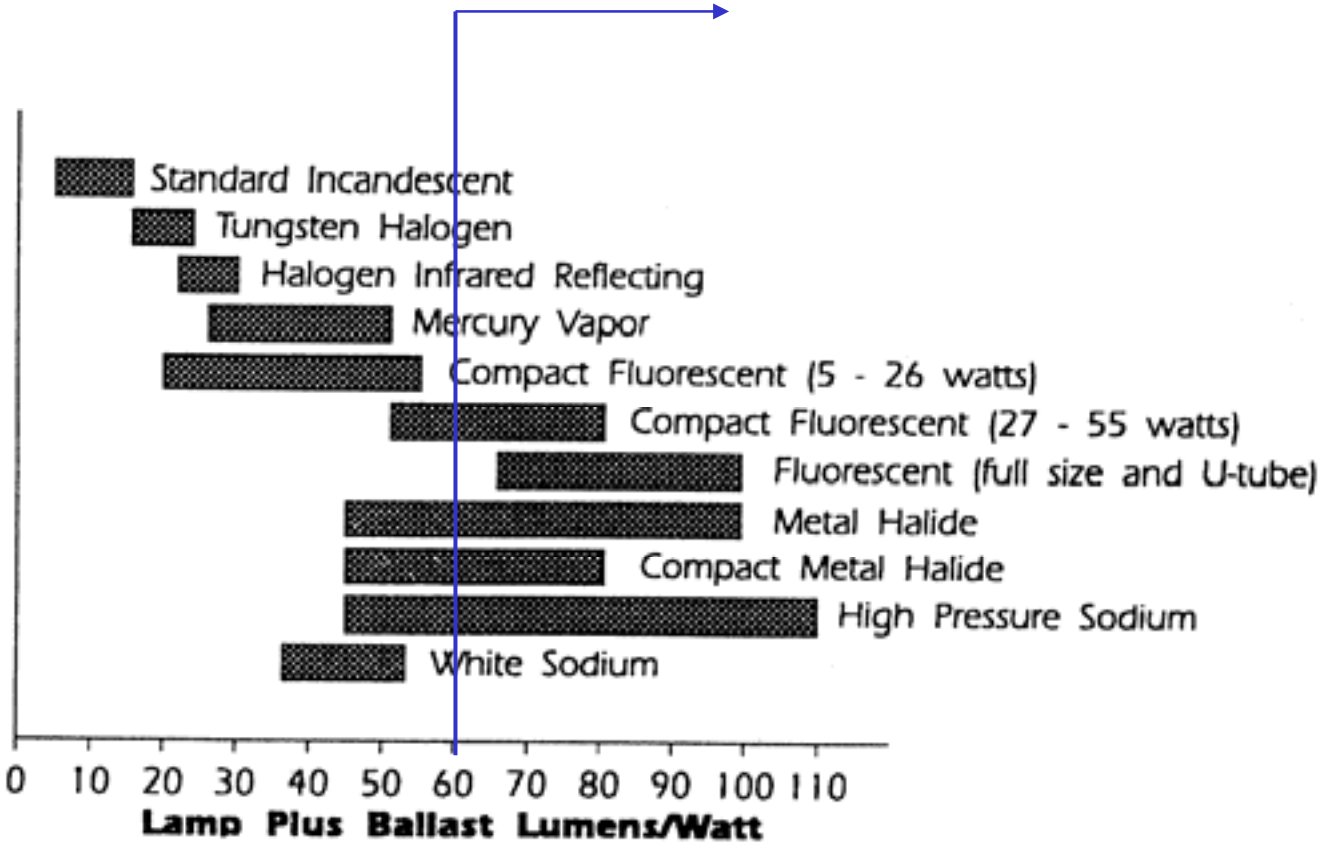
  Exceptions:

  1) Where approved because of historical, safety, signage or emergency

  considerations; or

  2) Where controlled by a motion sensor.

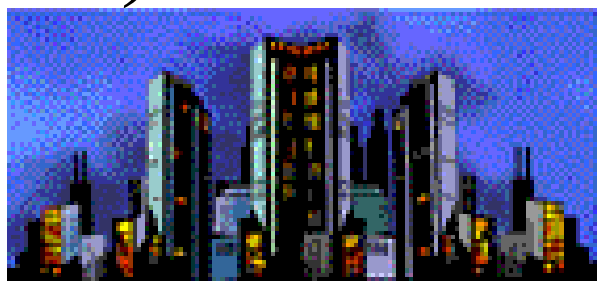
Energy Efficient Lighting Sources



ASHRAE 90.1-2004

General Formatting

- General Application *(Section 9.1)*
- Compliance Paths *(Section 9.2)*
- Mandatory Provisions *(Section 9.4)*
  - Lighting controls
  - Tandem wiring
  - Exit signs
  - Installed interior lighting power
  - Luminaire wattage
  - Exterior building grounds lighting



