**HID Lamps**

**What are HID lamps?**

HID stands for High Intensity Discharge. High intensity simply means a large amount of light is produced in a relatively small area (the arc tube) and Discharge means the light is produced in a gas arc and not by heated wire. The HID lamps produce light by means of heating a gas with an electric arc while the incandescent lamps produce light by electrically heating a solid wire - usually tungsten filament. All HID light sources require auxiliary equipment (such as ballast, capacitors, ignitors) to provide the appropriate electrical values for starting and operating (HID) lamps. These lamps require a starting voltage higher than their normal operating voltage.

**How does a high intensity discharge lamp work?**

The light source is called an **ARC TUBE**.

1. **Wire lead electrical connection**
2. **Molybdenum ribbon**
3. **Quartz pinch seal**
4. **Tungsten (main) electrode**
5. **Electric Arc**
6. **Small amount of Argon gas**
7. **Mercury and pure metal salts**
8. **Starter electrode**
9. **The arc tube body is made from quartz because it has a very high melting temperature and is not affected by the extreme heat produced by the electric arc.**

10. **In the case of non-pulse start metal halide and mercury vapor lamps, Heated Quartz is pinched tight around an extremely thin molybdenum ribbon that carries current to the electrodes. The pinch makes an air-tight seal that prevents the small amount of gas and chemicals from leaking out of the arc tube which would cause the lamp to tail.**

**How does the arc tube work?**

- When the lamp is turned on, an electric arc is struck between the starter electrode and the main electrode.
- The small arc starts a chain reaction of electron collisions in the fill gas around the electrode.
The chain reaction of the electron collisions multiplies within the tube until it reaches the opposite main electrode and the arc is then struck between the two main electrodes. The heat from the arc vaporizes the liquid mercury into a gas which enters the arc stream causing the voltage to rise. The arc becomes narrow and very intense in light output.

In metal halide lamps, the metal salts are melted and vaporized, and also enter the arc stream, further raising the voltage and adding colour to the arc.

Why does a high intensity discharge lamp require a ballast?

A ballast for HID lighting is a regulating device. It regulates how the lamp will start and operate.

- It supplies sufficient High Voltage to allow the lamp to start.
- It supplies sufficient Open Circuit Voltage (OCV) to allow the lamp to restrike every half cycle.
- It regulates current going to the lamp to allow the lamp to run at or near specified power.

Every HID lamp requires some level of high voltage to break down the gas in the arc tube and begin electric conduction. Starting volts vary depending on lamp design.

- Mercury and higher wattage non-pulse start metal halide require less voltage because they have extra starting electrodes in the arc tube.
- Standard HPS, pulse start metal halide and low watt metal halide have no starting electrode and therefore require much higher voltage to start.
- Ignitron and Sunlux Ultra Ace HPS lamps have starting aids on the outside of the arc tube which reduce the needed starting voltage.

The ballast supplies the needed high voltage for starting by either a high open circuit voltage (mercury and metal halide), or a high voltage pulse (HPS and low watt metal halide)

<table>
<thead>
<tr>
<th>Lamp</th>
<th>Starting Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>340</td>
</tr>
<tr>
<td>Metal halide (175 watts and higher)</td>
<td>500 - 800</td>
</tr>
<tr>
<td>Metal halide (150 watts and lower)</td>
<td>3500</td>
</tr>
<tr>
<td>Pulse start MH</td>
<td>3000 - 4000</td>
</tr>
<tr>
<td>Ceramic MH</td>
<td>3000 - 4000</td>
</tr>
<tr>
<td>HPS (regular)</td>
<td>2500 - 4000</td>
</tr>
<tr>
<td>HPS (Eye Ignitron and Sunlux Ultra Ace)</td>
<td>900 -1400</td>
</tr>
</tbody>
</table>

Types of HID Lamps?

There are four basic types of HID lamps, each with its own characteristics:

1. Metal Halide lamps
2. High Pressure Sodium lamps
3. Mercury Vapour lamps
4. Low Pressure Sodium lamps

Recent developments in new lamp designs have now made various types of HID lamps suitable for a wide range of applications.

Metal Halide Lamps

Metal halide lighting systems are growing in popularity and are becoming the customer's choice for lighting applications. This is because of the unique combination of product features offered by metal halide such as high energy efficiency, white and high colour rendering light, long life, wide selection of products, both indoor and outdoor applications and new compact sizes to allow for innovative fixture designs.
Basic Construction of a Metal Halide Lamp

- The metal halide (MH) lamps are generally similar in construction to the MV lamps.
- The main difference is that the arc tube contains metal halides - in addition to the mercury vapour.
- As all HID sources - MH lamps consist of an "arc tube", enclosed in an "outer bulb".

High Pressure Sodium Lamps

High Pressure Sodium lamps (HPS) were invented in the 1960's just as translucent high temperature ceramics became available. Such ceramics, used in the making of the HPS arc tube, made it possible to generate light by means of a sodium-mercury amalgam which would otherwise destroy the common quartz arc tube used in mercury lamps. The result is a lamp that is much more energy efficient than mercury vapour lamps, but the light's color - a yellow/orange - was dramatically different from the common mercury blue.

Basic Construction of a High Pressure Sodium Lamp

High pressure sodium (HPS) lamps are electric discharge lamps, at high pressure, in which the arc is generated by vaporized sodium.

