



WESTINGHOUSE
LIGHTING
SOLUTIONS

How To Design A Better Fixture...

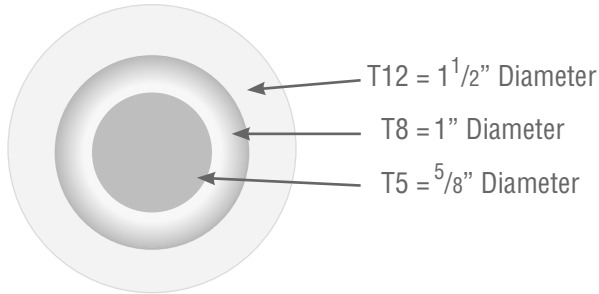


START WITH A BETTER LAMP

Goal: Use a powerful lamp that maintains light output, is rated for 35,000 hours, and is small in diameter to allow the design of accurate reflectors.

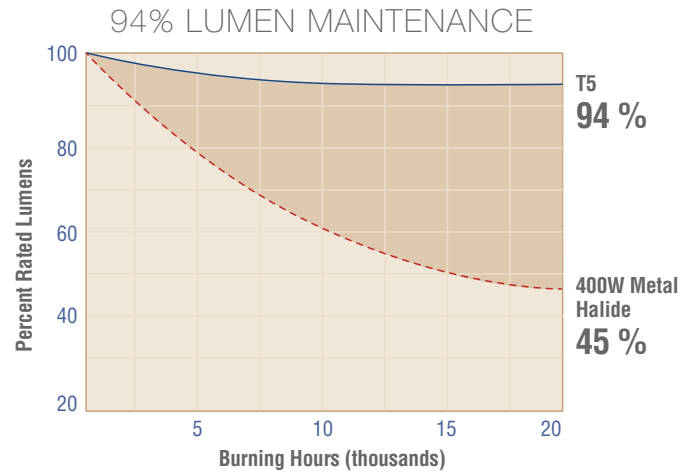
Millions of T5HO lamps have been installed over the past 10 years. They have proven to be a cost-effective reliable light source and are optimal for extremely efficient reflector designs. Additionally, T5HO lamps maintain a higher percentage of their lumen output over time.

T=TUBULAR DIAMETER IN 1/8^{THS} OF AN INCH



WESTINGHOUSE T5 LAMPS ARE RATED FOR 35,000 HOURS.

Based on 12 hours per start. ANSI testing "hour rating" is the point at which 50% of lamps have failed.



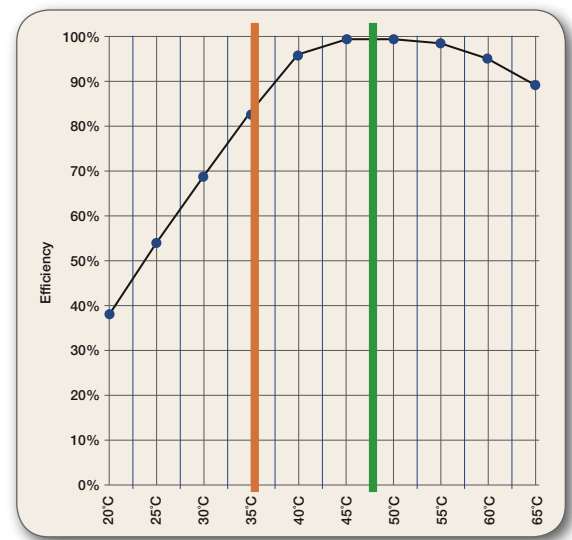
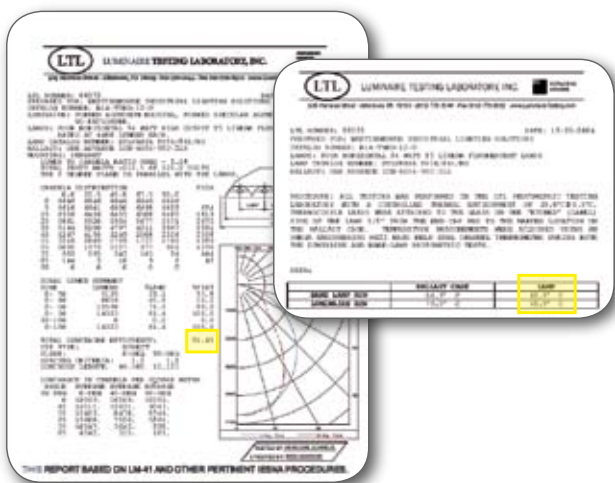
Notice how 400 watt metal halide lamps dip below 50% light output at 15,000 hours.

