APPLICATION GUIDE ON CONTROL GEAR FOR HIGH PRESSURE DISCHARGE (HID) LAMPS

1. Introduction

This Technical Statement is intended to advise specifiers and users of the relative merits of the various high intensity discharge lamps and control gear options that will provide the best economic and light technical benefits for their installations.

There is an extensive range of HID lamp types and control gear that will operate them from conventional magnetic control gear or from electronic control gear – high frequency and lower frequency. The various lamp/control gear combinations are designed to benefit certain market sectors and the selection and their benefits are identified in this document.

2. Definition

High Intensity Discharge Lamps operate at higher pressures and current than fluorescent lamps. This creates a compact light source with a high luminous flux that is suitable for many applications that are less suited for the larger fluorescent lamps.

3. Lamps

Lamps are available in the following configurations:

- Different operating currents, wattage etc
- Clear, coated, frosted
- Tubular, elliptical, blown tubular, reflector, special
- Horizontal, Vertical, Universal
- Single ended, Bi-Pin, Double Ended, wire ended, special
- Single phase lamps
- Cross phase lamps
- Low voltage lamps
- Open rated and closed rated
- Various Ra / CRI
- Various colour temperatures
- Various efficacies
4. Control Gear

With discharge lamps as opposed to filament lamps, there is a requirement to limit the current into the lamp using control gear, a device to strike the lamp (ignitor) and a means to correct the incoming power factor (capacitor). In some cases a particular lamp may not require an ignitor. With an electronic control gear (ECG) all of these components are within one box.

**Traditional control gear:**

- Magnetic
- Simple impedance
- Leakage Autotransformer
- Constant Wattage Autotransformer (CWA)
- Dimmable Bi-power (Bi-level)

*Note: There is very little usage of leakage autotransformer and CWA ballasts in Europe so no further reference of it is made.*

**Electronic (ECG):**

- High frequency
- Low frequency
- Standard (non-dimmable)
- Dimmable

**Control gear is currently available for the following lamp categories:**

**High Pressure sodium**

All currently available control gear are generally low loss and are available in wattages from 35W to 1kW on single phase, and for 600W and 1kW lamps, cross phase control gear are available.

With the exception of internal starter HPS lamps, all of these control gear require an additional ignitor either impulser or super-imposed pulse. Timed ignitors are available for all wattages.

Lamp run up time is approximately 5 minutes; hot re-strike time approximately 2-5 minutes except for twin arc lamps where restrike times are lower.

For double ended HPS lamps instant hot restrike systems are available (special luminaire designs).

Some HPS control gear will operate certain metal halide lamps.
In the UK the mains voltage is 230V +10% -6%, however the nominal in the UK is 240V. Site measurements are recommended as multi-tap control gear are available.

All control gear are now fitted with thermal cut-outs for protection at end of lamp life. Timed igniters can be used to switch off cycling lamps.

Power factor correction capacitors need replacing every 50,000 hours.

**Metal Halide (Quartz and Ceramic variants)**

Metal halide **magnetic** control gear are available in low loss wattages from 35W to 2kW. Cross phase control gear are available for 1kW, 1.5kW, 2kW and 3.5kW lamps.

Typically European metal halide lamp circuits require an ignitor (except for those with integral starting device), again either impulser or super-imposed pulse. Timed igniters are available for all wattages up to 1kW.

Metal halide electronic control gear are available from 20W to 2kW. Most commonly these are of low frequency square wave type. Some control gear are available in higher frequency operation, but care must be taken when selecting these to operate certain types of lamp due to the possibility of acoustic resonance effects which can shorten the life of the lamp or cause visible arc movement leading to the perception of flicker. If in doubt it is recommended to check with the lamp and control gear manufacturers for compatibility before selecting the lamp and ballast combination to be used.

Lamp run up time is approximately 5 minutes, hot re-strike time up to 20 minutes.

