THE ULTIMATE SOLUTION FOR DRIVING RANGE AND COURSE LIGHTING

GOLF-BRIGHT™

MAGNETIC INDUCTION LIGHTING

Overview –

Night lighting is the lifeblood of most driving ranges and is rapidly being adopted to extend hours of play on courses, too. New Golf-Bright™ technology reduces electricity consumption by up to 85% over conventional metal halide fixtures and eliminates serious problems associated with popular LEDs that include high glare and "strobe effect" due to rapid flicker. One 300-watt Golf-Bright™ lamp can replace a 1200-watt metal halide with better overall illumination. For the first time, golfing facilities can use lighting specifically designed to track flight by matching spectral frequency to reflective properties of golf balls in motion. At the same time, Golf-Bright™ employs nano-particle full diffusion reflectors to overcome glare and light pollution. This is a major consideration as more localities adopt "Dark Sky" ordinances and "light encroachment" rules and regulations. Light pollution from driving ranges has become a political and logistical nightmare for many operations.

With a 100,000 hour lifecycle, Golf-Bright™ can reduce maintenance costs by 600% over conventional metal halide, halogen, and 400% over LEDs. The wide dispersion Golf-Bright™ light source allows direct viewing without danger to the eye. Rapid light dissipation from the fixture and the unique VARiBEAM® focusing technology can eliminate sky shields and permit proper illumination of balls in flight.

There is a science to lighting golfing facilities that requires very specific designs for this highly specialized application. Until now, owner/operators were forced to adopt generic flood lights. Golf-Bright™ technology represents an evolutionary step forward.

The Science of Golf Lighting –

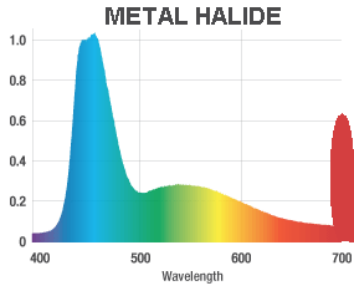
Resolving a fast-moving small white ball against a dark sky requires very specialized lighting that is absent from driving ranges and evening courses. The most frequent complaint customers express about nighttime golf is that they can't see the ball. If you can't see the ball, the experience is wasted. The objective is to provide the best visual tracking using the *least amount of light*. Golf-Bright™ lighting systems are specifically designed to solve modern lighting challenges that include Dark Sky compliance, high energy efficiency, low maintenance, and maximum visual results.

Key elements include:

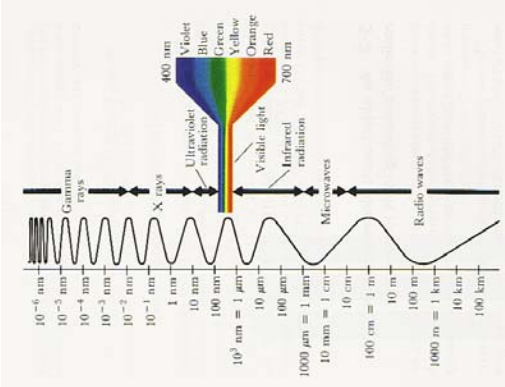
- Spectral output and Color Rendition Index (CRI)
- Light distribution
- Light diffusion
- Flicker (strobe effect)
- Energy efficiency
- Life cycle
- Hazardous materials (haz-mat) exposure

Spectrum –

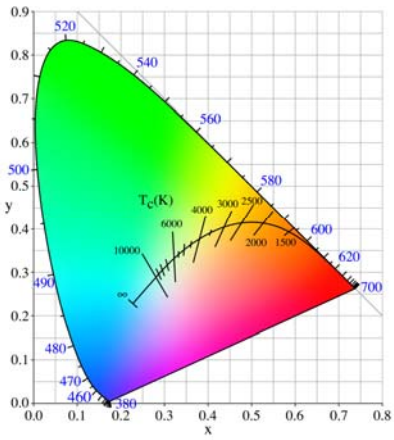
The fact is that all current golf range lighting is generic. This means that non-specific conventional high intensity discharge (HID) flood lights are used. These include metal halide, high pressure sodium, mercury vapor, and halogen. Driving range lighting is usually generic flood lighting consisting of 1000-watt to 1500-watt metal halide fixtures. These lamps are extremely hot and emit a high spectral bias in the upper red and ultra-violet ranges. The spectral bias does not emphasize colors that are most sensitive for the human eye. Light produced in the high sensitivity range is referred to as "visually effective lumens" (VELs). This means that despite high light levels (lux output), the actual visual experience is limited.