THERMAL MANAGEMENT:

Goal: Use thermal management techniques to design a fixture for optimal efficiency and peak lumen output.

A popular misconception is that room temperature has to be 35°C/95°F for T5 lamps to peak their lumen output (5,000 lumens). The reality is that the maximum light output of a T5 lamp is when the mercury "cold spot" is 48°C/118°F. WLS applies thermal management techniques to assure that fixtures operate at ideal temperatures.

The lamp cold spot is located 1/8" in from the end of lamp and is where excess mercury is stored when lamp is off.



Misconception ■ Reality ■

| Thermal Management Design | Total Luminaire Efficiency | T5HO Cold Spot Temperature |
|---------------------------|----------------------------|----------------------------|
| Test 1 | 81.4% | 60.9°C / 142°F |
| Test 2 | 86.7% | 57.0°C / 135°F |
| Test 3 | 96.2% | 48.5°C / 119°F |

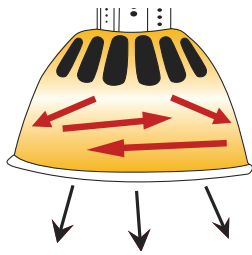
Lab test for the identical fixture, ballast, and lamp produced the results listed. The only variance was the amount of lamp venting.

WLS FURTHER MANAGES HEAT WITH ALUMINUM BALLAST COMPARTMENTS

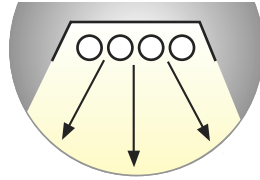
UNDERSTANDING REFLECTOR DESIGN

Goal: Maintain Beam Spread, Minimize bounces, get the maximum light out of fixture.

Fixture efficiency, by definition, is the percentage of total light output of the fixture divided into total light output of just the bare lamps. The measurements are taken on a Gonio photometer and represent how much of the total light gets trapped in the fixture.



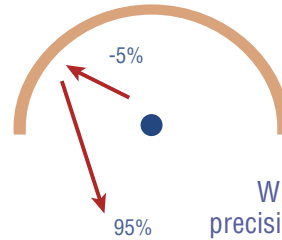
30% trapped in fixture = 70% efficient



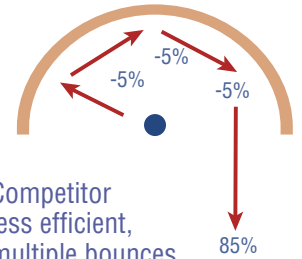
96% efficient
only 4% trapped in fixture

