MULTIFAMILY PERFORMANCE PROGRAM

Technical Topic – New Buildings

Savings Opportunity - Stairwell Lighting

Summary

Stairwell lighting offers opportunities for significant energy savings. Many stairwells are designed with more illumination than is required for safety. Furthermore, many light fixtures that are designed for stairwell use run continuously, even though building occupants rarely use the stairs.

Energy saving strategies for stairwells include:

- Reduce over illumination
- Bi-level lighting or occupancy sensors, and photocells for stairwells with windows
- Paint walls and ceilings bright white and stair treads lighter colors to increase reflectance

Findings and Recommendations

A lighting analysis was completed for a typical scissor-type stairwell in a multifamily building using the Visual 3D modeling program. The table below summarizes results from three lighting options. The savings were calculated assuming that lights are always on and electricity costs $0.15/kWh.

Option	Fixture Description	Watts per fixture	Power density* (W/sf)	Minimum foot-candles	Annual operating cost per floor
#1a Typical lighting	(2) T8 / electronic	58	0.77	13.0	$154.52
#1b Typical lighting	(2) T8 / electronic (low ballast factor ballast)	51	0.68	10.1	$134.03
#2 Better lighting	(1) T8 / electronic	32	0.37	6.9	$84.10
#3 Wall sconce	(1) CFL	18	0.72	4.8	$141.91

* The area used for the power density calculation is defined as two landings (one at floor level and one intermediate landing between floors) and the two flights of stairs that run between floors, 150 SF in this example. The power, foot-candle, and cost calculations for linear fluorescent fixtures assume two fixtures, one for each of the landings. The power, foot-candle, and cost calculations for the CFL wall sconce assume six fixtures, one for each landing and two per flight of stairs.

By using a single lamp four-foot T8 fixture over each landing, both the 2007 New York State Energy Conservation Code and ASHRAE 90.1 2004 power density maximums for stairwells can be met (0.7 W/sf and 0.6 W/sf respectively), with a savings of 35% compared to two-lamp T8 fixtures with energy efficient ballasts. In order to comply with the 2007 New York State Energy Conservation Code, a low ballast factor ballast was used with the two-lamp T8 option #1b. Although the 18W CFL wall sconce is slightly over the allowable Power Density and falls slightly short of the target of 5 foot-candles, it offers an alternative to the two-lamp T8 fixture. With a slight variation in stairwell size the wall sconces would fall below the required maximum power density. One advantage to the wall sconce is the flexibility in placement.

This information is provided as a summary to the Technical Topics discussion in March 2009

MULTIFAMILY PERFORMANCE PROGRAM

Technical Topic – New Buildings

Savings Opportunity - Stairwell Lighting

Stairwell Occupancy and Occupancy Sensors

Occupancy sensors that fail "on" have been approved by the Life Safety Code for use in stairwells and can play a significant role in saving energy. Confirm with the manufacturer that the model you are considering will default to the occupied setting if it fails.

To maximize energy savings, it is important that fixtures be controlled by individual occupancy sensors, not grouped. "On-time" should preferably be short. It is critical that the on-time be set during installation and checked during commissioning, because default factory settings for occupancy sensors can be 15 minutes or more, which reduces the potential savings.

Occupancy sensors should not be energized until after construction is complete, to prevent short-cycling of lamps during construction. Any fixture controlled by an occupancy sensor must use a rapid start ballast to prevent the lamp from burning out quickly due to frequent switching on and off. It is also necessary to allow any new lamps to stay on for the first 100 hours in a "burn in" mode that is provided by many occupancy sensors.

The following table evaluates the effects of using occupancy sensors to either turn off every other fixture (option #4 and #6) or to install bi-level fixtures to dim all fixtures during unoccupied periods (option #5 and #7).

