AABC Commissioning Group
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LED Lighting: Technology Selection and System Commissioning

Course Number: CXENERGY1519

Michael Chow, P.E., CxA, LEED AP BD+C,
Metro CD Engineering

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SAMPLE SLIDE

Course Description

This session will discuss the pros and cons of the different types of LED lighting, as well as information about commissioning different types of systems and technologies, including lighting controls.

Learning Objectives

At the end of the this course, participants will be able to:

1. Learn about the various types of LED lighting technology and how to select the best product for your application.
2. Understand the unique system commissioning requirements for various types of LED lighting.
3. Learn about the necessary control systems associated with various types of LED lighting.
4. Understand the ongoing commissioning requirements for LED lighting systems over the lifetime of a building.

LED Overview

1. Efficacy (Lumens Per Watt):
   a. 35 LPW: 2007
   b. 100 LPW: 2014
   c. Future 100+ LPW

2. No Mercury = non-hazardous for disposal or breakage.

3. Long life. Typically 25,000 to 50,000+ hours.

4. Works well at low temperatures.
   a. Fluorescents do not work well at low temps.

LED Overview

5. No issues with frequently on/off cycles.
   a. Fluorescent lamp life will be shortened due to frequent cycling (instant start ballasts).

6. Instant on.
   a. Great for replacing HID lamps.

7. Minimal UV and IR in illumination path.

8. Directional – eliminates reflectors.

9. L70 is when LED reaches 70% of its rated output.
   a. LEDs' light output fades over time.

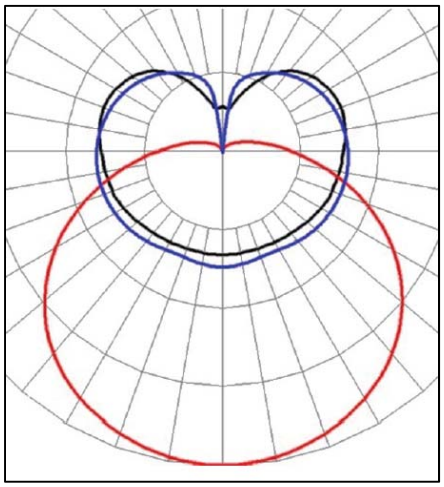
Various types of LED lighting technology

1. Screw-in LED lamps
2. Integral LED light sources
3. Retrofits

Screw-in LED Lamps

Screw-in LED Lamps

1. LED are directional; CFLs and halogen lamps are omnidirectional.
   a. Check light distribution.



2. Efficacy: 60-70 LPW.

Images Courtesy of DOE

Screw-in LED Lamps

3. Lower life due to driver and LEDs in relative close proximity to each other.
   a. Screw-in LEDs: 25,000 hours compared to 50,000+ hours for integral LED fixtures.

4. Screw-in LEDs should not be used in totally enclosed fixtures unless rated for this application.
   a. Allow for heat dissipation from the heat sink.

5. Dimming: verify if compatible with dimmers.

Integral LED Light Sources

Integral LED Light Sources

1. Longest life: 50,000+ hours.

2. Efficacy: 70 to 100+ lumens/watt.

3. Typical Dimming: 0-10 Volts.
   a. Verify dimmer is compatible.

Retrofit LEDs

Retrofit Tubular LEDs

1. Directional and not omnidirectional (fluorescent lamps are omnidirectional)

2. Life: 30,000+ hours (Source: DOE, March 2014).

3. Efficacy: 80-100+ lumens/watt (Source: DOE, March 2014).

4. Lumen output: about 2,000 lumens (T8 fluorescent lamp is about 3,000 lumens). Source: DOE, March 2014.
   a. Should sample tubular LED in retrofit application to ensure light distribution is adequate (e.g., fixtures with parabolic louvers and lenses).
5. Dimming: Verify dimmer is compatible.

