Ballast Function

In order to produce light, metal halide lamps ionize gas within an arc tube. Once an arc has been struck, resistance to the current flow in these lamps is virtually nonexistent. As a result, without a ballast to control the current, the lamp would be destroyed. For this reason, the lamps require a ballast to provide certain operating characteristics:

a) Starting Voltage: An H.I.D. lamp requires a minimum starting (open circuit) voltage to be applied to the electrodes to ensure reliable starting in normal and low temperatures. The ballast converts or transforms the line voltage to the voltage required to ionize the gas in the arc tube.

b) Regulation: Ballasts must provide operating characteristics as outlined by lamp manufacturers' specifications and in accordance with ANSI specification C82.4. These criteria are to be met even though the line supply voltage varies ± 5% from nominal.

c) Current Crest Factor: Lamp current crest factor must be within a predetermined maximum in order for the lamp to provide rated lumen maintenance and lamp life.

Choosing the Right Ballast

Fifteen years ago, matching ballasts and metal halide lamps was very simple because there were four basic lamp types and associated ballasts (175W, 250W, 400W, and 1000W). As metal halide usage increased, the need for specialty lamps and control gear became apparent. Metal halide users now demand additional qualities such as longer lamp life, higher lumen output, quicker starting, and most importantly better energy efficiency. To achieve these benefits, ballasts and lamps must be compatible. See our Specification Sheets to ensure that this compatibility is achieved. The following are the ballasts now commonly used.

Constant Wattage Auto Transformer (CWA)

This was formerly the "standard" and is still the most common type of ballast used for standard metal halide lamps (175W and higher). Lamps with starter electrodes are used with this ballast, so no ignitor is needed. The ballast can transform (increase) voltage so lower line voltages (120V) can be used. They use a capacitor and have a high power factor (90%). This ballast can tolerate a line voltage drop of 30% without the lamp extinguishing.

Reactor Ballast (R)

This is the simplest ballast and is often referred to as a lag or choke. It is used when the line voltage is high enough to start lamps (240 or 277V). It has low power factor (50%) unless it is corrected with a capacitor. These ballasts have very poor regulation of the secondary (lamp) voltage.

High Reactance Auto Transformer (HX)

This ballast is the most common type used today for low wattage (below 100W) lamps and uses an ignitor in these cases. This is also a reactor or lag type ballast with low power factor unless a capacitor is used (correctable to 90%). This ballast can transform (increase) input voltage so it is high enough to start lamps.

Regulated Lag Ballasts (Reg. Lag)

Until recently, these ballasts were primarily used for HPS lamps. Now they have been modified to operate Venture's *Uni-Form* formed body pulse start lamps. This is a premium ballast with excellent regulation and is used in conjunction with an ignitor. The *Uni-Form* pulse start lamps designed for this system generally have extended life and higher lumen output. These ballasts can tolerate a line voltage drop of 50% without the lamps extinguishing.

Instant Restrike System (IS)

This system typically uses a specially wired CWA ballast and a high voltage ignitor (20,000+V). They are used to instantly restart lamps after a momentary power failure. These require special lamps and a fixture with electromechanical interlocks.

Controlled Current Reactor

These new ballasts employ reactor circuitry that can reduce "typical" ballast losses by about 50%. For example, a 150 watt ballast will only have 17 watts loss compared to 35-45 watts loss in standard 175W or 150W ballasts. They are designed to run on 277 input volts and use an ignitor to start the lamp. When used with *Uni-Form* pulse start lamps, the combined energy savings can be over 25%. This is accomplished with little or no light loss.

Electronic Ballasts

Other ballast types utilize an iron core and copper wire windings in order to operate. Electronic ballasts use component circuitry to start and sustain lamps. This affords them the benefit of greatly reduced size and weight. Fixtures designed for these ballasts are small enough to be used in any application. Electronic ballasts typically operate the lamps on DC voltage and have negligible ballast losses. The DC voltage extends life and decreases lumen depreciation.

When choosing a ballast for H.I.D. lamps, the options are a luminaire that has an integrally-mounted ballast, or a fixture (reflector, diffuser and lampholder assembly) for use with a remote ballast. The following points show some of the advantages of both options.

Integral Ballasts (Core & Coil)

Integral ballasts, or "core and coil" ballasts, must be suitably mounted and enclosed in the luminaire to pass CSA/UL requirements for electrical safety and operating temperature. Venture technical experts work in close liaison with fixture manufacturers, who offer a wide variety of H.I.D. lighting alternatives.

Some advantages of integral ballasts are:

• ballast is pre-wired to reduce installation cost

• components of fixtures are delivered to the job site together

• the ballast is easily located when trouble-shooting the lighting system

Remote Ballasts

Indoor remote ballasts are intended specifically for areas protected from the weather. The design allows for operation in ambient temperatures of 40°C or less. The ballasts must be mounted in areas where the air will circulate freely around the enclosure. They can be mounted vertically or horizontally. Designs for 60°C high ambient temperature are available

Outdoor remote ballasts have deep drawn, one-piece cases with aluminum spun-on covers and finish, except 1000 W. Neoprene gaskets placed between the case and the cover are roll-clamped under hydraulic pressure. All wiring connections are made to neoprene-insulated leads, which are inserted through a waterproof plug. Outdoor ballasts can be used at a pole base, on a cross arm, or mounted on the top of a pole. The ballasts are recommended for operation in ambient temperatures up to a maximum of 25°C (77°F).

