Measure Information Template –

Bi-level Stairwell Lighting

2008 California Building Energy Efficiency Standards

PIER Program - EnergySoft, LLC February 3, 2006

CONTENTS

Overview

Description	A recent PIER research project has demonstrated the dramatic energy savings benefits of using occupancy sensors with bi-level illumination in stairwell applications in commercial buildings. Since stairwells are typically lit 24 hours a day, the potential for energy savings by reducing lighting to a lower level during unoccupied periods is significant. While this PIER project used a bi-level stairwell fixture, the use of bi-level illumination in general in this application has a much greater impact than currently recognized by the Standards.
Type of Change	This change is proposed to be an addendum to Table 146-A, the Prescriptive Lighting Power Adjustment Factor table. It is proposed to add an additional entry in this table providing credit for use of this technology specifically in stairwell applications. The electronic ballasts employed for this technology must have a Ballast Efficacy Factor (BEF) of 1.48 or greater.
Energy Benefits	To demonstrate the energy savings potential of this technology, four buildings were selected for testing based on how often the stairwells were used by occupants. Baseline measurements were taken prior to the installation of the bi-level stairwell fixtures. In these four buildings, building owners saved between 38 and 49 percent of lighting energy on 24-hour weekdays, and between 47 and 67 percent on weekend days. The percentage of time in dimmed mode ranged from 62 to 82 percent during weekdays, and from 85 to 97 percent on weekends. The energy savings from the application of bi-level technologies to stairwells at the four test sites ranged from 40 to 60 percent. The bi-level illumination technology reduces both peak energy demand and energy consumption. Because these fixtures are on 24 hours per day, both types of energy saving are significant. The BEF of 1.48 or more will ensure that these fixtures will operate efficiently at full load.
Non-Energy Benefits	The PIER study did not have enough data to determine if there will be an extension of lamp life due to the use of this technology. In some application, where the lamp is turned entirely off, the lamp life will probably be shortened. However, due to less operating hours, the actual calendar life of the lamp will be similar. The net result is greater energy savings with similar overall time frequency for lamp replacement. Because of the recent security concerns in the United States, the importance of lighting stairwells for safe emergency egress under extreme conditions has gotten increased attention from both building owners and property insurance companies. Many emergency preparedness experts are questioning whether current minimum light levels called for in life safety codes are really sufficient for emergency egress situations—especially where smoke may be a factor. By utilizing bi-level stairwell illumination, a building owner has the potential to significantly increase light levels in stairwells when needed, yet keep energy costs low. Even though the current Title 24 code will permit the higher footcandles, this will give building owners the ability to achieve these levels without a penalty on energy usage.

Environmental Impact	The issue of safety in the stairwell was considered in the PIER study. In fact, it is very likely that we will see a large increase in lighting levels in stairwells in coming years, due to possible code adoption of a 10 foot-candle requirement in the NFPA. This will dramatically increase the energy savings potential of this technology, and still have the positive benefit of allowing building owners to achieve compliance with this new regulation.
Technology Measures	Measure Availability and Cost At least three lighting fixtures are now in production and offered for sale in California that combine a fluorescent lighting fixture and an occupancy sensor so that it is possible to provide bi-level illumination in stairwells. In addition, the Bi-level control scenario is already encompassed in the Title 24 Standards, and occupancy sensors are an extremely common product. Currently, fixtures that incorporate the bi-level technology are 2-3 times the cost of conventional fixtures. However, this price will drop with the introduction of lower cost multi-step ballast technology. Useful Life, Persistence and Maintenance Persistence of this type of energy savings will be similar to current occupancy sensor based technology.
Performance Verification	It is recommended that the same procedures that are in the standards for performance verification of bi-level illumination in hotel/motel hallways be applied to bi-level illumination products when utilized in stairwells.
Cost Effectiveness	This study demonstrated that the bi-level illumination, even utilizing a fixture that cost three times the price of a conventional fixture, would still show a payback of under 5 years.
Analysis Tools	No impact on analysis tools would result from this proposal. This would simply be a change to the lighting control credits in table 146-A.
Relationship to Other Measures	No other measures would be impacted by this technology, although it might be argued that if the 10 foot-candle rule for stairwells is put into effect, this technology may be the only reasonable way to meet this requirement,

Methodology

The current Standards offer a Lighting Power Adjustment Factor for the use of bi-level illumination in corridors of Hotel/Motel applications. The credit given is a 25% savings adjustment. Clearly, these applications have a considerably higher usage factor than most stairwells in buildings. It is the recommendation that we apply the same savings fraction for stairwell applications in any nonresidential building as we do for the corridor application. Even though the technology has been shown to save 40 - 60%, it is reasonable to discount the savings for controls related problems, and user override of occupancy sensors.

As a follow-up to this, if the 10 foot-candle rule is implemented by NFPA, it is recommended that this technology be considered for adoption as a mandatory measure, perhaps in the 2011 Standards. Typically this section will contain the assumptions used for the analysis of the measure, a description of the base case (current Standards or current practice) and the proposed Standards case.

Analysis and Results

The purpose of the PIER study, upon which this measure template is based, was to test a new type of lighting technology, bi-level stairwell fixtures, in California to determine energy savings, demand reduction, and its acceptance among code-making officials. The bi-level fixtures use a built-in ultrasonic occupant sensor that causes the light to switch to high-level lighting when a stairwell is occupied. After a period of time with no motion detected, the light fixture switches back to low-level, standby lighting.