The human eye sees in a very narrow band of the electromagnetic spectrum from approximately 420 nanometers (nm) to 750nm. Within this range, maximum sensitivity begins near 520nm and extends to 650nm. An object's color is determined by the light spectrum it reflects. Thus, green grass will reflect green light in the range from 540nm to 560nm. The two reflective extremes are black that absorbs all wavelengths and white that reflects all wavelengths. For a driving range or golf course, we deal with a white ball arcing into a black sky

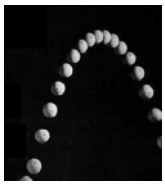


and falling to a green surface. The right light for illuminating this activity must produce a high contrast between the white golf ball in flight and the dark sky. It should also contrast the ball against the grassy surface when it lands. A generic HID lamp will not produce optimum results and new LEDs are also subject to spectral bias that is not appropriate for the golfing application.



All lighting is measured for intensity and "color temperature." Intensity is the number of lumens while color is the spectral hue. In lighting, color temperature is measured in Kelvin and has a highly technical foundation. In simple terms, higher Kelvin produces a "cooler" or more whitish light. Lower Kelvin is considered "warmer" or more orange. In addition to these measurements, light can be monochromatic if it displays a high spectral bias in a narrow range like the orange light produced by sodium lamps. Golf-Bright™ lighting uses a proprietary spectrum that accentuates golf balls while in flight and when resting on the green landing surface. As the Kelvin diagram illustrates, ideal color rendition should be between 6,000K and 10,000K. Typical golf range lighting using metal halide falls below 5,000K. LEDs can be as high as 6,500K, but LED floodlights are usually between 4,500K and 5,000K. By comparison, Golf-Bright™ ranges above 10,000K with particular emphasis in the green/yellow output with a fluorescing component in blue as well. It is a very white light associated with bright sunlight from the northern exposure in the northern hemisphere.

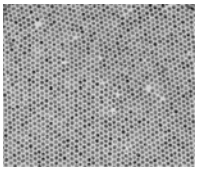
The Golf-Bright™ spectrum uses very precise LUMENTEC® tuning to achieve an astounding contrast. Golf balls have the resolution of "tracer bullets" without the trail. The frequencies match spinning properties and the light uniquely reflects from the surface contours. When using LEDs, the same trajectory and ball will appear to have more than one location due to strobe effect. This can confuse perception of the flight and lose the location. As a golf ball spins, the indentations can reflect light from changing angles at the rate of spin. With conventional lighting and LEDs, the reflection can cause the ball to appear blurry.



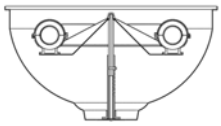
Golf-Bright™ fixtures have a very high color rendition index above 95. This means colors appear truer and are more easily distinguished. By comparison, metal halide lamps and LED floods may have up to 80 CRI. Sodium registers less than 50 CRI. This is an important consideration for achieving color contrast between the golf ball and surrounding areas. The high Golf-Bright™ CRI makes range markers more visible and identifiable.