ONE BOUNCE AND OUT

With 95% reflective material, each bounce costs 5% light output

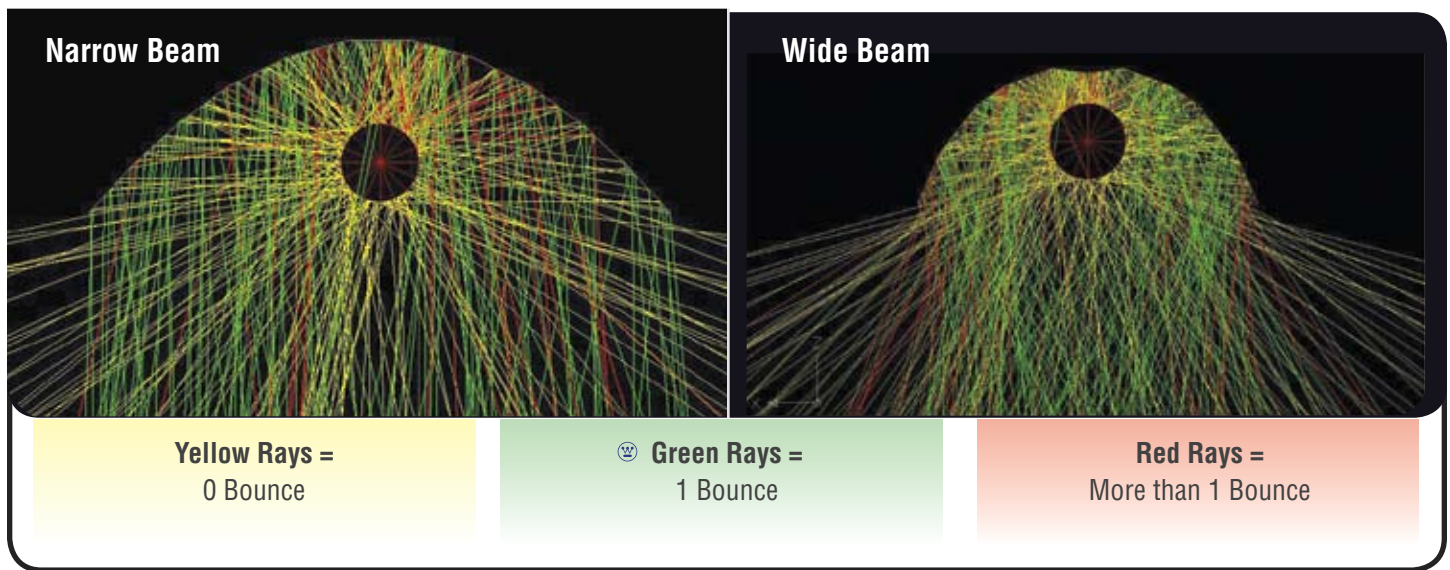


WLS precision optics



Competitor less efficient, multiple bounces

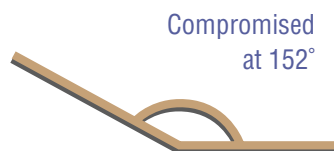
Using “Ray Trace” computer modeling, WLS traces 29,000,000 theoretical rays to calculate beam and efficiency.



THE DIFFERENCE BETWEEN SUCCESS AND FAILURE

Goal: Use precision tooling to insure reflector design matches fabrication.

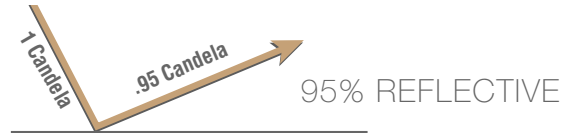
Westinghouse’s reflector designs are engineered to the tenth of a degree for bending angles, and to the thousandth of an inch for facet length. If fabrication tolerance does not match design, theoretical efficiencies are not realized. Below was a real world “miss”. One angle missed by 2° and the reflector spacing criteria was out of spec. WLS controls this situation by using precise CNC machinery to produce reflectors.



USE THE PROPER REFLECTOR MATERIAL

Goal: Total Reflectivity —The sum of diffuse and specular reflectivity.

To make accurate reflectors you need to minimize diffusion. Diffusion is when light scatters randomly in a material. Westinghouse uses specular material that is not only highly reflective, but is also minimally diffuse.



VIEW OF MICROSCOPIC SMOOTHING



Standard specular material



☺ Enhanced reflector material

LASER SHOWS DIFFUSION



Standard diffuse material: laser reflects but scatters

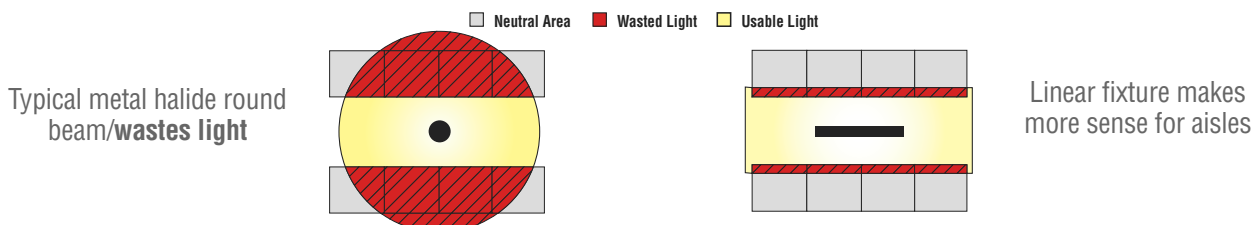
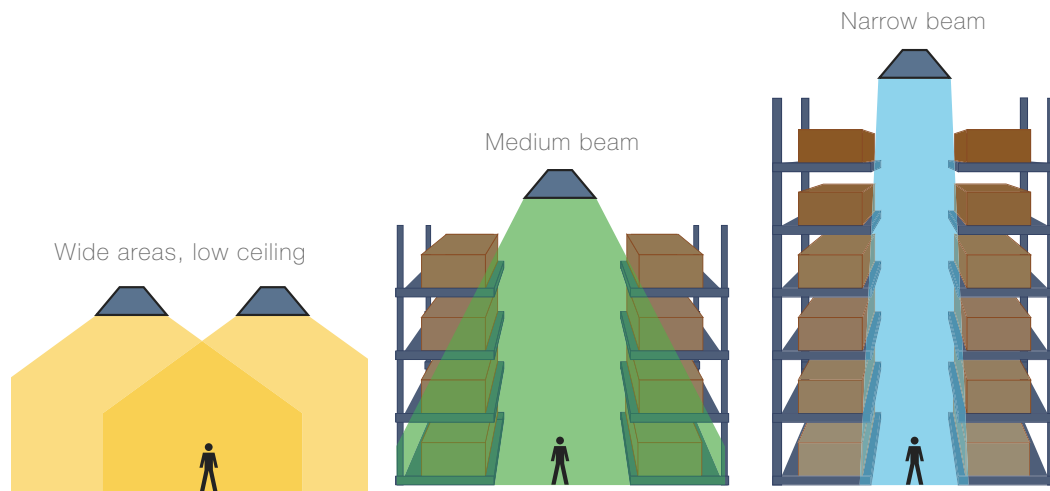


