PRESENTING
ART-BRIGHT™
LIGHT SPECTRALLY TUNED FOR MUSEUMS, GALLERIES, AND EXHIBITIONS

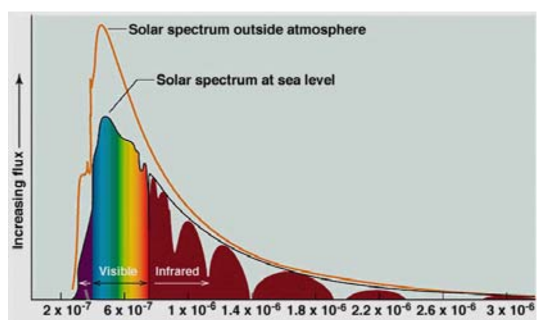
Overview –

Light is the single most important element of displaying any object. From paintings and photographs to artifacts and displays, art is light and lighting is an art. From any perspective, the most perfect light is fully diffused sunlight containing the most balanced spectrum within the eye's visual range. This is why optimal gallery design maximizes daylighting. However, even sunlight has significant drawbacks that include excessive ultraviolet (UV) spectrum and radiant heat. As the sun moves through the day, the spectral range significantly changes, altering the appearance of colors, contours, and reflective surfaces. Curators must avoid positioning sensitive artwork or objects where they can encounter direct sun.

The objective of artificial lighting is to mimic indirect sunlight and eliminate negative features like UV, heat, and spectral bias. Unfortunately, many museums and galleries have design conflicts between décor and displays. Warm light may be appropriate for illuminating floors, ceilings, and furnishings, but completely wrong for resolving colors and textures within a painting, photograph, or sculpture. Art-Bright™ technology is a synergistic lighting "system" that combines spectrally tuned magnetic induction bulbs and ballasts with ultra-reflective full diffusion nano-coatings to provide the truest representation of illuminated objects.

The Science of Lighting Art –

Since all art experiences are subjective, avoiding spectral bias is critical. This means any artificial light source must present a "full spectrum" as close as possible to indirect sunlight. This is frequently referred to as "northern light" and is most widely known in the diamond industry as the optimal source for viewing gem stones. Northern light is totally "reflective" and diffused. There are no "hot spots" of greater intensity or "sags" that present spectral voids or shadowing.

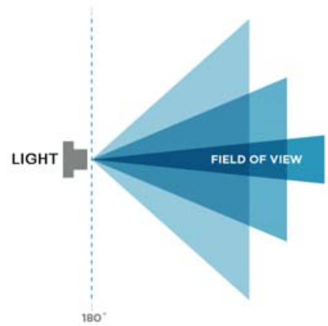


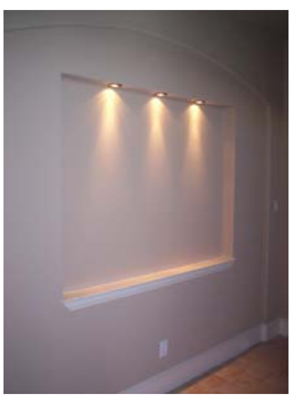
The natural "full spectrum" of solar radiation displays a blue bias associated with "cool" light. Most artificial light does not provide a full spectrum.

With the exception of tubular fluorescent, virtually all artificial indoor lighting has relied upon a singular intense light source (the bulb) and reflector geometry that disperses the source over a particular pattern; the photometric profile. Museums, galleries, and exhibition halls use a mixture of direct illumination and general lighting. Specific sources include incandescent, fluorescent, high intensity discharge (HID) and light emitting diode (LED). Within the HID category are halogen, metal halide, high pressure sodium (HPS), low pressure sodium (LPS) and mercury vapor (MV). Today's decision is narrowed down because certain technologies like incandescent and mercury vapor are being eliminated by law while monochromatic sources such as sodium-based lighting would never be appropriate for interiors. The majority of interior lighting is now fluorescent, halogen, metal halide (MH), and newly developed LED. Each of these suffers from shared and specific drawbacks. Magnetic induction lighting (MIL) was invented in the late 19th Century and patented by world renowned inventor Nikola Tesla. MIL solves most problems associated with artificial lighting in museums, galleries, and exhibition halls.

