

PG&E Pacific Energy Center

Provider Number: H663

Title 24 - Where We're Headed with the 2016 Nonresidential Standards - 16WS

Martyn Dodd

Aug 18, 2016



Credit(s) earned on completion of this course will be reported to **AIA CES** for AIA members.

Certificates of Completion for both AIA members and non-AIA members are available upon request.

This course is registered with **AIA CES** for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Course Description

The 2016 Title 24 Building Energy Standards will be more stringent than prior versions as we move closer to ZNE. The new standards are intended to reduce peak energy consumption and slow the growth in demand for electricity and natural gas in California. Martyn Dodd will summarize the new and revised requirements in the 2016 standards for nonresidential buildings and direct participants to informational and training resources that provide more in-depth Title 24 information. Architects, engineers, lighting designers, energy consultants, contractors, and building department staff should find this training of interest and directly applicable to their work. Participants will benefit if they have some background on California's Title 24 Building Energy Standards. See: <http://www.energy.ca.gov/title24/>

Learning Objectives

At the conclusion of the program:

1. Will have an overview understanding of changes in scope, and new and revised mandatory and prescriptive requirements for nonresidential building envelope in the 2016 Title 24 Energy Standards;
2. Will have an overview understanding of changes in scope, and new and revised mandatory and prescriptive requirements for nonresidential electric lighting and associated controls in the 2016 Title 24 Energy Standards;
3. Will have an overview understanding of changes in scope, and new and revised mandatory and prescriptive requirements for nonresidential mechanical systems and associated controls in the 2016 Title 24 Energy Standards;
4. Will be able to identify additional sources for in-depth information on the requirements of the 2016 Title 24 Energy Standards for nonresidential buildings

Course Conventions

Mandatory



- Always required regardless of compliance approach used.

Prescriptive



- Required when using the Prescriptive compliance approach.

Performance



- Optional feature that would be accounted for when doing Performance based computer modeling.

Overall Changes in Scope and Application

Welcome

Overall Changes in Scope and Application

- Schedule
- Additional Scope of Coverage
- Commissioning

Low-rise Residential Envelope

Nonresidential Envelope

Low-rise Residential Mechanical

Nonresidential Mechanical

Residential Lighting

Nonresidential Indoor Lighting

Nonresidential Outdoor Lighting

Update Schedule

- June, 2015 Business Meeting – Language Adoption
- **Jan 1, 2017 Implementation Date**

Any projects that apply for permit on or after Jan 1, 2017 will be subject to the 2016 Standards.

- Information and Documents available at:

<http://www.energy.ca.gov/title24/2016standards/>

Process Equipment



Elevators & Escalators

- Elevator cab LPD 0.6 w/sqft maximum
- Elevator ventilation fans 0.33 w/cfm
- Auto-shutoff of lights and fans after 15 minutes
- Escalators slow down when not conveying passengers
- Escalators in Airports, Hotels and Transportation function areas

- Mandatory Measures
- Elevators – 120.6(f)
- Escalators – 120.6(g)
 - Includes moving walkways



- Section 110.11
- Mandatory Measure
- Low-voltage dry-type transformer meets Title 20
- 600 volts or less, air cooled, does not use oil
- **EXCEPTIONS**
 - autotransformer
 - drive (isolation) transformer
 - grounding transformer
 - machine-tool (control) transformer
 - non-ventilated transformer
 - rectifier transformer
 - regulating transformer
 - sealed transformer
 - special-impedance transformer
 - testing transformer
 - transformer with tap range of 20 percent or more
 - uninterruptible power supply transformer
 - welding transformer

Design Review



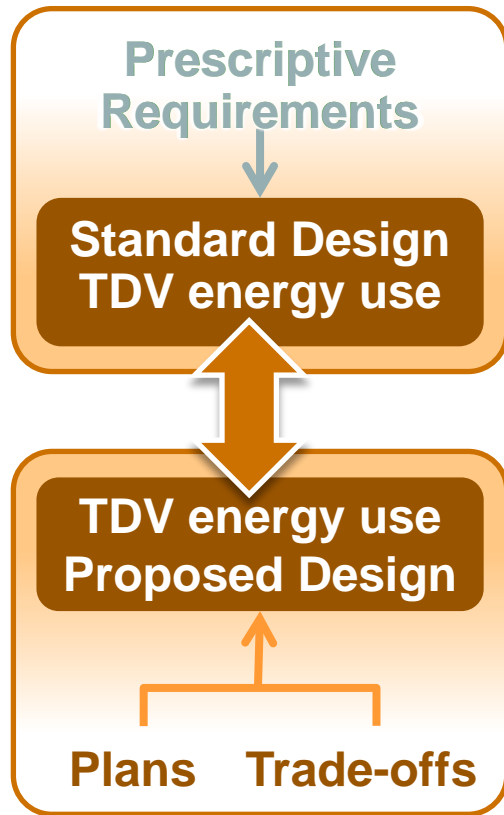
- Buildings less than 10,000 sq ft may be the engineer/**architect**/contractor of record.
- Buildings greater than 10,000 sq ft but less than 50,000 sq ft, shall be a qualified in-house engineer/**architect**/contractor with no other project involvement or a third party.
- Buildings greater than 50,000 sq ft or buildings with complex mechanical systems, the signer shall be a third party engineer/**architect**.

Commissioning



- Triggered for New Buildings with 10,000 sqft or more of Nonresidential Conditioned Space
- Owner's Project Requirements (OPR) now requires Building envelope performance expectations.

Performance Compliance Approach



- Approved Performance software for 2016 Standards:
 - Nonresidential
 - CBECC-Com Version 2016
 - EnergyPro Version 7.0
 - Residential
 - CBECC-Res Version 2016
 - EnergyPro Version 7.0
- Performance approach allows a custom description of building features for many tradeoff opportunities
- Residential Compliance – 30% tougher than 2013.
- Nonresidential Compliance – 5% tougher than 2013.