Some metal halide lamps run on HPS/metal halide control gear and some on mercury/metal halide control gear, if in doubt consult lamp or ballast manufacturer.

In the UK the mains voltage is 230V +10% -6%, however the average in the UK is still 240V. Site measurements are recommended as multi-tap control gear are available.

Unless the lamp is declared by the manufacture to be proof against end of life rectification, ballasts must be fitted with thermal cut-outs for protection at end of lamp life. Timed igniters can be used to avoid continuous striking of faulty lamps or lamps at end of life.

Power factor correction capacitors need replacing every 50,000 hours.
**SOX (strictly not an HID lamps but included for completeness - this technology is no longer promoted)**

Low loss control gear is used for lamps of 10 watt to 90 watt. Leakage reactance high loss control gear is used for 135w and 180watt lamps.

Only single-phase control gear is available.

Ignitors are only required up to 90 watt lamp rating.

**Mercury Vapour (this technology is no longer promoted)**

Mercury control gear are available in low loss wattages between 50W and 1kW single phase. Cross phase versions are available for ratings of 1Kw. Ignitors are not required for mercury vapour lamps, as they will strike at mains voltages.

**Electronic control gear characteristics**

The frequency of the output of the Electronic control gear and the size and shape of the arc tube must be carefully considered and a suitable type-testing regime established. Operating lamps at various frequencies and plotting a map of resonance peaks can give a reliable indication of frequencies that must be avoided.

Low frequency control gear, those operating below 250Hz in contrast to High Frequency control gear normally assumed operating at above 100 KHz, have a design topology utilising a square wave, again in contrast to High Frequency control gear which utilise a sine wave. Therefore acoustic resonance effects with Low Frequency square wave must also be considered, due to the inherent inclusion of high frequency components embedded in the square wave. Suitable filtering and rise time restrictions can be used to round off the square wave eliminating the high frequencies. The influence of the high frequency components can be minimised by controlling certain aspects of the square wave, such as ripple current amplitude and frequency, and spectral power ratio.

IEC 61167 gives specific requirements for square wave use.

**5 Dimming of HID**

There are some aspects that make the dimming of HID lamps more complex than Halogen and Fluorescent light sources:

- By reducing the lamp power the colour of the light may shift. With metal halide lamps a higher colour temperature is often the result, which shifts the colour to blue-green with clear lamps. The light of phosphor-coated lamps starts changing at about 60% lumen output. With high-pressure sodium lamps the colour shift will be almost negligible down to 50% lumen output; at lower levels the colour of the light will shift towards the yellow tinge of the low-pressure sodium lamp.
- Lamp life can also be affected, mainly depending on the method of dimming. Incandescent lamps will have a longer lifetime when dimmed, but with mercury and metal halide lamps the lifetime may be shortened.

- By changing the lamp power or dimming level the stabilisation time for the lamp lumen output may become much longer.

- HID lamps must be stabilised at full power after switch-on prior to dimming, and switched off from full power after dimming.

Some types of HID lamps have a restricted dim-down rate to minimise thermal stresses on some arc tube components thereby preserving lamp life. Some manufacturers do not recommend certain HID lamps for dimming.

The conclusion from the above is that HPS, CMH and QMH lamps must be dimmed by compatible control gear as recommended by the lamp manufacturer.

There are two common methods:

a) Regulation by means of a twin control gear circuit

b) Here, an additional dimming choke L2 is connected in series in the lamp circuit; in combination with the normal choke L1 (see below). With this rather simple system dimming levels of approx. 50 per cent can be obtained without any side effects. This one-step dimming is particularly popular with high-pressure sodium lamps from 70 W up to 400 W in, say, street lighting, in this instance, a power reduction of approx. 35 per cent is achieved. Regulation by increasing the frequency