☺ Very accurate specular material: Beams reflect without scattering

APPLICATION EFFICIENCY / BEAM CONTROL

Goal: Eliminating wasted light in the application, drives further efficiency.

Most lighting manufacturers offer a generic, one-size-fits-all fixture that can provide up to 50% energy savings. Westinghouse Lighting Solutions delivers lighting systems that are optimized for savings, given a specific facility. By creating a unique, application-specific system for each facility, Westinghouse has delivered savings up to 75% AND improved light levels (15-25% over anything a competitor can offer).



END RESULT

Goal: More Foot-Candles for less watts — true efficiency.



TIGHT BEAM CONTROL

2 lamp 117w fixture mounted at 33' on 36' centers.

You can see where the aisles will be prior to rack assembly—notice the accurate beam control.



Competitor Demo
10 foot candles at floor



☺ Demo/using narrow beam
21 foot candles at floor

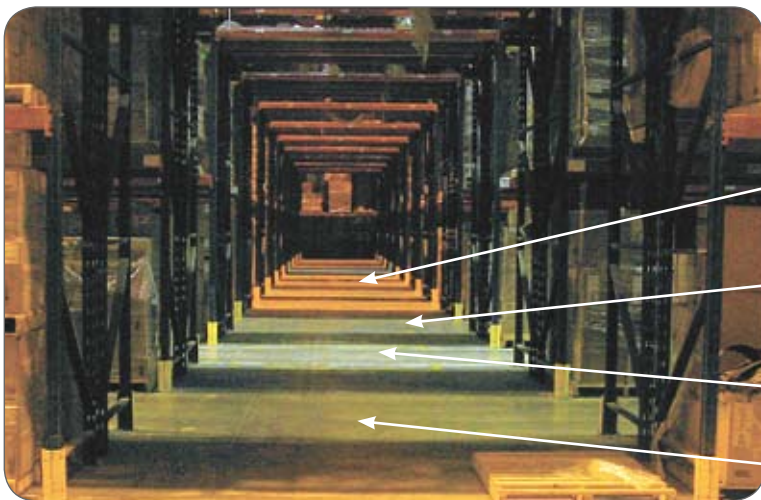
SAME WATTAGE TWICE THE LIGHT!

Notice the sharp cutoff angles vs. the competitors.

Westinghouse = 21 foot candles

Competitor aisle = 10 foot candles

Better control translates into less energy by eliminating wasted light.



(Existing foreground at 46' mounting) - 465 Watt/HiD System

SAME LIGHT HALF THE WATTAGE!

Half the energy for the same light, 46 ft. mount height.

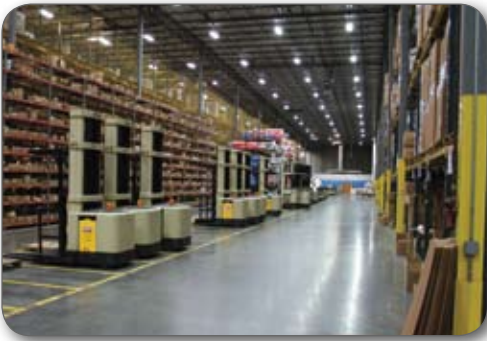
| | | |
|----------------|----------|--|
| Competitor | 226 Watt | Their 6 lamp T8— 6 footcandles |
| ☺ Westinghouse | 117 Watt | Our 2 lamp T5HO Narrow Beam — 11 footcandles |
| ☺ Westinghouse | 234 Watt | Our 4 lamp T5HO Narrow Beam — 24 footcandles |
| Competitor | 234 Watt | Their 4 lamp T5HO Cookie Cutter — 12 footcandles |