*** NOTE: The list of approved software changes over time. Please check the CEC site for the latest information:**

http://www.energy.ca.gov/title24/2013standards/2013_computer_prog_list.html

Nonresidential Envelope

Welcome

Overall Changes in Scope and Application

Low-rise Residential Envelope

Nonresidential Envelope

- Mandatory Measures
- Insulation
- Cool Roofs

Low-rise Residential Mechanical

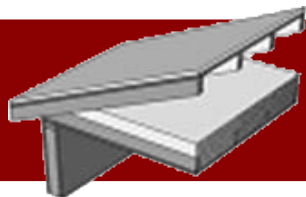
Nonresidential Mechanical

Residential Lighting

Nonresidential Indoor Lighting

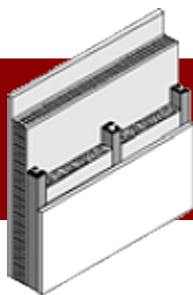
Nonresidential Outdoor Lighting

Envelope: New Construction Mandatory Insulation



Roof

Metal building:	U-factor = 0.098 (R-19)
Wood framed/other:	U-factor = 0.075 (R-13)



Wall

Metal building:	U-factor = 0.113 (R-13)
Metal framed:	U-factor = 0.151 (R-13 w/R-2)
Light mass:	U-factor = 0.440
Heavy mass:	U-factor = 0.690
Wood framed/other:	U-factor = 0.110 (R-11)
Spandrel/curtain wall:	U-factor = 0.280 (none)
Wood Demising:	U-Factor = 0.099 (R-13)
Metal Demising:	U-Factor = 0.151 (R-13 w/R-2)



Floor

Raised mass:	U-factor = 0.269 (none)
Other:	U-factor = 0.071 (R-11)
Heated slab:	CZ 1-15 = R-5; CZ 16 = R-10 or R-10 vertical + R-7 horizontal (see Table 110.8-A)

Exception: A dedicated data center that has a total covered process load exceeding 750 kW



Prescriptive Envelope Criteria

Table 140.3-B Prescriptive Envelope Criteria for Nonresidential Buildings

			Climate Zone															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Maximum U-factor	Roofs/ Ceilings	Metal Building	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>
		Wood Framed and Other	<u>0.034</u>	<u>0.034</u>	<u>0.034</u>	<u>0.034</u>	<u>0.034</u>	<u>0.049</u>	<u>0.049</u>	0.067 <u>0.049</u>	<u>0.034</u>	<u>0.034</u>	<u>0.034</u>	<u>0.034</u>	<u>0.034</u>	<u>0.034</u>	<u>0.034</u>	<u>0.034</u>
	Walls	Metal Building	0.113	0.061	0.113	0.061	0.061	0.113	0.113	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.061
		Metal-framed	<u>0.069</u>	0.062	0.082	0.062	0.062	<u>0.069</u>	<u>0.069</u>	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062	0.062
		Mass Light ¹	0.196	0.170	0.278	0.227	0.440	0.440	0.440	0.440	0.440	0.170	0.170	0.170	0.170	0.170	0.170	0.170
		Mass Heavy ¹	0.253	0.650	0.650	0.650	0.650	0.690	0.690	0.690	0.690	0.650	0.184	0.253	0.211	0.184	0.184	0.160
		Wood-framed and Other	<u>0.095</u>	0.059	0.110	0.059	0.102	0.110	0.110	0.102	0.059	0.059	<u>0.045</u>	0.059	0.059	0.059	0.042	0.059

2016 Standards Table 140.3-B lists **U-factors** rather than **R-values**

Note: Table 140.3-C provides prescriptive envelope requirements for high-rise residential and hotel/motel guest rooms, which have different requirements from nonresidential buildings.



Prescriptive Envelope Criteria

Table 140.3-C Prescriptive Envelope Criteria for High-rise Residential and Hotel/Motel Guest Rooms

			Climate Zone															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
U-factor	Roofs/ Ceilings	Metal Building	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>	<u>0.041</u>
		Wood Framed and Other	<u>0.028</u>	0.028	<u>0.034</u>	0.028	<u>0.034</u>	<u>0.034</u>	0.039	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028	0.028
	Walls	Metal Building	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.061	0.057	0.057	0.057	0.057	0.057	0.057
		Metal-framed	<u>0.069</u>	<u>0.069</u>	<u>0.069</u>	<u>0.069</u>	<u>0.069</u>	<u>0.069</u>	<u>0.105</u>	<u>0.069</u>	<u>0.069</u>	<u>0.069</u>	<u>0.069</u>	<u>0.069</u>	<u>0.069</u>	<u>0.069</u>	<u>0.048</u>	<u>0.069</u>



Cool Roof Trade-off Table



Nonresidential Roof U-Factor			
Aged Solar Reflectance	Metal Building	Wood Framed and Other	
	All Zones	Zones 6 & 7	All other Zones
0.62-0.56	0.038	0.045	0.032
0.55-0.46	0.035	0.042	0.030
0.45-0.36	0.033	0.039	0.029
0.35-0.25	0.031	0.037	0.028

Cool roof requirements also apply to roof replacements

Nonresidential Mechanical

Welcome

Overall Changes in Scope and Application

Low-rise Residential Envelope

Nonresidential Envelope

Low-rise Residential Mechanical

Nonresidential Mechanical

- Equipment
- Economizers
- Controls

Residential Lighting

Nonresidential Indoor Lighting

Nonresidential Outdoor Lighting



- Section 110.2 Mandatory Measures
- Effective Jan 1, 2016
- New efficiencies for DX equipment
- New efficiencies for chillers

TABLE 110.2-A ELECTRICALLY OPERATED UNITARY AIR CONDITIONERS AND CONDENSING UNITS – MINIMUM EFFICIENCY REQUIREMENTS

Equipment Type	Size Category	Efficiency ^{a, b}		Test Procedure ^c
		Before 1/1/2016 ⁵	After 1/1/2016 ⁵	
Air conditioners, air cooled both split system and single package	≥ 65,000 Btu/h and < 135,000 Btu/h	11.2 EER ^b 11.4 IEER ^b	<u>11.2 EER</u> <u>12.9 IEER</u>	ANSI/AHRI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	11.0 EER ^b 11.2 IEER ^b	<u>11.0 EER</u> <u>12.4 IEER</u>	ANSI/AHRI 340/360
	≥ 240,000 Btu/h and < 760,000 Btu/h	10.0 EER ^b 10.1 IEER ^b	<u>10.0 EER</u> <u>11.6 IEER</u>	

FDD on Economizers



- Section 120.2(i)
- Mandatory Fault Detection and Diagnostics (FDD)
- All air-cooled unitary packaged DX units
- Mechanical cooling capacity $\geq 54,000$ Btuh
- Must include a Fault Detection and Diagnostics (FDD) system

DDC Controls



- Section 120.2(j)
- Installed per Table 120.2-A
- New Construction, Additions & Alterations

Photo by Advanced Telemetry
<http://www.flickr.com/photos/41831077@N08/3870721152>

