E3T Energy Efficiency Emerging Technologies

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EMERGING TECHNOLOGIES SHOWCASE WEBINAR:

MOGUL BASE LED LAMPS FOR RETROFITS

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Question and Answer Session

Q: From the Annual Energy Use graph on slide 6, does "outdoor" include roadway and parking lot lighting? Are wall packs on commercial/industrial buildings considered outdoor lighting?

A: Yes, outdoor lighting includes wall packs, streetlights, parking lots, etc. A quote from the 2010 *U.S. Lighting Market Characterization* states "The outdoor stationary sector accounts for the remainder of lamps not installed inside buildings. The outdoor subsectors are based on the application where the lamp is used. This includes lamps that may be associated with a specific commercial or industrial building but are installed on the exterior, such as parking lot lights or exterior wall packs".

Q: Who sets the Design Lights Consortium (DLC) requirements?

A: DLC typically proposes a new requirement, which then goes through a series of reviews by stakeholders. The new potential specification for mogul lamps was in the process of review by stakeholders at the time of the webinar, and has since been adopted.

Q: Will all the testing for updates to the Qualified Products List (QPL) for this category take 2 years?

A: DLC announced a "Mogul Screw-Base Replacements for HID Lamps" category in November 2015. As of 12/22/2015 there are 88 mogul LED lamps on the DLC QPL.

Q: Who are the stakeholders that were mentioned in the DLC requirement process?

A: They are manufacturers who want to get products onto the DLC as well as utility members who use the qualified products list to support their incentive programs. Any manufacturer who is interested in getting a product onto the list qualifies as a stakeholder and could contact DLC.

Q: Was R9 measured in CRI?

A: R9 was not measured in CRI. It was not part of the DLC requirements for kits, so it was not measured.

Q: Did you measure the lamp thermals in the luminaire for various lamps?

A: Lamp thermals were not measured. Only photometric and electrical requirements were considered. However, we did observe that some lamps reduced their output after running for awhile, presumably because a thermal overload protection mode was triggered inside these lamps.

Q: How do these stabilization curves compare to similar purpose-built LED luminaires in both time and depth of lumen depreciation?

A: We can't comment on products that were not tested, however we did not see this decrease in light output and power in the other LED mogul lamps that were tested. We surmised that some of the tested mogul lamps overheated and some mechanism that was built into the driver then dropped power and light output, accordingly. But this mechanism was not stated on the specification sheets, and the rated power and light output given in the specification sheet did not match the final measured values once the lamps were stabilized as required in the test method.

Q: What are the life requirements in DLC, if any? Will any of the tested products meet lifetime requirements?

A: That was beyond the scope of this project. For example, we did not make any in situ thermal measurements of these products, to use that information along with TM-80 data to predict life, per TM-21. However, the TM-80 data and ISTMT measurements are believed to be required as part of the DLC application process.

Q: I assume these are high pressure sodium (HPS) as metal halide (MH) that are less than 175w are medium base?

A: They are metal halide lamps, not HPS.

Q: Was there a difference between pulse and probe starts in the failures?

A: Probe start lamps were examined, not pulse start lamps.

Q: Were any of your samples parabolic shape or were they all omnidirectional? If so, how did you take that into consideration for your photometry? Did you optimize the mounting/spacing to get the best results?

A: That's a good question. The lamp shapes varied, with most of them being cylindrical or half cylindrical shapes. Some were PAR-shaped lamps, but others were more trapezoidal shaped; these trapezoidal-shaped lamps were the ones that were used in the yard light or high bay combination. Photos of the lamps that were tested can be seen in the test reports. The lamps fit into the socket based on the socket position, the luminaire configuration, and the lamp size. How the LED lamp interacts with the refractor depends on the lamp geometry. This could not be controlled in the tests because, in most cases, an adjustable socket was not available. The photometric results are based on how the lamp screwed into the socket. If the lamp was a paddle-shaped lamp, we made sure that the optical part, where the lens is, was facing out of the fixture. For example in the wall pack, the cobra head, and the shoebox fixtures, the lamp was facing out and not facing back into the reflector.

