A NEMA Lighting Systems Division Document

Guidelines on the Application of Dimming to High Intensity Discharge Lamps

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Contents

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Preface

The exact performance of any high intensity discharge (HID) dimming system or of the lamp on that system is dependent upon the specific dimming circuitry employed with specific ballasts and lamps. These guidelines are meant to impart general information and considerations in the design and application of such systems. Contact the manufacturers of the lamps and dimming systems for specific recommendations. As there are few existing standards for the dimming of HID lighting systems, it is recommended that the user, lighting designer or specifier evaluate any new proposed combination of components as a system in a field test to ensure that the combined performance of the system is acceptable.

Common Types of Lamp Dimming Systems

Recently, there has been increased interest in HID dimming circuits for energy conservation applications. There are presently two types of lamp dimming systems in common use: (1) step-level or bi-level and (2) line voltage.

The step-level system generally operates by switching capacitive or inductive impedance into the ballast output to reduce the lamp current and therefore the lamp wattage. These systems are often used in conjunction with occupancy detection systems, although many types of switching controls are available. In a typical application, infrared or ultrasonic occupancy sensors are utilized to detect motion in the controlled area. During the period in which motion is detected by the sensors, the lamps operate at rated wattage. With the absence of local activity over a certain period of time, a switching mechanism in the system reduces the lamp power to a predetermined wattage, generally not lower than 50 percent of rated lamp wattage.

Line voltage dimming circuits work by changing the primary voltage to the whole system with a variable voltage transformer, by electronically modifying input voltage and current waveforms (so-called “phase control”), by employing electronic low or high frequency switching circuits, or by combinations of electronic and mechanical devices (so-called “hybrid systems”) to modify the lamp power. All of these systems can reduce lamp wattage continuously. These

systems, however, have not been fully explored; and lamp power reduction due to line voltage control should generally be less than 50 percent of rated lamp wattage. Questions on line voltage lamp dimming should be directed to individual lamp or controller manufacturers.

Ideal applications of these energy saving systems include parking garages, warehouses, shipping docks, street lights, supermarkets, ball fields, factories, and security lighting. They are also used in conjunction with daylight lighting systems to conserve energy.

Issues, such as color shift and lamp performance, continually arise regarding the use of HID lamps on dimming systems. NEMA Lamp Section members make these recommendations addressing dimming issues.

A General Statement

HID lamps are designed to keep the lamp electrodes and discharge tube wall operating within a specific temperature range in order to maintain the proper vapor phase concentrations of discharge tube additives. Thus, when dimming lamps, users will experience degradation of efficacy, color, and life if the starting and operating recommendations below are not followed.

Since the exact situation is dependent on how long the lamps are operated in the dimmed mode, the type of dimming system, and how deeply the lamps are dimmed, it is difficult to quantify the effect on life when dimming an HID source. Lamp and ballast systems should meet the requirements of the appropriate American National Standards Institute (ANSI) specifications for both starting and operating lamps at full power. The information below represents some practical guidelines when considering an energy saving HID dimming system.

High Pressure Sodium

It is recommended that high pressure sodium (HPS) lamps be started and operated in the full power mode, i.e. at rated wattage, for a minimum of 15 minutes before dimming. This is necessary to clean the arc tube of deposits from starting that would artificially raise the arc voltage and promote reaction with the alumina tube. If an interruption to the ballast input voltage should occur, the lamp may extinguish and require several minutes to re-ignite. The timing circuit should be reset for 15 minutes only after the lamp has restarted. If the input voltage activates the timer, then 30 minutes is recommended before dimming is resumed.

Users need to be aware that there may be decreases in lamp color temperature and color rendering with dimming; and, depending on the depth of the reduction, there can be a loss of luminous efficacy. As a general guideline, when dimmed below 50 percent wattage for sustained periods, there is an increased likelihood of poor lumen maintenance and shorter lamp life.

Additionally, users need to know that HPS lamps, having aged approximately 15,000 hours, are susceptible to dropout when rapidly dimmed. This could be misconstrued by the user as a failed lamp, when in fact, if allowed to cool, the lamp will re-light and operate at rated wattage for its rated life in an undimmed mode.