DDC Controls



- 1. Monitoring zone and system demand for fan pressure, pump pressure, heating and cooling;
- 2. Transferring zone and system demand information from zones to air distribution system controllers and from air distribution systems to heating and cooling plant controllers;
- 3. Automatically detecting the zones and systems that may be excessively driving the reset logic and generate an alarm or other indication to the system operator;
- 4. Readily allow operator removal of zones(s) from the reset algorithm;
- 5. For new buildings, trending and graphically displaying input and output points; and
- 6. Resetting heating and cooling setpoints in all non-critical zones upon receipt of a signal from a centralized contact or software point

DDC Controls for New Construction



Application	Qualification
Air handling system and all zones served by the system	Individual systems supplying more than three zones and with design heating or cooling capacity of 300 kBtu/h and larger
Chilled water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design cooling capacity of 300 kBtu/h and larger
Hot water plant and all coils and terminal units served by the system	Individual plants supplying more than three zones and with design heating capacity of 300 kBtu/h and larger

DDC Controls for Additions & Alterations



Application	Qualification
Zone terminal unit such as VAV box	Where existing zones served by the same air handling, chilled water, or hot water systems that have DDC
Air handling system or fan coil	Where existing air handling system(s) and fan coil(s) served by the same chilled or hot water plant have DDC
New air handling system and all new zones served by the system	Individual systems with design heating or cooling capacity of 300 kBtu/h and larger and supplying more than three zones and more than 75 percent of zones are new

DDC Controls for Additions & Alterations



Application	Qualification
New or upgraded chilled water plant	Where all chillers are new and plant design cooling capacity is 300 kBtu/h and larger
New or upgraded hot water plant	Where all boilers are new and plant design heating capacity is 300 kBtu/h and larger



- **Optimum Start/Stop Controls 120.2(k)**
- Space conditioning systems with DDC to the zone level shall have optimum start/stop controls.
- The control algorithm shall, as a minimum, be a function of the difference between space temperature and occupied setpoint, the outdoor air temperature, and the amount of time prior to scheduled occupancy.
- Mass radiant floor slab systems shall incorporate floor temperature onto the optimum start algorithm.



Mechanical System Shut-off 140.4 (n)

- Interlock controls for any directly conditioned space with operable wall or roof openings to the outdoors
- For each space when open for more than 5 minutes:
 - Disable or reset the temperature setpoint to 55°F for mechanical heating
 - Disable or reset the temperature setpoint to 90°F for mechanical cooling
- **EXCEPTION:** Doors with automatic closing devices.
- **EXCEPTION:** Any space without a thermostatic control (thermostat or a space temperature sensor used to control heating or cooling to the space)

Residential Lighting

Welcome

Overall Changes in Scope and Application

Low-rise Residential Envelope

Nonresidential Envelope

Low-rise Residential Mechanical

Nonresidential Mechanical

Residential Lighting

- Kitchens
- Bathrooms
- Garages, Laundry Rooms & Utility Rooms
- Outdoor

Nonresidential Indoor Lighting

Nonresidential Outdoor Lighting

Overview of Residential Lighting



- ALL lighting requirements are Mandatory Measures
- Lighting energy is NOT part of energy budget for the whole building
- No tradeoffs between lighting and other features
- Standards apply only to permanently installed luminaires (light fixtures)

Occupancies Covered

- ✦ Single-family buildings
- ✦ Low-rise multifamily buildings (three stories or less)
- ✦ High-rise multifamily residential units
- ✦ Hotel and motel guest rooms
- ✦ Outdoor lighting controlled from the inside of a high-rise multifamily unit or hotel/motel guest room
- ✦ Fire station dwelling accommodations
- ✦ Dormitory and senior housing dwelling
- ✦ Accessory buildings such as sheds or garages (U occupancy type) on residential sites

Light Sources



- All light sources must be high efficacy per Table 150.0-A

High Efficacy

- Pin-based linear or compact fluorescent lamps light sources using electronic ballasts.
- Pulse-start metal halide lamps.
- High pressure sodium lamps.
- GU-24 sockets containing light sources other than LEDs.
- Inseparable SSL luminaires that are installed outdoors.
- Inseparable SSL luminaires containing colored light sources that are installed to provide decorative lighting.

Light Sources



JA8 High Efficacy

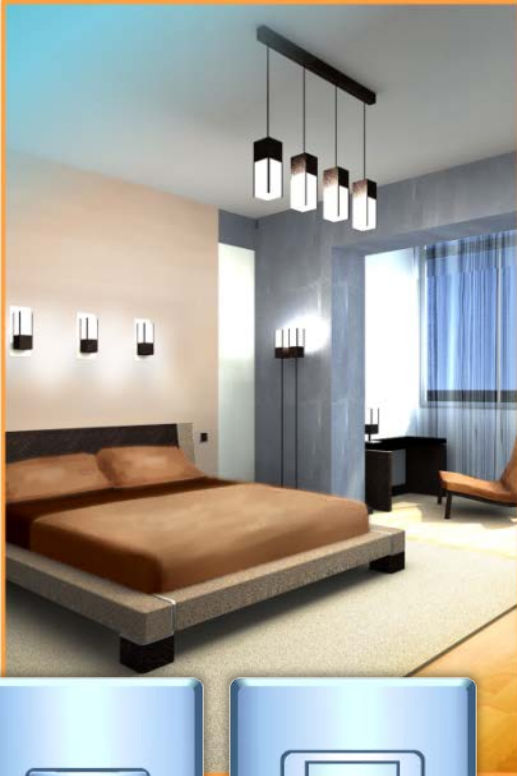
- ✦ Light sources in ceiling recessed downlight luminaires.*
- ✦ LED luminaires with integral sources
- ✦ Screw-based LED lamps (A-lamps, PAR lamps, etc.)
- ✦ Pin-based LED lamps (MR-16, AR-111, etc.)
- ✦ GU-24 based LED light source
- ✦ Any source or luminaire not listed elsewhere on the prior table
- ✦ Note controls required! (next slide)

* No screw based sockets

JA8 High Efficacy Light Sources



Residential Lighting



- ✦ Must be controlled by **vacancy sensor**
- or
- ✦ Must be controlled by a **dimmer**

Exceptions:

- ✦ Closets <70 ft²
- ✦ Hallways



Blank Electrical Boxes



- The number of electrical boxes that are more than 5 feet above the finished floor and do not contain a luminaire or other device shall be no greater than the number of bedrooms.
- These electrical boxes must be served by a dimmer, or vacancy sensor control, or fan speed control.