SUNNY DELIGHT (Food Processing)

Case # 00600-08

| | |
|-----------------------|-----------|
| Monthly KwH Savings | 63% |
| Annual Energy Savings | \$160,622 |
| Utility Incentive | \$36,450 |



WEST MARINE (Distribution)

Case # 00606-08

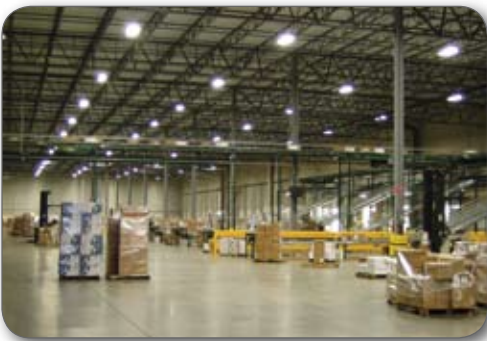
| | |
|------------------------------|-------------|
| Payback | < 13 months |
| Annual Energy Savings | \$151,000 |
| 23% Compounded Annual Return | |



ACE HARDWARE (Distribution)

Case # 00617-07

| | |
|--------------------|-----------|
| Annual Savings | \$120,154 |
| 70% Energy Savings | |



SEA GULL LIGHTING (Distribution)

Case # 00919-07

| | |
|---|----------|
| Annual Savings vs. Metal Halides | \$80,000 |
| Annual Savings vs. T8 Fluorescent System | \$26,000 |



CSX LOCOMOTIVE SHOP (Maintenance)

Case # 00616-07

65% Energy Savings with 8 lamp fluorescent high bay
46' mounting height required
Westinghouse precision optics



Westinghouse Lighting Solutions meets the specified foot candle levels using less energy and fewer lamps than any other manufacturer.

The choice is not T5 or T8,
the choice is which is the better investment.

HELPFUL INDUSTRY TERMS

Industrial lighting Glossary

A **ADA** – Americans with Disabilities Act as it relates to lighting products requires that wall mounted lighting (sconces) not extend more than 4" from the wall unless positioned over a certain height.

AMPERE (AMP) – Standard unit for measuring the strength of an electric current defined as rate of flow of charge.

ANSI – American National Standards Institute. The coordinator of standards, including lighting standards, on a national level. It is composed of trade organizations, technical societies, professional groups, consumer organizations, as well as company members.

ARC TUBE – A tube in which a current traverses a gas between two electrodes.

ASHRAE – American Society of Heating, Refrigeration, and Air Conditioning Engineers sets guidelines regarding energy usage and system design.

B **BALLAST** – Electrical device used with fluorescent and high intensity discharge lamps to provide the necessary starting and operating power conditions.

BALLAST CYCLING – The ballast turning lamps on and off (cycles) due to the overheating of the thermal switch inside the ballast. This may be due to lamp misapplication, improper voltage, high ambient temperature, or the early stage of ballast failure.

BALLAST, COLD WEATHER – A ballast designed to provide sufficient starting voltage for fluorescent lamps in cold weather, generally down to 20° F.

BALLAST, DIMMING – A ballast which when used together with a dimmer control will vary the light output of a lamp.

BALLAST, ELECTRONIC – A ballast made of electronic components to start and operate the lamp.

BALLAST COVER – A component installed to cover ballast and wiring also referred to as a channel cover or wireway cover.

BALLAST EFFICIENCY FACTOR (BEF) – The ballast factor divided by the input power of the ballast. The higher the BEF, the more efficient the ballast.

BALLAST FACTOR (BF) – A light loss factor applied to lighting calculations for fluorescent lamps. Lamps operated by a ballast with a BF of 0.90 will provide 90 percent of their rated light output (lumens). BFs between 0.85 and 1.0 are the most common.

BALLAST, MAGNETIC – A ballast using a core and coil transformer to start and operate the lamp.

BI-LEVEL SWITCHING – A fixture or string of fixtures set up to operate at two levels, which usually switch half the lamps off based on programming a sensor, timer or 2nd circuit.

C **CANDELA** – A unit of luminous intensity.

