



## TESTING HIGH INTENSITY DISCHARGE LAMPS FOR BREAKAGE FROM THERMAL SHOCK

Arc tube ruptures in high intensity discharge lamps have been identified as the cause of multiple fires. Metal halide lamps are the most frequent offenders because of the high operating temperatures and pressures in their arc tubes and large installed base of unprotected lamps in unenclosed luminaires.

A common question that arises when investigating a fire that may have been ignited by a lamp failure is, "Did the lamp failure cause the fire or did the lamp fail because of the impact of firefighting efforts, most commonly fire suppression water striking a hot operating lamp?"

To investigate this question, we conducted a series of tests where a metal halide luminaire was operated in close proximity to a sprinkler head that was then actuated. These tests were conducted in 2006 in the sprinkler demonstration room of Seneca College of Applied Arts & Technology in Toronto. The demonstration room was built for educational purposes in their School of Fire Protection Technology.

The 400 watt<sup>2</sup> metal halide luminaire was hung from the ceiling by a hook on the top of the ballast housing with the top of the reflector at the elevation of the sprinkler head – matching the dimensional circumstances of one of the warehouse fires we investigated. The luminaire was powered and allowed to operate for at least 15 minutes each time to dry off and heat up to essentially full operating temperature, before the sprinkler was actuated. The distance between the sprinkler head and the luminaire was varied during four tests

from 43 inches (where the operating lamp experienced a gentle misting) to 25 inches (where the spray water shook the luminaire, striking the ballast housing and reflector, running down the socket and over the outside of the lamp - Figure 1).



*Figure 1:  
A sprinkler head discharging directly against and into an operating metal halide luminaire*

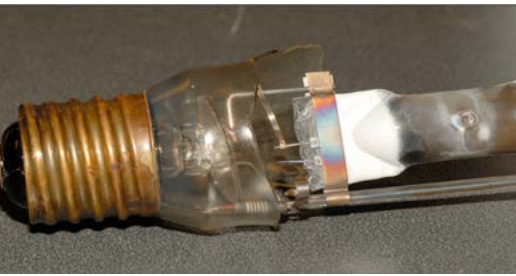
1. A single, large American insurance firm reported in 2000 of receiving reports of 29 dangerous lamp failures over the prior 10 years. In the last 10 years at Giffin Koerth we have investigated 6 fires determined to have been caused by metal halide lamp arc tube ruptures.

2. 400 watt lamps predominate in warehouse and large commercial applications.

3. Its near end of life condition was determined by the fact that the operating electrode had eroded to the wire-wraps utilized for temperature control.

4. The sprinkler demonstration system was connected to the building's operational fire suppression system and utilized a common cold water supply around 15C.

Two lamps were tested: one brand new and the other near the end of its rated life.<sup>3</sup> The lamps were completely unaffected by the mist and never broke when hit by the cold sprinkler water.<sup>4</sup> However, the outer envelope of the new lamp finally broke while drying out after its third wet/dry exposure cycle. Interestingly in that one instance, the outer envelope of the lamp broke fairly cleanly near the stem of the bulb just below the socket (Figure 2). That outer envelope broke further when it hit the concrete floor although the arc tube remained intact and operating generating potentially harmful UV light.



*Figure 2:  
The outer envelope of an operating lamp repeatedly heated and doused with water eventually sheared off rather cleanly near the stem while the inner arc tube remained intact.*

The water-induced break in the outer envelope was quite different from the breakage we have observed resulting from arc tube ruptures. When an arc tube at full operating conditions violently ruptures, it usually shatters the bulbous part of the outer envelope through multiple radial penetrations at the elevation of the arc tube (Figure 3).



*Figure 3:  
A metal halide lamp that caused a fire had a shattered arc tube and the outer envelope was penetrated radially at that elevation.*

Infrequently, the rest of the outer envelope may even remain intact with just one or a couple of holes through the outer envelope where the chunks of the ruptured arc tube penetrated.

While we were initially surprised how robust the outer envelopes of metal halide lamps were, in retrospect, this could have been anticipated. Metal halide lamps mounted outdoors routinely experience extreme thermal stresses as they cycle on and off, on the coldest of winter days. We only tested two lamps from a single manufacturer, but the common design, materials and applications suggests that similar products from other manufacturers may be similarly robust and resistant to thermally induced breakage and exhibit the observed different breakage patterns from arc tube rupture versus water induced thermal stress.

#### Conclusions:

1. The outer envelopes of tested metal halide lamps were very robust and unlikely to break from the thermal effects of fire suppression water.
2. If the outer envelope of an operating metal halide lamp was broken by the thermal effects of fire suppression water, it will likely exhibit a significantly different breakage pattern (simple shearing, most likely near the stem although subsequent breakage may occur when the falling envelope strikes the floor, and the arc tube may remain intact) than one caused by an arc tube rupture (a shattered arc tube and multiple radial penetrations of the outer envelope at the elevation of the arc tube). ♦

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