HID – The Burning Question …
Base Up, Base Down or Horizontal: What's the Deal with Orientation?

By Jerry Cassel, LC
Senior Specification Engineer

How many times have you wondered why a certain lamp is vertical base up or vertical base down, universal or horizontal? What does it matter and why should I need to know?

The reason for the concern, or at least something to be aware of, has more to do with color consistency, lumen output and life. So, lets explore these issues.

Unlike incandescent and fluorescent lamps where color variations are usually imperceptible, metal halide lamps have a normal expected color variation lamp-to-lamp and over life. To the casual observer, this color difference may be judged as improper lamp operation. Though all manufacturers of Quartz Metal Halide lamps attempt to control this variation, current science of the technology makes the total elimination of color variation a physical impossibility. However, understanding and adjusting certain factors over which the user has control can achieve some additional reduction of color variation.

GE standard Multi-Vapor® lamps are multi-component lamps. The lamp contains various metals, which reside in the arc tube in gaseous form. Applying a voltage to the arc tube electrodes produces light. That voltage excites the gaseous metals to the point where they emit light — each metal emitting a different spectral color.

LAMP-TO-LAMP COLOR VARIATION
Variations in the individual pressures of each of the gasses produce minute but nevertheless noticeable variations in lamp color appearance. This electrically produced light can be additionally affected by other variables as well. Variables such as arc tube dimensional variability, temperature effects, chemical mixture tolerances, input voltage variations, ballast wattage control and a host of other contributing factors all affect a lamps appearance.

VARIATION OVER OPERATING LIFE
During the first 100 hours of lamp operation (referred to as lamp seasoning), the halides are blending together for the first time and will display even wider color variation than when they reach their stable operating point beyond 100 hours. At about the 100-hour point, the halides are sufficiently mixed so that infant variation is minimized.

However, as a population of lamps begins to age, another color shift becomes apparent. This phenomenon occurs as the chemistry changes within the arc tube as a result of sodium migration through the arc tube wall. This type of color shift is predictable in direction. The standard family of Multi-Vapor® lamps normally shifts to a warmer color (lower Kelvin temperature), while the family of lamps with an MXR prefix (Halarc® lamps), shifts to a cooler color (higher Kelvin temperature) as the lamps age. This color shift

becomes most obvious when a new lamp is installed in place of a burned out lamp that has shifted in color.

COLOR SHIFT — MEASUREMENT AND CONTROL

The appearance of the lamp's color is described by the measurement of the Correlated Color Temperature (CCT). The normal expected color variation of a population of MVR400 lamps can be as little as 600 Kelvin (K), or as much as 1000 K. All lamps will fall within the industry-wide standard "10 step color oval." Visually, in simple terms, a one-step color oval increment on the x, y CIE Chromaticity Diagram represents approximately 100 K. metal halide lamps are usually made in small batches that have less color variation than the wider 10-step color oval. If an installation receives lamps from a smaller batch, the color spread will often be less than if the several smaller batches are mixed.

Burn orientation can effectively influence these color variation qualities. Mercury and High-Pressure Sodium lamps may be operated in any burn position and will still maintain their rated performance specifications. Metal Halide and Low-Pressure Sodium lamps, however, are optimized for performance in specific burn positions, or may be restricted to certain burn positions for safety reasons. They are:

U = Universal burning position
HBU = Horizontal -15° to Base Up
HBD = Horizontal +15° to Base Down
HOR = Horizontal ±15°
H45 = Horizontal to ±45° only
VBU = Vertical Base Up ±15°
VBD = Vertical Base Down ±15°
If no special burn position is noted, the burn position is universal.

LUMENS — LUMENS LISTED ARE REFERENCE LUMENS

Rated average lamp lumens are obtained under controlled laboratory conditions in a prescribed burning position. **Initial Reference Lumens** refer to the lamp lumen output after 100-hours burning. **Mean Reference Lumens** refer to the lamp lumen output at the mean lumen point during lamp life. The mean lumen point occurs at 50% rated life for HPS and mercury lamps, and at 40% rated life for metal halide lamps. Lamp performance on typical systems under typical service conditions will vary from the reference lumen ratings.

