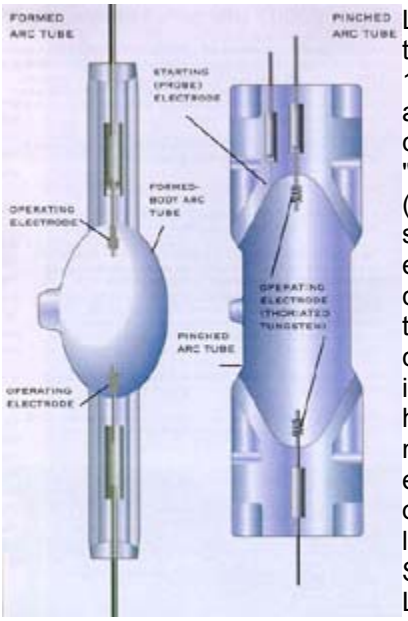
## Metal Halide - Advances & Improvements

By David Houghton, PE, Contributing Editor, Architectural Lighting Magazine

Of all the lamps in the high-intensity discharge (HID) family, the metal halide family of lamps has the brightest future. These lamps offer much higher efficiency than mercury vapor lamps and better light quality than either mercury or sodium lamps. Metal halide lamps, however, have historically had limitations. They take up to five minutes to start and up to 20 minutes to restart after a power outage. They can only be dimmed to about 50 percent of full output (and generally don't save much energy when dimmed). The lamps can shift color erratically by as much as 400K, may fail by exploding, and emit significant amounts of ultraviolet (UV) radiation. Finally, metal halide lamps are fairly expensive because of their complex construction.

Nevertheless, for a bright, white point source of light, metal halide lamps are the best thing we've got. Recent technology advances are tackling the operating limitations and improving overall performance, which in turn creates new opportunities for specifiers. More than any other lamp, metal halide lamps must be considered as a complete system--lamp, ballast, ignitor, fixture and controls that must work together to get the best performance. The halide lamp is a finely tuned device with precise doses of chemicals and carefully calibrated thermodynamics (see sidebar "How Halide Works"). "Every lamp is different," said Jerry Flauto, senior product specialist/HID at GE. "You have to design each one individually. They don't scale as easily as incandescents or fluorescents."

### Pulse-start Technology




Lamp manufacturers are bringing pulse-start technology&emdash;already used in metal halide lamps 150W and smaller--to their entire product lines. The advantages of pulse-start are subtle but significant. In a conventional metal halide system--sometimes called "probe start"--there are three electrodes inside the arc tube (Figure ). To start the lamp, a spark is initiated across the short gap between the "probe electrode" and the operating electrode--like the spark plug of a car engine. The ions created by this spark then jump across the arc tube to start the lamp. A small bimetal switch pulls the probe out of the circuit as the lamp heats up. In a pulse-start system, there is no starter electrode (see Figure 1). An ignitor sends a high-voltage pulse (about 3000 volts or so) across the main electrodes, kicking the lamp into operation. "By eliminating the probe and bimetal switch-components that often caused the lamp to fail, we can make metal halide lifetime nearly as long as high-pressure sodium," said Gary Smith, director of product management for Venture Lighting. Smith noted that pulse technology has boosted lifetime of mid-size halide lamps from 10,000 hours to 15,000 hours and that continuously burning 400W metal halide lamps can last up to 30,000 hours (about three and a half years). Pulse starting also improves lumen maintenance, color stability, restrike time, lamp life and system efficiency. According to Venture, conventional systems with 400W lamps and 60W ballasts can be replaced by pulse-start systems using 320W lamps and 30W ballasts. Other substitutes for the widely used 400W halide probe-start systems include 360W pulse-start lamps. Jim LaPointe, HID group product manager at Osram Sylvania, sees the potential for significant energy savings in warehouse applications. "Across the country we're seeing lots of new warehouse spaces being built to service Internet companies," said LaPointe. "We've got a chance to light these more efficiently with the new metal halide technology."

### Arc Tube Improvements

Lamp designers have also been tinkering with the arc tube itself. The first breakthrough came a few years ago when Philips engineers borrowed a ceramic arc tube from a sodium lamp and stuck it into a metal halide lamp, creating the ceramic metal halide (CMH). "We call

them 'halogen killers' because their color is so good they can tackle retail applications like spots and tracks," said Bill Ryan, HID product manager at Philips. The other manufacturers soon followed suit. "We're very excited about CMH," said GE's Jerry Flauto. "It gives us great color stability, good efficacy and long life." Today, most metal halides 150W and lower are available as CMH lamps. The formed-body arc tube has been pioneered by lamp manufacturer Venture&emdash;a company that specializes in metal halide technology. While conventional arc tubes are made by pinching a tube of quartz glass, the formed-body tube is carefully blown from a hollow rod. "The formed body tube has a number of advantages," said Venture's Gary Smith. "It gives us more uniform geometry and a smaller, lighter arc tube. Because the tube has only one-third the mass of a conventional pinched tube, it heats and cools quickly, which makes for faster ignition and restrike." Smith also noted that the pulse-start revolution made the formed-body tube possible, since it would be difficult to insert a probe electrode into the new design.