Distribution and Diffusion –

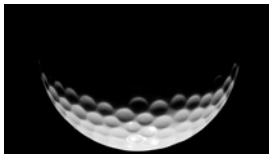
One of the most important considerations for golf illumination is the ability to evenly distribute and diffuse light from the source. To achieve these mutually beneficial goals,

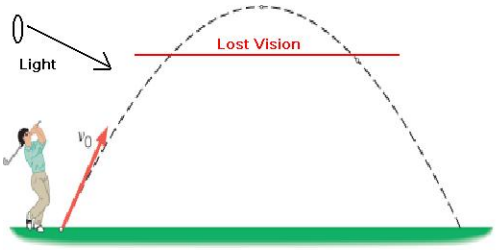


Golf-Bright™ technology uses a nano-particle reflective coating with an index exceeding 90. The millions of nano-particles are aligned to diffuse light rather than create a directly focused beam like standard floodlights. The result is even light distribution across the intended target. Equally important, diffused light dissipates with distance to avoid light encroachment. The fully diffused Golf-Bright™ illumination carries to the end of the field, but quickly fades with distance. This allows Golf-Bright™ technology to comply with Dark Sky ordinances. The nano-particle reflector also increases lumen output from fixtures by up to 20%.



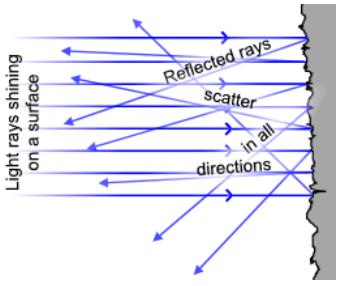
Golf-Bright™ fixtures incorporate an ingenious focusing technology called VARiBEAM® that changes the focal length of the fixture and eliminates the need for sky glow shields. The bulb mounting and interior reflector can be moved within the lamp housing to change the angle of light distribution while eliminating glare from the leading edge of the fixture. Thus, the lamp housing acts as its own sky glow shield. At the same time, VARiBEAM® permits light to extend upward along the ball trajectory. When sky glow shields are used with conventional floodlights, the illumination field is truncated causing lost vision. Typically, driving range lights are pointed downward in addition to having shields. This has the effect of intensifying light at the tee and dropping the field of view within a very short distance… a low as 50 yards. This type of lighting may be sufficient for ground illumination, but it fails to address the way ball sports are played. Conventional floodlights with shields cause problems for baseball and even football because the sky view is eliminated or highly compromised. For driving ranges, shielded lights can distort the ball appearance by bottom lighting. Half of the image disappears because of the angle of the shielded light.





Golf balls travel fast. The typical drive off a tee travels between 60mph and 150mph, with maximum measurements as high as 200mph. The highest theoretical velocity is estimated at 211mph and depends upon all the components from the driving force to the ball composition and construction and even wind velocity and altitude. As the ball arcs from the tee, it gains altitude that is often beyond the illumination field. This is more the case when sky shields are used to prevent light from migrating upward. The result is that the ball disappears from the visual scope.

Golf-Bright™ illumination leaves the leading edge of the fixture and immediately spreads out. The further the spread, the greater the diffusion. The VARiBEAM® adjustment allows you to control the amount of light and distance it will travel. When properly adjusted, Golf-



Bright™ imitates diffused daylight. Keep in mind that sunlight is the ultimate diffused light source. During the day, entire areas are indirectly illuminated by reflected and diffused sunlight. Rays are scattered in all directions after bouncing off multiple and varied surfaces with different reflective properties. This is how Golf-Bright™ technology achieves maximum effectiveness with less power and glare. Diffused light provides uniformity while having the added advantage of controlled dissipation. This means that a field of diffused Golf-Bright™ lighting can be created to illuminate within the intended area (property line). As light moves away from the intended site, it quickly fades to avoid disturbing neighboring properties.

In addition to diffusion technology, the Golf-Bright™ bulb has a large footprint which means that the light source is less concentrated at the source. This is an important feature because it allows the fixture geometry to disperse light more effectively. While the lumen output is high, you can look directly at a Golf-Bright™ fixture without the discomfort you would experience when viewing a metal halide lamp. High intensity light sources like HID and LED can cause eye damage as well as discomfort.