Bathrooms, Laundry Rooms, Utility Rooms & Garages



- At least one fixture must be controlled by a **vacancy sensor**



Undercabinet Lighting



Lighting Under Cabinets

- Switched separately from other lighting systems



Outdoor Lighting



- Must be high efficacy like the Indoor Lighting
- Include On/Off Switch; and
- Include either:
 - Photocell and Motion Sensor; or
 - Photocell and Time Clock; or
 - Astronomical Time Clock; or
 - Energy Management Control System

Nonresidential Indoor Lighting

Welcome

Overall Changes in Scope and Application

Low-rise Residential Envelope

Nonresidential Envelope

Low-rise Residential Mechanical

Nonresidential Mechanical

Residential Lighting

Nonresidential Indoor Lighting

- Power Adjustment Factors
- Complete Building Method
- Area Category Method
- Tailored Method
- Alterations

Nonresidential Outdoor Lighting

Control Credits – Called PAFs



TABLE 140.6-A LIGHTING POWER ~~DENSITY~~ ADJUSTMENT FACTORS (PAF)

TYPE OF CONTROL		TYPE OF AREA	FACTOR
<p>a. To qualify for any of the Power Adjustment Factors in this table, the installation shall comply with the applicable requirements in Section 140.6(a)2</p> <p>b. Only one PAF may be used for each qualifying luminaire unless combined below.</p> <p>c. Lighting controls that are required for compliance with Part 6 shall not be eligible for a PAF</p>			
1. Partial ON Occupant Sensing Control		Any area \leq 250 square feet enclosed by floor-to-ceiling partitions; any size classroom, conference or waiting room.	0.20
1. <u>Daylight Dimming plus OFF Control</u>		<u>Luminaires in skylit daylit zone or primary sidelit daylit zone</u>	<u>0.10</u>
2. Occupant Sensing Controls in Large Open Plan Offices		In open plan offices > 250 square feet: One sensor controlling an area that is:	No larger than 125 square feet
			From 126 to 250 square feet
			From 251 to 500 square feet
3. Dimming System	Manual Dimming	Hotels/motels, restaurants, auditoriums, theaters	0.10
	Multiscene Programmable		0.20
3. <u>Institutional Tuning</u>		<u>Luminaires in non-daylit areas:-</u> <u>Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.</u>	<u>0.10</u>
		<u>Luminaires in daylit areas:-</u> <u>Luminaires that qualify for other PAFs in this table may also qualify for this tuning PAF.</u>	<u>0.05</u>
4. Demand Responsive Control		All building types less than 10,000 square feet. Luminaires that qualify for other PAFs in this table may also qualify for this demand responsive control PAF	0.05
5. Combined Manual Dimming plus Partial-ON Occupant Sensing Control		Any area \leq 250 square feet enclosed by floor-to-ceiling partitions; any size classroom, conference or waiting room	0.25



Table 140.6-A Lighting Power Adjustment Factors (PAFs)

Institutional Tuning

- The lighting controls shall limit the maximum output or maximum power draw of the controlled lighting to 85 percent or less of full light output or full power draw; and
- The means of setting the limit is accessible only to authorized personnel; and.
- The setting of the limit is verified by the acceptance test required by Section §130.4(a)7;.
- The construction documents specify which lighting systems shall have their maximum light output or maximum power draw set to no greater than 85 percent% of full light output or full power draw.



Table 140.6-A Lighting Power Adjustment Factors (PAFs)

Daylight dimming plus OFF control

- The lighting controls system shall meet all of the requirements of §130.1(d) – Daylighting Controls
- The lighting control system shall turn lights completely OFF when the daylight available in the daylit zone is greater than 150 percent of the illuminance received from the general lighting system at full power.
- The lighting equipment must be included in the Skylit Daylit or Primary Sidelit Daylit lighting zones only.
- This PAF shall not be available for atria or any other areas that operate with a photocell ON/OFF control that does not include intermediate steps.
- The OFF step must be demonstrated in the acceptance testing.

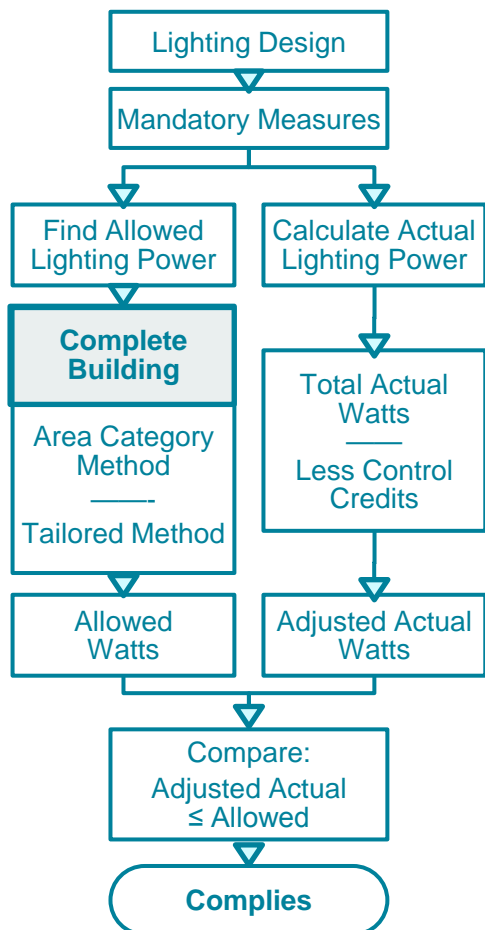


Complete Building Method

Entire building's lighting system is designed and permitted at one time, and when at least 90 percent of the building is one primary type of use.

TABLE 140.6-B: Complete Building Method Lighting Power Density Values (Watts/Ft²)

Type Of Use	Allowed Lighting Power
Auditoriums	1.4
Classroom Building	1.1
Commercial and industrial storage buildings	0.6
Convention centers	1.0
Financial institutions	1.0
General commercial and industrial work buildings	
High bay	1.0
Low bay	1.0
Grocery stores	1.5
Library	1.2
Medical buildings and clinics	1.0
Office buildings	0.8
Parking Garages	0.2
Religious facilities	1.5
Restaurants	1.1
Schools	0.95
Theaters	1.3
All others	0.5



Support areas (e.g., bathrooms, corridors, etc.) may be counted as part of the primary type of use when determining if ≥ 90% of building is one primary type of use