Option*		**Fixture Description**	**Watts per fixture**	**Power density (W/sf),** (occupied/ unoccupied)	**Minimum foot-candles** (occupied/unoccupied)
#4	NYS Efficient	(1) energy efficient T8 w/ occupancy sensor	21	0.28/0.14	5.3/1.5
#5	NYS Occu-Smart +	(1) T8 Occu-Smart	30	0.40/0.12	6.0/1.5
#6	NYC Efficient	(1) energy efficient HO T8 w/ occupancy sensor	21 and 28	0.33/0.19	6.5/2.1
#7	NYC Occu-Smart +	(1) T8 Occu-Smart (decreased dimming)	30	0.40/0.19	6.0/2.4

* NYS means conforms to NYS code and NYC means conforms to NYC code

+ Occu-Smart is a product of Lamar Lighting, Farmingdale, NY

The savings provided by occupancy sensors or bi-level fixtures will depend on the amount of traffic in the stairwells and how long the lights remain on each cycle, after the motion sensors stop sensing movement.

This information is provided as a summary to the Technical Topics discussion in March 2009

MULTIFAMILY PERFORMANCE PROGRAM

Technical Topic – New Buildings

Savings Opportunity - Stairwell Lighting

Summary of Evaluated Options

#1 Corridor wraparound fixture, (2) four-foot T8 lamps
   a. Instant start electronic ballast
   b. Instant start electronic ballast with a low ballast factor (BF=.75)
#2 Corridor wraparound fixture, instant start electronic ballast, (1) four-foot T8 lamp
#3 Wall sconce fixture, (1) compact fluorescent lamp
#4 Corridor wraparound fixture, energy efficient instant start ballast, (1) four-foot T8 energy efficient lamp for in-between floor landings (always on), and energy efficient rapid start ballast with (1) four-foot T8 energy efficient lamp and occupancy sensor for floor level landings.
#5 Occu-Smart bi-level fixture, dimming ballast, (1) four-foot T8 lamp, occupancy sensor, emergency backup battery, dim lamp to 20% during unoccupied conditions.
#6 Same as Option #4, but use high output (HO) T8 lamps for the in-between floor landings.
#7 Same as Option #5, but dim lamp to 33% during unoccupied conditions

Key Assumptions

- Typical scissor type stairwell (intermediate landing between floors).
- Foot-candle measurements were taken at the surface of the stairs. The minimum foot-candle values represent the lowest average foot-candles found over the area of a single landing or stair tread.
- Minimum of five foot-candles at floor level on all landings and stair treads during occupied times.
- Minimum of one foot-candle at floor level during unoccupied times for New York State.
- Minimum of two foot-candles at floor level during unoccupied times for New York City.
- For calculating lighting power density, the square footage per floor equals the summed areas of the landings plus all stair treads. In our example scissor type stairwell, the square footage for a floor equals the area of two landings plus the tread areas of two lengths of stairs.
- No outside light sources such as daylighting in the stairwell.
- Calculated Light Loss Factors used for each lighting option.
- Reflectances of 50% for the ceiling, 80% for the walls, and 20% for the floor.
- Ceiling-hung fixtures (10’-0” above finished floor).
- Temperatures of at least 60 degrees Fahrenheit in the stairwells.
- Savings calculated assume $0.15/kWh

Additional Considerations

Emergency Lighting
Given that stairwells are a means of egress it is important to make sure appropriate emergency lighting is provided. Some stairwell light fixtures are equipped with back up emergency lighting, therefore eliminating the need for additional emergency lighting.

Reflectance Value
By changing the reflectance values in the model of the walls and ceilings to 90% and 80% respectively it becomes possible to use lighting option #4 above in a NYC stairwell. This results in a lower power density (as seen by comparing option #4 and option #6 above). Similar results are also seen for the

Occu-Smart fixtures. With the same increase in wall and ceiling reflectances, the dimming level can be reduced from 33% to 20% in NYC stairwells and from 20% to 10% in NYS stairwells.
For more information on reflectances, refer to the New Construction corridor lighting tech tip released February 19, 2009.

Code Changes
It is important to keep up to date on the current code requirements for both minimum foot-candles and maximum power density allowed in multifamily building stairwells. In NYC, Local Law 26 requires the use of photoluminescent tape in commercial buildings over 75 ft high. Even if this becomes law in residential buildings, it will not have an effect on the use of occupancy sensors or allowable foot-candles as long as the minimum light level of 2 foot-candles is maintained at all times.