Intensity and Glare –

In the May 13, 2013 edition of *Live Science,* Assistant Editor Marc Lallanilla reported on the research of Dr. Celia Sánchez-Ramos of Complutense University (Madrid, Spain) regarding potential dangers of directly viewing unshielded LED lighting. Simply put, the intense concentrated light of LEDs can permanently damage the retina, causing blind spots and color de-sensitivity. As the installed base of LEDs rapidly expands, more and more emphasis is being placed upon health risks associated with directly viewing LEDs. In fact, the problem has become sufficiently serious for CREE, one of the largest LED lighting manufacturers, to issue its own warning white paper.

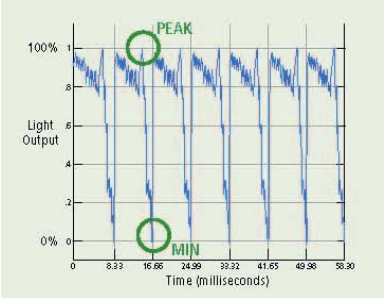
The high glare and intensity of LED flood lighting is not good for driving ranges and courses. Aside from dangers to the eye, LEDs generate narrow focal patterns and infringe upon neighboring properties. The light cannot be as easily controlled to avoid light pollution. While some facilities have installed LED lighting, the facility managers now face a tradeoff between their energy efficient LED fixtures and potential liability associated with *eye-damage claims*. There is concern that children may fixate on outdoor LED lighting, causing serious permanent retinal damage. The most serious problem stems from high intensity ultraviolet and near-ultraviolet light as well as the small footprint of individual LED components. The uneducated public may have a propensity to admire an LED fixture. In the process, eye damage can occur.

Flicker and Strobe Effect –

One of the greatest lighting challenges deals with mid-frequency flicker. Because we use alternating current (AC) in the United States, conventional lighting experiences fluttering at the same frequency as the electric cycle or hertz. This results in a 60 cycles per second

to 120 cycles per second flicker. For metal halide, the light experiences a modest vibration. For LEDs, the intensity is much greater because the diode loses energy and drops significantly. Flicker literally stops the visual perception of action. This is the principle behind the strobe light that can capture still pictures of objects in motion. For tracking golf balls, a 60 cycle per second flicker removes 0.7333 feet of visual perception from an object moving 30mph, or 44 feet per second. That would be a chip shot made with a sand wedge. Driving a ball off the tee at 150mph (220 feet per second) experiences a loss of 3.666 feet of visual perception per second. That is more than a yard for every second the ball travels at high velocity. Perception becomes more confusing as the ball slows down because the brain must adjust for the changing strobe effect. This is why it is so difficult to track a golf ball at night under conventional lighting or LEDs.

Strobe effect has been linked to major disorders that include strobe epilepsy, mood swings, sleep disruption, seasonal affective disorder (SAD), confusion, headaches, hypnotic effect, nervousness, concentration problems, and more. The problem is increased by the amount and intensity of exposure as well as the flicker rate and drop-off. This represents a serious deficiency in popular new LED lights because of the intensity of the flicker. Many manufacturers have resorted to using drivers (ballasts) that double the AC cycle rate from 60 to 120 hertz. Although 120cps may be beyond conscious visual cognition, the brain can detect light flashes at 1000th of a second. For LED floodlights, the peak to trough is dramatic. This is not good for visualizing action at a driving range or on a golf course. Flicker can even disturb a game of miniature golf.



Golf-Bright™ fixtures use magnetic induction bulbs that do not flicker. Light is activated by alternating magnetic fields that spin atoms within a tube. The faster the cycle, the more consistent the spin. Proprietary Golf-Bright™ drivers (ballasts) operate at frequencies exceeding 250,000 cycles per second. There are no electrodes to vibrate or carry the alternating current rate to the light being emitted. No other lighting is more flicker-free.

Environmentally friendly –

Increasing environmental concerns have been addressed by Golf-Bright™ technology. For example, drivers (ballasts) are silent to avoid disturbing nocturnal wildlife like bats and canines. Since bats navigate using sound, making Golf-Bright™ silent was a key element in the design. The diffused light is also less likely to disturb other wildlife including owls and deer. All these features are increasingly important as environmental regulations become more strict and broad.