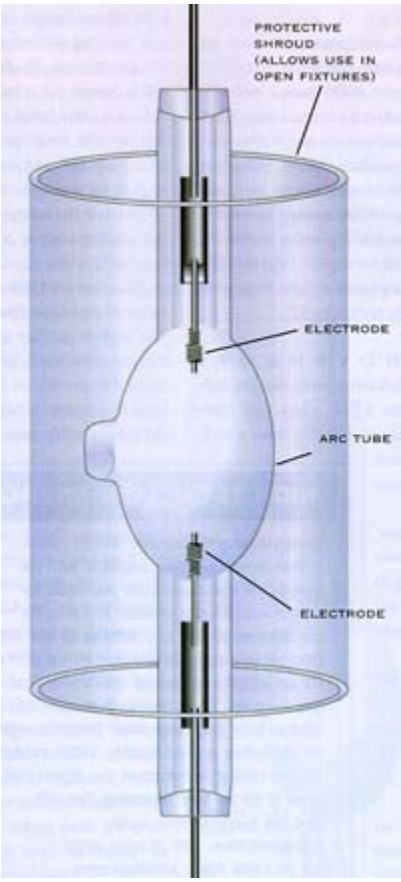
**Electronic Ballasts**

Like all arc lamps, metal halide lamps need a ballast to provide starting and running voltage to the lamp and to control the arc current. Traditional core and coil ballasts for metal halide lamps are relatively bulky and heavy. Several companies now offer solid-state electronic ballasts for metal halides that provide better performance in smaller, lighter packages. Electronic ballasts always use pulse-starting and are generally used for smaller metal halide systems (150W and below). Delta Power Supply builds electronic metal halide ballasts that operate at 100kHz and above. "Starting an arc lamp is usually a destructive event," said Denny Beasley, VP of engineering for Delta, referring to the sputtering of electrode material that accompanies conventional startup. Beasley said that high-frequency ignition reduces electrode deposition on the arc tube wall, which gives much better lumen maintenance (90 percent at 15,000 hours, versus only 60-70 percent for conventional), better color stability, longer lamp life and the potential for near-instant strike and restrike. An additional benefit is deeper dimming. "We can bring metal halides down to 33 percent of full output, while maintaining the efficiency of the lamp" said Beasley. Conventional ballasting can only dim metal halides to about 40-50 percent of full output, with a significant reduction in system efficiency. Electronic ballast manufacturer Aromat takes a different approach. "We believe in solid-state ballasts, but we use a low-frequency square wave to avoid possible problems with acoustical resonance and electromagnetic interference," said Wayne Letwink, national sales manager for Aromat. Letwink noted that electronic ballast features such as compensating for changes in input voltage help solve problems such as color shift. "Together with CMH arc tubes, electronic ballasts have cut the color drift of metal halides from 1000K to about 100K. That's a major improvement, and that's why metal halides are now competitive for applications such as retail track lighting."

**Seeing Yellow**

One key application for metal halide systems is outdoor lighting, where they often compete with high-pressure sodium (HPS) for use in streetlights, security lights and pedestrian-scale fixtures. These days, specifiers are shunning the yellowish sodium lamps in favor of the whiter light of metal halides, even though the former has a higher lumen-per-watt efficiency. Lighting researchers are finding, however, that the blue-rich light of metal halides and fluorescent lamps provides better "seeability" under the low illumination levels of parking lot and roadway lighting (2 fc and less). Some observers don't need research findings to see which way the wind is blowing. "I think a sociological change is underway--people just don't like yellow sodium light much anymore," said Philips' Bill Ryan, who has seen metal halide lamp sales rise relative to HPS sales. Jim LaPointe of Osram Sylvania noted that industry-wide, metal halide lamp sales are growing by 12 percent per year, while HPS sales are only growing by about four percent.

**Metal Halide Safety**




An unfortunate reality is that metal halide lamps have the potential to "fail non-passively" (that means explode). In such an event, hot chunks of the arc tube could come raining out of the fixture, which is why many halide fixtures include a tempered-glass or acrylic enclosure to contain any possible explosion. Lamp manufacturers have tackled this problem by enclosing the arc tube with a protective glass shroud. These lamps carry an "O" designation (for Open fixtures). The figure (left) shows this type of lamp. Another lamp rating, the "S" lamp, does not include any protective shroud, but is technically allowable for use in open fixtures if operated according to certain parameters (mounted base up, turned off for at least 15 minutes each week, and group relamped at 70 percent of rated lifetime). There is some controversy about this lamp type. On their website, Venture noted that the insurance industry is concerned about the use of "S" lamps in open fixtures, and said "it is increasingly clear that the 'S' rating may become a liability to the metal halide lighting industry." However, "The risk is very low if the operating guidelines are followed," said Jerry Flauto of GE.

**Halide House?**

A couple of years ago, manufacturers announced plans to build a "Metal Halide House" to demonstrate the flexibility and variety of halide sources and fixtures. However, the house has failed to materialize and primary sponsor Venture says that the plans have been scrubbed. Some of the fixtures that were destined for the halide house are doing well, however. Venture's Micro-Sun product line currently consists of a torchiere and a table lamp, both illuminated by 68W metal halide lamps. "Because we design and manufacture all parts of the Micro-Sun line--lamp, ballast and fixture--we can integrate the technology and create a product that works really well," said Venture's Gary Smith. One key to the product line is the solid-state ballast, which is small enough to fit in a table lamp base and quiet enough to operate in residential living rooms.