Previous research, funded by the New York State Energy Research and Development Authority (NYSERDA), was conducted in 2003 by the Lighting Research Center from Rensselaer Polytechnic Institute (RPI.) The fixtures were installed in a high-rise residential complex located on Roosevelt Island just east of Manhattan and a high-rise office building located on Lexington Avenue in New York City. In both cases, the stairwells were not used frequently due to security restrictions. The resulting energy savings were substantial, 53 to 60 percent, when compared to the existing lighting fixtures. Findings from this NYSERDA study are included in the PEIR report.

Like New York, Californians experience some of the highest energy costs in the country. Introducing technologies that reduce energy consumption can help building owners improve building performance and decrease utility costs. The International Facility Management Association (IFMA) was commissioned to find commercial building owners in California who would be willing to install bi-level fixtures in their stairwells and allow researchers from Lawrence Berkeley National Laboratory (LBNL) to monitor occupancy patterns and lighting energy consumption. The PIER report documents the performance of these fixtures and the building owners' reaction to the fixtures. It also documents the presentations of the bi-level technology along with other LRP technologies and products to various California organizations.

Recommendations

It is recommended that the following language be included in Table 146-A of the Standards:

TYPE OF CONTROL	TYPE OF SPACE	FACTOR
Occupant sensor controlled multi-level switching or dimming system that reduces lighting power at least 50% when no persons are present with a BEF of 1.48 or greater	Hallways of hotels/motels	0.25
	<u>Any stairwells</u>	<u>0.25</u>

Material for Compliance Manuals

Changes to the Nonresidential Manual are included below:

Other Control Credits

Table 146-A of the Standards also provides control credits for the following technologies and spaces:

- Occupant sensor controlled multi-level switches or dimming systems that reduce the lighting power at least 50% in hallways of hotel/motels, any stairwells, commercial and industrial storage stack areas (maximum two aisles per sensor), and library stacks (maximum two aisles per sensor). This can be accomplished by placing half of the lighting in these areas on an occupancy sensor and the remainder on a manual switch. Only the fraction of the lighting that is on the occupancy sensor qualifies for the credit (§146(a)4 "controlled watts of any luminaire…").

In this section of the research report, provide information that will be needed to develop the

Table 0-1 – Standards Table 146-A Lighting Power Adjustment Factors

TYPE OF CONTROL	TYPE OF SPACE		FACTOR
Occupant sensor with "manual ON" or bi-level automatic ON combined with multi-level circuitry and switching	Any space ≤ 250 square feet enclosed by floor-to-ceiling partitions; any size classroom, corridor, conference or waiting room		0.20
Occupant sensor controlled multi-level switching or dimming system that reduces lighting power at least 50% when no persons are present with a BEF of 1.48 or greater	Hallways of hotels/motels		0.25
	Any stairwells		0.25
	Commercial and Industrial Storage stack areas (max. 2 aisles per sensor)		0.15
	Library Stacks (maximum 2 aisles per sensor)		0.15
Dimming system			
Manual	Hotels/motels, restaurants, auditoriums, theaters		0.10
Multiscene programmable	Hotels/motels, restaurants, auditoriums, theaters		0.20
Manual dimming with automatic load control of dimmable electronic ballasts with e BEF of 1.48 or greater.	All building types		0.25
Combined controls			
Occupant sensor With "manual ON" or bi-level automatic ON combined with multi-level circuitry and switching in conjunction with daylighting controls	Any space ≤ 250 square feet within a daylit area and enclosed by floor-to-ceiling partitions, any size classroom, corridor, conference or waiting room.		0.10 (may be added to daylighting control credit)
Manual Dimming with Dimmable Electronic Ballasts and Occupant sensor with "manual ON" or automatic ON to less than 50% power and switching	Any space ≤ 250 square feet enclosed by floor-to-ceiling partitions; any size classroom, corridor, conference or waiting room		0.25
Automatic Daylighting Controls with Windows (Stepped Switching or Stepped Dimming/Continuous Dimmed) (Numbers on the left side of a slash apply to Stepped Switching or Stepped Dimming. Numbers on the right side of a slash apply to Continuous Dimming)			
	WINDOWS – Window Wall Ratio		
Glazing Type	< 20%	20% to 40%	> 40%
VLT ≥ 60%q	0.20/0.30	0.30/0.40	0.40/0.40
VLT ≥ 35 and < 60%	0/0	0.20/0.30	0.30/0.40
VLT < 35%	0/0	0/0	0.20/0.40
Automatic Multi-Level Daylighting Controls with Skylights			
Glazing Type - Skylights	Factor		
Glazing material or diffuser with ASTM D1003 haze measurement greater than 90%	$10 \times \text{Effective Aperture} - \frac{\text{Lighting Power Density}}{10} + 0.2$ WHERE Effective Aperture is as calculated in the Equation 146-A. Lighting Power Density is the lighting power density of general lighting		

Bibliography and Other Research

Information for this measure template has been taken from the PIER research project number 500-01-041-A16 report. This PIER report is available from the California Energy Commission's PIER group as an Adobe Acrobat file, and includes the detailed background and research related to this measure template proposal.

The hyperlink for this project is as follows:

http://www.archenergy.com/lrp/lightingperf_standards/project_5_1.htm