For halogen, MH, and LED, common undesirables include bulb/reflector geometry, glare, spectral bias, lumen degradation, and "flicker." Taken individually:

- **Bulb Geometry** – HID and LED light sources are singular and extremely intense. In the case of LED, a single diode can emit light that is strong enough to actually damage the human eye when directly viewed. In the case of HIDs that include halogen and metal halide, the singular source must be dispersed into a desired lighting pattern using a reflector, lens, and fixture geometry. In all cases, the reflector and lens will be subject to bulb shape and intensity. LED fixtures use a combination of reflector and diode distribution to achieve a desired illumination pattern.





The distribution pattern will be a function of the fixture's focal length. Just as a camera lens captures varying angles, a fixture will display a lighting spread in accordance with the distance of the light source from the focusing reflector. Unfortunately, this focused light can create hot spots and voids that adversely affect the viewing experience. The best illustration is seen in a white gallery wall lit by three 3,700K halogen "museum lights." Absent a painting, the distribution pattern is immediately ascertained by the wall reflection and the yellow/pink spectral bias is contrasted by the white wall surface. It is obvious that any artwork hung under this light will display three hot spots at the top of the frame, followed by significant lighting deficiency at the bottom. Surprisingly, many museums and display galleries employ this type of lighting.

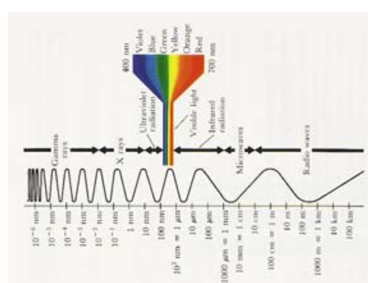
Equally popular are frame-mounts, top-lighting, and bottom lighting. While less obtrusive than multiple spot lights, similar deficiencies exist. The design intent is to use bulb and reflector geometry that more accurately adheres to the size and shape of the artwork. This type of lighting can be attached to the picture frame or suspended from the ceiling at a calculated focal distance from the artwork. Frame-mounts are more popular in homes and exhibitions. As seen in the illustration, there is a hot-spot at the top of the picture frame that extends halfway through the picture. These lamps are similar to the old "banker's light" that used an elongated incandescent bulb. As incandescent is being phased out, new versions use a tubular fluorescent bulb.

To the casual observer, hot-spots and voids may be innocuous. People stroll through galleries, exhibitions, and museums without realizing the degree of distortion on display resulting from lighting. However, to the trained eye, such alterations in the intended image are massively intrusive upon the viewing experience. For photographers, uneven lighting can be the ultimate source of frustration. No amount or manner of lighting compensation can fully remove some of the problems associated with hot spots and spectral deficiencies.

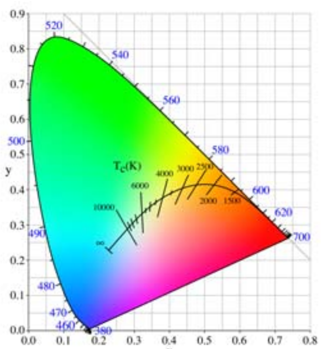
- **Glare –** The lack of diffusion associated with conventional lighting causes glare. Similar to a hot spot, glare is the result of non-polarized light on a reflective surface. This is a particularly irritating phenomenon that is often picked up by even the most casual observer. The reflective index of the art surface in conjunction with the lighting source will determine glare. For example, glass can have a high reflective index despite being clear. This is why artwork is often framed with "non-glare" glass that uses a matte finish to diffuse light across the glass surface rather that reflect it directly back toward the viewer. Oil paintings have a higher reflective index than water colors. In all cases, colors have different degrees of reflectivity relative to their light source.

Each picture on the left is illuminated by its own individual spotlight. Although the lighting design attempts to limit glare and hot spots with a translucent shade, the focal distortion is quite obvious on the top wall. Since white surfaces have the highest reflective index, there are hot spots on each white matte. The uneven distribution creates shadowing around each picture while the intense focus on the interior art appears "over heated." The void at the bottom is inconsequential since the art is well above the picture frame bottom.