CANDLEPOWER – The luminous intensity of a light source expressed in candelas. Candlepower is a measurement of light intensity. It is used as a measurement of beam intensity at various angles from reflector lamps or fixtures.

CHANNEL – A fluorescent fixture composed of only a wireway and cover to hold the ballast and sockets. Also called a strip light.

CLASS "P" – A safety feature that switches the ballast off if the ballast case temperature rises above 105° F.

COEFFICIENT OF UTILIZATION (CU) – A percentage commonly applied to indicate the efficiency of a luminaire determined by room size and mounting height.

COLOR RENDERING INDEX (CRI) – A measure of the color shift created by artificial light. Color rendering is measured on a scale from zero to 100, with natural outdoor light having a CRI of 100. The higher the index, the more true to life colors appear.

COLOR TEMPERATURE – Expressed in degrees Kelvin, color temperature indicates the color of a light source. For example, incandescent lamps are approximately 2700° Kelvin (K°) and appear yellowish. Fluorescent range from 2700° Kelvin up to 7500° with those at the high end appearing blue-white, or "cool". Rather than being the physical temperature of the light itself, the Kelvin number refers to the color a theoretical "black body" would be if heated to that temperature.

COMPACT FLUORESCENT – A small fluorescent lamp that is often used as an alternative to incandescent lighting. The lamp life is about 10 times longer than incandescent lamps and is 3-4 times more efficacious. Also referred to as PL, DL, CFL, or BIAH lamps.

CONDUIT – A metal tube or pipe used as an enclosure to protect wires.

CONSTANT-WATTAGE AUTOTRANSFORMER (CWA) – A common type of ballast used for HID lamps which maintains constant power wattage to the lamp when input voltage fluctuates.

[Glossary continued on back page](#)

D **CONTRAST** – The relationship between the brightness of an object and its surroundings.

CORD SET – Electrical cord which is wired to a fixture. See also Whip

CSA – Canadian Standards Association is similar to UL. Dual listing is available with both entities as either cUL or CSA/US making products acceptable throughout North America.

CUTOFF ANGLE – The angle from vertical at which a reflector, louver, or other shielding device cuts off direct visibility of a lamp.

DAMP LOCATION FIXTURES – Fixtures suitable for areas that do not come in direction contact with water, including partially protected canopies and overhangs.

DISTRIBUTION CURVE – A graphic representation of candela values.

DISABILITY GLARE – Bright light that impairs vision also known as veiling luminance.

DISCOMFORT GLARE – Glare that is uncomfortable and distracting, yet less obvious than disability glare.

E **EFFICACY** – A non-linear relationship of efficiency. For instance, lumens per watt, miles per gallon, etc.

ENHANCED ALUMINUM REFLECTOR – Highly polished reflectors designed to control light and improve efficacy.

EPACT 2005 – Energy Bill passed by Congress designed to reduce energy consumption through product regulation and incentive programs.

F **FIXTURE** – Any type of luminaire.

FIXTURE SCHEDULE – A form that lists all luminaires used on an installation. The list typically includes all the fixture types and quantities.

FLOODLIGHTING – A type of outdoor lighting commonly used in parking lots or sports fields

FLUORESCENT LAMP – A light source consisting of a tube filled with argon, along with krypton or other inert gas. When electrical current is applied, the resulting arc emits ultraviolet radiation that excites the phosphors on the inside of the lamp wall, causing them to radiate visible light.

FOOTCANDLE (FC) – A unit of direct illumination; the amount of light produced by one candela on a square foot of surface, every part of which is one foot from the candle. A lumen per square foot.

FOOTCANDLE, MAINTAINED – Illumination level calculated using light loss factors, including lamp lumen depreciation (LLD), luminaire dirt depreciation (LDD) and other factors which reduce the light levels.

FUSE – An electrical safety device which will break the circuit in the event of a current overload.

G **GASKET** – A device used to form a seal to limit light leaks or the penetration of dust, water, oil or other contaminants.

GLARE – The effect of brightness or differences in brightness within the visual field, sufficiently high to cause annoyance, discomfort or loss of visual performance.

H **Harmonics (THD)** – Most electronic ballasts provide reduced harmonics providing <10% power quality distortion.

HID – High Intensity Discharge. Generic term used to describe mercury vapor, metal halide, high pressure sodium, and (informally) low-pressure sodium light sources and luminaires.

HIGHBAY – Typically pertains to general warehouse lighting which is 15' or higher.