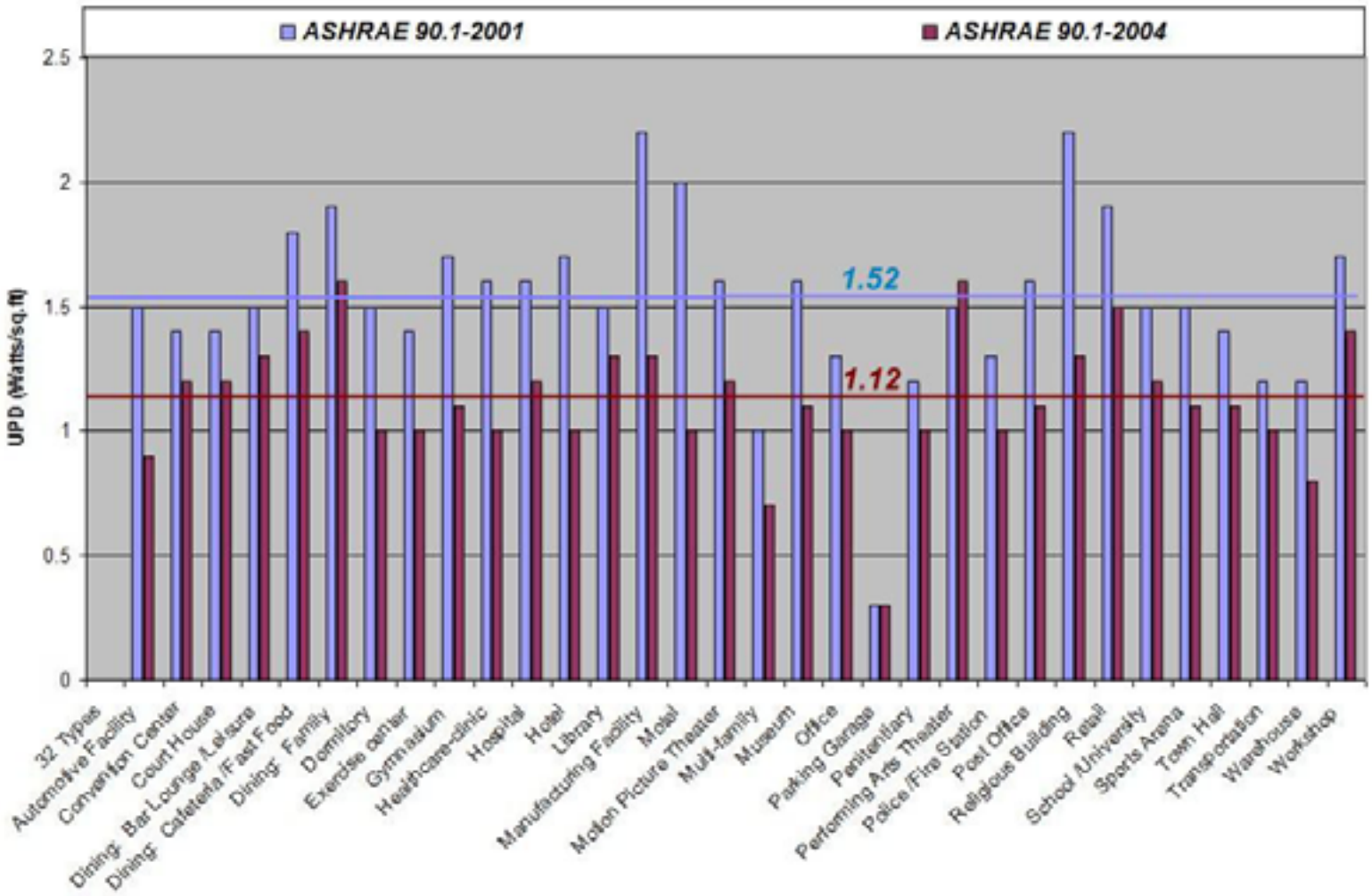
- Building Area Compliance Path *(Section 9.5)*
- Space-by-Space Compliance Path (*Section 9.6*)

ASHRAE 90.1-2004

New Requirements

- Power limits added for exterior lighting categories (e.g. – walkways, parking lots, ATMs).
- Exit signs wattage reduced to 5W per face.
- Interior power allowances significantly reduced.