Area Category Method

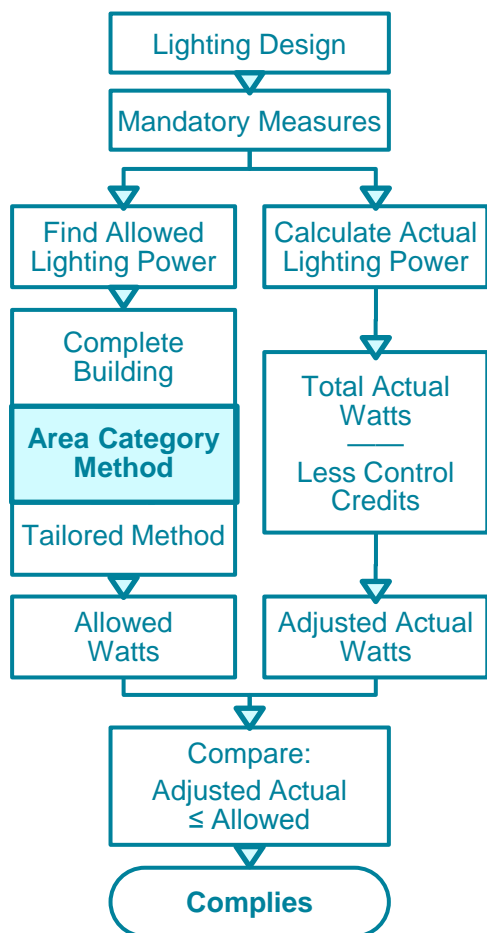


Table 140.6-C. Lighting power values assigned to each major function area of building (offices, lobbies, corridors, etc.)

TABLE 140.6-C AREA CATEGORY METHOD - LIGHTING POWER DENSITY VALUES (WATTS/FT²)

PRIMARY FUNCTION AREA		ALLOWED LIGHTING POWER (W/ft ²)	PRIMARY FUNCTION AREA		ALLOWED LIGHTING POWER (W/ft ²)
Auditorium Area		1.4 ³	Library Area	Reading areas	1.1 ³
Auto Repair Area		0.9 ²		Stack areas	1.5 ³
Beauty Salon Area		1.7	Lobby Area	Hotel lobby	0.95 ³
Civic Meeting Place Area		1.3 ³		Main entry lobby	0.95 ³
Classroom, Lecture, Training, Vocational Areas		1.2 ⁵	Locker/Dressing Room		0.7
Commercial and Industrial Storage Areas (conditioned and unconditioned)		0.6	Lounge Area		0.9 ³
Commercial and Industrial Storage Areas (refrigerated)		0.7	Malls and Atria		0.95 ³
Convention, Conference, Multipurpose and Meeting Center Areas		1.2 ³	Medical and Clinical Care Area		1.2
Corridor, Restroom, Stair, and Support Areas		0.6	Office Area	> 250 square feet	0.75
Dining Area		1.0 ³		≤ 250 square feet	1.0
Electrical, Mechanical, Telephone Rooms		0.55 ²	Parking Garage Area	Parking Area	0.14
Exercise Center, Gymnasium Areas		1.0		Dedicated Ramps	0.3
Exhibit, Museum Areas		1.8		Daylight Adaptation Zones ⁹	0.6
Financial Transaction Area		1.0 ³	Religious Worship Area		1.5 ³
General Commercial and Industrial Work Areas	Low bay	0.9 ²	Retail Merchandise Sales, Wholesale Showroom Areas		1.2 ^{6 and 7}
	High bay	1.0 ²			
	Precision	1.2 ⁴	Theater Area	Motion picture	0.9 ³



Area Category Method (cont)

CONTINUED: TABLE 140.6-C AREA CATEGORY METHOD - LIGHTING POWER DENSITY VALUES (WATTS/FT²)

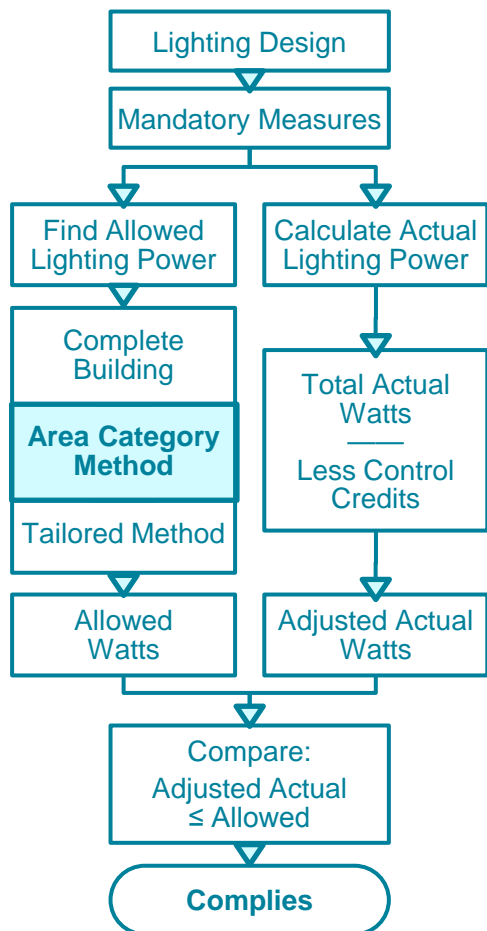
Hotel Function Area	1.5 ²	Transportation Function Area	1.2
Hotel Function Area	1.4 ³	Transportation Function Area	Concourse & Baggage
			Ticketing
Kitchen, Food Preparation Areas	1.6-1.2	Videoconferencing Studio	1.2 ⁸
Laboratory Area, Scientific	1.4 ¹	Waiting Area	1.4-0.80 ³
Laundry Area	0.90-0.70	All other areas	0.60-0.50

Footnotes for this table are listed below.

FOOTNOTES FOR TABLE 140.6-C:

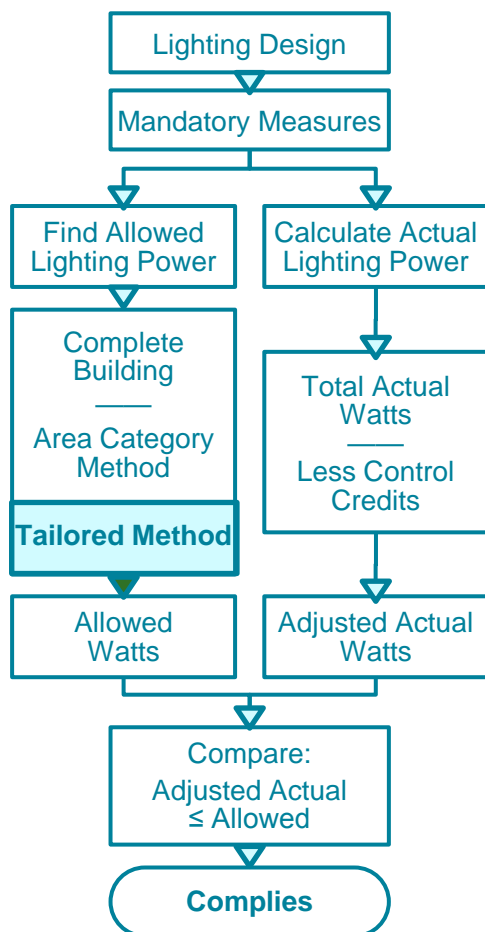
See Section 140.6(c)2 for an explanation of additional lighting power available for specialized task work, ornamental, precision, accent, display, decorative, and white boards and chalk boards, in accordance with the footnotes in this table. The smallest of the added lighting power listed in each footnote below, or the actual design wattage, may be added to the allowed lighting power only when using the Area Category Method of compliance.

