Photocontrol Testing Under Accelerated Lifetime Conditions

Subject: Photocontrol testing under accelerated lifetime conditions performed using a utility grade NEMA Type 5, 100W HPS dusk-till-dawn luminaire with the legacy ballast remaining in the circuit.

Scope: Clearlight replacement lamps extend the life and lower the maintenance cycle of compatible dusk-till-dawn luminaires. With the extended life, the photocontrol experiences a higher number of on-off cycles. Common perception of the photocontrol, one of the least expensive parts of the luminaire, is that it may not withstand extended lifetime conditions.

Inquiry: Are photocontrol lifetimes a limiting factor when analyzing the maintenance savings associated with the Clearlight's projected long lifetime of 70,000 hours or more?

Two Tests Were Performed:

1.The first test was conducted using a Clearlight EcoSpot installed in a utility grade NEMA Type 5, 100W HPS luminaire from a reputable manufacturer with the legacy ballast remaining in the circuit. The photocontrol had a load rating of 1000W, 1800 VA ballast, and a MOV rated for multiple surges. Evluma test results were independently reviewed by Patrick Andre of Andre Consulting.

Optical feedback was provided via an optical fiber permitting the photocontrol to switch the Clearlight on and off at its maximum rate. This rapid switching rate was judged to be the worst-case test. An HPS lamp typically requires approximately one minute to start up; this condition does not apply when using LEDs. The photo control failed after 57 hours at a 4 second cycle time for an approximate total of 51,300 cycles. At 1 cycle per day that represents approximately 140 years of service.

2.The second test was conducted using a Clearlight EcoSpot installed in the same utility grade NEMA Type 5, 100W HPS luminaire with the legacy ballast remaining in the circuit. The photocontrol had a load rating of 1000W, 1800 VA ballast and a MOV rated for multiple surges. Evluma test results were independently reviewed by Patrick Andre of Andre Consulting.

A digital timer was used to power a small incandescent lamp, simulating a diurnal cycle with a 2 minute light time and a 2 minute dark time. These day and night periods were longer than the 4 second cycle used in the first test in order to more closely simulate actual

operating conditions. A digital counter was used to record the number of cycles before failure. The test was terminated at 20,000 cycles, with the photocontrol still operational, representing 20K/365 = 68 years. Note that since the photocontrol was still operational, the value of 68 years is not considered to be a value of MTBF or Useful Life, since such values would be greater than 68 years.

Conclusion

It is reasonable to expect much longer photocontrol life when using a Clearlight with a legacy ballast than with the original HPS lamp. This finding supports the maintenance savings claims associated with the Clearlight. Several factors contribute to the expected improved reliability of the photocontrol with Clearlights:

1. **Less contact arc-over due to inductive "kick back" with the same legacy ballast.** Magnetic HPS ballasts are large inductors that store energy, as all inductors do, in their magnetic fields. When power is applied to an inductor, the current flowing into the ballast lags the voltage applied. However, when the relay in the photocontrol opens, the stored energy in the inductor's magnetic field causes the open circuit voltage to "kick-back" to a very high voltage across the relay's contacts. Over time, the resulting arcing across the contacts leads to erosion of the plating material and high resistance in the contacts. The contacts may eventually heat to the point where they weld or stick closed, overcoming the force of the relay's return spring. This is why photocontrols are typically rated at 1800VA for incandescent lamps, which have no inductive kick-back, and only 1000VA for ballasted lamps, which do have it. The measured AC voltage across the ballast was found to stabilize at: 121VRMS line –48.0VRMS across the lamp = 73VRMS across the ballast with an HPS lamp installed. With a Clearlight installed, the voltage across the ballast is less than 2 VRMS. This means that much more energy is stored in the magnetic field of the ballast with the HPS lamp installed than with the Clearlight, resulting in substantially greater inductive kick-back, and greater damage to the relay contact.

2. **Clearlight's inrush current protection.** A circuit component in the Clearlight limits its inrush current at power on. This also protects the relay contacts. Since the relay contacts are closed when the majority of the inrush current transient occurs, this effect is less important to the increase in photocontrol lifetime than inductive kick-back.

3. **Reduced impact on photocontrol componets from changes in ballast temperature.** See also, ballast temperature rise, as measured in a previous report, *Possible Reliability Numbers for Clearlight with Legacy Ballast*. With an HPS lamp installed in a NEMA Type 5 luminaire, ballast temperature (not the luminaire housing) can rise to over 114°C with an ambient temperature of 23°C. However, with a Clearlight installed, the maximum temperature of the legacy ballast was found to stabilize at 30.0°C. Typically, the photocontrol, mounted on the top of the luminaire, becomes hot after the HPS lamp and ballast heat the luminaire. The lifetime of an electrolytic capacitor, a key photocontrol componet, is a function of voltage, temperature and "ripple current". A rule of thumb is that the life of the capacitor will be halved for every 10°C increase in temperature. Therefore, a much cooler photocontrol, due to a cooler legacy ballast as provided by the Clearlight, will have a longer life expectancy.