ASHRAE 90.1-2004



ASHRAE 90.1-2004

Lighting Power Limits for Building Exteriors

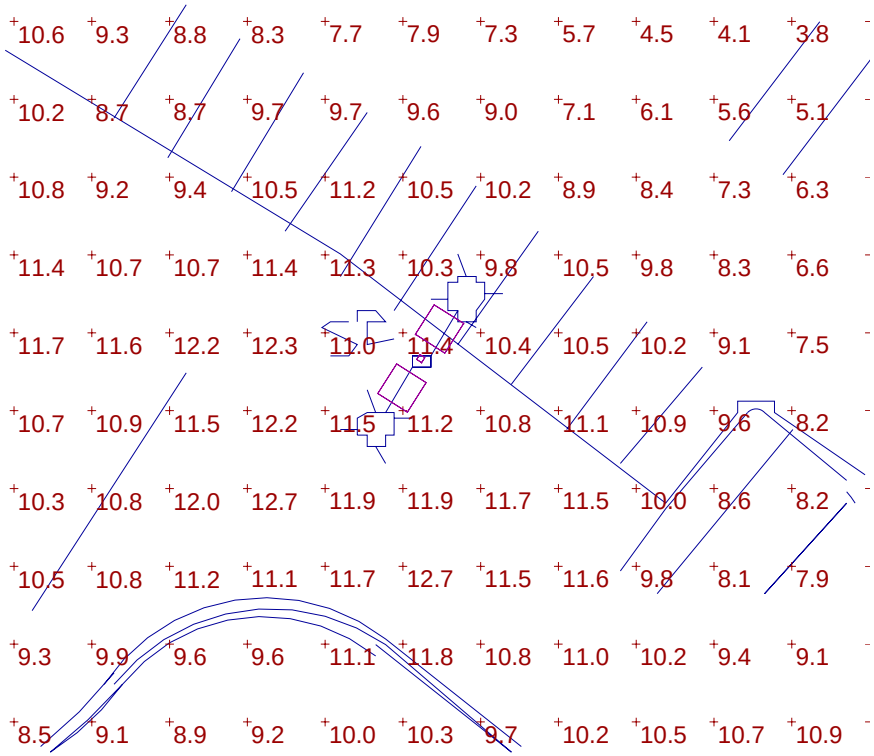
Table 9.4.5

Uncovered Parking Areas Parking lots and drives	**0.15** W/ft^2
Building Grounds	
Walkways < 10 feet wide	**1.0** W/lin. ft.
Walkways >10' wide, plazas, special feature areas	**0.2** W/ft^2
Stairways	**1.0** W/ft^2
Building Entrances and Exits	
Main entrances	**30** W/lin. ft. of door width
Other doors	**20** W/lin. ft. of door width
Canopies & Overhangs... Free standing or attached	**1.25** W/ft^2
Outdoor Sales	
Open areas (incl. vehicle sales lots)	**0.5** W/ft^2
Street frontage for vehicle sales lot (additional)	**20** W/lin. ft.
Note: The above items are "Tradable Surfaces" among themselves. The ones below are NOT.	
Building Facades	**0.2** W/ft^2 or **5.0** W/lin. ft. for ea. wall or surface
Automatic teller machines & night depositories	**270** W for 1st ATM plus **90** W per ATM
Entrances & gatehouse inspection stations	**1.25** W/ft^2 of uncovered area
Loading areas police, fire, ambulance, etc.	**0.5** W/ft^2 of uncovered area
Drive-up windows at fast-food restaurants	**400** W per drive-through
Parking near 24-hr retail entrances	**800** W per main entry

ASHRAE 90.1-2004 & EXTERIOR LIGHTING

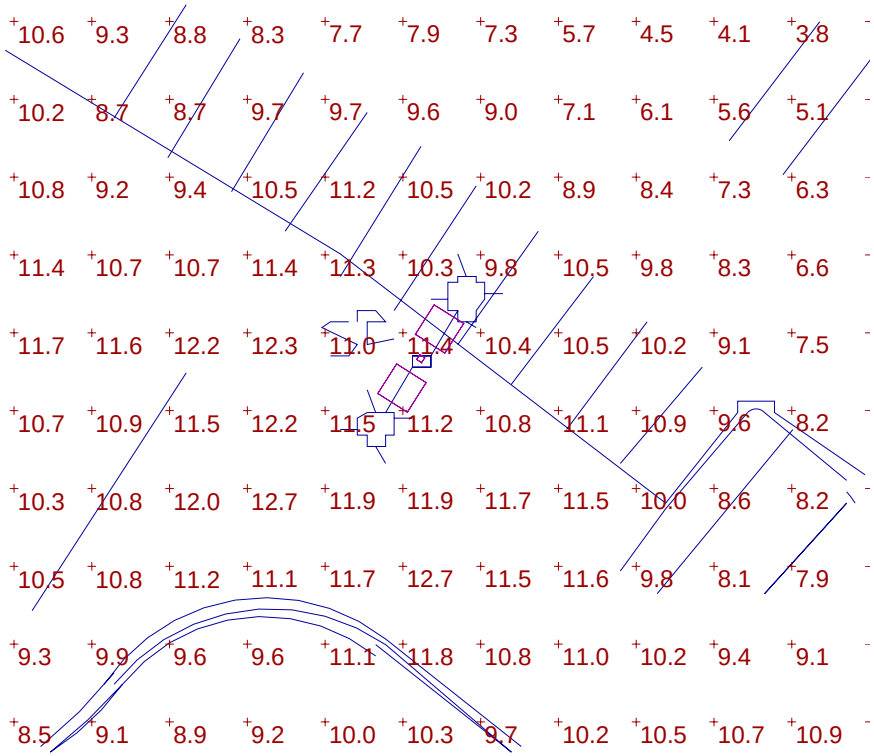
- ASHRAE 90.1-1999 does not limit exterior lighting, except building entrances and canopies
- ASHRAE 90.1-2004 includes wattage limits on exterior lighting