Retrofit LED Troffers

1. Usually where a fluorescent troffer's housing is kept and the ballast is replaced with a driver that powers LEDs.
   a. Known as "LED Luminaire Conversion Retrofit Kits" by UL.
      i. Required to be labeled.
      ii. DOE study found 50% of sampled retrofit kits would not meet the UL Listing requirements (labeling issues, poor mounting, etc.)

2. Life: 50,000+ hours.

3. Efficacy: 85-100+ lumens/watt.

4. Dimming: Verify dimmer is compatible.

Unique System Commissioning Requirements

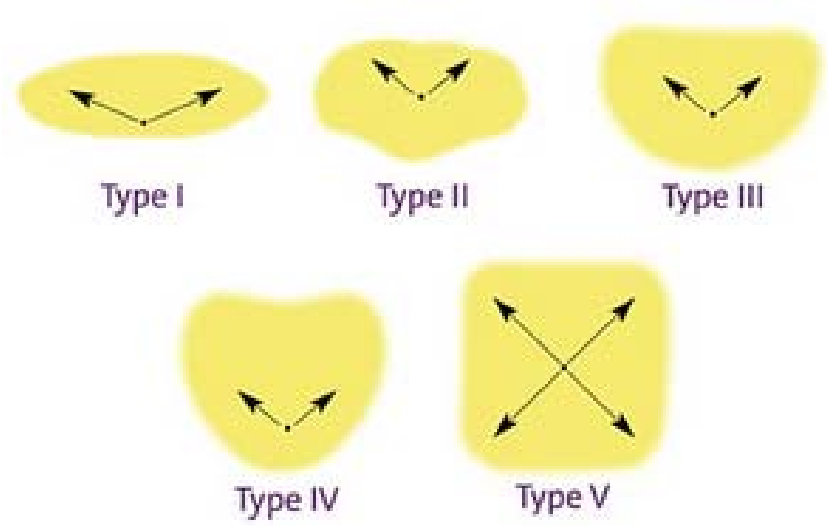
1. Design, Shop Drawing Review
   a. Look for IES LM-79, LM-80 and TM-21.
   b. Dimmer compatibility (more on this later).

2. UL Retrofit Label for retrofits (see Retrofit LED Tubes slide).

3. Functional testing
   a. Required by ASHRAE 90.1-2010.
   b. IES-DG-29, The Commissioning Process Applied to Lighting and Control Systems

Unique System Commissioning Requirements

4. Verify distribution (Type) for exterior lighting fixtures.



Unique System Commissioning Requirements

5. In-rush Current
    a. Example: dimming with 0-10 Volt DC control at 120 Volts equates to LED and its driver to draw 0.4 Amps.
        i. In-rush current is 40 Amps – 100 times the normal steady state operating current.
        ii. This may trip a circuit breaker depending upon the circuit breaker type.
        iii. May need an in-rush current limiting device and “pairing” of the LED/driver and the dimmer.

In-rush Current Example: LED exterior fixture

ELECTRICAL SYSTEM

- **Input Voltage:** 120–277V or 347–480V, 50 / 60Hz, Class 1 drivers
- **Power Factor:** > 0.9 at full load
- **Total Harmonic Distortion:** < 20% at full load
- Integral weathertight electrical box with terminal strips (12Ga–20Ga) for easy power hookup
- Integral 10kV surge suppression protection standard
- To address inrush current, slow blow fuse or type C / D breaker should be used

REGULATORY & VOLUNTARY QUALIFICATIONS

- cULus Listed
- Suitable for wet locations
- Enclosure rated IP66 per IEC 60529 when ordered without P or R options
- Consult factory for CE Certified products
- Certified to ANSI C136.31-2001, 3G bridge and overpass vibration standards
- 10kV surge suppression protection tested in accordance with IEEE / ANSI C62.41.2
- Luminaire and finish endurance tested to withstand 5,000 hours of elevated ambient salt fog conditions as defined in ASTM Standard B 117
- Product qualified on the DesignLights Consortium™ ("DLC") Qualified Products List ("QPL") when ordered without full backlight control shield
- Meets Buy American requirements within ARRA

Unique System Commissioning Requirements

6. Harmonics
    a. Dimming chops up the sine wave of current.
        i. May cause excessive neutral current and may impose a fire hazard.
    b. Harmonics lower the power factor (pf) of the circuit
        i. A pf below 95 for a building may result in a utility penalty charge.
        ii. May need to add a capacitive filter in the circuit to minimize the THD (Total Harmonic Distortion)
        iii. Important to match/pair LEDs, drivers and dimmers to avoid these issues.