Footnote number	Type of lighting system allowed	Maximum Allowed added lighting power density . (W/ft ² of task area unless otherwise noted)
1	Specialized task work	0.20 W/ft ²
2	Specialized task work	0.50 W/ft ²
3	Ornamental lighting as defined in Section 100.1 and in accordance with Section 140.6.(c)2.	0.50 W/ft ²
4	Precision commercial and industrial work	1.0 W/ft ²
5	Per linear foot of white board or chalk board.	5.5 W per linear foot
6	Accent, display and feature lighting - luminaires shall be adjustable or directional	0.30 W/ft ²
7	Decorative lighting - primary function shall be decorative and shall be in addition to general illumination.	0.20 W/ft ²
8	<u>Additional Videoconferencing Studio lighting complying with all of the requirements in Section 140.6(c)2Gvii.</u>	1.5 W/ft ²
9	<u>Daylight Adaptation Zones shall be no longer than 66 feet from the entrance to the parking garage</u>	
10	<u>Additional allowance for ATM locations in Parking Garages. Allowance per ATM.</u>	<u>200 watts for first ATM location. 50 watt for each additional ATM location in a group.</u>
8	<u>Additional Videoconferencing Studio lighting complying with all of the requirements in Section 140.6(c)2Gvii.</u>	1.5 W/ft ²
9	<u>Daylight Adaptation Zones shall be no longer than 66 feet from the entrance to the parking garage</u>	





Tailored Method



- When additional flexibility needed to accommodate special task lighting in specific areas
- Lighting power allowances determined room-by-room and task-by-task

TABLE 140.6-G ILLUMINANCE LEVEL (LUX) POWER DENSITY VALUES (WATTS/FT²)

Illuminance Level (Lux)	RCR ≤ 2.0	RCR > 2.0 and ≤ 3.5	RCR > 3.5 and ≤ 7.0	RCR > 7.0
50	<u>0.20.18</u>	<u>0.30.22</u>	<u>0.40.32</u>	<u>0.60.46</u>
100	<u>0.40.30</u>	<u>0.60.38</u>	<u>0.80.56</u>	<u>1.20.84</u>
200	<u>0.60.48</u>	<u>0.80.64</u>	<u>1.30.88</u>	<u>1.91.34</u>
300	<u>0.80.64</u>	<u>1.00.82</u>	<u>1.41.12</u>	<u>2.01.76</u>
400	<u>0.90.78</u>	<u>1.10.98</u>	<u>1.51.34</u>	<u>2.22.08</u>
500	<u>1.00.90</u>	<u>1.21.10</u>	<u>1.61.52</u>	<u>2.42.32</u>
600	<u>1.21.06</u>	<u>1.41.26</u>	<u>2.01.74</u>	<u>2.92.60</u>
700	<u>1.41.24</u>	<u>1.71.46</u>	<u>2.31.981.82</u>	<u>3.32.96</u>
800	<u>1.61.44</u>	<u>1.91.70</u>	<u>2.62.28</u>	<u>3.83.30</u>
900	<u>1.81.66</u>	<u>2.22.00</u>	<u>3.02.64</u>	<u>4.33.74</u>
1000	<u>1.91.84</u>	<u>2.42.20</u>	<u>3.32.90</u>	<u>4.84.06</u>

Multi-level Controls



Section 130.1(b)

- Multi-level controls required in areas $> 0.5 \text{ w/sqft}$ and $\geq 100 \text{ sqft}$
- Lighting shall meet requirements of Table 130.1-A
- This eliminates other options from prior code, more or less means dimming.



Multi-Level Lighting Controls

TABLE 130.1-A MULTI-LEVEL LIGHTING CONTROLS AND UNIFORMITY REQUIREMENTS

Luminaire Type	Minimum Required Control Steps (percent of full rated power ¹)				Uniform level of illuminance shall be achieved by:
Line-voltage sockets except GU-24	Continuous dimming 10-100 percent				
Low-voltage incandescent systems					
LED luminaires and LED source systems					
GU-24 rated for LED					
GU-24 sockets rated for fluorescent > 20 watts	Continuous dimming 20-100 percent				
Pin-based compact fluorescent > 20 watts ²					
GU-24 sockets rated for fluorescent ≤ 20 watts	Minimum one step between 30-70 percent				Stepped dimming; or Continuous dimming; or Switching alternate lamps in a luminaire
Pin-based compact fluorescent ≤ 20 watts ²					
Linear fluorescent and U-bent fluorescent ≤ 13 watts					
Linear fluorescent and U-bent fluorescent > 13 watts	Minimum one step in each range:				Stepped dimming; or Continuous dimming; or switching alternate lamps in each luminaire, having a minimum of 4 lamps per luminaire, illuminating the same area and in the same manner
	20-40 %	50-70 %	80-85 %	100 %	
Track Lighting	Minimum one step between 30 - 70 percent				Step dimming; or Continuous dimming; or Separately switching circuits in multi-circuit track with a minimum of two circuits.
HID > 20 watts	Minimum one step between 50 - 70 percent				Stepped dimming; or Continuous dimming; or Switching alternate lamps in each luminaire, having a minimum of 2 lamps per luminaire, illuminating the same area and in the same manner.
Induction > 25 watts					
Other light sources					

Multi-level Controls



Exceptions to Section 130.1(b)

- Classrooms, with a connected general lighting load of 0.7 watts per square feet and less **and public restrooms**
 - Can have at one control step between 30-70 percent of full rated power.
- An area enclosed by ceiling height partitions that has only one luminaire with no more than two lamps.