Q: What was the shelf spacing between shelves?

A: The aisle width was 9.5 feet.

Q: There are CFL and incandescent lamps with mogul bases, both with 120 and 277V. Why are these called HID replacement Mogul Base lamps?

A: That term is used because according to the Navigant data most of the wattages for HID are 175W or higher and these are typically the mogul base lamps. While there are certainly other lamp types like CFL and incandescent which are also available with a mogul base, they likely do not make up a large part of the market.

Q: Does UL 1598C apply to these lamps?

A: [Two of the attendees provided answers to this question]: UL is still trying to develop specific categories for these types of lamps. These lamps will then be UL recognized instead of listed. UL 1598C applies to Types B and C; UL 1993 applies to Type A.

Q: Was LSAE calculated at the initial "nominal" lumen output, or at the steady-state decreased lumen output due to high temperatures?

A: The steady state data was used. All the photometric files were based on LM-79 testing, which measures steady state data. The LSAE calculations were based on maintained illuminance values, so there was a light loss factor applied in all those simulations.

Q: The LED replacement lamp LSAE lumens per watt appear quite low. How do those numbers compare to the HID numbers?

A: An example of one of the HID numbers is given on slide 27 in a bullet at the bottom of the slide: 150W HPS fixture that was simulated at a 30 ft. mounting height would meet RP-20 criteria at a pole spacing of 140 x 110 ft. on center, and it has a LSAE value of 7 lm/W. At that mounting height a lot of the tested LED combinations in our study were either at, or less than, that value. There is an indication of this on the graph on slide 27: at a mounting height of 30 ft., if you track the dot over to the y-axis, the LSAE is less than 5.

Q: In the test, you tested lamps meant for wall packs in a different area. Why was that done?

A: For the lamps that were tested, we followed the rated applications. So if an LED lamp was rated to be used in an area lighting fixture, a roadway fixture, or a wall pack, we took that into consideration when we tested the lamp. Lamps were not used in a category in which they were not approved. For example, some of the cylindrical lamps that were used in the decorative acorn luminaire can only be operated in a base-up or base-down orientation, so we did not put them into a horizontal socket in a roadway fixture.

Q: It appears these lamps were direct line [voltage] lab tests. This means the targeted luminaire would have to be completely rewired. What sort of instructions did the LED manufacturers provide for rewiring and validation? Luminaires of this nature require HiPot testing.

A: Most of the products that were tested did include instructions on how to bypass the ballast, i.e., to remove the ballast and then rewire line voltage directly to the socket. Those instructions were followed. Some of the instructions required that an external driver be used with a surge protector; those

instructions were followed as well. All of the testing was at 120V, the line voltage that is used in the photometric equipment for this testing.

None of the instructions mentioned HiPot testing, and this was not performed.

Q: Were there any unique technologies that made some products stand out more than others?

A: One tested product that stood out was rated to operate on the existing HID ballast. Some products were silent as to whether to bypass the ballast or not. It could be expected that the efficiencies and performance change based on which way the lamp is wired; therefore a fair way of testing these products was determined and documented in the report. Some of the products had free-form optics, mounted on the LEDs that changed their distribution; this could result in a lamp with a Type 2 or Type 3 distribution due to the optics. The variety in the shapes and sizes was most surprising. Also surprising was that the LEDs were so much longer than the HID lamps they were replacing, so getting lamps that fit was a big part of the project. It was also noticed that some of the lamps were quite heavy, causing them to sag in the socket and touch the lens when they were mounted in the luminaire.

Q: Are there plans to conduct this type of test again since you mentioned there has been growth and change?

A: Not by BPA or LRC at this time.

Q: Was there any consultation with UL on any of the safety issues?

