Lighting Best Practices Summary

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Overall Scope and Purpose

The goal of the "Best Practices" Summary is to provide overall general guidelines useful in the selection of appropriate lighting systems consistent with maximized lighting quality and energy efficiency. As general guidelines, these recommendations should not be construed as the only reasonable and practical solutions for each and every application situation. Rather, they should serve as a starting point from which to begin the process to determine the most appropriate lighting system for a particular lighting application, based on the task dynamics and minimized life cycle cost. Technologies included in the recommendations have been proven through years of successful application and performance. By its very nature a summary is broad in scope and details for your particular application should usually be determined with the help of a qualified lighting professional.

Commercial Interior Spaces

Best Practice recommendations for commercial interior spaces include:

1) For general area lighting, use of high quality fluorescent lighting systems with electronic ballast technology, including both T8 and T5 systems as may be appropriate, are recommended.
2) Where mounting height, the nature of the lighting task, and other factors are favorable, utilize pulse start metal halide systems.
3) For downlighting, track lighting, and spotlighting applications, utilize compact fluorescent technology or ceramic metal halide products wherever possible in place of incandescent lighting products.
4) For emergency lighting, fluorescent lighting products should be selected whenever practical over incandescent products consistent with the system providing for safety in the emergency lighting condition.
5) For exit signs and signage, LED technology is the preferred choice.
6) Control strategies should be utilized and combined to maximize savings, including:
   - Individual work space control
   - Occupancy sensors
   - Multi-level switching
   - Building lighting control systems.
7) Building design should include Daylighting where reasonable and practical.

Industrial Interior Spaces

Best Practice recommendations for industrial interior spaces include:

1) For general area lighting, and depending on mounting height and task application factors, the use of pulse start metal halide technology and high quality fluorescent lighting systems with electronic ballast technology, including both T8 and T5 systems as may be appropriate, are recommended.

2) Multi-level HID and fluorescent switching systems should be integrated into the lighting design where appropriate and practical, especially in warehouse aisles and other areas that may be vacant for extended periods of time.
3) Occupancy sensors and timing devices should be combined with multi-level switching to maximize savings.
4) For emergency lighting, fluorescent lighting products should be selected whenever practical over incandescent products consistent with the system providing for safety in the emergency lighting condition.
5) For exit signs and signage, LED technology is the preferred choice.
6) The lighting design should include Daylighting where reasonable and practical.

Retail Interior Spaces

1) For general area lighting, use of high quality and high color rendering fluorescent lighting systems with electronic ballast technology, including both T8 and T5 systems as may be appropriate, are recommended. Where mounting height and application considerations permit, pulse start metal halide is an appropriate choice as well.
2) Incandescent sources should be replaced with ceramic metal halide or fluorescent sources whenever practical for highlighting and spotlighting applications within the interior retail environment.
3) For exit signs and signage, LED technology is the preferred choice.

Commercial, Industrial, Educational, and Retail Exterior Spaces

1) Pole mounted and building mounted luminaires featuring high performance optics meeting the IESNA criteria full cutoff criteria should be utilized for desired visibility and site attraction consistent with minimized light trespass, light pollution and life cycle cost. Luminaires featuring high performance full cutoff optics can minimize pole locations and minimize luminaire quantity, lowering initial cost and ongoing energy and maintenance costs.
2) Pole mounting heights, and minimum light levels, should be selected based on specific site and application conditions, to provide desired visibility consistent with control of light trespass and light pollution.
3) When shielding is required to control light trespass, utilize internal shields if possible, with external shields being a last resort.
4) Uniformity should be based on maximum to minimum footcandle ratios, and should not exceed 15 to 1.
5) High performance light sources, particularly pulse start metal halide, should be utilized whenever practical, to provide for improved site lighting quality. High pressure sodium sources may provide satisfactory lighting quality for industrial and security applications. Monochromatic low pressure sodium systems are not recommended.

6) Where mounting heights and site ambient temperature conditions permit, high performance fluorescent systems may be appropriate and may provide minimized life cycle cost.
7) Control strategies that are appropriate for outdoor lighting include:
   - Multiple circuiting to poles with multiple luminaires, permitting multiple light levels based on time settings or level of site activity.
   - Site control systems utilizing time settings or photo control input.
   - Individual luminaire based photo controls often result in added initial costs and maintenance costs, and should be considered only as a choice of last resort.

K-12 School Applications

High traffic areas of schools should always have light during hours of normal occupancy for safety and security reasons. Occupancy sensors should be set to provide a lower light level in these areas when unoccupied.

All areas should utilize LED exit signs.

More specialized areas and recommendations include:
1) Classrooms, lunch areas and teachers lounge:
   - Lighting should be T8 fluorescent with electronic ballasts and be capable of on and off switching in both recessed and suspended luminaires to permit users the ability to reduce lighting.
   - Teacher study areas should be individually controlled.
   - Daylight harvesting should be employed where practical including both on/off photo sensors and dimming photo sensors. On/off photo sensors are best employed near windows.
   - Solar tubes may be utilized where practical to bring sun light into interior classroom areas to reduce energy load.
2) Gymnasiums
   - Multi-level switching capability is highly recommended.
   - Dual level occupancy based MH systems or Compact Fluorescent or high output T5 systems all help to achieve the goal of minimized energy cost, and maximized light output during use and occupancy.
3) Auditorium and lobby:
   - Recessed Compact Fluorescent luminaires provide a reasonable comfort level and should be used in place of or to replace inefficient incandescent luminaires.
   - Occupancy sensors are recommended to reduce lighting load during periods when these areas are unoccupied.
4) Restroom and locker rooms:
   - Lighting should be T8 electronic fluorescent systems.
   - Switching in these areas, if required, should be remotely located.
   - Occupancy sensors should utilize ceiling mounted ultrasonic or dual technology.