HIGH OUTPUT (HO) – A lamp designed for use with an 800 milliampere (MA) ballast; will usually operate at low temperatures (down to zero) while still producing high light levels.

HIGH PRESSURE SODIUM – A high-intensity discharge (HID) lamp whose light is produced by radiation from sodium vapor (and mercury).

HOUSING – The body of the fixture that holds the electrical and decorative components.

I **IALD** – International Association of Lighting Designers.

IBEW – International Brotherhood of Electrical Workers.

IES (IESNA) – Illumination Engineering Society of North America.

ILLUMINANCE – A photometric term that quantifies light incident on a surface or plane. Illuminance is commonly referred to as light level. It is expressed as lumens per square foot (footcandles), or lumens per square meter (lux).

INDUSTRIAL – A strip light with an attached reflector.

INSTANT-START – A light source that will start from a high voltage with no preheating of the electrodes. Instant-start lamps cannot be interchanged with rapid-start lamps.

ITL – Independent Testing Laboratories. Lighting manufacturers use this laboratory to conduct photometric tests for luminaires.

K **KNOCKOUT (KO)** – A portion of the metal enclosure which has been partially cut out. It can be easily removed to attach wires, convenience outlets, conduit fittings, etc.

L **LAMP** – Industry term for commercial light bulb.

LAMP LIFE – Rated life of a lamp, as established through laboratory testing during which a sample group of lamps is burned, including being subjected to a scheduled number of starts per day. The length of time required for half the lamps to fail is the rated lamp life.

LAMP LUMEN DEPRECIATION (LLD) – Mean lumens divided by initial lumens.

LAY-IN TROFFER – A fluorescent fixture, which lays into a grid ceiling. Nema type G.

L.E.D. – (Light Emitting Diodes) Efficient lamp features extended life and environmental benefits.

LENS – Cover for the face of a lighting fixture; diffuses or focuses light passing through it and protects internal components. Also called "refractor" or "diffuser". Usually made of glass or acrylic, clear or prismatic.

LIGHT LOSS – Used to calculate or project lighting system performance after a given period of time under certain conditions; takes into account variations in temperature and voltage, dirt, lamp depreciation and maintenance. Also called "maintenance factor".

LOWBAY – Typically for mezzanine lighting which is 15' or lower.

LOW PRESSURE SODIUM LAMP – Lamp where arc is passed through gaseous sodium producing monochromatic light (589-589.6 nm).

LPD – Lighting Power Density is a calculation derived by multiplying the number of fixtures by input watts and dividing by the square footage of the space. This calculation is commonly used in lighting system comparisons

LUMEN (LM) – Unit of measure for the flow of light; expresses the total quantity of light given off by a source regardless of direction. Defined as the amount of light falling on a surface of one square foot, every point of which is one foot away from one-candlepower sun.

LUMINAIRE – A complete lighting unit consisting of a lamp or lamps, along with the parts designed to distribute the light, hold the lamps and connect the lamps to a power source. Also called a fixture.

LUMINAIRE EFFICIENCY – Light that comes out of the fixture. See chart.

LTL – Luminaire Testing Laboratory. Lighting manufacturers use this laboratory to conduct photometric tests for luminaires.

MASTER/SATELLITE – Labor-saving, factory-installed wiring option in which ballasts are shared by two luminaires to reduce installation labor. The master unit contains a ballast that provides power to some or all of the lamps in the satellite unit. (Formerly Master/Slave).

M **MEDIUM BEAM** – Light fixture with a medium beam designed for aisles, open industrial, or retail space usually mounted from 22' to 40'.

MERCURY VAPOR LAMP – A type of HID lamp in which the major portion of the light is produced by radiation from mercury vapor. Emits a blue-green cast of light. Available in clear and phosphor-coated lamps.

METAL HALIDE – A type of HID lamp in which the major portion of the light is produced by radiation of metal halide and mercury vapors in the arc tube. Available in clear and phosphor-coated lamps.

MOUNTING HEIGHT – The distance from the bottom of the fixture to the floor.

MULTI-LEVEL SWITCHING – A system with the ability to switch multi-lamp fixtures in such a way as to provide two or more levels of light.

MULTI-TAP BALLAST – A ballast designed to operate on more than one supply voltage.

N **NADIR** – The point directly below the luminaire (0° angle)

NAED – National Association of Electrical Distributors.

NAILD – National Association of Independent Lighting Distributors, an organization supporting lighting distributors in the US with publications, training, and conferences.

