A common question today about LED traffic signals, especially for those early adopters, is “When should I replace my older LED traffic signals?”

Some of the initial installations of LED traffic signals have been in use now for in excess of 10 years. Due to their longevity, municipalities have many different approaches when it comes to the replacement of old signals. These approaches range from those that plan to replace their signals on a rotating basis, with a defined percentage of their signals being replaced every year, to those that still utilize a hold-over approach from incandescent bulbs and only replace the LED signal when it goes out.

The latter approach may not be the wisest choice. As LED traffic signals age they typically do not die, they just fade away and operate at a significantly reduced intensity. The operation of an older faded LED signal can be dangerous for several reasons, all of which affect public safety. A signal operated at a reduced intensity would be less visible from a distance, be potentially washed out under bright direct sunlight, and be even less visible in poor weather conditions such as heavy rain, fog and snow. All of these could result in vehicle operators and pedestrians misinterpreting the signal.

There are a number of factors that contribute to a fading LED signal related both to the signal itself as well as where the signal is installed.

**Lens Degradation**

Virtually 100% of the LED signals are manufactured with an outer lens made from UV stabilized polycarbonate and most are also treated with a coating to provide protection from abrasion. The typical specification for this polycarbonate is for 6 months of exposure in a south facing Arizona Desert installation without appreciable degradation. Since many signals have been installed significantly longer than 60 months there may be degradation or yellowing of the outer lens resulting in a decrease in the light transmission properties of the lens. The extent of this degradation would vary greatly based on the length of time the signal has been installed, the geographic location, and orientation of the signal. Older installations in south facing, sunny southern areas would be the worst due to the amount of UV exposure.

**LED Degradation**

Catastrophic failure of an LED traffic signal is easy to spot. The light output degradation of an LED traffic signal, and the extent of the degradation, is a greater problem and more difficult to diagnose. LED traffic signals may be the first application of LED technology that truly test the life and durability of this solid state device. Up until the introduction of LED traffic signals the traditional application for LEDs had been in products that were typically used indoors in a relatively controlled environment. With the advent of LED traffic signals, LEDs are now being exposed to a very wide range of environmental conditions for extended periods of time.

The early LED traffic signals were designed and manufactured using a large number of 5 mm LEDs. Designed in the 1970s, the 5 mm LED became one of the industry standard sizes, but it was designed for protected use in a controlled environment, not necessarily for use in an LED traffic signal. It was not until LED traffic signals started to gain in popularity that the leading LED manufacturers started to develop high flux LEDs packaged specifically for traffic applications. Regardless of being a 5 mm package or the newer high flux LED package, the output of an LED will degrade slowly over time. Factors that affect the rate of decline include operating current, on-time and the temperature at which the LED is being operated. Under controlled conditions an LED loses 30% to 50% of its initial intensity over 70,000 hours of operation. The exact losses of a particular signal can be greatly affected by the temperatures that the signal is exposed to during its operating life. Most manufacturers factor this loss into their designs so that the products will comply with the stated intensity.
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Comparison of Old and New Photometric Distribution

requirements through the typical 5 year warranty period.

Additionally, being a semiconductor device, the performance of an LED is affected by exposure to temperature cycling. This occurs most significantly in areas with warm sunny days, where the LED experiences a high temperature from both operation and solar loading, followed by cool nights. Occurring thousand of times over the life of an LED signal, the affect of temperature cycling can range from significant light loss to complete catastrophic failure of the LED.

Power Supply Aging
The power supply in an LED traffic signal module is taking the 120 VAC and converting it to the proper drive currents for the LED board. These power supplies will contain several active and passive components to achieve proper operations. The active semiconductor components are subject to the same temperature cycling issues as previously discussed for the LED where the performance and efficiency can be significantly reduced over time. In terms of passive components, most designs utilize electrolytic capacitors on the input side of the circuit. These capacitors will dry out over time, reducing their performance and impacting the drive currents supplied to the LED board.

Should I replace my old LED traffic signal modules?
If your signals are greater than 7 years old, then the probable answer to this is yes. In their recently released report entitled “Replacement Processes for Light Emitting Diode (LED) traffic signals, Project 20-01/Task 246”, the National Cooperative Highway Research Program (NCHRP) of the Transportation Research Board (TRB) presents data that shows it may actually be less costly long term to replace older LEDs in groups vs. spot replacing the older products on an as needed basis. This report is available on the TRB website, www.trb.org/nchrp.

If your signals are between 5 to 7 years old, then the answer to this question is not a simple yes or no. As discussed above, there are many factors that affect the performance of an LED signal module. These factors vary greatly from installation to installation. Instead a user should be reviewing the various factors and asking themselves question such as:
• Are my older LED installations as visible as my newer LED installations in all weather conditions?
• Are my older installations starting to show a significant increase in the failure rate?
• What is my liability in leaving the older product in operation if it fails?
• Are there any advantages of upgrading my older LEDs?

Advantages of Newer LED Traffic Signals
Since 2004 the Institute of Transportation Engineers (ITE) has released specifications written exclusively for LED traffic products. During the development of these specifications the ITE considered all of the unique properties of LEDs and incorporated testing and performance requirements to ensure the overall safe performance of the products. More specifically, for the photometric requirements of the

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LEDs have experienced dramatic evolution over the last 5 to 10 years. This evolution has resulted in substantial price reductions and performance improvements over the initial LED signals produced a decade ago. In comparing the older LED products to today’s LED signals, if older LED installations were replaced with the latest LED technology the potential benefits would include:

- Additional reduction in power consumption
- Additional reduction in associated CO₂ emissions
- Improved signal uniformity
- Improved signal visibility
- Reduction in emergency light out calls for older LEDs failing

Summary

Replacement of older, out of warranty, LED traffic signals needs to be carefully reviewed. The initial LED traffic signal installations are now at the point where, if a user does not already have a replacement policy or plan, then serious consideration needs to be given to the development of a plan. As they age further, the failure rates of the older signal will continue to accelerate. If nothing is done in terms of the preventative maintenance or replacement of aging signals, then the potential liability will increase along with the failure rates. LED technology has improved significantly since the initial introduction of LEDs to traffic signals to the point where there are several advantages to installing the newer LED traffic signal products.

IMSA sustaining member, John Vines is the LED Traffic Signals Product Manager for LED specialist Dialight Corporation based in Farmingdale, New Jersey. John has a total 18 years experience working on LED products in both the engineering and marketing functions with 15 years working specifically with LED products for transportation and signaling applications.

SIGN OF THE MONTH

This photo was taken at an intersection being upgraded to a Light Rail Train (LRT) system. The temporary work zone called for a 3-way stop to be used and the contractor utilized an already existing YIELD sign pole.

Submitted by
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