5) Maintenance areas:
   - Lighting should be provided by industrial grade T8 electronic fluorescent luminaires.
   - A time-delay switch is recommended for these areas, to insure that work is completed prior to lights automatically turning off.
   - If lights are not set to turn off automatically in these areas, they could go unnoticed for weeks if the light was accidentally left on.
6) Administrative offices:
   - Lighting should be provided by either T8 electronic fluorescent luminaires or recessed compact fluorescent luminaires, or the appropriate combination.
   - General lighting should be controlled by a manual wall switch type occupancy sensor.
   - A station-based sensor should be used to control task lighting.
7) Halls and stairways:
   - T8 electronic fluorescent luminaires and compact fluorescent luminaires are recommended for these areas.
   - Occupancy sensors should not be set in such a way that all lights in these areas go off. Settings and circuitry needs to provide for some level of light in these areas at all times.
8) Energy Management Systems and lighting panels can be combined to sweep areas to turn lights off during periods of school closure.

Colleges and Universities

Colleges and universities present a diverse mix of building types. This section will address recommendations for assembly buildings and education buildings. Recommendations for commercial interior spaces can generally be applied to office buildings in a college or university setting. Also, dormitories share many traits in common with Multi-family housing whose recommendations should be consulted. Laboratory buildings often have special requirements that need to be considered given the individual circumstances. LED exit signs should be used throughout the campus. Existing exit signs should be replaced with new LED units.

1) Classroom and educational buildings:
   - Utilize T8 electronic fluorescent luminaires and systems. Existing older systems should be replaced, usually with paybacks under 8 years.
   - Utilize occupancy sensors for classrooms.
   - When possible, design or retrofit classrooms for dual switching with the front and rear of a classroom on separate circuits. This is more conducive to presentation needs in classrooms and can permit half of the lights to off more often.
   - Replace non-dimming incandescent lamps or luminaires with more efficient compact fluorescent luminaires.

- New or remodeled classrooms should incorporate daylight harvesting whenever practical.

2) Assembly buildings:
   - Utilize T8 electronic fluorescent luminaires and systems. Existing older systems should be replaced, usually with paybacks under 8 years. For new construction or major renovation dimmable electronic fluorescent ballasts and luminaires are recommended.
   - Replace non-dimming incandescent lamps or luminaires with more efficient compact fluorescent luminaires.
   - For new construction or major renovation, strong consideration should be given to indirect systems as well as direct/indirect systems. The greatest efficiency will often be achieved by T5 high output fluorescent systems.

Multi-Family Housing

While each project has its own unique characteristics, there are some general guidelines that should form a starting point.

- LED Exit signs should be utilized and older exit signs replaced with new LED signs.
- Exterior lighting should utilize the recommendations provided earlier for Commercial, Industrial, Educational and Retail Exterior spaces. Parking areas should be handled with extreme care and concern for light trespass into project residences and off the site. Full cutoff luminaires should be utilized on wall mounted exterior luminaires to minimize light pollution and trespass, with either fluorescent or high performance Metal Halide sources.
- Hallways and stairways should utilize high efficiency fluorescent sources.
- Any permanent luminaires utilized in individual units should use electronic fluorescent sources for minimized energy consumption.

Municipalities

Many municipal applications, like municipal office buildings, have common characteristics with commercial interior spaces, or other areas already covered in these recommendations. Depending on the type of municipal project involved, the previous recommendations should be consulted. Some unique considerations to municipalities include:

1) Traffic signals, which should utilize LED technology for maximized energy and maintenance savings.
2) Street Lighting generally should utilize high efficiency HID sources, often with the appropriate use of timers and photocells for control
3) Parking lots should be treated as shown in the recommendations provided earlier for Commercial, Industrial, Educational and Retail Exterior spaces. Municipalities that have exterior lighting ordinances should pay careful

attention to see that their own facilities perform appropriately. Full cutoff luminaires are recommended to minimize light pollution and light trespass.

Barriers Identified to Best Practices

1) An overall reluctance to change past practices, even though they may be outdated.
2) The perception that utilizing high performance lighting equipment and sources increases initial costs for new construction. In fact, the opposite is often true.
3) Retrofit opportunities are often postponed due to up-front cost.
4) Expectations are often unrealistic. Expecting, for instance, a two-year payback or 50% return on investment on every project is simply not realistic. Many of these types of opportunities have already been exploited.
5) The demands for verification can be unrealistic, given that conditions affecting energy and maintenance costs are in a constant state of change. It is often difficult to "prove" what savings will be achieved.
6) Accepted standard practices may at times create barriers to Best Practices due to the fact that standard practices are not questioned or reevaluated in light of new technologies.
7) Lack of understanding of the Life-Cycle cost approach.
8) Political obstacles, often discouraging project initiation.
9) Natural resistance to trying new technologies in the face of past known performance.
10) Many organizations have no structure to initiate to perpetuate an ongoing modernization program.