NARROW BEAM – Light fixture designed to produce a narrow beam of light similar to a spot light.

NEC – National Electrical Code. The document compiled by the National Fire Protection Association to provide guidelines for installation and application of electrical equipment.

NEMA – National Electrical Manufacturers Association, the leading trade association in the US representing the interests of electroindustry manufacturers and providing a forum for standardization of electrical equipment and input into laws and regulations regarding electrical products.

NEMRA – National Electrical Manufacturers Representatives Association, an organization promoting the use of independent manufacturers representatives as the most effective method to market electrical products.

NLB – National Lighting Bureau, a non-profit industry and government sponsored US lighting information source, focusing on the benefits of quality lighting.

O **OCCUPANCY SENSOR** – A device that is preprogrammed to dim, shut off, or turn on a fixture or string of fixtures when a person enters or leaves a designated area. Occupancy Sensors can be designed to detect motion or heat (IR).

ONE FOR ONE – Terminology used when retrofitting or replacing a lighting system utilizing the same wiring and mounting location as the existing system.

OPEN-CIRCUIT VOLTAGE – The voltage applied across the output terminals of a ballast when no load is connected.

P **PENDANT** – A method of hanging luminaires.

PHOTOCCELL – A light-sensing device used to control luminaires and dimmers in response to detected light levels.

PHOTOMETRIC LAYOUT – A chart or model of light levels generated by an array of fixtures or lamps usually computer generated.

PHOTOMETRY – Numeric or graphic representation of light output of a light source.

PREHEAT – Refers to smaller fluorescent lamps systems that use a "starter" to warm the lamp electrodes, causing a delay before lamp produces light.

PRISMATIC LENS – Lens with a pattern of pyramid-shaped refracting prisms on one side used to distribute the emitted light.

R **RAPID START** – An instant on fluorescent lighting system that does not use a starter. Electronic ballasts may also feature programmed start for soft instant on in frequent switching areas.

REFLECTOR – A piece of glass or metal, usually concave, with a reflective surface that directs radiant energy in a desired direction.

REFRACTOR – A translucent or transparent "lens" or "diffuser" that changes the direction of the light.

RESTRIKE TIME – The time required for a lamp to start after a power interruption. Some HID lamps need up to 11 minutes to restrike.

ROTARY LOCK LAMP HOLDER (Also see SOCKET) – A common socket type for European style T5 and T8 fixtures.

S **SOCKET** – Electro-mechanical connection in the fixture for the lamp.

SOCKET, MOGUL BASE – A 39 mm socket commonly found in high wattage incandescent and HID lamps.

STRIP FIXTURE – See CHANNEL.

T **T5 LAMP** – Fluorescent lamps that are 5/8 of an inch in diameter.

T8 LAMP – Fluorescent lamps that are 8/8 or 1 inch in diameter.

T12 LAMP – Fluorescent lamps that are 12/8 or 1.5 inches in diameter.

TAMPERPROOF SCREW – A special screw used to prevent vandalism.

TANDEM INLINE WIRING – Fixtures wired together in pairs so they can share ballasts.

TROFFER – A long, recessed luminaire usually installed with the opening flush with the ceiling.

U **UNDERWRITERS LABORATORIES (UL) INC.** – An independent organization whose responsibilities include rigorous testing of electrical products. When products pass these tests, they can be labeled (and advertised) as "UL listed." UL tests for product safety only.

ULTRAVIOLET (UV) – Radiant energy between 10 and 380 nanometers in wavelength, beyond the violet end of the visible spectrum. Typically used in ozone-producing light sources (120-220 nanometers), germicidal lamps (220-300 nanometers), and "black lights" (320-400 nanometers).

V **VANDAL RESISTANT** – Fixtures made of materials designed to withstand shock or methods of vandalism.

W **WALLWASHER** – A fixture used to illuminate vertical surfaces from ceiling to floor.

WATT – The unit of power consumption or use; one watt (w) is equal to one ampere of current flowing through one ohm of resistance.

WET LOCATION FIXTURE – Fixtures designed to come in direct contact with water.

WHIP – A prewired cable assembly attached to the fixture to aid in installation.

WIDE BEAM – Light fixture designed to light wide open areas, mounted 18' to 30'

WIREGUARD – An assembly made of heavy gauge wire to protect the housing or lamps from breakage.

WORK PLANE – The level at which work is done and at which illumination is specified and measured.