The impedance of the choke coil will increase by changing to a higher frequency. Consequently, lamp current and lamp power will decrease. This is similar to how modern fluorescent lamps are dimmed. These systems offer compact, one-piece and simple adjustment of the output of HPS lamps. The benefits include stable flicker free lamp operation and increased lamp life. Because of slow-warm-up and hot re-strike delay characteristics of HID lamps, all dimming methods use an automatic procedure, whereby the lamp is started at full power and any dimming is delayed by 3 to 10 minutes until the lamp is fully warmed up. There are currently 2 commonly known methods available.
- **The Low Frequency solution**: The electronic regulating control gear can dim the light level of HPS lamps continuously between 100 and 35 per cent due to its increased operating frequency of 100 - 250 Hz, providing Stable Colour, Longer Lamp Life and Improved Lumen Maintenance.

- **The High Frequency solution**: Dimming is fully programmable from 100% down to 50% or better, depending on each lamps capability. The lamps electrodes are kept at a constant temperature, providing Stable Colour, Longer Lamp Life and Improved Lumen Maintenance.

### 6 European Standards

*With reference to applicable standards the following documents are currently in force:

EN 61347-1: Lamp control gear. General and Safety requirements
EN 61347-2-9: (Safety) Requirements for (magnetic) ballasts for discharge lamps
    (replaced EN 60922)
EN 60923: Performance requirements for (magnetic) ballast for discharge lamps
EN 61347-2-12: (Safety) Requirements for d.c or a.c. supplied electronic ballasts for discharge lamps

At the time being it does not exist a performance standard for electronic ballasts. Some references can be obtained from lamp manufacturer’s documentation.

*Other Standards to be considered are:

EN 60598 Luminaires
EN 60188 High Pressure Mercury Lamps
EN 61167 Metal Halide Lamps
EN 60662 High Pressure Sodium Vapour Lamps
EN 60192 Low pressure Sodium Vapour Lamps

To be noted that all these lamp standards must be implemented with the technical data for the correct working with electronic ballasts

### 7 Applications

HID lamps are used in very different field of applications. They are an excellent solution for indoor lighting in retail, in hotels and restaurants as well as for outdoor lighting and in city beautification.

Because of the different performance in colour rendering and efficacy the application field depends on the lamp type.
Main application fields are:

Industry, trade and commerce, Retail outlets, Shop windows, public and amenity areas, Traffic installations, Industrial installations, Building sites, Sports grounds, Flood-lighting, Special applications.

8 European HID control gear Market

In recent years there has been an increase in the electronic control gear share of the market. The reasons for this share increase are mainly:

- The development of small power HID lamps with very high colour rendering that can be run only with electronic control gear
- The increase of luminaire equipped with HID lamps in indoor application and especially in the application where the luminaires have to be hanged on tracks (shop lighting, accent lighting). In this case electronic control gear lower weight represents a key issue.

Obviously where new technologies arise the first increases are significant. The destination of these electronic control gear is in indoor applications for mainly shop lighting where the incandescent lamps PAR type have been replaced. So they are replacing incandescence systems, not HID magnetic control gear with electronic ones.

11 ANNEX

i HID Electronic control gear have an ignition circuit built in and this is normally a timed device which will shut down after typically 20 minutes. Variations on a theme can be to pulse for just a few seconds every minute, and shut down after three ignitions, assuming the lamp is then cycling.

ii A point of note for Electronic control gear is that each will contain a pre-regulator circuit that ensures the power factor is maintained at near unity, with the exception of some 20W and 22W types where power factor correction is not always required.

iii The dimming of HID lamps is becoming more common for reducing power consumption, lengthening lamp life, and reducing maintenance costs and light pollution. Lamp dimming is also a way of providing attractive and dynamic lighting.

iv For environmentally friendly disposal of lamps visit [www.recolight.co.uk](http://www.recolight.co.uk) and luminaires visit [www.lumicom.co.uk](http://www.lumicom.co.uk).

For further information on the manufacturers of quality compliant control gear visit [www.thelia.org.uk](http://www.thelia.org.uk)

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