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Design Guide for **Roadway Lighting Maintenance**



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IES Design Guide for Roadway Lighting Maintenance

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Prepared by:
Subcommittee on Lighting Maintenance and Light Sources
Of the IES Roadway Lighting Committee

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K. Molloy, Vice Chair
J. Andrew Bloomfield, Secretary

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B. Chau	D. Okon	V. Waight
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1.0 INTRODUCTION

The primary purpose of roadway lighting is to provide a safe nighttime environment for vehicular and pedestrian traffic. For a lighting system to operate at maximum effectiveness, the lighting system maintenance should be considered and included during the system design process. Once a system has been designed and installed, proper maintenance then becomes essential to the reliability and continued high performance of the roadway lighting system.

Like any lighting system, a roadway lighting system is subject to performance degradations. Exposure to the unfriendly outdoor environment makes timely system maintenance of paramount importance. If a roadway lighting system is not properly maintained, safety may be compromised in addition to the increased costs of deferred maintenance.

The cost/benefit relationship of proper system maintenance should be determined by the individual owner based upon the needs for, and commitment to, system reliability. The purpose of this guide is to provide the designer and owner with an understanding of maintenance problems and procedures so that sound decisions can be made on maintenance practices that are appropriate for a roadway lighting system.

2.0 FACTORS AFFECTING MAINTENANCE

The following operational factors affect the performance of a Roadway Lighting Maintenance Program.

2.1 Lamp Life

The rated lamp life of HID lamps is the total operating time at which, under normal operating conditions, 50% of any large group of initially installed lamps is expected to have failed. This is a statistically determined estimate of median operational life. For HID lamps used in most roadway applications, the rated life is based on the life performance of a large representative group of lamps usually operating 10 hours or more per start under controlled electrical, thermal, and mechanical conditions.

Rated life is based on the survival of 50% of the lamps and thus allows for individual lamps to vary considerably from this value. Manufacturers' lamp mortality or survival curves indicate the average lamp failures that can be expected at any percentage of rated life. These curves are useful in establishing a relamping schedule, which may be

part of the total maintenance program. Rated life is stated in hours; it is expected that 50% of the lamps will remain operational at that stated point in time. In a real world system, other factors can affect life. Lamp mortality curves for all light sources are available and can be obtained directly from lamp manufacturers.

For discharge lamps it is important to understand not only rated life but also the manner in which such lamps perform over their life. For example, high-pressure sodium lamps can be expected to cycle on and off signaling the end of their life. If cycling lamps are not replaced promptly, ignitor and/or ballast failure could result. This illustrates the need for replacing discharge (HID) lamps before the end of their rated life so that the designed-for illumination levels are maintained and the number of outages is reduced. Technology advances now make non-cycling HPS systems available.

Factors that affect the life of all commercial discharge lamps [i.e., high-pressure sodium (HPS), low-pressure sodium (LPS), metal halide (MH)] include:

- Installation (i.e., mechanical mounting of the equipment) and vibration control
- Luminaire design and operating characteristics
- Lamp operating wattage
- Lamp ambient temperatures
- Ballast characteristics
- Line voltage
- Burning hours per start

Solid state sources with Light Emitting Diodes (LEDs) do not presently have a rated life as other sources do. LEDs rarely completely extinguish ("burn out") as discharge and filament sources do. Their rated life can be defined as when the lumen output reaches 70%, known as L70, (or any specified percentage) of initial output. Usually LED manufacturers provide LED lumen maintenance information (See **Section 2.2**), but this is not LEDs rated life. Statistical information on failure rates (e.g., B50, B10) should be provided for LEDs, in order to obtain rated life.

2.2 Lamp Lumen Depreciation (LLD)

During their lifetime, the lumen output of most lamps gradually diminishes. This gradual reduction in light output with burning time is called lamp lumen depreciation (LLD). Lamp lumen maintenance curves represent percentages of "initial" (first 100 hrs) or rated light output at any specific operating time. These life test lamps for HID are operated on the basis of 10 hours or more per start on ballasts of specified electrical characteristics.