ASHRAE 90.1-2004 & EXTERIOR LIGHTING

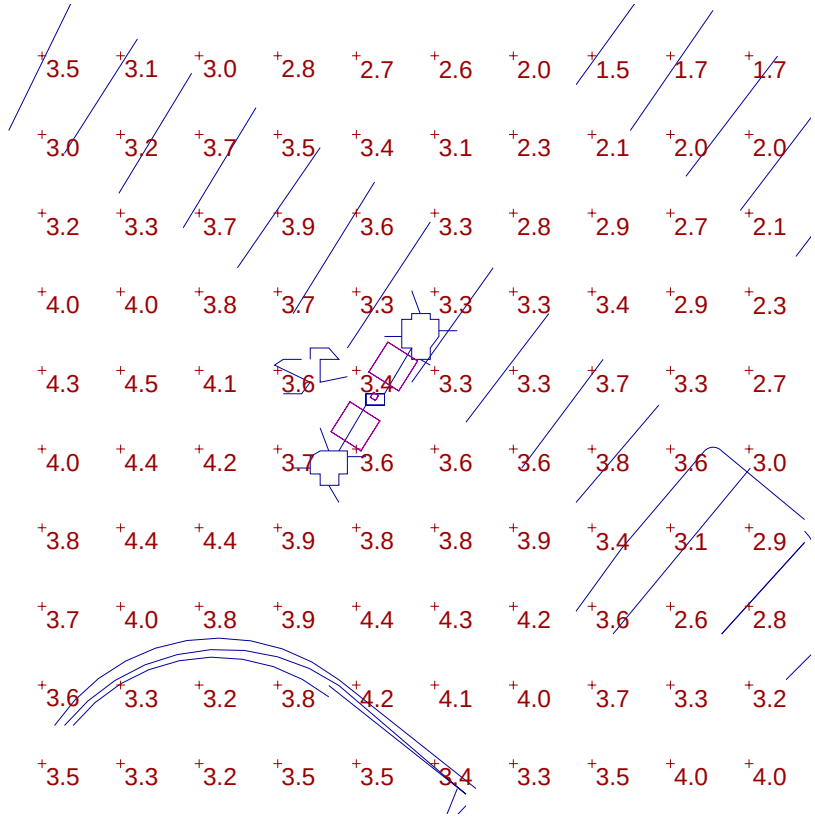


1,000 WATT METAL HALIDE @ 30 FT

ASHRAE 90.1-2004 & EXTERIOR LIGHTING



1,000 WATT METAL HALIDE @ 30 FT



400 WATT METAL HALIDE @ 30 FT

Demonstrating Compliance

Section 104

- Include the following information on the electrical plans
  - Schedule source types/efficacy
  - Make/model of exterior lighting controls

COMcheck v3.0

Lighting Application Worksheet
Standard 90.1-1999

COM*check-EZ* Software Version 3.0 Release 1a

Section 1: Allowed Lighting Power Calculation

A Area Category	B Floor Area (ft2)	C Allowed Watts (watts/ft2)	D Total Allowed Watts (B x C)
Common Space Types:Lobby	340	1.8	612
Common Space Types:Lobby	935	1.8	1683
Common Space Types:Conference/Meeting/Multipu	419	1.5	628
Common Space Types:Conference/Meeting/Multipu	1003	1.5	1504
Common Space Types:Stairs-Active	255	0.9	230
Common Space Types:Conference/Meeting/Multipu	512	1.5	768
Allowance(s) common to all activity types:			
Allowance: Decorative Appearance / Fix. ID: L04	658(a)	1	350(b)
Allowance: Decorative Appearance / Fix. ID: L03	935(a)	1	500(b)
Allowance: Decorative Appearance / Fix. ID: L02	935(a)	1	150(b)
Allowance: Decorative Appearance / Fix. ID: L01	935(a)	1	200(b)

(a) Area claimed must not exceed the illuminated area permitted for this allowance type.
(b) Allowance is (B x C) or the actual wattage of the fixtures given in Section 2, whichever is less.

Total Allowed Watts = 6626

COMcheck v3.0

Section 2: Actual Lighting Power Calculation

A Fixture ID	B Fixture Description / Lamp Description / Wattage Per Lamp / Ballast	C Lamps/ Fixture	D # of Fixtures	E Fixture Watt.	F (D x E)
F08	COVE / 48" T8 32W / Electronic	2	6	177	1062
F09	COVE / 48" T8 32W / Electronic	1	8	30	240
F07	INDIRECT PENDANT / 48" T8 32W / Electronic	6	1	177	177
F06	INDIRECT PENDANT / 48" T8 32W / Electronic	4	1	118	118
F10	PARABOLIC / 24" T8U 32W / Electronic	3	17	89	1513
F13	FLUOR COVE / 36" T8 25W / Electronic	1	2	28	56
F01	DOWNLIGHT / Triple 4-pin 26W / Electronic	1	2	28	56
F05	DOWNLIGHT / Triple 4-pin 26W / Electronic	1	2	28	56
F11	DOWNLIGHT, DIMMED / Other / Electronic	1	33	33	1089
F02	DOWNLIGHT / Triple 4-pin 26W / Electronic	1	2	28	56
F12	WALLWASH, DIMMED / Other / Electronic	1	7	33	231
F04	DOWNLIGHT / Triple 4-pin 18W / Electronic	1	4	20	80
F03	DOWNLIGHT / Triple 4-pin 26W / Electronic	1	2	28	56
H01	DOWNLIGHT FOR PLANTS / MH 150W / Electronic Exemption: Exemption:Plant Growth Lighting	1	3	167	Exempt
L01	DOWNLIGHT / Incandescent 50W	1	4	50	200
L02	DOWNLIGHT / Incandescent 50W	1	3	50	150
L03	WALL WASH / Incandescent 50W	1	10	50	500
L04	WALL WASH / Other	1	10	35	350
			Total Actual Watts =		5990

COMcheck v3.0

Lighting and Power Compliance Certificate
Standard 90.1-1999

Checked By/Date

COM*check-EZ* Software Version 3.0 Release 1a
Data filename: M:\Projects\LLOYD GOSSELINK 0504\DOCUMENTS\OTHER\GOSSELINK ENERGY BUDGET 061505.cck

Section 1: Project Information

Project Name: LLOYD GOSSELINK
Designer/Contractor: ARCHILLUME LIGHTING DESIGN
Document Author: ADAM BUSH

Section 2: General Information

Building Use Description by: Activity Type
Project Type: New Construction

Activity Type(s)	Floor Area
Common Space Types:Lobby	340
Common Space Types:Lobby	935
Common Space Types:Conference/Meeting/Multipurpose	419
Common Space Types:Conference/Meeting/Multipurpose	1003
Common Space Types:Stairs-Active	255
Common Space Types:Conference/Meeting/Multipurpose	512

