Common area lighting for public housing

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Obtaining durable, energy-efficient lighting for common areas of public housing projects has been a severe challenge for many housing authorities. Common area lighting plays a key role in the safety and security of residents. A U.S. Department of Energy (DOE) project at Auburn University has produced a lighting fixture designed specifically for the rigours of public housing. Working closely with the Chicago Housing Authority (CHA), Oak Ridge and Argonne National Laboratories, and industry advisors, Auburn developed an attractive fixture that resists vandalism and lowers energy and maintenance costs. The design won an award in 1999 from the Association of Energy Engineers, Chicago Chapter.

Common-area lighting is one of CHA's biggest problems. Years of use, exposure to the elements, limited maintenance budgets and vandalism have left some fixtures virtually inoperable. Auburn University in Alabama began working on a solution to this in January 1999, after it was approached by Oak Ridge, representing DOE's Office of Building Technology, State and Community Programs and CHA. This collaboration has enabled CHA to provide residents with safe and cost-effective lighting by going beyond products currently offered and developing a design specifically addressing issues such as security, maintenance, and efficiency.

Design development, selection and testing

The project at Auburn was divided into four tasks. Firstly, a senior-level design class created over 50 different concepts and designs, which were evaluated by project team members from ORNL and the CHA. Secondly, a professor and three graduate students spent several months refining the best concepts into three separate designs, which were again evaluated by ORNL, CHA, and the project's industrial advisors (Lithonia Lighting, Southco Fasteners, and Prolight). A design for the prototype fixtures was selected and prototypes were created in the summer of 1999 in conjunction with the project's industry advisors. The final task was the installation, field-testing and evaluation of the fixtures.

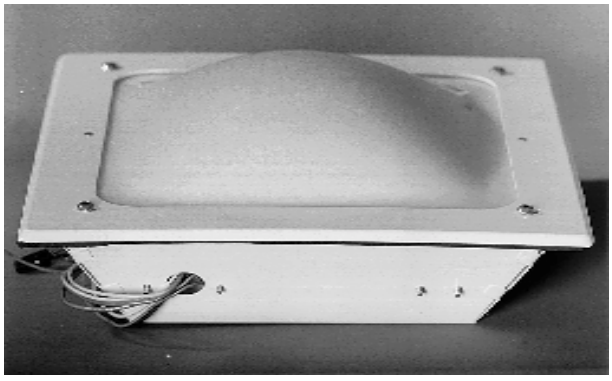
The prototype

The prototype fixture (**Figure 1**) is 13 inches (33 cm) square and made of 16-gauge steel with a white powder-coat finish, with slanted sides to reflect light. Two 18 W compact fluorescent bulbs with electronic ballasts provide 20% more light than available from current fixtures with two 60 W incandescent bulbs. The dome-shaped lense is made of "milky" polycarbonate surrounded with a powder-coat finish steel frame. The lense, reflective enclosure, and brighter bulbs of the prototype fixtures provide significantly higher lighting levels than the deteriorated existing fixtures.

The new fixture fits within existing standard 13 x 13 inch (33 x 33 cm) metal boxes recessed into the concrete slab, minimising exposure. Surface mounting techniques are being investigated to broaden its potential application.

Many variables were considered in all phases of design development, including light levels, energy consumption, maintenance, safety, function and cost. The fixture was to be designed as maintenance-friendly as possible. The prototype keeps all parts of the fixture together when a bulb is changed. Screws holding the lense to the mounting remain in place, and the lense drops out of the way on a cable so workers can change bulbs without having to hold or keep track of various parts. Compact fluorescent bulbs also last about 10 times longer than incandescent bulbs.

Figure 1: Photo of the new lighting fixture.



Prototype testing

During development of the prototype, various elements of the design were tested to identify the likely performance under field conditions. The polycarbonate lense, the exposed element in the design, was tested to determine its ability to withstand various forms of vandalism.

In October 1999, six prototypes were installed in one of CHA's sixteen-story Robert Taylor Homes buildings on the south side of Chicago. Weekly monitoring of the fixtures occurred for the first few months, followed by a monthly check.

The fixtures remained "as installed" until the end of 1999. No vandalism or operational problems occurred. However, ongoing renovation of the building resulted in power to the fixtures being shut-off several times. In January, three prototypes were removed by persons unknown. Whether this was a result of the renovation or theft could not be determined.

CHA were sufficiently impressed that they installed 200 additional pre-production fixtures to complete the building (**Figure 2**). In March 2000, relamping was completed and performance evaluation began. The additional fixtures contained a single electronic ballast, but retained the two 18 W compact fluorescent bulbs.

As a result of field-testing, several modifications are under consideration. One is the use of an automotive grade adhesive to bond fixtures to the structure, preventing theft. Another is the use of more common and cheaper 13 W bulbs instead of 18 W bulbs. A third is the use of ballasts that protect bulbs from current variations common in older buildings. Some or all of these modifications may be included in the production versions.

Figure 2: CHA's Robert Taylor Homes building at 4525 South Federal in Chicago.

CHA also considered relamping the 10 remaining buildings, but chose not to given the buildings' short (<5 years) remaining life.

Projected performance

The existing fixtures in CHA's high rise housing contained two 60 W incandescent bulbs operating continuously. These each consume about USD 76 of power per year. The new fixtures contain two 18 W compact fluorescent bulbs, which along with electronic ballasts consume about 40 W per fixture, or about USD 25 per year. Based on this USD 51 annual cost saving, the new fixtures are expected to have a simple payback of 2.5 years.

The fixture cost is estimated to be about USD 100 per unit, with installation expected to cost about USD 25-35. Firm costs were not available, but prices are expected to be similar to other currently available "rough use" fixtures.

A more impressive performance factor is the dramatically reduced maintenance costs. The existing incandescent bulbs can last up to 1,000 hours in-service, but vandalism and theft sometimes reduce this to a few days. The new fixtures, with more durable enclosures (reducing vandalism) and compact, push-in base, fluorescent bulbs (less desirable theft target) are expected to achieve their projected service life of 10,000 hours. This will cut maintenance by a factor of at least ten, reducing maintenance costs by about USD 75 per year and giving a simple payback of 1.8 years based on this saving alone. Combining energy and maintenance savings yields a payback of just 1.1 year.

Final activities

The field test of the prototypes continued through Winter and Spring 2000 to provide maximum exposure to potential climate-related problems and vandalism. At the conclusion of the test, final design recommendations were developed and documented as fabrication drawings. These will be available to interested parties.

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