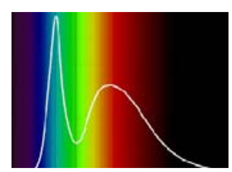
- **Spectral Bias –** Perhaps the most upsetting aspect of artificial lighting for any observer is spectral bias. The human eye sees a very limited part of the electromagnetic spectrum from about 420nm (violet) to 750nm (red). Within this range, the highest sensitivity or "acuity" is between 520nm and 620nm from green to orange. For lighting, color intensity is a measure in degrees Kelvin (°K) which refers to the light emitted by a "black body radiator." Without going into the physics, imagine a piece of hot glowing metal. As it just begins to glow, it appears orange. As it becomes hotter, it glows yellow and, at some point, it becomes "white hot" with a bluish tint. Regardless of the specific sensitivities of the human eye, it is generally agreed that the truest color rendition is achieved from the "full spectrum" output of the sun. As mentioned earlier, the most desirable sunlight is diffused as though



from a northern exposure in the northern hemisphere. A bright sunny day can measure above 10,000K on the color temperature scale. When viewed on a white background, such a high color temperature appears to have a blue bias. On an overcast day, the color temperature drops down to about 6,500K which has a more natural appearance because the blue hue is muted. This is why many perceive colors as more intense after a rain storm as the sky begins to lighten. Browns and greens (earth tones) seem more intense and vivid while yellows and reds look brighter. The degree to which the human eye can discern color differences and subtleties is measured as the "color rendition index" (CRI). Generally, the higher the °K, the higher the CRI. For displaying art, the higher the CRI, the more accurately colors will appear.



Since human vision has greater acuity within the green/yellow spectrum, interior designers try to set moods, establish tones, and create textures using different color lighting. Many are familiar with the term "warm light" as opposed to "cool light." Light ranging from 1,500K to 3,000K is generally considered warm. From 5,000K and higher, light is categorized as cool. Unfortunately, not all measurements in Kelvin are the same. Within each spectra there are varying intensities. This means that two 6,500K lamps can display varying degrees of yellow, green, blue, and red. Thus, some light sources can be more precisely tuned. Notice where 6,500K falls on the Kelvin color chart. Photographers are keenly aware of color temperatures. In the days of film, different emulsions were used to match situations and exposures. There were distinct trade-offs between speed/sensitivity, grain, and color rendition. Nothing is more critical than lighting.

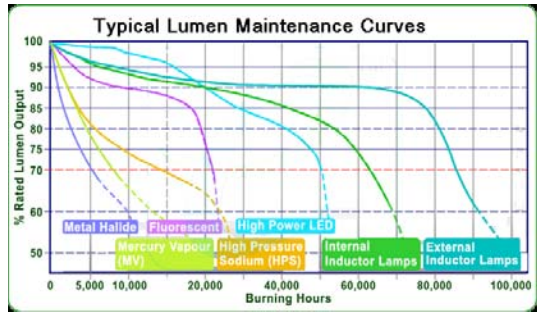


New LED lighting has received a great deal of attention, and many exhibition halls, museums, and galleries are adopting LED. Although the fixtures can be very creatively designed and attractive, LEDs suffer from *significant* spectral bias and can emit ultraviolet (UV) radiation that can fade colors, damage canvas, and harm paper. Simply put, UV is bad in lighting. It is not visible, but it is dangerous. LED achieves the appearance of white light by mixing prime colors or filtering. This is why artwork can appear well lit, but muted when displayed under LED lighting. LED display lighting has been known to bleach clothing and wash out printed signage.

Halogen and other HID generally fall into a range from 2,700K to 4,100K. In some cases

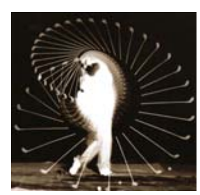
color will be as high as 5,000K, but this is not used by designers because of the misconception that the color is too "cold." A cool light may not be appropriate for a living room, but perfect for a display area. The idea that warm light is relaxing is significantly derived from the color of sunset. As the sun moves lower on the horizon, the curvature of the earth's atmosphere elongates wavelengths, causing a yellow/orange accentuation. We associated the transition with going to sleep. Interestingly, as color fades our eyes rely more upon rod receptors that distinguish contrast rather than cones that resolve color. We tend to be *more alert* under lower light as we strain to visualize our surroundings. It should be obvious that the warm scene of a sunset *does not* provide good color rendition. This light is monochromatic and fails to reflect blues and greens.