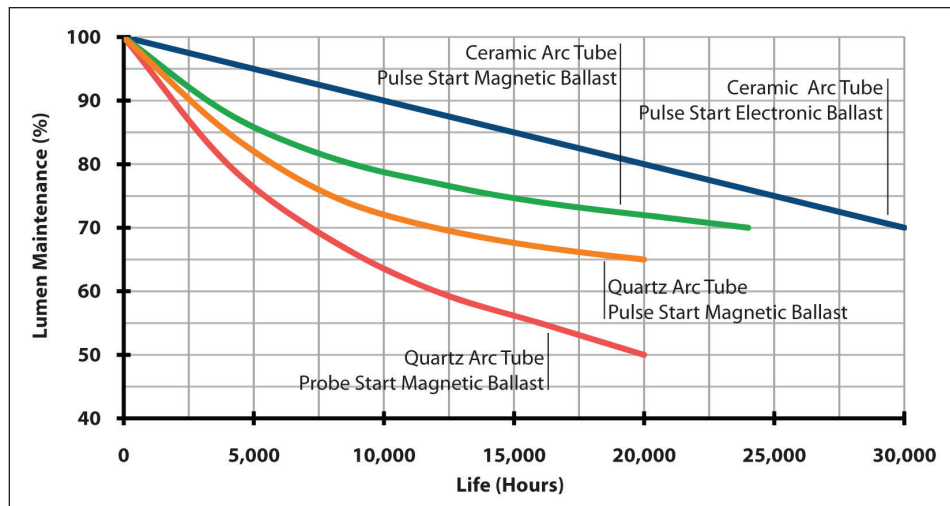


Figure 1a. Lumen Maintenance for several Metal Halide Lamps. Actual mortality curves are available from the various lamp manufacturers. (© Illuminating Engineering Society of North America)

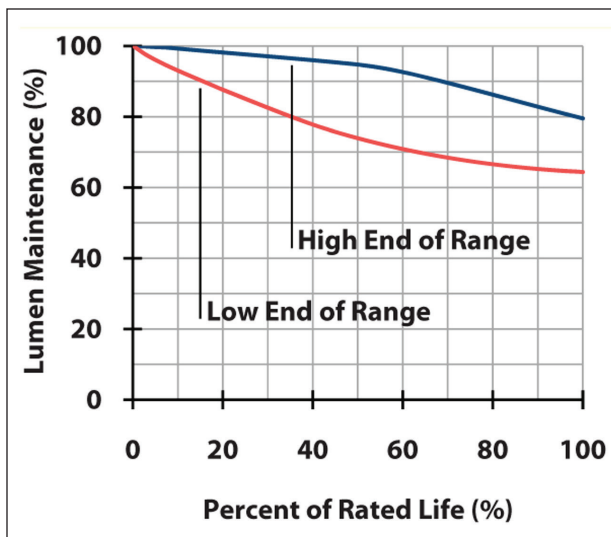


Figure 1b. Typical Lumen Maintenance for High Pressure Sodium Lamps. (© Illuminating Engineering Society of North America)

When applying these curves as a reference, the user should be aware that some or all of the following factors may change the resultant initial and maintained light output characteristics from those shown (see **Figure 1a,b,c**):

- Lamp current crest factor for the (type of) ballast to be used
- The lamp position in the luminaire
- The range of the supply voltage as compared to the allowable variation swing in the input voltage of the ballast
- The difference in the life and maintenance characteristics of the lamp to be used as compared to those shown for the example 400-watt HID lamps in **Figure 1**

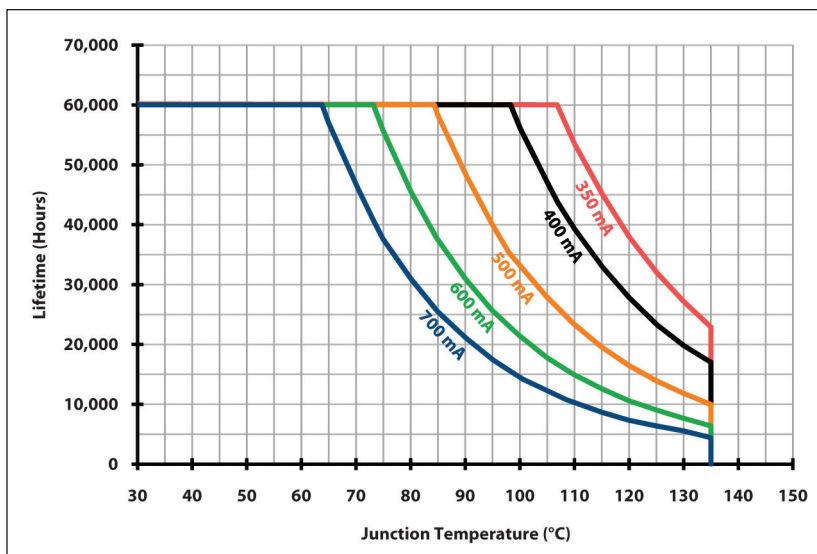


Figure 1c. LED Lifetime versus Junction Temperature. (© Illuminating Engineering Society of North America)
(Expected (B50, L70) lifetimes for AlInGaP* (e.g., amber, red-orange, and red) LED packages as a function of junction temperature, and for different drive currents. (B50, L70) is the time to when either 50% of the population is expected to have either failed catastrophically (failure to emit light) (B50), or degraded by more than 30% from initial lumen output (L70). Note that these curves vary considerably with LED package and these data should not be generalized.)

*Aluminum/Indium/Gallium Phosphorus

- For LED sources, operation under higher than manufacturer's recommended temperature or driving current is primarily responsible for lower lumen maintenance and rated life. For LED source lumen maintenance projection, refer to *IES TM-21-11 Projecting Long Term Lumen Maintenance of LED Light Sources*.

