

HIGH INTENSITY DISCHARGE ELECTRICAL LIGHTING



INTRODUCTION

High Intensity Discharge (HID) lighting has been used for many years internally, in factories and warehouses, and externally, principally in street and security lighting. They are increasingly common as a light source and appear in many specialist industries such as vehicle headlights, medical equipment, projectors, graphic design, reprography, photopolymerisation as well as commercial and domestic sunlamps. They provide a long life-span, up to 25,000 hours, and give a wide covering of efficient lighting. They use ballasts to produce light when an electric current is passed between two tungsten electrodes inside a gas filled quartz or ceramic arc tube. This flow of current creates an arc that vapourises the metallic content in the tube. When operated, the temperature [up to 1300 °C] and pressure [up to 6 bar in the case of metal halide lamps and 3.5 bar otherwise] of the lamp rises, with a characteristic delay of several minutes in the visible light coming from the lamp. A hot lamp cannot be re-started until it has cooled down again. Bulb sizes range from 75Watts to 1500Watts.

Whilst these lamps are thus cost effective and efficient, they also have been involved in a number of fires over the years, and there are a number of potential health hazards. In the third quarter of 2001 there were two fires in UK warehouses, both incidentally associated with plastics goods production, where the lights appeared to be involved in the ignition of packaging material. Between 1990 and 2000 Factory Mutual, in the United States, reported 29 similar fires in a range of industries. Taking this as a representative sample of fire experience, the three types of HID lamps would show the following incidence rate:

Metal Halide 48% of fires

Mercury Vapour 41% of fires

Sodium Vapour 11% of fires

There are millions of these lights in current use with one manufacturer, Philips, selling over a million lights a year. The lights are often sold separately to enclosures but enclosures should always be used.

HID TECHNOLOGY

Metal Halide lamps have mercury, argon and metal halides, usually sodium iodide, scandium iodide and occasionally lithium iodide, in the gas filled tube. These are put in the tube to improve luminance and colour quality. This type of light is often used inside buildings, can be 75% more efficient than fluorescent lamps, and the bulb has the letter "M" to denote this type. A variety of this type of light is known as HMI, this having a more intense arc, and generally used in spotlights. HID lights are now being used in car headlights in the luxury range of vehicles.

Mercury Vapour lamps have mercury sealed in an argon gas fill in the quartz tube that emits a blue-white visible light, and Ultra Violet invisible light, that is corrected to a more natural light by the addition of phosphors. These lights have existed since 1934 and are have longest lasting lifetimes in this class of lights, although they are not as efficient as the other types, being only as efficient as fluorescent lamps, with less lumens (measure of light) for the same wattage. Unlike other types of Discharge lamps they can work on DC as well as AC current, and are generally used in outside locations. They are denoted "H" on the bulb.

High Pressure Sodium Vapour lamps have an arc tube of ceramic construction due to the high temperatures associated with this type of light (1300 °C) as hot sodium chemically attacks glass and quartz. Solid sodium and mercury are sealed in the xenon (or sometimes neon-argon) inert gas filled arc tube within the outer glass envelope. These produce an orange – white light with the highest luminance efficiency of all HID lights and as people do not find this acceptable inside, they are mostly used for exterior lighting. These are the only HID lights with starters, except for "instant re-start" metal halide lamps. They are denoted "S" on the bulb. High pressure sodium lights are not manufactured in the UK but are imported from Europe. Low pressure sodium lights are manufactured in the UK, with millions sold each year.

There are also short arc lamps, sometimes of the mercury type, but usually xenon, where an intense source of UV is needed. These are used in film projection and endoscopes, and are subject to violent explosions on occasion.

FAILURE PROBLEMS

Position

Each lamp is designed to operate vertically or horizontally with the manufacturer specifying this position. If the lamp is operated in a different position it can increase the risk of failure and explosion.

Breakage

This can occur from impact, for instance by goods, on fork lift trucks, being stored. Even scratches on the surface, or water contact giving a thermal shock, can cause failure, and in these circumstances the hot arc tube can explode. Water is a particular problem for sodium lights as combining sodium and water creates an instant fire.