Remote ballasts have several advantages:

• Remote mounting can be done to keep a ballast cool for lighting in high-ambient temperature areas.

• When fixture location is difficult to reach, the ballast can be mounted near the floor or a balcony.

• When low levels of sound are important, the ballast can be mounted outside an occupied area.

Factors that Affect Specification of A Ballast

The following factors affect ballast specifications:

a) Lamp wattage regulation spread (expressed as a %): To arrive at the lamp wattage regulation spread, divide the difference between the maximum watts and minimum watts by the nominal or design watts; then multiply by 100. As an example, a nominal 400 watt H.P.S. lamp is rated at 100V, and the ballast is designed to operate a nominal 100V lamp at rated watts. The nominal watts in this example equals the design point at 400 watts. The same nominal 100 volt lamp with 10% more line voltage from the ballast measuring 435 watts is the maximum watts; with 10% less line voltage is the minimum watts, measuring 365 watts. The regulation spread then, using the formula detailed above, is 70 divided by 400, times 100 or 17.5 percent for a 400 watt H.P.S./C.W.I. type ballast. A safe spread for ballasts with lamps less than 400 watts is 18 percent. Note: H.P.S. regulation is a total percent spread and not a plus or minus variation. When the 400 watt H.P.S. lamp reaches 130 volts, the spread is 31 percent.

b) Lamp current crest factor: This is the ratio of the peak current to the average current. To ensure rated lamp life and lumen maintenance, manufacturers specify a maximum limit. Anything above this can shorten the lamp electrode life. Ballasts with a 1.8 crest factor or less will provide rated lamp life performance. Venture now offers newly-engineered ballasts with reduced current crest factor for use with *Uni-Form* pulse start lamps. The improved crest factor design yields additional benefits over traditional ballast designs due to less stress on the electrodes from the higher current.

These low crest factor ballasts work with high voltage pulse ignitors to allow quicker cold starting and faster hot restarts, a proven factor in longer lamp life and superior lumen maintenance. The new designs all offer lower current crest factor, as low as 1.4.

c) Ballast power factor: A regulating ballast design compensates for line voltage range, and a non-regulating design does not compensate. Common names for non-regulating types are reactor, lag, and autotransformer/reactor. Common names for regulating types are: regulator, constant wattage (CW), constant wattage isolated (CWI), and constant wattage autotransformer (CWA). All regulating types are HPF with the capacitor in series with the lamp. Non-regulator ballasts can be either normal power factor (NPF) or high power factor (HPF). HPF has a capacitor across the line.

d) Lamp failure modes: All. lamps will eventually fail and ballasts must be designed with that fact in mind. Lamps which need to be replaced usually cycle on and off, although they may also fail in a short circuit mode as a result of mechanical failure. The ballast must be designed for the following operating modes: start, warm-up, and proper burning operation; failure due to open circuit cycling; and mechanical failure due to open or short circuit.

e) Ballast/starting aid compatibility: Venture designs and controls the components of all starting aid systems. When used as designed, a ballast and starting aid will operate under open circuit conditions without an appreciable loss of life for three months.

f) Ambient and operating temperature rating: The life of any ballast is directly affected by heat. The introduction of smaller lighting fixtures, ballast housings, and ballasts has resulted in higher operating temperatures. Insulation systems that have been designed for specific operating temperatures will last for an average of approximately 60,000 hours. But if a ballast is operated at 10°C over the design temperature, its operating life will be decreased by approximately 50 percent. Temperature ratings for ballasts take into account the temperature of the surrounding air where the ballast is placed (ambient), and the operating temperature which includes the heat generated by the lamp and the ballast. The following is a typical profile:

Normal rated ambient temperature 40°C

Typical average ballast temperature rise 90°C

Typical fixture temperature rise (lamp heat) 15°C

Total operating temperature of insulation system 145°C

All *Venture* core and coil ballasts are manufactured to Class H standards. The total operating temperature of 145°C is safely below the ANSI standard maximum limit of 165°C, and will give the system normal H.I.D. ballast life.

NOTE: The fixture temperature rise may vary substantially depending on the fixture design, lamp rating, and operating conditions. The total operating temperature should not exceed the ANSI standard maximum limit of 165°C.

Recommended maximum ambient temperatures are listed below.

APPLICATION	°C	°F
Outdoor Lighting	25	77
Indoor Lighting	40	104
Indoor Lighting	55	131
Indoor Lighting	60	140

Venture manufactures a line of specially designed ballasts for operation in maximum ambient temperatures of 60°C (140°F). Design features of this line include superior insulation, high temperature potting compound, and specially designed capacitor enclosures. These ballasts are recommended for use in areas where high ambient temperatures prevail.

The advice of a Venture technical specialist should be sought whenever the installation of ballasts in abnormal conditions is required. One proven method to combat conditions such as a corrosive atmosphere, high ambient temperatures, or excessive humidity, is to mount the ballast in a remote location.

g) Fixture/Ballast Housing design: The mounting of core and coil ballasts within the enclosure of a lighting fixture or ballast housing is critical to its operation. Heat dissipation leading to premature ballast failure and can be prevented by a core and coil ballast. It is therefore necessary to install the core and coil ballast in a way that conduction and radiation take place to dissipate the heat generated.