- **Lumen degradation –** Most lighting suffers from deterioration in lumen output over the bulb lifecycle. The amount of light and even its color change as the bulb ages. In the case of fluorescent, as much as 40% of the lumen output can degrade within the first third of the expected bulb/ballast life. This means that the lighting specification you initially install may not be the lighting you get through the lifecycle of a fixture. The most dramatic falloff in performance occurs in fluorescent lighting that degrades rapidly immediately from the time of installation. Metal halide, that includes halogen lighting, also suffers from rapid degradation. LEDs remain more stable, but generally experience a double dip as illustrated by the chart. Inductor lamps (MIL), maintain more than 90% of their original lumen and spectral output over a 100,000 hour lifecycle… the longest in lighting.



  In order to maintain specifications and allow artwork to be consistently displayed, LED, HID, and fluorescent lighting require high maintenance and replacement *well in advance* of the projected lifecycle. Unfortunately, maintenance schedules do not often adhere to the lighting degradation as opposed to failure. This means artwork is being less than optimally displayed for as much as 70% of the time.

- **Flicker –** One of the most overlooked lighting weaknesses involves "strobe effect" resulting from flicker. Fluorescent, LED, and some incandescent lamps flicker at the electrical cycle rate of 60Hz up 120Hz. Although there has been an extensive effort to increase the cycle rate above human visual perception, ballast circuits become more expensive as flicker is addressed. Strobe lighting is typically used for stopping action. A slow camera shutter speed combined with a fast strobe light produces an "event series" in "stop action." Such photography has been used to analyze motion and was the basis for developing frame rates in motion pictures.



  It is generally known that flicker rates can impair vision and perception. Strobe effect is linked to many maladies including migraine headaches, nausea, sleep disorders, drowsiness, confusion, seasonal affective disorder (SAD), hypnotic effect, agitation, nervousness, concentration problems, and general lethargy. Strobe effect has even been noticed by professional photographers when consecutive frames under the same static lighting have different exposures. New LED studio lighting has presented problems for videographers when the flicker rate conflicts with the frame rate.

Flicker has been overlooked by most museums, galleries, and exhibition halls because it is not a published specification for bulbs and ballasts. It has generally been accepted that flicker rates beyond assumed conscience frequencies are not perceived. For static viewing where no motion is involved, flicker is assumed to have little impact. However, with increasing deployment of compact fluorescent (CFL) and LED lighting there has been greater awareness of adverse health effects of flicker. The problem is serious enough for the IEEE Standards Working Group, IEEE PAR1789 to take up "Recommending practices for modulating current in High Brightness LEDs for mitigating health risks to viewers." What you can't see can hurt you.

As it turns out, flicker can negatively impact any viewing experience. It causes eye strain and plays havoc with depth perception. The good news for many day-lit exhibitions is that sunlight mitigates much of flicker depending upon the dominance of each light source. Still, flicker within hallways and common areas may lead to viewer discomfort. It is not uncommon for people to become sleepy when attending a museum or exhibition. Those who are more sensitive to strobe effect may have to exit into the sunlight to recover.

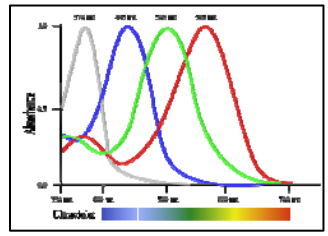
Introducing Art-Bright™ Technology –

Art-Bright™ technology uses magnetic induction lighting to create a full diffusion and full spectrum light source. The objective is to come as close to recreating northern light as possible while eliminating harmful ultraviolet wavelengths. In addition, Art-Bright™ fixtures address environmental issues by being extraordinarily energy efficient and long lasting. MIL bulbs have the added advantage of not using dispersed mercury within the bulb envelope. This means expired or broken bulbs can be disposed of as common waste by removing a solid mercury amalgam slug. There are significant advantages to this approach that include:

1. Full spectrum output with emphasis within human visual acuity
2. No UV protects artwork from fading or light induced degradation
3. Cool operation with no significant infrared radiation
4. Instant strike with no warm-up or cool-down
5. Full dispersion bulb and fixture geometry
6. Full diffusion nano-reflector technology
7. 100,000 hour rated lifecycle (11 years at 24 hours x 365 days)
8. No flicker (strobe)
9. Low lumen loss, retaining 90% of output over lifecycle
10. Silent operation; no buzz, no hum