High Intensity Discharge (HID) lighting systems are subject to a wide range of variations that may affect final lighting levels. As a result, lamp performance on actual systems may vary due to lamp orientation, ambient temperatures, ballast variations, line voltage and other reasons. Care must be taken when choosing a system to consider how these changes can affect your light levels both initially and at the mean lumen point.

LIFE EXPECTANCY AND POSSIBLE LAMP FAILURE

Most HID lamps are constructed of an outer bulb with an internal arc tube made of quartz. The arc tube operates under high pressure at very high temperatures — as high as

approximately 1100°C. The arc tube and outer bulb may unexpectedly rupture due to internal causes or external factors such as a system failure or misapplication.

An arc tube rupture can burst and shatter the outer glass bulb resulting in the discharge of glass fragments and extremely hot quartz particles (as high as 1100°C). There is a risk of personal injury, property damage, burns and fire. Because of this, some Metal Halide lamps are “position-sensitive” and must only be operated in specified burning positions using compatible electrical equipment and installation in suitable fixture types as prescribed in the LET “Lamp Enclosure Type” designation field of the manufacturer’s catalog. For more information about the use of Metal Halide lamps, see NEMA’s *"Best Practices for Metal Halide Lighting Systems, Plus Questions and Answers about Lamp Ruptures in Metal Halide Lighting Systems,"* NEMA LSD 25-2004.

Note: HPS and mercury are not position-sensitive and may be operated in any burning position.

EFFECTS FROM IMPROPER ORIENTATION

The Arc tube may become bulged or swollen. After extended operating hours some bulging is normal, especially in the off-vertical burning position. If a lamp bulges prematurely, this condition may indicate the lamp is operating at a higher-than-rated wattage due to miswiring, using the wrong lamp on specific ballast or the fixture optical system is directing too much heat onto the arc tube. This problem must be corrected or else the lamp may unexpectedly shatter.

POTENTIAL FOR NON-PASSIVE FAILURE

Normal end-of-life (EOL) of these lamps is a “non-start” condition, resulting from a loss of sodium from the arc that changes the electrical characteristic so that the ballast can no longer sustain the lamp. The 400- and 1,000-watt lamps, when burned vertical $\pm$ 15°, usually have a passive EOL failure mode. Other wattages, regardless of burning position, and the 400- and 1000-watt lamps when burned in other positions, can fail in a non-passive manner, and the outer bulb may shatter. Therefore, they should be operated only in an enclosed fixture that will contain the lamp if it shatters. Color at EOL will usually be warmer (pinker) than a new lamp, since the arc tube has blackened due to electrode deterioration. This can cause a change in the thermal balance within the arc tube that results in this color change.

ORIENTATION IN OPEN FIXTURES

For lamps operated in the vertical position that are not designated “Enclosed Fixtures Only – Type E,” lamps may be used in an open or enclosed lighting fixture depending upon the application and operating environment. For example, if the lamp is located near combustible material or in an area unoccupied for extended periods, an enclosed fixture that can contain fragments of hot quartz or glass is recommended.

For more information**,** contact your fixture manufacturer and consult the NEMA standard LSD 25-2004 on the Open Rating ruling according to NEC2005, section 410. The ***"Best Practices for Metal Halide Lighting Systems, Plus Questions and Answers about Lamp Ruptures in Metal Halide Lighting Systems***," NEMA LSD 25-2004, publication provides educational information for the selection, operation, and maintenance of metal halide lighting systems with specific emphasis on those items pertinent to the risks associated with lamp rupture. The implications of the 2005 NEC provisions on these risks are also addressed.

Reference:

"Troubleshooting HID Systems," GE Lighting, 2003
"GE Multi-Vapor®: A Whitepaper Guide to Lamp Color Variation," J.R. Flauto, GE Lighting
"Best Practices for Metal Halide Lighting Systems, Plus Questions and Answers about Lamp Ruptures in Metal Halide Lighting Systems," NEMA LSD 25-2004