Tube failure

The causes of this failure are not at all well known, although they can have violent results, and can occur spontaneously with an ageing bulb. Lamp quality could have an effect, improper lamp selection or incorrect use of ballasts (this component starts and then controls the flow of power to the lamp) and lamps could be a cause. Failure can occur through the glass texture of the arc tube turning into a crystalline structure with cracks developing, allowing argon to leak out of the tube, or conversely nitrogen to leak in,

with the result that the light is extinguished. This type of failure does not normally cause a fire problem. Some metal halide lights could be fitted with a standard ignition that tries to re-start the light when the bulb has failed, with no limit on the number of re-ignition attempts. It is possible that this action can cause explosions, as happened at Loughborough University in 1999. Following this, around 35 lights were replaced with ones fitted with Timed Ignition - these try to re-ignite the failed light on a very limited number of occasions only, thereby reducing the risk of dynamic failure. The replacement lights also have a fused silicon shroud cover around the lamp which is essential to retain any exploding inner parts.

Self-Cycling

Sometimes the bulb will start correctly and then turn off. This is usually caused by bad ballast or overheating of the bulb with the result that the protector shuts off the bulb. Sodium lights can do this when they get old, although recent improvements have been made to reduce this problem. On occasion, reflection from a white wall can turn off the bulb once the light intensity (mostly by reflected light) is high enough on the photoelectric switch. In any event, immediate replacement and rectification is recommended when this happens.

Incorrectly matched Ballasts and Bulbs

A particular ballast will generally only effectively work with one type of bulb. The wattage of the bulb must always be matched with the ballast. For instance, if a smaller bulb is used than the correct one it can easily overheat and then explode. Conversely, if a larger bulb is used it will have a shortened lifetime but the ballast could overheat because the bulb is not warming to the correct temperature. If considering substituting metal halide lamps by another type it must be remembered that this is not a simple process, as the arc voltage, AC or DC match to the power supply, and ballast type must be compatible. In addition, when measuring arc voltage to ensure this part of the equation is correct, as this information may not be published on the product, there is a possibility that there could be exposure to UV. There may also be operational difficulties arising from using the substitute bulb, such as the arc having a different colour or spectrum – in a projector, for instance, this can have the effect of illuminating only a part of a picture.

"P" Rated Metal halide Lights

There are special Protected ("P") versions of metal halide lamps that the manufacturers claim do not need "expensive front glass" and can be used in open luminaires, but if these are used with incompatible ballasts, fires can result. Philips, for instance, state "Do not use this lamp(P):

In a fixture that contains a Pulse Start metal halide ballast.

In a fixture that is specifically designed for use with Pulse Start metal halide lamps.

Operation of these lamps on Pulse Start Metal Halide systems may increase the chance of an outer bulb rupture and pieces of extremely hot glass might be discharged into the surrounding environment. If such a rupture were to happen, THERE IS A RISK OF PERSONAL INJURY, PROPERTY DAMAGE, BURNS AND FIRE". In any event where there is a possibility of impact damage, glass covers should still be used with "P" designated lights.

"O" and "S" Rated Metal Halide Lights

Many metal halide lamps can have end-of-life arc tube ruptures, hence the need to have enclosures. However there are "O" and "S" type lights that could be used in an open nature, under the ANSI (American National Standards Institute) rules.



"S" means suitable for open lights, if positioned within 15 ° of the vertical. These lamps must also be "cycled" for 15 minutes every week. There may still be a chance of end-of-life rupture and as they do not have containment shrouds, they could pose a risk.



Ruptured arc tube contained in the in-tact outer jacket of an "O" rated lamp

"O" rated lamps do have containment shrouds around the arc tube. It is strongly recommended that all metal halide lights made for open luminaires must have shrouded arc tubes to contain shattered particles. As an added precaution the lights must be fitted with exclusive sockets so that another type of light cannot be mistakenly fixed in their place.

"O" Rated

Arc tube shrouded
 No cycling required
 ANSI tested

Can have (recommended) socket that does not allow another type of light to be fitted by mistake
 FM approved

"S" Rated

No shroud used
 Cycled 15 minutes per week
 ANSI tested but do not meet rating requirements for open luminaires

Could be replaced by other lights
 Not FM approved

"E" rated lights

These lights must always be fitted within luminaire enclosures.

