SSL DEMONSTRATION:

Bridge Lighting Minneapolis, MN

The country's first report on the longer-term performance of LED lighting in the field documents performance changes in the system installed in 2008 on Minneapolis's I-35W Bridge.

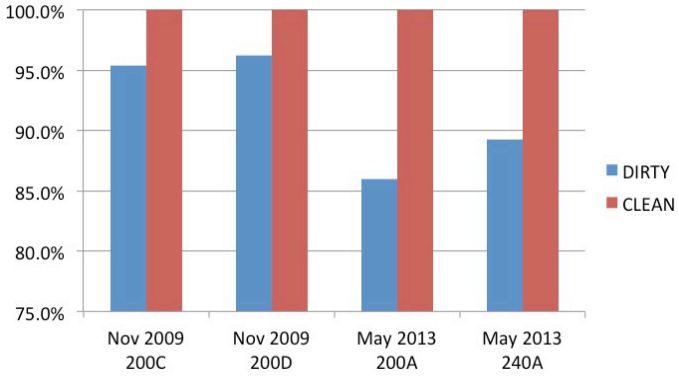
LED luminaires on the I-35W Bridge

The LED lighting system on the I-35W Bridge in Minneapolis is one of the country's oldest exterior LED installations in continuous operation. It was implemented in September 2008 in place of a conventional high-pressure sodium (HPS) system, and a GATEWAY report comparing energy use and illuminance levels with a simulated HPS baseline condition was issued in August 2009. Additional testing was subsequently performed, and the results were published in a September 2014 GATEWAY report. The first detailed account of longer-term performance of LED lighting in the field, that report is summarized in this GATEWAY Brief.

A Five-Year Follow-Up

The 2014 report examined three distinct sets of testing:

- Prior to installation, two of the LED luminaires were tested, along with a third luminaire that was not installed on the bridge but was tested for 6,000 hours in a laboratory for comparison purposes. Follow-up testing on the two installed luminaires was conducted by GATEWAY and the Minnesota Department of Transportation (MnDOT) in May 2013—with the luminaires tested first in their as-is condition and then again after cleaning.
- During the first three years of operation, illuminance levels on the bridge were monitored and recorded using a mobile monitoring system (MMS) designed by the Virginia Tech Transportation Institute (VTTI), with seven sets of measurements collected by MnDOT at various times between April 2009 and October 2011.
- Two luminaires (different from the pretested units) were removed from the installation in November 2009 because of a marked reduction in illuminance in the corresponding roadway area. These removed luminaires were tested in their as-is condition and then retested after cleaning.



Measured dirt depreciation of four luminaires. Estimated operating time was 5,000 hours for the luminaires tested in November 2009, and 20,300 hours for the luminaires tested in May 2013.

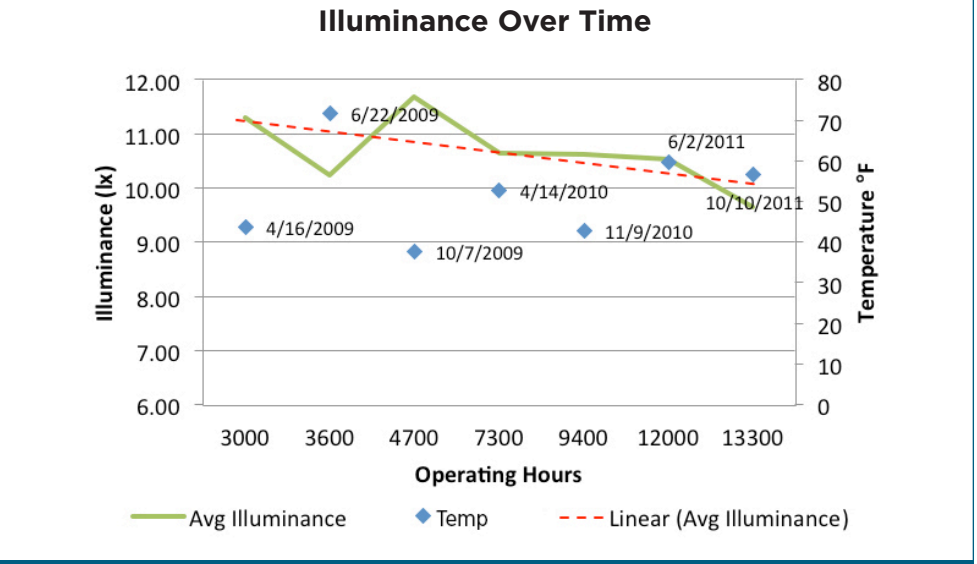
Although the bridge's LED luminaires represent a very early state of the art for the technology, they were found to still be effective in May 2013, exhibiting comparatively reliable performance compared with a conventional HPS baseline and still providing value for a generally pleased MnDOT. At the time of the follow-up report (i.e., after approximately 25,000 hours of cumulative operation), the bridge would have required at least one complete re-lamping if HPS had been installed instead of LEDs in 2008. What's more, there would likely have been an additional number of premature failures that are typical with any traditional lamp-based technology.