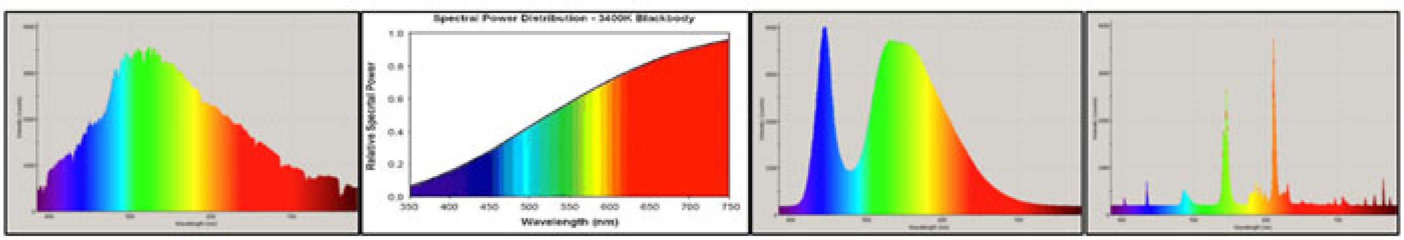
Art-Bright™ lighting can save up to 70% in electricity over halogen, metal halide, and incandescent lighting with up to 600% savings in maintenance. Art-Bright is 20% to 40% more efficient than conventional T5 and T8 fluorescent lighting and on a par with LED.

The Spectrum – The healthy human eye sees between 420nm to 740nm, ranging from violet to bright red. Most of us have three types of cone receptor cells in our retina to distinguish primary colors; blue, yellow/green, and red. We are known as “trichromats” because of the 3-way parsing of the spectral range. Some more fortunate individuals (mostly women) can see four color ranges and are called “tetrachromats.” Combinations of primary colors make up various shades from dark blue to ruby red. White light and reflective surfaces combine all colors. Estimates for color perception range from 100,000 hues (Calkins, David J. *Mapping color perception to a physiological substrate.* The Visual Neurosciences Volumes 1 and 2) to 10 million (Wyszeki, Gunter, *Color*, Chicago World Book Inc. 2006).



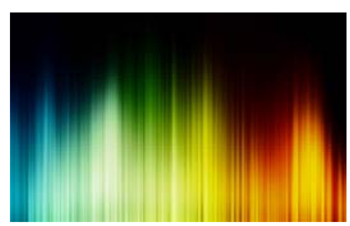
Rod cells are highly light sensitive, but monochromatic. Rods provide the ability to see at night, distinguish shapes and sizes, detect contrast, and resolve single field-of-view depth (monocular). Rod vision is called scotopic. Cones are less light sensitive, but can distinguish colors (polychromatic) known as photopic vision. More recently, a great deal of attention has been paid to photosensitive ganglion cells that are responsible for regulating our circadian rhythms and melatonin production.

This may sound overly technical, but a holistic understanding of how we see is critical when selecting artificial lighting. Recall that the best light is natural sunlight. The closer we come to sunlight, the more accurately objects will reflect their intended colors. Consider the spectral output of popular lighting in comparison to the sun.



Daylight Incandescent LED Fluorescent

Interestingly, the daylight spectrum coincides with the human eye’s visual acuity. We have the greatest sensitivity in the green range. It should be easy to see how incandescent lighting can distort color perception with an overly red bias while LED will exaggerate blues. Florescent lighting is often highly orange. The Art-Bright™ spectrum is tuned to replicate hazy sunlight between 6,500K and 7,500K, but with no harmful UV. The spectrum is balanced in exact proportions to provide the most accurate color rendition.



Balanced Art-Bright™ Spectrum

A great deal of attention is being paid to the impact of UV on sensitive objects. UV is responsible for bleaching, oxidation, dehydration, and overall accelerated aging. Since many LEDs emit UV radiation, curators have become increasingly concerned about the potential for damaging artwork. Art-Bright™ raises blue-range emissions to only extend into the visible range.