Section 3: Requirements Checklist

Bldg. Dept. Use	
[ ]	**Interior Lighting**
	1. Total actual watts must be less than or equal to total allowed watts

Allowed Watts	Actual Watts	Complies(Y/N)
6626	5990	YES

SPREADSHEET MODEL

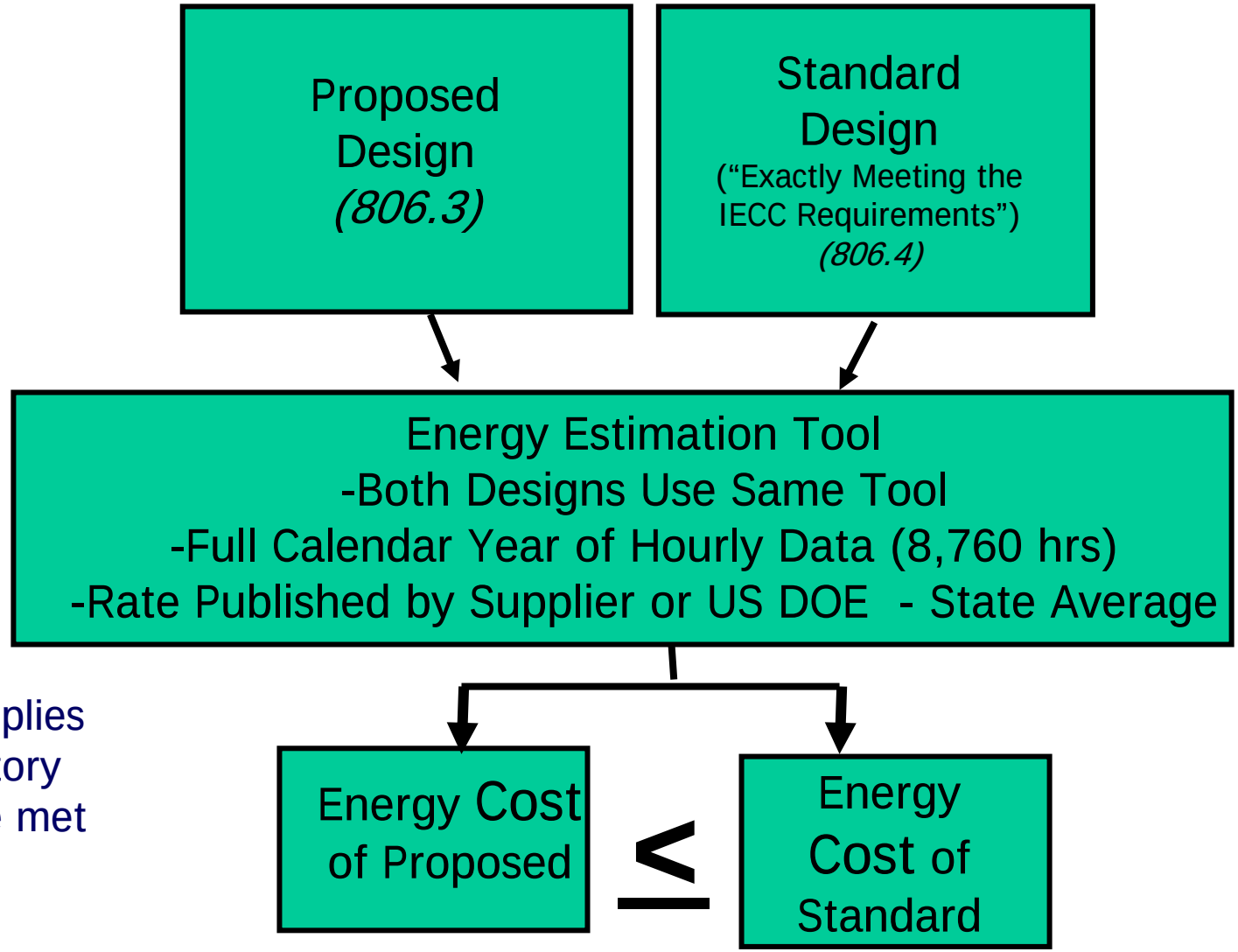
		ACTUAL			ACTUAL				
REF	**AREA ID BY USE**	**AREA**	**UPD**	**BUDGET**	**MARK**	**WATTS**	**QTY**	ACTUAL	**COMMENTS**
1001	**RETAIL**	**1322**	**2.10**					0	
1002	ENTRY	169	1.80	304	F15	29	2	58	
1003	PUBLIC VENDING	574	1.40	804	F13	29	8	232	
1004	TEL/COM	92	1.30	120	F31	61	2	122	
1005	CORRIDOR	167	0.70	117	F15	29	7	203	
1006	CITY STAFF BULLPEN	868	1.65	1432	F02	114	7	798	
1006	CITY STAFF BULLPEN				F15	29	3	87	
1006	CITY STAFF BULLPEN				F16	29	3	87	
1006	CITY STAFF BULLPEN				F55	61	1	61	
STAIR 1	STAIRWAY	267	0.90	240	F20	61	3	183	
STAIR 3	STAIRWAY	270	0.90	243	F20	61	4	244	
STAIR 4	STAIRWAY	255	0.90	230	F20	61	3	183	
STAIR 2	STAIRWAY	270	0.90	243	F20	61	2	122	
	TOTALS BY COLUMN	**31101**		**38027**				37034	
								97.4%	% OF ALLOWABLE
				1.22				1.191	WATTS PER SF

