MULTIFAMILY PERFORMANCE PROGRAM

Technical Topic – Existing Buildings

Savings Opportunity - Stairwell Lighting

Summary

Stairwell lighting offers opportunities for significant energy savings. Many stairwells have more illumination than is required for safety. Furthermore, many stairwells are illuminated continuously, even though building occupants rarely use them.

Energy saving strategies for stairwells include:

- Upgrade from T12 to T8 lamps and convert from magnetic to electronic ballasts
- 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 return-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
#1 Typical existing	(2) T12 / magnetic	82	1.09	13.7	$215.50
#2a Typical retrofit	(2) T8 / electronic	58	0.77	13.0	$154.52
#2b Typical retrofit	(2) T8 / electronic (low ballast factor)	51	0.68	10.1	$134.03
#3 Better retrofit	(1) T8 / electronic	32	0.43	6.9	$84.10

* 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. The power used for the calculation includes two fixtures, one for each of the two landings.

By using a single four-foot T8 fixture over each landing, both the New York State Energy Conservation Code and ASHRAE power density maximums for stairwells can be met (0.7 W/sf and 0.6 W/sf respectively), with a savings of 45% compared to two-lamp T8 fixtures.

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.

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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 or bi-level lighting to control half of the stairwell fixtures (i.e., every other fixture).

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

* 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.

Summary of Evaluated Options

#1 Corridor wraparound fixture, magnetic ballast, (2) four-foot T12 lamps
#2 Corridor wraparound fixture, (2) four-foot T8 lamps
   a. Instant start electronic ballast (BF=.88)
   b. Instant start electronic ballast with a low ballast factor (BF=.75)
#3 Corridor wraparound fixture, instant start electronic ballast, (1) four-foot T8 lamp

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#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 #6, but dim lamp to 33% during unoccupied conditions

Key Assumptions

- Typical return type stairwell (intermediate landing between floors).
- 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.
- 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-mounted fixtures.
- Temperatures of at least 60 degrees Fahrenheit in the stairwells.
- Savings calculated assume $0.15/kWh

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. The reflectance of walls, ceilings, and floors also affect light levels. More reflective surfaces (typically lighter colors) will lower the required lighting power densities in order to deliver target light levels.

Appendix

Methodology

As described above, the computer program Visual-3D was used to analyze lighting options in a return 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 that for all T12 fixtures LLD = 0.92 and the magnetic ballast factor = 0.93. For all T8 fixtures it was assumed 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.

The T12 lighting combination represents a baseline lighting scenario in an existing building. A common retrofit option is to switch the (two) T12 lamp combination with the (two) T8 lamp combination. The (two) T8 combination is therefore representing the retrofit baseline.

When choosing to replace lights in an existing building, there are two installation options to consider. The old fixtures can either be replaced or they can be retrofitted for new lamps and ballasts. Since T8 lamps can fit in the same fixture as T12 lamps with a simple retrofit kit, there is noteworthy savings potential by performing a retrofit. However, it is important to consider the condition of the existing fixtures before choosing this option.

Code Requirements

The following light level requirements, lighting power density requirements, and uniformity ratios were the assumptions used throughout the analysis with the exception of the two baseline scenarios (two-bulb T12 and two-bulb T8), which do not meet the lighting power density requirements.

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Light Level Requirements – Occupied:
The New York State Building Code (NYSBC) requires a minimum illumination level of not less than 1 foot-candle at floor level in stairwells. The New York City Code (NYCBC) requires that the minimum illumination level in stairwells be at least 2 foot-candles. In contrast, the Illumination Engineering Society of North America (IESNA) 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.

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 NYSBC and 2 foot-candle as defined by NYCBC.

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

Additional Considerations

Given that stairwells are a means of egress it is important to make sure appropriate emergency lighting is provided. Many existing buildings already have backup emergency lighting installed in their stairwells.

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

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