- As all HID sources, HPS lamps consist of an "arc tube", enclosed in an "outer bulb".
- HPS lamps do not use starting electrodes.
- Because of the arc tube's small diameter - a high-voltage, high-frequency pulse is used to start the lamp (provided by the ballast).
- Outer glass: Borosilicate glass.
Mercury Vapour Lamps
Mercury Vapour lamps were first developed in the 1930's in both Europe and the United States. They represented a new type of lamp that was more efficient and that lasted longer than incandescent lamps. They were ideal for street lighting and factory lighting. However, the Mercury Vapour lamp had its own set of disadvantages:

- The colour of the light emitted is a dull blue-white, compared with incandescent yellow-white.
- Mercury’s ability to render true colours (CRI) is much less than incandescent, so some colours, especially red, yellow and orange are distorted under Mercury light.
- Mercury lamps require a ballast to operate properly, whereas incandescent lamps do not require one.

In spite of some of the disadvantages listed above, the lamp has been widely used because of its low initial cost, low maintenance cost and because it is the longest life HID lamp (old Mercury lamps never die... they just fade away).

Basic Construction of a Mercury Vapour Lamp

- Mercury vapour (MV) lamps are gas discharge lamps which use mercury at high pressure, to create the electric arc.
- An MV lamp consists of an "arc tube", enclosed in an "outer bulb" (a bulb in a bulb).
- The arc tube contains the mercury vapour, a starting gas (argon), and the electrodes.
- The outer bulb contains an inert gas (nitrogen), to prevent oxidation of internal parts, and to maintain the operating temperature.
- The outer bulb also provides the inner surface, for a phosphor coating.

Low Pressure Sodium Lamps
Low Pressure Sodium lamps (LPS or SOX) are High Intensity Discharge lamps operating at low pressure in which vaporized sodium produces an electric arc. Because of their linear shapes, low pressure and low intensity discharge source, these lamps are similar to fluorescents. The U-shaped "arc tube" is enclosed in a clear tubular "outer bulb". The "outer bulb" is coated on the inside with an indium oxide which reflects most of the infrared radiation back to the arc tube. These lamps are designed to maximize the use of its generated heat. Therefore, the arc tube is enclosed in a vacuum to minimize heat loss. As a result the arc tube can maintain an operating temperature of about 260°C, creating an extremely high luminous efficacy. The LPS lamp has the highest efficacy of all light sources ranging from 100 to more than 180 lumens per watt. The efficacy increases with lamp size. The LPS lamp is available in various sizes ranging from 18 to 180 watts. The colour rendition in an LPS lamp is very low, emitting a yellow (monochromatic) light output, close to the peak of the eye sensitivity curve, which again results in high efficacy.
HID Lamp shapes

HID lamps come in various shapes and sizes. The lamp designation is made up of two components: first, the abbreviation letters for the lamp shape and second, a numerical designation for the lamp diameter which is expressed in eighths of an inch (1/8”). For instance, a BT56 lamp is a Bulged Tubular lamp that is 7” in diameter (56 ÷ 8 = 7).
NOTE: Drawings are not to scale.

HID Lamp operating position symbols

Lamps must be operated in their specified operating positions in order to maximize lamp performance and life. Incorrect operating positions may also create the possibility of a lamp rupture. Because of these factors it is imperative that users adhere to the specified operating positions and fixture requirements. The following chart shows the correct lamp positions based on the Position Code Letters which are contained in the lamp description.

Fixture requirement codes

O: Open fixtures permissible. Lamps can be operated in an open fixture within the lamp’s specified operating position limits.
S: Open fixture permissible with operating position restrictions.
E: Enclosed fixture required. Lamps must be operated in an enclosed fixture.

<table>
<thead>
<tr>
<th>Position Code Letters</th>
<th>Description</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>No code letters or U</td>
<td>Universal</td>
<td>ALL TOUTES</td>
</tr>
<tr>
<td>BU±15°</td>
<td>Base up ±15°</td>
<td></td>
</tr>
<tr>
<td>Angle</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>-------------</td>
<td>------------------------------------</td>
<td></td>
</tr>
<tr>
<td>BUD ±15°</td>
<td>Base down ±15°</td>
<td></td>
</tr>
<tr>
<td>BU ±75°</td>
<td>Base up ±75°</td>
<td></td>
</tr>
<tr>
<td>BD ±75°</td>
<td>Base down ±75°</td>
<td></td>
</tr>
<tr>
<td>BU ±90°</td>
<td>Base up to horizontal ±90°</td>
<td></td>
</tr>
<tr>
<td>BU ±90°</td>
<td>Base down to horizontal</td>
<td></td>
</tr>
<tr>
<td>HOR ±15°</td>
<td>Horizontal ±15°</td>
<td></td>
</tr>
<tr>
<td>HOR ±45°</td>
<td>Horizontal ±45°</td>
<td></td>
</tr>
<tr>
<td>HOR ±60°</td>
<td>Horizontal ±60°</td>
<td></td>
</tr>
<tr>
<td>BU-HOR ±105°</td>
<td>Base up to horizontal ±105°</td>
<td></td>
</tr>
<tr>
<td>BD-HOR ±105°</td>
<td>Base down to horizontal ±105°</td>
<td></td>
</tr>
</tbody>
</table>
Thanks to today’s technology, lamp manufacturers developed many unique HID lamps to satisfy the growing needs of the end users. Because there are so many different lamp types for so many different specific applications, manufacturers utilize different models of lamp bases, each with specific function to guarantee the proper lamp installation in the socket and to ensure the lamp operates as designed. The most common bases used are:

**Medium:**
"MED" bases are usually pulse rated for use on maximum 175 watts lamps, most often used on ED-17 lamp shapes.

**Medium Skirt:**
"MED. Skt." is a medium brass base with a skirt used on PAR-38 HID lamps.

**Mogul:**
"MOG" bases are used for most high wattage HID lamps. All mogul bases are either made of brass or nickel-plated brass on which the date of installation can be marked, thanks to a date code system on the base itself.

**Recessed Single Contact:**
"RSC" bases are used for double ended HID lamps and have silver plated contacts to provide best electrical contact.
NOTE: Drawings are not to scale.