Shut-OFF Controls §130.1(c)



- Automatically shuts off or reduces light when the space is typically unoccupied
 - Occupancy sensor
 - Automatic time-switch
 - Signal from another building
 - Other control
- Separate controls for each enclosed space, lighting in each floor and for general, display, ornamental and display case lighting

Exceptions:

- ✦ Emergency egress lighting during occupied times
- ✦ 0.1 W/ft² for egress in ANY building
- ✦ Continuous use lighting and electrical equipment rooms



Entire Luminaire Alterations



- For each enclosed space, alterations that consist of either
 - Removing and reinstalling a total of 10 percent or more of the existing luminaires; or
 - Replacing or adding entire luminaires; or
 - Adding, removing, or replacing walls or ceilings along with any redesign of the lighting system.
- Required to comply with 140.6 LPD requirements for new construction and control requirements of Table 141.0-E



Entire Luminaire Alterations

TABLE 141.0-E Control Requirements for Entire Luminaire Alterations

<u>Control requirements that shall be met when 10% or more of existing luminaires in an enclosed space are altered</u>	<u>Resulting lighting power, compared to the lighting power allowance specified in Section 140.6(c)2, Area Category Method</u>	
	<u>Lighting power is \leq 85% of allowance</u>	<u>Lighting power is > 85% to 100% of allowance</u>
<u>Section 130.1(a)1, 2, and 3 Area Controls</u>	<u>Yes</u>	<u>Yes</u>
<u>Section 130.1(b) Multi-Level Lighting Controls – only for alterations to general lighting of enclosed spaces 100 square feet or larger with a connected lighting load that exceeds 0.5 watts per square foot</u>	<u>For each enclosed space, minimum one step between 30-70 percent of lighting power regardless of luminaire type, or meet Section 130.1(b)</u>	<u>Yes</u>
<u>Section 130.1(c) Shut-Off Controls</u>	<u>Yes</u>	<u>Yes</u>
<u>Section 130.1(d) Automatic Daylight Controls</u>	<u>Not Required</u>	<u>Yes</u>
<u>Section 130.1(e) Demand Responsive Controls – only for alterations > 10,000 ft² in a single building, where the alteration also changes the area of the space, or changes the occupancy type of the space, or increases the lighting power</u>	<u>Not Required</u>	<u>Yes</u>



Entire Luminaire Alterations



- Alterations where existing luminaires are replaced with new luminaires, and that do not include adding, removing, or replacing walls or ceilings along with redesign of the lighting system
- Replacement luminaires shall collectively have at least 50 percent lower rated power as compared to the existing luminaires being replaced for Office, Retail and Hotel Occupancies.
- All other Occupancies shall be at least a 35 percent reduction.



Entire Luminaire Alterations

Must also meet the applicable requirements of Sections:

130.1(a) Area Controls

130.1(c) Automatic Shutoff Controls

EXCEPTION - Alteration of portable luminaires, luminaires affixed to moveable partitions, or lighting excluded by Section 140.6(a)3.

EXCEPTION - In an enclosed space where two or fewer luminaires are replaced or reinstalled.

EXCEPTION - Alterations that would directly cause the disturbance of asbestos, unless the modifications are made in conjunction with asbestos abatement.

Luminaire Component Modifications



- Replacing the ballasts or drivers and the associated lamps in the luminaire
- Permanently changing the light source of the luminaire
- Changing the optical system of the luminaire
- 70 or more existing luminaires are modified either on any single floor of a building or, where multiple tenants inhabit the same floor, in any single tenant space, in any single year

Luminaire Component Modifications



- Shall meet the applicable requirements of Sections:
 - 130.1(a) Area Controls
 - 130.1(c) Automatic Shutoff Controls
- Required to comply with 140.6 LPD requirements for new construction; or
- Modified luminaires shall collectively have at least 50 percent lower rated power as compared to the existing luminaires being modified for Office, Retail and Hotel Occupancies.
- 35 percent reduction required for all other Occupancies.
- Lamp replacements alone and ballast replacements alone shall not be considered a modification of the luminaire provided that the replacement lamps or ballasts are installed and powered without modifying the luminaire

Luminaire Component Modifications



EXCEPTION - Modification of portable luminaires, luminaires affixed to moveable partitions, or lighting excluded by Section 140.6(a)3.

EXCEPTION - In an enclosed space where two or fewer luminaires are modified.

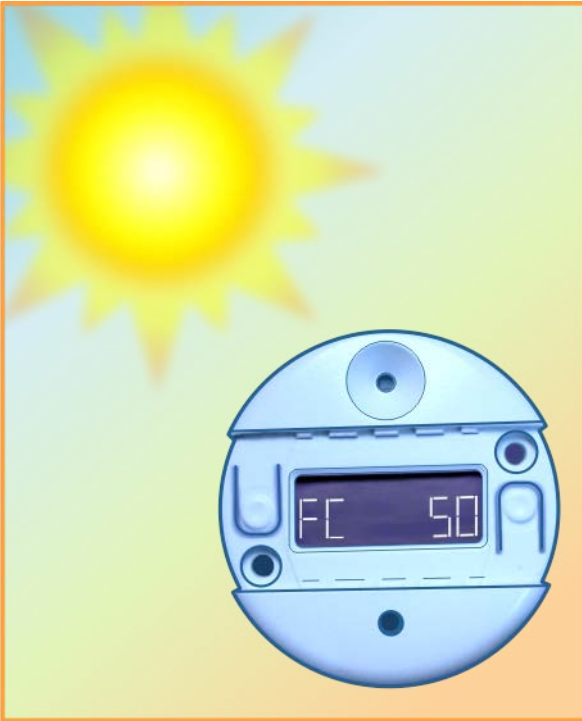
EXCEPTION - Modifications that would directly cause the disturbance of asbestos, unless the modifications are made in conjunction with asbestos abatement.

Wiring Alterations



- For each enclosed space, wiring alterations that
 - Add a circuit feeding luminaires; or
 - Replace, modify, or relocate wiring between a switch or panelboard and luminaires; or
 - Replace lighting control panels, panelboards, or branch circuit wiring;
- Meet the LPD 140.6;
- Shall be meet the applicable requirements of Sections:
 - 130.1(a) Area Controls
 - 130.1(c) Automatic Shutoff Controls

Wiring Alterations (cont)



- Each enclosed space, be wired to create a minimum of one step between 30-70 percent of lighting power; and
- Each enclosed space where wiring alterations include 20 or more luminaires that are located within the primary sidelit daylit zone or the skylit daylit zone
 - 130.1(d) - Daylighting controls

EXCEPTION - Alterations strictly limited to addition of lighting controls.