SPREADSHEET MODEL

NEW CONSTRUCTION
PERMIT ADDRESS: 301 WEST SECOND STREET
AUSTIN, TEXAS 78701
APPLICATION DATE: 11/22/2002
PROPOSE OCCUPANCY: OFFICE
CERTIFYING ARCHITECT: CHARLES K. THOMPSON, AIA, IALD, LC
ARCHILLUME LIGHTING DESIGN, INC.
PHONE: 512-346-1386

		WATTS				
	SF	ALLOWABLE	ACTUAL	ASHRAE BUILDING ALLOWABLE	W/SF	
EXTERIOR	NA	40,628.7	17,136.0	**2.590**	**1.09**	**42.18%**
INTERIOR						
BASEMENT	11,561.0	13,758.3	10,295.0	1.19	0.89	
LEVEL 1	31,101.0	38,027.2	37,034.0	1.223	1.191	
LEVEL 2	25,118.0	32,467.2	27,388.0	1.293	1.090	
LEVEL 3	23,555.0	29,730.4	27,220.0	1.262	1.156	
LEVEL 4	21,150.0	26,102.3	23,399.0	1.234	1.106	
LEVEL 4.5	4,030.0	5,167.8	1,095.0	1.282	0.272	
TOTALS BY COLUMN	**116,515.0**	**145,253.2**	**126,431.0**	**1.247**	**1.085**	**87.04%**
(ROOM BY ROOM)						
	SF					
BLDG METHOD	**116,515.0**	**163,121.0**	**126,431.0**	**1.300**	**1.085**	**77.51%**
UPD	1.4	W/SF				

Total Building Performance



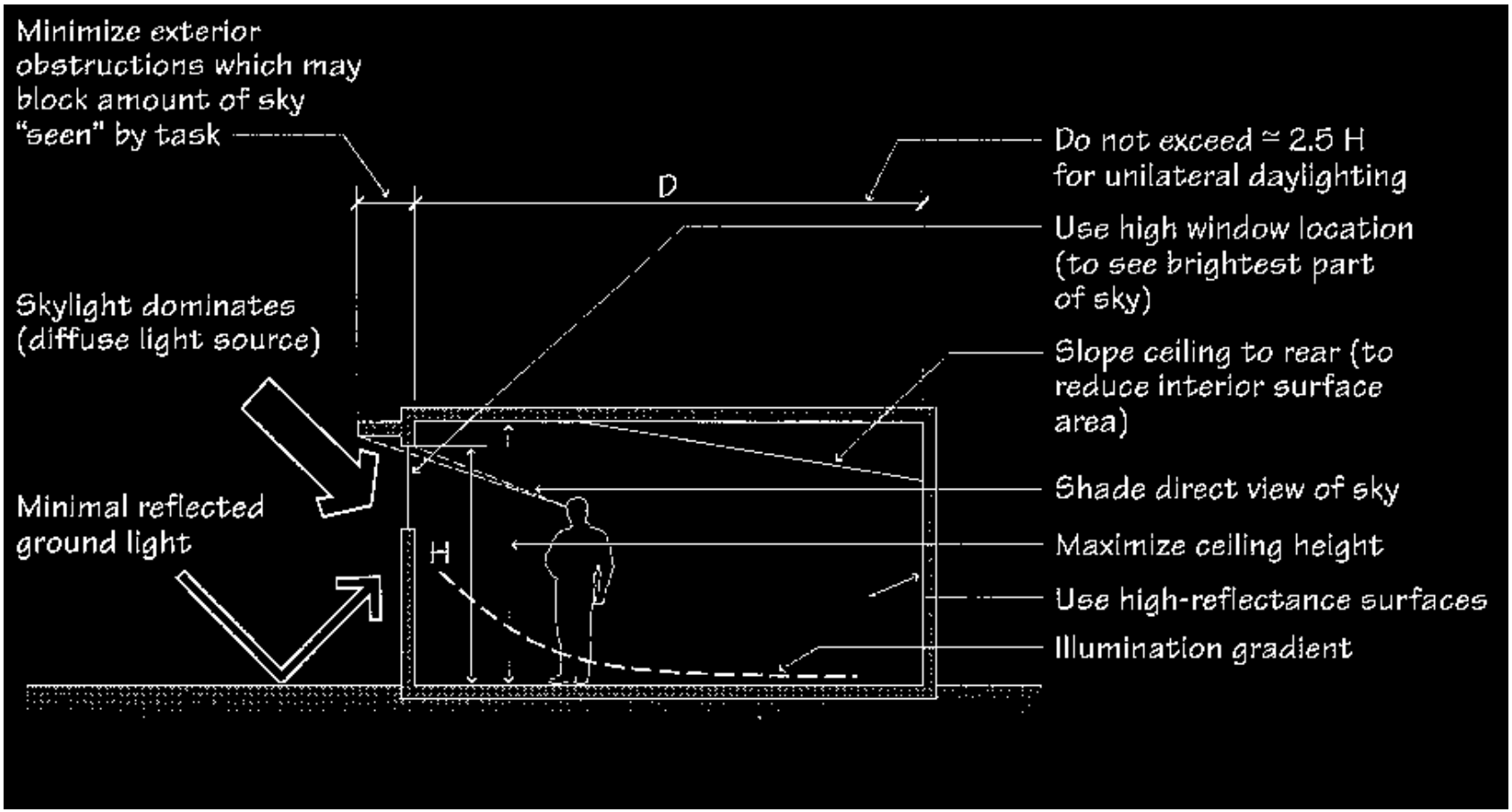
(Building complies if all mandatory provisions are met and...)