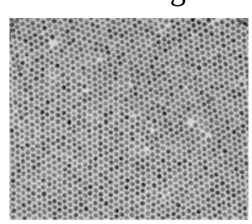
It is also important to takes into consideration the range associated with melatonin reduction to prevent drowsiness. Art-Bright™ lighting can be literally “picture perfect.” Photographers find they have the most vibrant and realistic results when taking pictures using Art-Bright™ fixtures. Output drops off at the near UV range to provide ideal lighting for sensitive objects. Lamps are only warm to the touch with very little infrared. Low heat means less air conditioning load and less need for humidity adjustments resulting from lighting.

The Light Source (Geometry) – A major advantage of Art-Bright™ technology is the large format (footprint) bulb. Unlike incandescent and LED lighting, Art-Bright™ is tubular to spread the light output over a dispersed area. This lowers glare and lends itself to creating a more diffused and natural light. When looking directly at an Art-Bright™ bulb and looking away, the eye’s recovery time is nominal… less than half a second. There is no “after image” in the retina. Art-Bright™ fixtures have similar lumen efficiency to most LED at about 95 lumens per watt. Since the light source is spread over the bulb geometry, the apparent intensity is less. By comparison, it is *dangerous* to directly view an unshielded LED. This is because the light source is condensed and very powerful. 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.

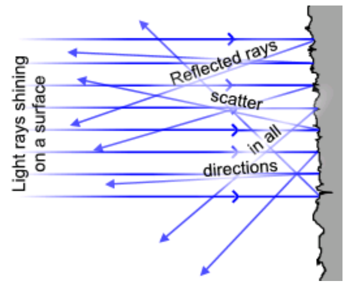
The large format light source works in conjunction with the unique nano-particle reflector to produce a diffused light as opposed to focused light. This is extremely important for creating uniform lighting without voids or hot spots. The reflector is impregnated with multi-directional microscopic reflective materials that achieve an astounding 95% and greater reflectivity index. This accomplishes two objectives; 1) maximizes output, and 2) spreads the light field evenly over the target area.

Conventional reflectors focus light onto an intended area or object. This concentrates light, making it unevenly intense. It is fine for stage lighting or other applications where such intensity is desirable. In contrast, diffused light spreads over an intended field to provide even distribution and better uniformity. Photographers and videographers are intimately familiar with using diffused light. They employ various techniques to appropriately spread light over a subject. From umbrella flash kits to scrims, presenting smooth lighting is critical for proper reproduction. When taking a portrait shot or illuminating a still shot with special perspective, diffused light is critical.

The Art-Bright™ “secret sauce” uses aligned nano particles that can be shaped to bounce light in all directions much the way sunlight reflects off varied surfaces. To be sure, the eye does not see the light of the sun as it travels through space. Rather, we see the reflected light or luminance produced by the sun, moon, or



artificial source. Maximum luminance would come at high noon on the equator during the spring or autumnal equinox; a condition that would produce no angular shadow. Ideally, if an area could be artificially illuminated to achieve the same condition, there would be optimal viewing. Each nano reflector particle can be positioned to achieve a particular reflective pattern. This is correlated to the tubular bulb design and large format light source.



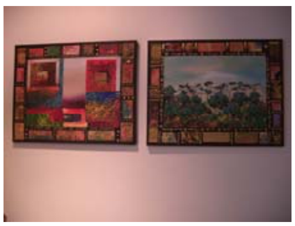
Consider that sunlight bounces off a multitude of irregular surfaces and colors. The combinations and permutations of reflective angle, surface characteristics, and colors produce homogenized full spectrum light. Although the sun's angle to an object produces a shadow, the overall lighting appears uniform on a clear day or if there is a consistent overcast. The nano-particle diffusion reflector acts like the variety of surfaces in the typical outdoor setting and represents a departure from lighting norms. Art-Bright™ technology allows you to approach lighting *spatially* as opposed to object by object. The goal is to illuminate the space occupied by the artwork. Ideally, the viewer is less aware of the light source and is focused upon the art. To be sure, very few exhibition attendees are likely to notice the use of daylighting versus artificial illumination. It is enough for the art to appear as close to the artist's original intention as possible.