EXCEPTION - In an enclosed space where wiring alterations involve two or fewer luminaires.

EXCEPTION - Alterations that would directly cause the disturbance of asbestos, unless the alterations are made in conjunction with asbestos abatement.

Nonresidential Outdoor Lighting

Welcome

Overall Changes in Scope and Application

Low-rise Residential Envelope

Nonresidential Envelope

Low-rise Residential Mechanical

Nonresidential Mechanical

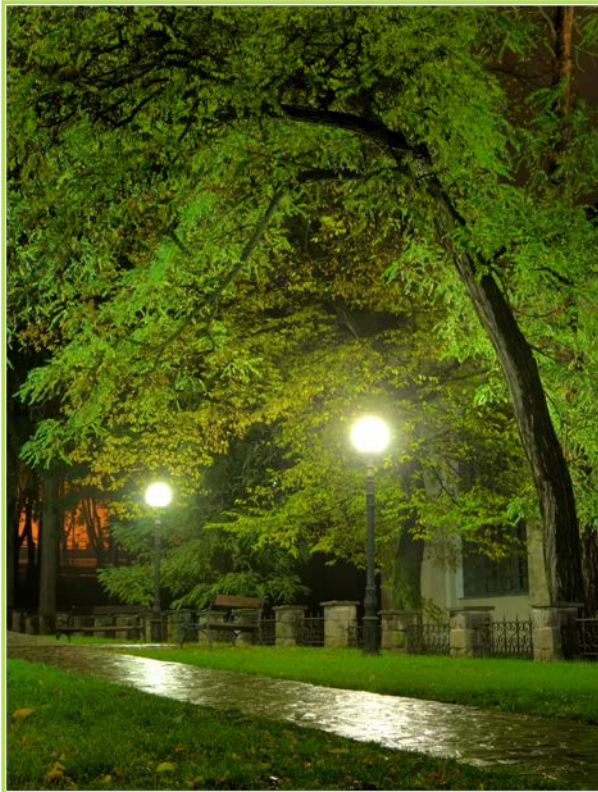
Residential Lighting

Nonresidential Indoor Lighting

Nonresidential Outdoor Lighting

- General
- Hardscape Lighting Power
- Specific Applications Lighting Power
- Controls

Outdoor Lighting Zones



- New Lighting Zone 0 added
- Undeveloped areas of state or national parks
- No continuous hardscape lighting allowed
- A single luminaire of 15 Watts or less may be installed at:
 - Entrance to a parking area
 - Trail head
 - Fee payment kiosk
 - Outhouse, or toilet facility



Hardscape Lighting Power



- Table 140.7-A
- Hardscape Allowances
- Reductions in Lighting Allowances (shown in red)

Type of Power Allowance	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Area Wattage Allowance (AWA)	0.020 W/ft ²	0.030 W/ft ²	0.040 W/ft ²	0.050 W/ft ²
Linear Wattage Allowance (LWA)	0.15 W/lf	0.25 W/lf	0.35 W/lf	0.45 W/lf
Initial Wattage Allowance (IWA)	340 W	450 W	520 W	640 W

Specific Applications Lighting Power



- Changes in Lighting Allowances

Lighting Application	Lighting Zone 1	Lighting Zone 2	Lighting Zone 3	Lighting Zone 4
Building Entrances or Exits. Allowance per door. Luminaires qualifying for this allowance shall be within 20 ft of the door.	15 W	25 W	35 W	45 W
ATM Machine Lighting. Allowance per ATM machine. Luminaires qualifying for this allowance shall be within 50 feet of the dispenser.	250 watts for first ATM machine, 70 watts for each additional ATM machine			

Motion Sensors



- All luminaires with mounting heights less than 24' above the ground
- Motion sensor required
- Reduce lighting power of each luminaire by at least 40 percent but not exceeding 90 percent

OR

- Provide continuous dimming
- Shall employ auto-on functionality
- Maximum of 1,500 watts of lighting power shall be controlled together

Motion Sensors



- Exceptions to motion sensors
 - Sales Frontage
 - ~~Sales Lots~~
 - ~~Sales Canopies~~
 - Building Facades
 - Ornamental Hardscape
 - Dining
 - Pole-mounted luminaires ≤ 75 watts
 - Non-pole mounted luminaires ≤ 30 watts
 - Linear lighting ≤ 4 watts per linear foot of luminaire

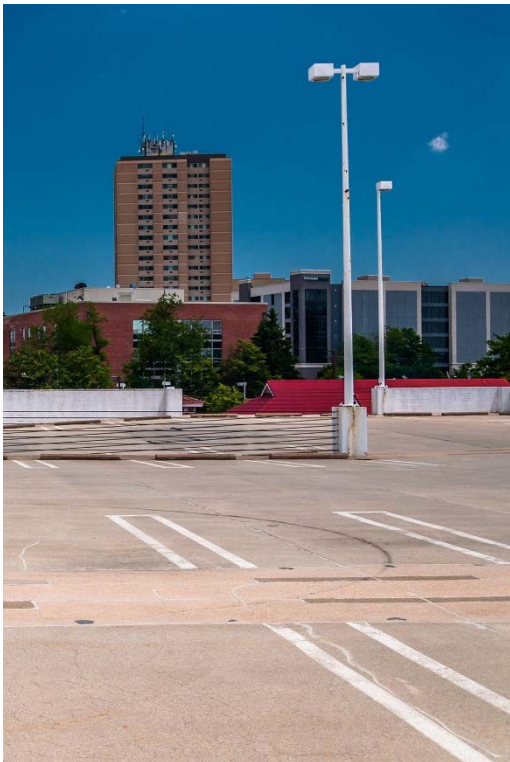
Alterations



- Increase in connected lighting load
 - 130.2(c) Mandatory Controls
 - 140.7 Power Allowances



Alterations



- No increase in connected lighting load, where the greater of 5 luminaires or 10% of the existing luminaires are replaced
- Parking lots/outdoor sales lots with luminaires ≤ 24 feet include
 - Photocontrol or Astro Timeclock
 - Motion Sensor
- All other luminaires include
 - Photocontrol or Astro Timeclock
 - Independently controlled or have Motion Sensor

Alterations



- No increase in connected lighting load, where the greater of 5 luminaires or 50% of the existing luminaires are replaced
 - 140.7 Power Allowances

EXCEPTION - Alterations where the replacement luminaires have at least 40 percent lower power consumption compared to the original luminaires



Questions?

This concludes the Title 24 Standards Training.

Please be sure to complete your evaluation sheets so we can plan future events.