INTERIOR DAYLIGHTING STRATEGIES

INTERIOR DAYLIGHTING STRATEGIES

- MUST be integrated from beginning
- Site selection a major impact
- Form follows function for building footprint, orientation
- Form follows function on bay depth (2.5 x window head height)
- Form follows function for fenestration, window treatment, finishes, landscape…

DAYLIGHTING DESIGN STRATEGIES



CONCEPTS IN ARCHITECTURAL LIGHTING, SECOND EDITION,
M. David Egan and Victor Olgyay

Lighting Documentation

- Include the following information on the electrical plans
  - Switching schemes
  - Notes on automatic lighting shutoff devices (bldgs. > 5,000 s.f.)
  - Make/model of exterior lighting controls
  - Notes for tandem wiring
  - Display areas/allowance additions
  - Lighting schedule with types, installed wattage
  - Exterior source types/efficacy

Predictable Problem Areas

- Bi-level switching of lighting
- Automatic lighting shutoff
- Track lighting wattage
- Screw lamp holder wattage
- Display lighting allowances
- Medical lighting allowances
- Exterior lighting controls
- Exterior lighting efficacy requirements

TRICKS OF THE TRADE FOR DESIGNERS

- Custom labeling of fixture wattage
- Halogen IR lamps
- Overcurrent protection on track to limit wattage
- Multi-volt and multi-watt ballasts
- Maximizing system design
- Keep an open mind
- Beware of boutique products

Sample Question

- Which of the following interior building areas are not required to have bi-level light switching?
  a. Areas that are used for public meetings.
  b. Areas designated as libraries.
  c. An enclosed office space.
  d. Areas that are controlled by an occupant–sensing device.

Sample Question

- When calculating interior lighting power according to the entire building method, what is the total allowable wattage of a 30,000 square foot office building?
  a. 30,000 watts
  b. 33,000 watts
  c. 40,000 watts
  d. 45,000 watts

Sample Question

- When calculating interior lighting power according to the tenant area or portion of building method, what is the total allowable wattage of a 10,000 square foot retail space?
  a. 15,000 watts
  b. 17,000 watts
  c. 19,000 watts
  d. 21,000 watts

Sample Question

- Under the 2003 IECC, automatic lighting shutoff must be installed in buildings larger than:
  a. 3,000 Square Feet
  b. 5,000 Square Feet
  c. 10,000 Square Feet
  d. 20,000 Square Feet

Sample Question

- When documenting the total connected lighting power for a proposed building what wattage should be used for a screw lamp holder?
  a. Wattage of the light bulb proposed for the fixture
  b. 100 watts per fixture
  c. Maximum labeled wattage of the luminaire
  d. 150 watts per fixture

Questions?

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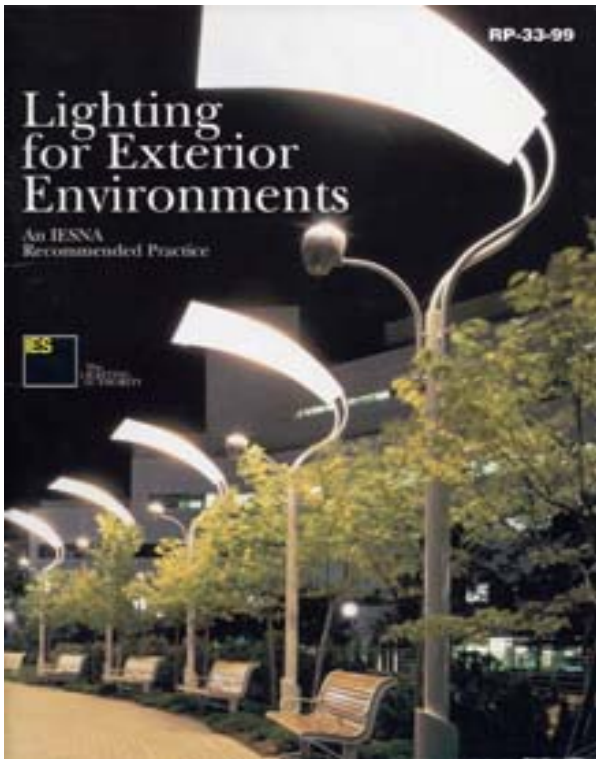
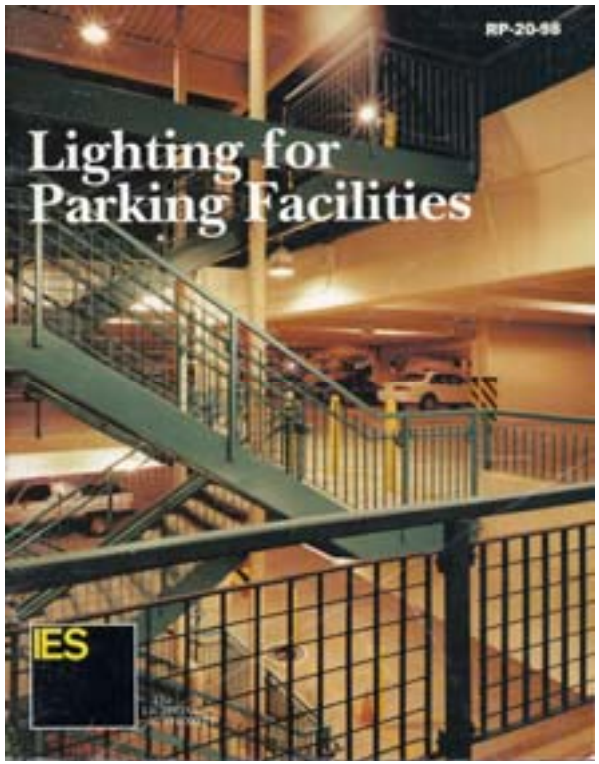
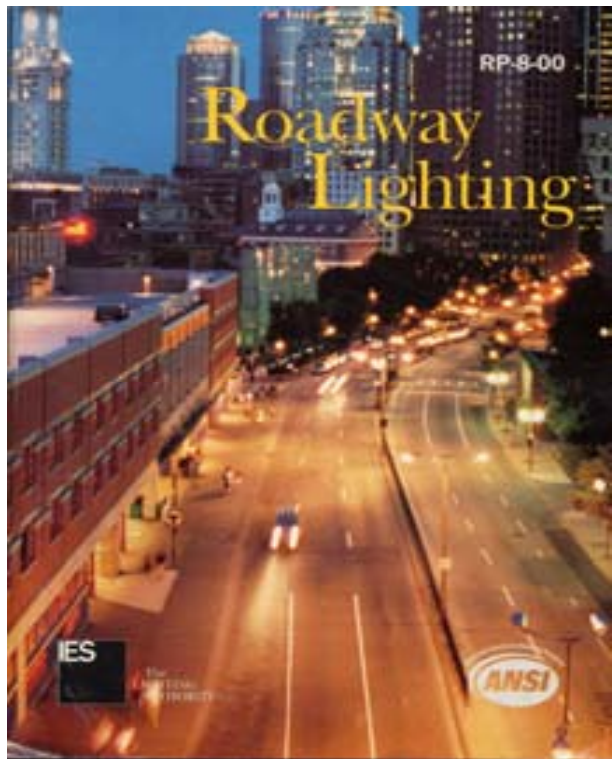
Resources