Even with the use a non-glare glass, focused light creates a reflection that can obscure the artwork. Depending upon the angle of the viewer to the object and relative to the light source, the glare will appear in different positions within the frame. The same picture taken using the Art-Bright™ fully diffused source shows uniform light. Even the shadowing is evenly distributed around the picture since the light is multi-directional as opposed to directionally focused. The colors are more balanced and the total content of the picture is available to the viewer without the need to change viewing angle. If the viewer stands in front of the directional light source, his shadow will likely appear on the picture. If standing behind the reflected light source, the viewer may see his own reflection.

Sculpture presents problems associated with the three dimensional surface and angles. The photograph on the left was taken of the sculpture "Nobody's Boy" with commonly used halogen down-lighting. Notice lighting emphasis on the legs and the shadows cast by the book, hat, and forward tilt of the head. This is a typical problem when attempting to use a spot light from the ceiling or floor. The halogen fixture was rated at approximately 4,000K and casts a slightly pink hue. Diffused Art-Bright™ light more fully illuminates the statute on the right. Both pictures were taken with the same amateur snap-shot digital camera with the same settings. Notice the more distinct shadow cast by the halogen behind the figure on the left. The corner of the adjoining walls is obscured; it

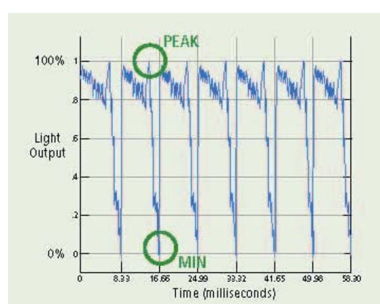
is clear under the diffused light. To be sure, shadowing from the focused light accentuates certain features like the creases in the sleeves. However, the same shadowing fails to reveal the facial features. Notice the difference in color on a white marble sculpture. The pink overtone is eliminated to the extent that this printed reproduction of the original snap-shots can be accurate. The narrowly focused halogen does not fill the space with light. The background wall appears darker.

Although Art-Bright™ attempts to reproduce diffused light on a hazy day, there may be instances where a more desirable color rendition requires a lower temperature. Since Art-Bright™ can be custom ordered, any color temperature from 1,500K to 10,000K can be accommodated. Instances where this may become an issue is when the art was produced under known lighting conditions that introduced specific color bias. An example would be art created under the influence of stained glass windows. This is a very particular application that requires consultation and evaluation. Regardless of the color temperature, full diffusion yields the more desirable results.



The oil paintings above are displayed with overhead halogen lighting (left), a combination of overhead halogen and background Art-Bright™ diffusion (center), and only background diffusion with no overhead halogen lighting. There is a distinct red bias in the halogen as well as a hot spot on the left side of the left picture. The overhead light does not have the necessary photometric characteristic to evenly illuminate both pictures. The red colors become exaggerated and even the other colors are contaminated by the spectral bias. The center picture shows how Art-Bright™ evenly distributes over both paintings and the wall. There is still some residual intensity from the halogen that appears on the wall and in the accentuated reds of the painting on the left. There are gold accents around the left side painting that are visible, although small in this reproduction. The example on the right illustrates more uniformity with no spectral bias. Keep in mind that accurate lighting may not necessarily engender universal appeal. Nonetheless, accuracy is the goal.

Flicker – Art-Bright™ lighting has no electrodes and is not subject to flicker. Magnetic induction generates light by exciting atoms as they spin through a magnetic field. The energy used to spin the atoms determines the amount of light. MIL uses drivers rather than ballasts with frequencies exceeding 250,000 cycles. The result is a constant light that is not affected by the 60Hz electricity frequency. All of the inherent problems associated with flicker are solved by using Art-Bright™ technology.



Flicker has received much of its negative notoriety because of the adverse impact upon health and human performance. However, flicker can have a major impact on video and even still-shot photography. If the flicker rate causes “destructive interference,” video will display horizontal or vertical lines that appear to move up and down or across the video display. When taking still shots without supplemental lighting, pictures may experience a dip in light if the shutter coincides with the flicker. In reality, the extent of flicker can be astonishing. In the case of some LED fixtures, light can actually dip to zero, creating an intensity that causes visual voids. When the eye scans an exhibit of paintings, photographs, or sculpture, the brain interpolates between visual information received by the occipital lobe and visualization context processed in the parietal lobe. The complexity of visual comprehension is still under intense investigation. It is enough to say that flicker can deceive the eye and confuse the brain. This is why it may be more difficult to read under LED or fluorescent lighting. The eye's scan rate can conflict with the flicker rate.