Creative solutions can be developed for specific stairwells using photometric software, like Visual-3D (http://www.visuallightingsoftware.com/)

Disclaimer

Despite modeling a typical multifamily residential stairwell in this report, it is important to evaluate lighting on a case-by-case basis. Stairwells are often different sizes and styles and may require more or less lighting.

Appendix

Methodology

As described above, the computer program Visual-3D was used to analyze lighting options in a scissor type stairwell. The goal of the lighting analysis was to find lighting fixtures and configurations that would supply the required foot-candles while minimizing the lighting power density.

The modeled stairwell was based on a typical multifamily residential building stairwell. All stairs and landings were modeled accurately and therefore comply with New York State Building Code (NYSBC). Some basic assumptions were made for the model and are as follows:

- It was assumed that there were no outside light sources such as daylighting
- The reflectances were assumed to be 50% for the ceiling, 80% for the walls, and 20% for the floor. It was observed that in many different building the undersides of the stairs (ceiling) was painted a neutral color and that many walls were painted white. The industry standard floor reflectance of 20% was used.

Light Loss Factors (LLF) were calculated using Lamp Lumen Depreciation (LLD), Luminaries Dirt Depreciation (LDD), and Ballast Factors. For all of the scenarios tested, 0.89 was used for LDD, which is based on a clean environment and non-regular cleaning. For some of the luminaries tested the LLD and Ballast Factor were given. When these values were not given it was assumed for all T8 fixtures that the LLD for Rapid Start = 0.9 and for Instant Start = 0.92 and the electronic Ballast Factor = 0.88.

The lighting model was run with a variety of fixtures, ballasts, and lamps in an attempt to determine both the most efficient and practical lighting options for stairwells. Wall and ceiling placement were analyzed for each of the lighting combinations and it was found that fixtures hung from the ceiling at 10’-0” above finished floor produced the best light distribution.

Code Requirements

The following light level requirements and lighting power density requirements were used throughout the analysis.

Light Level Requirements – Occupied:
The 2007 New York State Building Code (NYSBC) requires a minimum illumination level of not less than 1 foot-candle at floor level in stairwells. The 2008 New York City Building Code (NYCBC) requires that the minimum illumination level in stairwells be at least 2 foot-candles. In contrast, the Ninth Edition of the Illumination Engineering Society of North America (IESNA) Lighting Handbook recommends a minimum of at least 5 foot-candles at floor level. For the purpose of this report, lighting scenarios were developed based on the ability to provide a minimum of at least 5 foot-candles at floor level on all landings and stair treads. Although not required by law, we believe this level of luminance is significant and will provide both comfort and safety for the occupants.

MULTIFAMILY PERFORMANCE PROGRAM

Technical Topic – New Buildings

Savings Opportunity - Stairwell Lighting

Light Level Requirements – Unoccupied:
During times when the stairwells were unoccupied, light levels were allowed to drop to the 1 foot-candle minimum as defined by 2007 NYSBC and 2 foot-candle as defined by 2008 NYCBC.

Lighting Power Density Requirements:
The current 2007 New York State Energy Conservation Code requires a maximum power density of 0.7 W/sf. ASHRAE 90.1 2004 requires a maximum of 0.6 W/sf in stairwells, which indicates the direction that corridor lighting is going, and the potential for savings.

References:

2007 New York State Building Code
New York City Building Code, enacted 2008, effective July 1, 2009.
2004 ASHRAE 90.1
2007 New York State Energy Conservation Code
2003 Life Safety Code
Ninth Edition of the Illumination Engineering Society of North America (IESNA) Lighting Handbook
LaMar Lighting Co., http://www.occu-smart.com/
LaMar Lighting Co., *Occu-Smart Lighting System*, http://www.occu-smart.com/pdf/occu-smart-motion-sensing-lighting-system.pdf
Lithonia Lighting, http://www.lithonia.com/
California Energy Commission's Public Interest Energy Research (PIER), Case Study, *Bi-Level Stairwell Lighting*, http://www.occu-smart.com/pdf/PIER-20CaseStudy-205-201.pdf