2.3 Luminaire Dirt Depreciation (LDD)

In addition to lamp lumen depreciation over time, dirt accumulates both on the inside and outside of the refractor, on the inside of the luminaire reflector, and on the lamp. This dirt accumulation is responsible for an additional reduction in luminaire light output and is known as luminaire dirt depreciation (LDD). For guidance on the calculation of luminaire dirt depreciation refer to the latest edition of *ANSI/IES RP-8-00/R05 Roadway Lighting*.

ing cycle is the maximum time frame recommended in relatively untainted environments. However, in industrial environments, where the luminaires are exposed to smoke and/or dust, it will be necessary to establish a much shorter cleaning cycle period.

Depending upon the material to be cleaned, there are a number of different techniques available. Glass refractors are easily cleansed with soap and water or glass cleaner to restore light output to its original level. A metal reflector finish can be severely damaged by abrasives or solutions containing ammonia. The simplest procedure is to spray a non-abrasive solvent on the reflector surface and then wipe dry with a soft cloth: this method is slow, but effective.

Alternately, the reflector or refractor can be removed from the luminaire, submerged in a tank of mild detergent and water, and then rinsed in clean water:

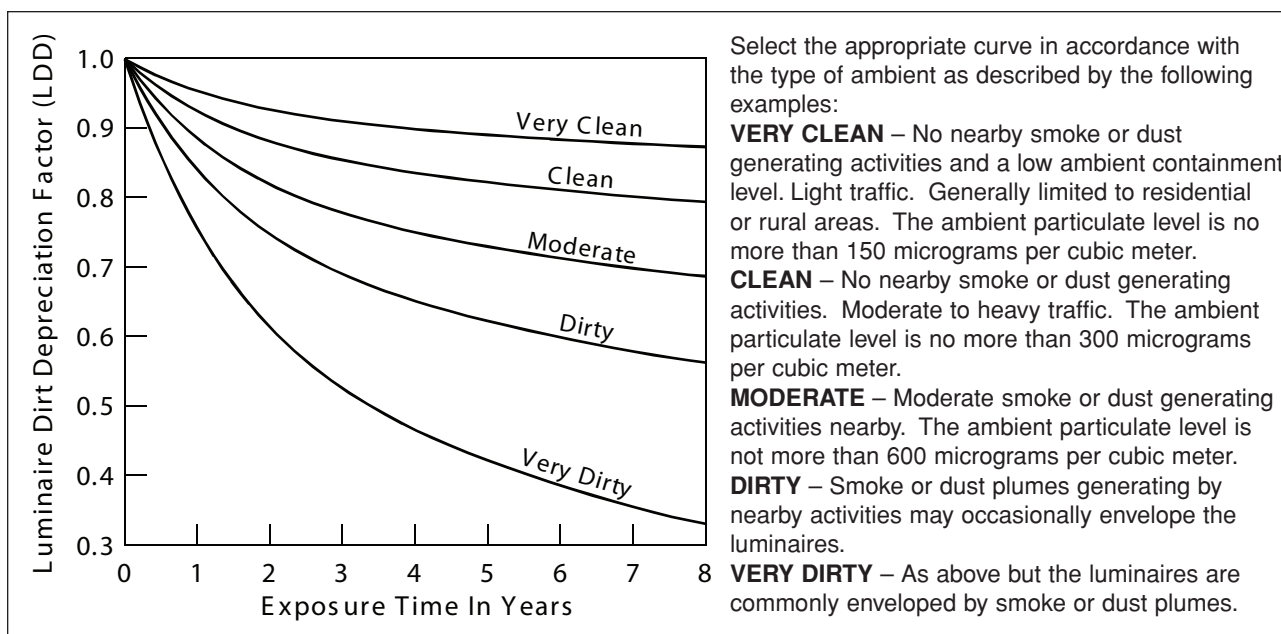


Figure 2. The luminaire dirt depreciation (LDD) factor for enclosed and gasketed roadway luminaires can be estimated using this chart.

Cleaning reflectors, refractors, and lamps is very important to counteract LDD. Factors affecting the cleaning schedule are the atmosphere, the number of suspended particulates in the luminaire's environment, and the luminaire design. Luminaires that are installed under or near trees could accumulate tree sap on the refractors, which will affect light transmission. Removing tree sap from refractors made of plastic may require special cleaning solvents that will not damage the plastic refractor.

For group re-lamped systems, the cleaning cycle should be an even multiple or sub-multiple of the lamp replacement time interval so that these two operations can be combined. Generally a four-year clean-

two rinses are suggested. If the water is hot, it is best to air dry. While ultrasonic units may be used to aid in the washing process, rinsing is still required. If the reflectors or refractors are removed for cleaning, they should be replaced correctly in order to maintain optical system integrity. The reflectors and refractors of one luminaire type may fit another luminaire type, but might have very different optics. This could result in an unplanned change of light distribution with potentially serious consequences.

Both plastic and glass refractors are used in roadway lighting luminaires. The manufacturer should be consulted about the appropriate cleaning methods for these units.