Depending upon an individual's sensitivity, flicker can degrade an entire visual experience. The most commonly shared experience is a feeling of sleepiness known as the "hypnotic effect." Like the preverbal hypnotist's watch, the subject is subjected to a rhythmic visual pattern while concentrating on a particular object.

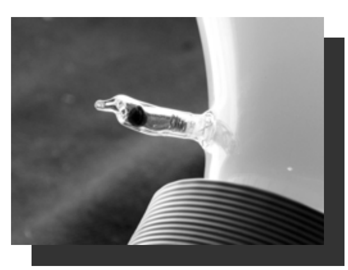
Consistent Lumen Output – One of the most important positive features of MIL is its longevity. Bulbs and ballasts (drivers) typically last more than 100,000 hours which translates into eleven years running 24 hours every day. There is more to longevity than the operational lifecycle. A fixture should deliver consistent performance throughout its entire lifecycle. This is where Art-Bright™ excels over other technologies. As the performance chart above indicated, MIL retains more than 90% of its original lumen output and spectral profile for more than 90% of its lifecycle. This advantage is enormous when considering the consequences of using energy efficient fluorescent T5 and T8 fixtures that can lose 30% to 40% of their luminosity within the first third of their lifecycle. LEDs can degrade 20% to 30% within the first third of their life cycle; and another 20% within the next half of their rated life.

With 70% or less in output, there can be significant lumen deficiency. Unless scheduled maintenance replaces LED and/or fluorescent bulbs and ballasts well in advance of failure, it is given that light quality will be far less than anticipated. In some cases, curators may need to overdesign lighting based upon anticipated lumen degradation. This can defeat the purpose of using energy efficient lighting because the installation will be oversized to compensate for lumen degradation.

Art-Bright™ technology maintains its color temperature through 95% of its lifecycle. This is important to make sure exhibits retain consistent appearances. As electrodes age, the color can significantly change. Since Art-Bright™ lighting does not use electrodes or filaments, it is not subject to performance deterioration.

Environmentally Safer – Fluorescent lighting contains dispersed mercury that presents a danger if a bulb is accidentally broken. Under EPA and OSHA clean-up regulations, broken fluorescent bulbs must be handled as "hazardous materials" ("Haz-Mats"). The cost of mitigation can be several hundred dollars for a bulb that may sell for just $9.95.

Art-Bright™ technology uses a solid mercury amalgam similar to the mercury/silver fillings used in dentistry. Since there is no



dispersed mercury, the isolated "slug" can be broken off and shipped back to Ultra-Tech™ Lighting for recycling. The remainder of the bulb is treated as glass and metal waste… non-hazardous. This is very important as more and more states impose hefty fees for Haz-Mats disposal. It is one more reason why Art-Bright™ is the better choice.

Silent Operation – Art-Bright bulbs and drivers (ballasts) are silent. Often, LED drivers can emit a high pitch sound while fluorescent lamps are known to buzz and hum. High pitch frequencies, buzzing, and hums can disturb patrons.

The Art-Bright™ Experience – Seeing is believing when it comes to lighting technologies. Art-Bright™ is available in floods, ceiling cans, 2' x 2' ceiling troffers, high-bays, low bays, and even as custom "built-ins." Powers range from 40-watts to 400-watts with lumen output between 90 and 100 per watt.

You can experience an Art-Bright™ demonstration to see for yourself. All lights are rugged and dependable and can use 110V to 277V. Before you commit to any lighting technology, you should check out the Art-Bright™ advantages first-hand.

Wide-Area Full Diffusion Flood:

40 Watt	60 Watt
80 Watt	100 Watt
120 Watt	150 Watt
200 Watt	250 Watt
300 Watt	400 Watt

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2' x 2' Ceiling Troffer available in:

40 Watt
60 Watt
80 Watt
120 Watt

Ceiling Can available in:

40 Watt
60 Watt
80 Watt
120 Watt

Open or with lens

High-Bay fixture available in:

80 Watt	100 Watt
120 Watt	200 Watt
250 Watt	300 Watt

Open or with lens