Measure Information Template –

Integrated Classroom Lighting

2008 California Building Energy Efficiency Standards

PIER Program - EnergySoft, LLC

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Overview

Description	Based upon products developed and tested by the PIER research group, it has been demonstrated that adequate classroom lighting levels can be achieved at considerably lower Lighting Power Densities than are currently prescribed in the standards. As part of a PIER research project, with input from representatives of the Collaborative for High Performance Schools (CHPS), a high performance lighting system has been demonstrated that has the potential to save 1/3 of the lighting energy versus current practice. Using a combination of best practices and new technologies, the team developed and tested an integrated classroom lighting system (ICLS) for use in K-12 classrooms. The basic system includes indirect luminaires with energy efficient T-8 lamps and electronic ballast, 96% reflective material within the fixture, a teacher control center located at the front of the classroom, and plug-and-play components.
Type of Change	This measure change is proposed as a revision to the allowed Lighting Power Densities for classrooms in the prescriptive standards. It is proposed that the allowed Lighting Power Densities specified in Table 146-B for schools and Table 146-C for classrooms be reduced to 1.10 watts/square-foot.
Energy Benefits	This measure change will result in reduction in both peak demand, due to the lower installed LPD as well as a reduction in kWh consumption. In retrofit applications, which this code would apply to, the PIER testing demonstrated as much as 35% savings with the use of better lighting technology.
Non-Energy Benefits	Teachers at each of the 6 schools in which the ICLS system was installed were surveyed and provided valuable feedback to the researchers and the manufacturers about the system. Overall, the teachers preferred the ICLS to typical classroom lighting systems. Some teachers expressed the comment that they did not realize the poor quality of light from the typical classroom lighting systems (which were 2X4 lay-in troffers with T-8 lamps and on/off switches located only at the room entryway) until the ICLS was installed.
Environmental Impact	Lighting in classrooms may potentially impact the rate of learning for over 6 million students attending K-12 classes in California. Lighting whiteboards, teaching walls, students' and teachers' desks, and teachers' faces is fundamental to the learning process. New methods of learning and other factors affect the way classrooms should be lighted. These changes mean that old, proven ways to light classrooms are obsolete. Classrooms are becoming computerized environments. Schools are installing cable and fiber networks in over 99% of all new classrooms. Classrooms need glare-free lighting systems with proper light levels for computer use. Indirect lighting, used in the ICLS, is recommended for lighting classrooms by both the Illuminating Engineering Society of North America (IESNA) in their publication RP-3 and by the Collaborative for High Performance Schools (CHPS) in their training materials.

Technology Measures	Measure Availability and Cost The high performance lighting system demonstrated here is made by a number of manufacturers. While these types of fixtures are more expensive, overall, the installed cost of the ICLS (~$2.71 / sq ft) is less than the cost of a typical layout using 15 parabolic troffers (~$2.86 / sq ft.). This is due to a smaller quantity of fixtures needed in the classroom. This study demonstrated that the higher performing technology had a zero first cost impact on the classrooms. Useful Life, Persistence and Maintenance Designing classrooms with this technology does not introduce any significant life, maintenance or persistence issues that do not exist with the use of lower performing fixtures.
Performance Verification	No performance verification issues will arise with a reduction in classroom LPDs.
Cost Effectiveness	This measure was shown to have a zero first cost in the test application studied in the PIER report.
Analysis Tools	As a reduction in the prescriptive LPD, there is no impact on analysis tools.
Relationship to Other Measures	There is no relationship to other measures.

Methodology

The classroom designs developed in these studies had 0.96 watts/square-foot of installed lighting. This is well below the current 1.2 watts/square-foot in the 2005 code. 1.10 watts/square-foot was chosen as a reasonable compromise LPD between the highest performing design and current code. However, it should be pointed out, that with the use of occupancy sensors in the classroom, the LPD for the high efficiency design studied here is reduced to an effective value of less than 0.8. So it is not unreasonable that the 1.0 watt/square-foot value could be considered. Especially since this study has shown that this is the most cost-effective solution. Designers could still easily beat this goal with the use of additional controls. By using daylighting systems, the effective LPDs could be driven down into the 0.65 – 0.70 watt/square-foot range.

While certain classroom designs, such as portables, may not lend themselves to conventional indirect systems, the system demonstrated in the PIER report is suitable for installations even when suspended only 3 inches from the ceiling. In instances where designers were still not inclined to use such a system they could still utilize classroom occupancy sensors in the design, which would allow an effective LPD of 1.375 w/sqft. Either solution would result in a more efficient classroom with lower overall energy use.

Analysis and Results

Working with six California schools, variations of the ICLS were installed in 19 classrooms. Researchers continuously monitored the ICLS and other baseline classrooms for one school year and analyzed the resulting data. The data shows a 30 to 50 percent reduction in energy use in the ICLS classrooms with improved lighting on the teaching walls and better flexibility for adjusting light levels during audio/visual presentations. The ICLS also provides approximately 40 to 70 foot-candles of light on student's desks while maintaining less than 1 watt/square-foot in the classrooms.

Recommendations

In the Standards, Table 146-A should have the category for Schools changed from 1.2 to 1.1
In the Standards, Table 146-B should have the category for Classrooms changed from 1.2 to 1.1.

In the Nonresidential ACM Manual, Table N2-2 should have the category for Schools changed from 1.2 to 1.1.
In the Nonresidential ACM Manual, Table N2-3 should have the category for Classrooms changed from 1.2 to 1.1.

Material for Compliance Manuals

In the Nonresidential Manual, Table 5-2 would have Schools changed from 1.2 to 1.1.
In the Nonresidential Manual, Table 5-3 would have Classrooms changed from 1.2 to 1.1.

This will not affect any other documents or forms.

Bibliography and Other Research

Information for this measure template has been taken from the PIER research project number 500-01-041-A14 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/advlight_luminaires/project_4_5.htm