Fixture Compatibility

It must be noted that whilst the fixtures are tested and approved to one standard, the bulbs are tested to a completely different set of standards. Some standards, such as Underwriter Laboratory (UL) 1572 for fixtures, do not require a containment barrier for the lamp – it depends on the rating of the lamp, the positioning of the lamp and fixture markings. A containment barrier could be a metal housing to enclose the lamp. It could also be a glass diffuser (plastic ones have been known to have been involved in fires), a polymeric enclosure (although borosilicate glass is preferred), or a metal canopy or screen. The standards can also allow for holes in the barrier, although 'no gaps' is a preferred protective standard to adopt, irrespective of the allowances in the published standards. Sometimes retro-fitting barriers can cause overheating of the "open fixture" type lamp.

RECOMMENDATIONS FOR SAFE USE OF HID LIGHTS

Only retrofit lamp containment barriers if the action does not invalidate the approved standard for the fixture assembly. Always fit the correct bulb to the correct ballast and power supply. Remember that tempered or borosilicate glass barriers are preferred as normal glass could shatter. Plastic and aluminium barriers could melt and are not recommended.

Fit a shroud to protect the arc tube where a lamp containment barrier is not possible in the case of open fixtures. The ANSI electrical safety code designates "O" rating usually for shrouded lamps suitable for use with open fixtures, and these can be used without covers, providing there is an exclusive socket that does not allow for another type of light to be fitted by mistake. An "S" rated lamp, under the code, is similar but has restrictions on its position ie within 15 ° of the correct vertical position. It also may not contain the protective shroud, and in general should be fitted with a containment barrier.

Where there are high values of goods, particularly susceptible goods, such as packaging materials are present, both a lamp containment barrier, as part of the fixture, or an "O" rated lamp with a shroud fitted are strongly recommended. A similar position is taken with "S" rated lamps, particularly if not fitted with a shroud.

New installations should have external barriers fully enclosing the whole lamp unit. "E" rated units must have enclosed fixtures. There is little or no history of fires caused by HID lights that are fitted with non-combustible enclosures.

Lamps must always be positioned in accordance with the manufacturers requirements and must be clear of both combustible building construction materials as well as combustible goods. The positioning of goods should take account of the possible explosion and descent of very hot materials from these lamps. This is particularly important for the higher temperature lights, and less so for low pressure sodium lights that can be cooler than ordinary domestic lighting.

The lamps should be changed after 70% of its rated life-span. They should be regularly inspected, and if found to be scratched or damaged in any way, these should also be changed. Lights should be fitted with a monel wire that cuts the power supply when the light reaches its end-life but users should not solely rely on this working – lights reaching the end of their life draw more power and are less economic to operate so that changing lights with 70% life spent is also an economic option. The checks should also look for water ingress in the area of the light to prevent a thermal shock and potential explosion.

Where the lamps are operated continuously night and day it is required that they are turned off for around 15 minutes each week. Quite often if there are problems with the lamp it will not re-ignite after the "cycle-off" period and should be replaced – in this event the fault has had a passive rather than violent reaction due to the fault. By doing this "cycle-off" process the potential for explosions in operation is reduced. There is no need to cycle "O" rated lamps.

Work safely with the lamps. Those checking the lamps should only handle them when the lamps are cold and the power is locked off. Remember that lamp explosions could seriously injure staff working in the area so that full enclosures and the use of shrouds is strongly recommended where there is a regular exposure to the workforce. Fork-lift truck drivers should be trained in the hazards of these lights and should take care in storing and moving goods.

HID lamps can have blue-light and retinal thermal hazards, although the glass envelopes to the lamps prevent UVB leakage, as they are usually fitted with an ultraviolet filter. However, sometimes they do need to be the subject of a UVR risk analysis as they can emit large amounts of Ultra Violet Radiation, particularly in the case of special mercury and metal halide lamps used in photopolymerisation, reprography and graphic arts. Those units using bare lamps should be interlocked to prevent exposure to workers, with appropriate warning signage posted. Also note that when the mercury HID lamp envelope shatters, there is a substantial leak of actinic UVR from the lamp.

Remember that the term "shatter resistant" on lamps, that are fitted to open fixtures is not within the testing regime, and whilst better than lamps without this nomenclature, it is not a guarantee that they will not shatter. Also when replacing these lamps maintenance staff should be made aware of the increased risks if they accidentally fit lamps that are not "shatter resistant".

Generally lights should only be changed by qualified electricians