A: We did speak with UL as documented in the report. They thought this testing and what we saw was useful information. The testing that was conducted with the fuse was very preliminary pilot testing. There is a lot more work that could be done to optimize the fuses, to meet all the UL criteria for the fuse holders and fuses, so that they're labeled and can be replaced, etc. That was a pilot test to see if there is potentially a solution so that the non-passive failure would not occur if a HID lamp happened to be reinstalled into the socket after the ballast had been bypassed. There is potentially more work that could be done to determine optimization of fuses and fuse holders and to set criteria for what that equipment might need to be.

Q: Is this technology viable now?

A: In terms of initial photometric and electrical performance, it was determined that almost 40% of the products that were tested in this pilot project could meet the DLC standard performance criteria. This seems very promising. Obviously, manufacturers will need to submit all the rest of the data required by DLC in terms of life performance. It is incumbent on specifiers to do their due diligence with these technologies, as they would with any product, to make sure they can meet their lighting requirements with their target luminaire. Application efficacy types of simulations are important to make sure the lighting requirement is met, for these products but also for any product.

Q: There are a multitude of 277V mogul-base incandescent and CFLs available for purchase now. This presumably means that there is also a multitude of sockets wired to 277V in the installed base already. One can mistakenly purchase an HID lamp and install it in one of these sockets. So the risk of mis-lamping and rupture has been around for a long time. Have problems been seen in the field with this situation?

A: To the best of our knowledge, there is no published literature regarding outcomes for operating an HID lamp without a ballast, other than our report.

Q: Even now, the probe start type lamp can rupture if placed in a pulse start ballast, which is a lot more likely to happen than replacing a LED lamp with a HID lamp. HID Lamps have warnings on them. Is it considered a danger that already exists in the field?

A: As far as we know, there are no publications discussing this mismatch and the resulting outcomes.

Q: AGi32 is notorious for undervaluing LED lighting in point by point layouts, in my experience by almost 20%. Was this taken into account?

A: We have found AGi32 to be a reasonably accurate predictor of illuminance when the environment is simulated accurately. However, footcandles and lux do not accurately characterize the human response of perceived brightness, peripheral vision, etc. Specifically, the tested LED lamps produced an increased brightness perception due to their increased short-wavelength content. The Phase 2 report includes relative and absolute brightness calculations using a proposed brightness metric which includes the photopic luminous efficiency function as well as input from the S-cone photoreceptors. The LED lamps tested were 52% brighter, on average, than an HPS lamp, because of their increased short-wavelength content (assuming the lamps provided the same illuminance level). The brightness effect was calculated for exterior applications in the report, but these lamps could also provide a potentially larger brightness benefit should they be installed in an interior application such as a warehouse or grocery store.

Q: There is a high probability of rupture of a lamp when keeping it on continuously (24hour/7days operation) without a recommended rest period of 15 -30 minutes. This hazard already exists. Isn't it more severe compared to a professional retrofitting a lamp?

A: The lamps that ruptured were rated for use in enclosed fixtures. If a lamp ruptured from continuous use, then the explosion would be contained within the enclosed fixture, provided the lamps were used in a rated application. In other words, the probability of rupture would be higher, but the probability of injury caused by rupture would be low.

For the rupture of an HID lamp that was incorrectly installed into a socket retrofitted with line voltage, the hypothetical risk of injury would require a combination of multiple mistakes:

1) The warning label, saying that the fixture was no longer suitable for the original lamp type, was either missing or ignored.
2) The LED lamp was replaced with an HID lamp, rather than another LED.
3) Either (a) an HID lamp rated for enclosed fixtures was installed while the circuit was energized, or (b) an HID lamp rated for enclosed fixtures was installed in an unenclosed fixture.

The probability that all 3 mistakes would occur together is very small in facilities that practice operational excellence; but might be larger in facilities where operational excellence is not a priority.