Solid State Lighting

Department of Environmental Quality
The Panel

Panelists:

- **Dr. Lynn Davis**, Fellow, RTI International
- **Robert Talley**, PE, NC Dept. of Administration, State Construction Office
- **Renee Hutcheson**, FAIA, NC Department of Environmental Quality
- **Questions during the presentation**
The Work Group

Department of Environmental Quality
The Work Group

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David Bell, PE
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Thomas Hunter, PE, RA

Jonathan Jones, PE
Lalitha Krishnasami, PE
John Majernik, EI, PEM
Jeannie Smith, PE
Robert Talley, PE
Dr. Leonard White, PE

Department of Environmental Quality
AGENDA

1. Background
2. Basic Principles of Good Lighting Design
3. Basic Principles of Building Designs
4. LED Retrofits
5. Additional Resources
   A. Nomenclature and Common Terms
   B. List of Reference Standards
   C. Examples of Performance Specifications
GUIDELINES not RULES for using SSL
BASIC PRINCIPLES OF GOOD LIGHTING DESIGN

• Illuminance
  • Amount of light falling onto and illuminating an object such as table or sidewalk (horizontal illuminance) or wall or open space (vertical illuminance)
  • Two common units of measure
    • Lux – lumens/m²
    • Footcandles (fc) – lumens/ft²

• Luminance
  • Amount of emitted or reflected light contained within a solid angle.
  • Common units
    • Candela/m² (nit, Σ)
Basic Principles of Good Lighting Design

- Light Level and Illuminance (measured in lux or foot-candles)
  - Energy consumption (costs) is proportional to light level
    - Less energy can be consumed if a lower lighting level or illuminance is feasible,
  - IES recommended illuminance levels have changed as more technology is used in the office and classroom
  - Provide illuminance levels sufficient for the task
  - Light levels must still meet code requirements.
  - Follow appropriate recommended IES illuminance levels for the space type/application,
  - Understand light distribution in the space
  - Lighting calculations are recommended for all spaces
**BASIC PRINCIPLES OF GOOD LIGHTING DESIGN**

- **Correlated Color Temperature (CCT) and Color Rendering Index (CRI)**
  - lower CCT value - warmer the perceived color of the light
  - higher CCT value - cooler the perceived color of the light
  - CRI - metric that measures how accurately the lighting source reproduces colors
  - R9 – what is it?

![Cool white (6500 K)](image1)

![Warm white (2750 K)](image2)
**BASIC PRINCIPLES OF GOOD LIGHTING DESIGN**

- Luminance and Luminous Intensity (measured in candela)
  - LED light sources tend to produce intense white light
  - Glare can be an issue in both indoor and outdoor lighting
  - Luminance values can be too high
  - Luminance ratios can be too high
- 4 Factors to Evaluate for glare
  - Luminance of light source
  - Size of the light source
  - Position of the glare source in the field of view
  - Luminance of the background
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BASIC PRINCIPLES OF GOOD LIGHTING DESIGN

- Control
  - Dimming range
  - Dimmer loads
  - Control architectures and compatibility
  - Improper use of controls can lead to premature failure
BASIC PRINCIPLES OF GOOD LIGHTING DESIGN

• Exit and Emergency Lighting
  • LED Exit signs typically are in use 24/7
  • This section of the document is based on over 20 years of use

• Third Party Listings and Certifications
  • NC General Statutes for Electrical Safety
  • NEC requirements
  • Life Safety

• Outdoor Lighting
  • Surge protection - rated for surges of at least 10 KV.
  • Grounding
  • Filters
BASIC PRINCIPLES OF BUILDING DESIGNS

• Wiring Methods
  • Dedicated full-sized (i.e., 100%) neutrals
  • Wiring per NEC

• Special Considerations for the Distribution System
  • A dedicated lighting panel is recommended
  • Separate from large non-linear loads
  • Consider harmonic filters and harmonic mitigating

• Voltage Drop
  • consideration should be given to wire length and size

• Inrush Current and Circuit Loading
  • NEMA 410 allows for short duration (i.e., less than several milliseconds) inrush currents
  • many of our successful project have used branch circuit loading of 50% or less.

• Emergency Power for LED Systems
**LED RETROFIT PROJECTS**

- **Costs/Budget**
  - consistent with the scope of the work
  - consistent with the Life Cycle Costs Analysis (LCCA)

- How many hours will they be used?
- Free money?
- Are there other benefits?
- Can I afford the first cost?
- Will I need a building permit?
LED RETROFIT PROJECTS

• Costs/Budget
  • The cost-benefit analysis of LED lighting could be impacted by site considerations

What is the condition of the existing system?