To reduce the potential for dropout due to rapid dimming, it is recommended that dimming rates be slowed to approximately 1.5 minutes from full light to maximum dimmed condition while maintaining sufficient open circuit voltage, as specified in the appropriate ANSI standards.

Recommendation:

High Pressure Sodium	Maximum Recommended Percent Dimming
All wattages	Down to 50 percent rated lamp wattage[1]

Metal Halide

It is recommended that metal halide lamps be started and operated at full power, i.e. at rated wattage, for a minimum of 15 minutes before dimming. If an interruption to the ballast input voltage should occur, the lamp may extinguish and require several minutes to re-ignite. The timing circuit should be reset for 15 minutes only after the lamp has restarted. If the input voltage activates the timer, then 30 minutes is recommended before dimming is resumed. This recommendation includes lamp types that are started with the assistance of a starter probe as well as those that require external high voltage ignitors.

Lamp manufacturers may restrict the operating positions of lamps with starting probes to the base-up position when they are used on dimming systems. This restriction originates from consideration of the operating temperature of the bimetal switch which is used with a starting probe. Failure of the bimetal switch to operate at the design temperature and position in the dimmed mode cause premature lamp failure and possible rupture of the lamp. (See the lamp warning notice.) Consult the lamp manufacturer before operating lamps in other positions, though horizontal operation of the lamp is generally discouraged due to the increased possibility of arc tube rupture.

[1] The reduced wattage recommendation for HPS lamps must be achieved with a ballast meeting the recommended ANSI specifications for starting and operating a reference lamp. Step-level systems should not drop below this wattage specification when using a reference lamp at 90 percent of the rated input voltage. Line voltage dimming systems may not be capable of maintaining the minimum ANSI open circuit voltage in the dimmed mode. Failure to meet this required open circuit voltage may cause premature lamp dropout and short life. The lamp manufacturer should be consulted if lamps are to be dimmed below this specification.

There are metal halide lamps commonly available that require external ignitors for starting and do not utilize probes and switches. These lamps, often referred to as "pulse starting" lamps, may be dimmed in any position that the lamp manufacturer recommends. However, whether a probe or pulse start lamp, lamp manufacturers' recommendations for enclosure must be followed.

Users should be aware that there is a color shift with dimming. In a clear lamp, the color will change towards higher color temperature; with sufficient dimming the source will appear as a clear mercury lamp, approximately 6,000 K versus the typical 3,000 to 4,000 K for the common metal halide lamps. In a coated lamp the color temperature increase will not be as drastic. For example, a 3,700 K coated lamp may increase to only 4,000 K with dimming. There will be, in addition, a reduction in lamp efficacy and color rendering.

Self-extinguishing lamps are not recommended for use with dimming systems.

Recommendation:

Metal Halide	Maximum Recommended Percent Dimming
All wattages	Down to 50 percent rated lamp wattage[2]

Mercury Vapor

It is recommended that mercury vapor lamps be started and operated at full power, i.e. at rated wattage, for a minimum of 15 minutes before dimming. If an interruption to the ballast input voltage should occur, the lamp may extinguish and require several minutes to re-ignite. The timing circuit should reset for 15 minutes only after the lamp has restarted. If the input voltage activates the timer, then 30 minutes is recommended before dimming is resumed. Systems must be capable of maintaining the minimum specified ANSI open circuit voltage during starting and in the dimmed mode. Failure to meet this required open circuit voltage may cause lamp dropout.

Mercury vapor lamps do not suffer from the same degree of color change described for metal halide lamps. The percentage dimming guidelines proposed for metal halide lamps should be followed for mercury vapor lamps.

Self-extinguishing lamps are not recommended for use with dimming systems.

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[2] The reduced wattage recommendation for MH lamps must be achieved with a ballast meeting the recommended ANSI specifications for starting and operating a reference lamp. Step-level systems should not drop below this wattage specification when using a reference lamp at 90 percent of the rated input voltage. Line voltage dimming systems may not be capable of maintaining the minimum ANSI sustaining voltage in the dimmed mode. Failure to meet this required sustaining voltage may cause premature lamp dropout and short life. The lamp manufacturer should be consulted if lamps are to be dimmed below this specification.

References

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