Control of LEDs

1. Dimming
   a. Re-use of incandescent dimmers: May need to meet minimum wattage (typically 25 to 40 Watts).
   b. Consider min/max number of LED sources per control.
   c. Neutral conductor required (with 2011 NEC).
   d. 0-10V, DMX, DALI, Wireless.

2. Occupancy/Vacancy Sensors
   a. LEDs: no ill effects from frequent cycling…use a shorter time delay? Standard of 20 minutes was developed to help prolong fluorescent lamp life.

3. Daylight Harvesting

Understand the ongoing commissioning requirements for LED lighting systems over the lifetime of a building

1. L70
    1. Recall that LEDs' light output fades over time and don't burn out.
    2. Lumen maintenance is a prediction of the number of hours an LED will operate before it fades below a useful level of intensity. L70 = 70% of initial lumen output.

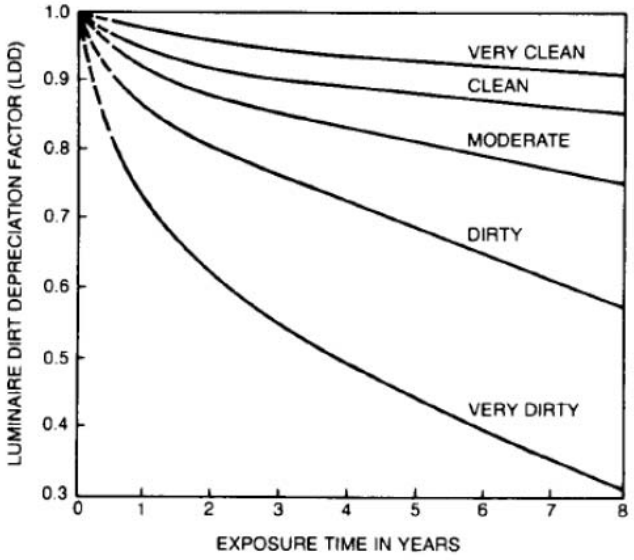
2. Daylight harvesting
    a. Commissioning tip sheet: http://www.ecw.org/sites/default/files/daylightcontrolstipsheet.pdf
    b. Recalibration of sensors (locate so they are readily accessible)

Understand the ongoing commissioning requirements for LED lighting systems over the lifetime of a building

3. LEDs are not maintenance free

Luminaire Dirt Depreciation - LDD

ANSI / IESNA RP-8-00



SELECT THE APPROPRIATE CURVE IN ACCORDANCE WITH THE TYPE OF AMBIENT AS DESCRIBED BY THE FOLLOWING EXAMPLES:

VERY CLEAN—No nearby smoke or dust generating activities and a low ambient contaminant level. Light traffic. Generally limited to residential or rural areas. The ambient particulate level is no more than 150 micrograms per cubic meter.

CLEAN—No nearby smoke or dust generating activities. Moderate to heavy traffic. The ambient particulate level is no more than 300 micrograms per cubic meter.

MODERATE—Moderate smoke or dust generating activities nearby. The ambient particulate level is no more than 600 micrograms per cubic meter.

DIRTY—Smoke or dust plumes generated by nearby activities may occasionally envelope the luminaires.

VERY DIRTY—As above but the luminaires are commonly enveloped by smoke or dust plumes.

Learning Objectives

Recap:

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This concludes The American Institute of Architects
Continuing Education Systems Course

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Contact Information:

Michael Chow, P.E., CxA, LEED
AP BD+C

Phone: (614) 923-3930

E-mail:
mchow@metrocdengineering.com

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