Are there impacts to fire safety or hazardous materials?

How assessable are the lights?

Do the lights serve a special function?
UNC System-wide Lighting PC

15 Universities and Affiliates

East Carolina
UNC Charlotte
Western Carolina
UNC Asheville
Appalachian State
NC A&T
NCCU
The NC Arboretum

UNC Pembroke
School of the Arts
School of Science of Math
Fayetteville State
UNC General Administration
Winston-Salem State
UNC-TV

Department of Environmental Quality
## UNC System-wide Lighting PC

<table>
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<th>Item</th>
<th>Cost</th>
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<tbody>
<tr>
<td>Lighting Contract Costs</td>
<td>$25.5m</td>
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<tr>
<td>New Fixtures</td>
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<tr>
<td>New Lamps</td>
<td>174,000</td>
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<td>Occupancy Sensors</td>
<td>2,850</td>
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<td>Exit Signs</td>
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</table>

Department of Environmental Quality
UNC System-wide Lighting PC

$ 4m  Annual Projected Energy Savings

$ 29.2m  Energy Savings over 7 Years

7 yr.  Payback

Improved Light Quality
Lower Maintenance Costs

<table>
<thead>
<tr>
<th>Yr</th>
<th>Guaranteed Electric Dollar Savings*</th>
<th>Guaranteed Natural Gas Dollar Savings*</th>
<th>Guaranteed Operational Dollar Savings</th>
<th>Guaranteed Dollar Savings</th>
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<td>$ (522,602.36)</td>
<td>$ 3,688,150.06</td>
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LED RETROFIT PROJECTS

LESSONS FROM THE FIELD
LED RETROFIT PROJECTS

• 4 Types of Retrofit Projects
  1. Lamp replacement
     • a direct replacement of an existing conventional lamp
LED RETROFIT PROJECTS

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     • replace key components of a luminaire such as lamps, drivers, connectors, lenses, reflectors
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(2) 14 Watt LED with existing ballast  (2) 32 Watt T8 with ballast
LED RETROFIT PROJECTS

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3. Complete luminaire replacement
   • 1:1 replacement

Before: (7) 175 w metal halides After: (7) 99 w LED’s

View of Dayrooms from Officer’s Control Room
LED RETROFIT PROJECTS

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New and Old Fixtures Side-by-Side

66% reduction in energy

50% increase in fc
4 Types of Retrofit Projects

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   - 1:1 replacement
4. Lighting system redesign
   - Re-design of the illuminance in a space - lighting simulation software

Wake County - Sunnybrook Road Parking Deck
LED RETROFIT PROJECTS
LED RETROFIT PROJECTS

• Existing Infrastructure and Building Conditions
  • Electrical – non linear loads
  • Hazardous materials
  • Ceiling types
  • Painting and patching
  • Insulation above ceilings
  • Emergency systems and exit lighting
  • HVAC and heat load effects
  • All fixtures are not equal…
LED RETROFIT PROJECTS

• Condition of Existing Fixtures
  • Physical Size
  • Housing
  • Sockets
  • Lenses
  • Ballast/drivers
  • Input voltages
  • Whip length and location of knock out boxes
  • Manufacturer
  • Third Part Listing
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**LED RETROFIT PROJECTS**

- Two main methods of lighting controls for dimming
  - Analog/change in AC power supplied to luminaire
    - Phase-cut
    - Amplitude reduction
    - Most existing dimming circuits
  - Independent supply signal between control & driver (Pulse width modulation)
    - DALI
    - DMX
    - Others

- Compatibility between the existing control system and the retrofit must be verified.
  - Check with manufacturers
  - Mock-ups and hardware verification
LED RETROFIT PROJECTS

- **Common Controls**
  - Photocells
  - Daylight harvesting controls
  - Dimming
  - Occupancy/Vacancy
  - Building or room control systems

- Controls can have an impact on both energy consumption and flicker.
LED RETROFIT PROJECTS

• Outdoor and Exterior Lighting
  LED Retrofits
  • Spacing and light distribution
  • Glare
  • Light trespass
  • Sky glow
  • Backlight, Uplight, and Glare (BUG) rating
  • Durability
  • Surge protection
  • Vibration rating
  • Grounding
  • Photocell and controls
  • Warranty
  • Wiring / rewiring
  • Availability
  • Cost payback
Where Can I Find The Guidance Document?

SCO Website
http://ncadmin.nc.gov/document/ssl-guidance

DEQ Website
http://deq.nc.gov/conservation/utility-savings/tools-technology

Where Can I Find The Presentation?

http://deq.nc.gov/conservation/utility-savings/outreach-training
For Questions and Comments:

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