- www.lighting???.com
- www.???lighting.com
- www.iesna.org
- www.iald.org
- www.ncqlp.org
- www.lightfair.com
- www.energycodes.gov
- www.lighting.com
- www.darksky.com

Resources

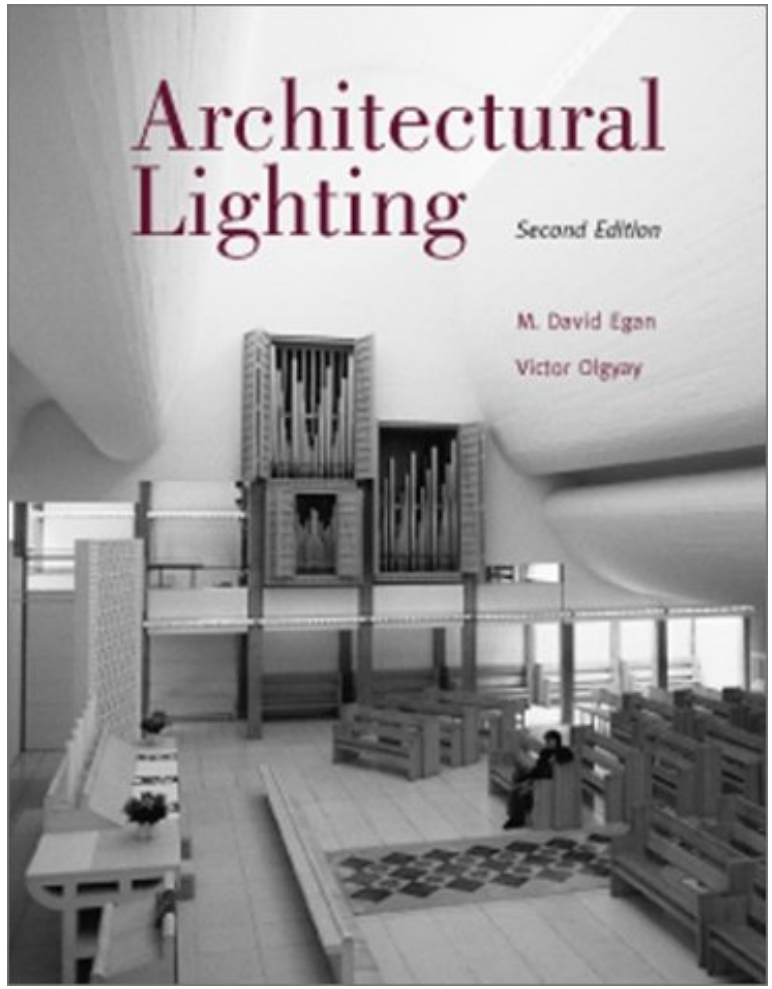

RP-33-99
Lighting for Exterior Environments
An IESNA Recommended Practice
IES


RP-20-98
Lighting for Parking Facilities
IES


RP-8-00
Roadway Lighting
IES
ANSI

Resources

ARCHITECTURAL LIGHTING Second Edition by M. David Egan and Victor Olgyay



Thanks!

- Energy Systems Laboratory
  http://energysystems.tamu.edu
- Tom Fitzpatrick (512) 475-6982
- Charles Thompson, ckt@archillume.com

- ***Air Quality 2005****: Energy Leadership &Emissions Reduction Conference*, November 7-10, 2005; Crowne Plaza - Dallas Market Center, Dallas, TX