Longer-Term Performance Results

While the I-35W Bridge's LED installation has not been problem-free, the few issues that have been encountered have not been entirely unexpected, given the early stage of SSL development at the time of purchase. After roughly 20,300 hours of operation, the two installed luminaires that had been pretested in 2008 were found to average an 18% decline in light output that was independent of dirt accumulation. Overall luminaire efficacy fell by a corresponding 15%. A slight and unexplained reduction in input power was partly responsible for the decline in light output, but two other factors also contributed: normal LED lumen depreciation, which by itself was estimated to be responsible for a 10% decline; and a bubble issue in the optical gel that was estimated to be responsible for a 5–7% decline but which the manufacturer subsequently resolved.

Dirt depreciation averaged 4% after 5,000 hours and 12% after 20,300 hours. A 30% decline from initial output is commonly used to define luminaire design lifetime for LED systems; thus, more than one-third of that lifetime reduction was caused by the effects of dirt alone within the first 20,300 hours of operation. While it wasn't possible to determine whether this depreciation occurred steadily over that period or varied widely on a seasonal or other basis, the data suggest that periodic cleaning of the luminaires may be important in applications where maintaining road illuminance is critical.

Some change in color properties was noted after 6,000 hours of use in the luminaire that remained in the testing lab —namely, a decrease in CCT of roughly 800K, an increase in D_{uv} of roughly 0.01 toward the yellow-green region, and a decrease in R9. The factors causing this color shift couldn't be precisely determined within the scope of the project, but the nature of the shift appeared to be consistent with a possible change in the phosphor used in the LED packages—although other factors may have also contributed.



Average illuminance readings from the bridge's southbound lanes, with ambient temperatures for those dates. Temperature may affect LED output and light meters, but it does not explain all the variation.

Over the period that VTTI's MMS was used (covering roughly 10,000 hours of operation), the measured average ground illuminance decreased by about 10%. Illuminances measured on the ground reflect the cumulative impact of many factors (e.g., lumen depreciation, dirt, ambient temperature and other weather conditions at the time of measurement, measurement uncertainty), and the relative contribution of individual factors cannot be determined from the illuminance data alone.

The entire lighting community continues to learn from the I-35W Bridge's LED system, as well as from other early installations. But it's also important to recognize the limitations in applying longer-term performance of early LED luminaires to their modern counterparts, because of the continuous and ongoing advancements in the technology.

Final reports on GATEWAY demonstration projects are available for download at ssl.energy.gov/gatewaydemos_results.html.

GATEWAY Demonstrations

GATEWAY demonstrations showcase high-performance LED products for general illumination in commercial, municipal, and residential applications. Demonstrations yield real-world experience and data on the performance and cost effectiveness of lighting solutions. For more information, see ssl.energy.gov/gatewaydemos.html.

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