An added advantage is the elimination of loud buzzing often present in metal halide ballasts that can be highly distracting. Conventional lighting can hum, buzz, and even emit high pitch noise. Golf-Bright™ fixtures are silent to comply with noise pollution guidelines.

Efficiency –

From an operations standpoint, efficiency is paramount. This is where Golf-Bright™ lighting truly excels. A 300-watt Golf-Bright™ fixture can replace a 1200-watt metal halide, saving more than 75% when adding ballast overheads. For miniature golf courses, managers can replace 150-watt fixtures with 60-watt Golf-Bright™ and 400-watt conventional lighting with 150-watt Golf-Bright™. You can usually receive generous rebates and incentives for replacing conventional lighting with Golf-Bright™ fixtures.

Golf-Bright™ lights go on and off instantly with no extended warm-up period. There is no need to cool down Golf-Bright™ lamps before turning them on. Temperature does not impact performance as it does for HID and fluorescent lighting. Golf-Bright™ lights operate effectively from negative 40 degrees to positive 140 degrees. The fixtures generate just enough heat to melt snow and ice, but are safe to the touch at all times.

Maintenance and Safety –

With a 100,000 hour life cycle, Golf-Bright™ lights will last eleven years if they are on continuously 24 hours by 365 days. In fact, Golf-Bright™ lighting is the longest lasting of any commercially available lighting, regardless of cost. This saves more than 600% in maintenance over conventional metal halide lighting and 400% over the longest rated LEDs. Golf-Bright™ lights maintain the same performance level (lumen output) over 90% of their lifecycle. This means top performance from the day of installation until the end of the lifecycle.

Even with the extraordinary lifespan of Golf-Bright™ there are concerns about disposal and recycling. Unlike mercury vapor or fluorescent lamps, there is no dispersed mercury in Golf-Bright™ fixtures. Instead, Golf-Bright™ incorporates a solid mercury amalgam similar to the material used by dentists to fill teeth. Since there is no dispersed mercury in Golf-Bright™ bulbs, all that is needed is to clip the solid mercury from the bulb and recycle it. The rest of the bulb can be disposed of as regular metal and glass. There is no hazardous material (haz-mat) problem associated with Golf-Bright™ and no special and costly clean-up procedure if a Golf-Bright™ bulb should happen to break. Golf-Bright™ bulbs are not pressurized and will not explode. There is no vacuum or dangerous gas in the Golf-Bright™ bulb. It will not implode.

The Ultimate Solution –

The Green Movement has changed the way we think about energy cost and sustainability. From energy conservation to environmental concerns like light pollution and hazardous materials… golfing establishments face new challenges. The goal in meeting these new

challenges is to achieve the obvious objectives of saving energy and lowering maintenance cost while *improving* the environment for customers. New Golf-Bright™ fixtures provide cutting edge lighting that saves more than 75% in energy over conventional HID lighting, lowers maintenance by up to 600%, and gives your customers the absolute best experience under any light… period.

A full line of lamps from 300-watts down to 60-watts is available. From the driving range to parking lot illumination… from miniature golf to putting greens… there is no better lighting solution at any price. When you illuminate your facility with Golf-Bright™ lighting, customers see and feel the difference. Golf-Bright™ builds customer loyalty because the experience is so much better than playing under generic lighting or LEDs.

If you want to save money and build business, Golf-Bright™ lighting is an obvious and highly effective choice. In many cases, retrofitting using Golf-Bright™ can save enough to pay for the complete installation within less than two years. Of course, the speed of payback will depend upon your electricity rate.

Since Golf-Bright™ lighting is super efficient, most utilities offer rebates and other incentives when the switch is made. Programs include cash rebates and even reduced electric charges. There are also state and federal programs for implementing energy efficient lighting.

Find out how Golf-Bright™ can improve your operations, customer experiences, and bottom line. Ultra-Tech™ Lighting even has specialized fixtures for club houses and pro shops. Shop-Bright™ lighting uses a unique Health-Bright™ spectrum that is actually more healthful and can improve sales. Contact your representative today!

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60-Watt Flood

150-Watt Flood

300-Watt Flood