Outdoor Advertising Association of America

LED Lighting Guidance for Outdoor Advertising Owners and Operators

Introduction

Although there are numerous available lighting technologies intended to reduce energy consumption, such as conventional metal halide with solid state ballast, ceramic metal halide, fluorescent, induction and plasma, this guidance will focus on LED (light emitting diode) lighting technology.

The evolution of LED technology has and will continue to transform every aspect of lighting, and our industry is no exception. As the technology matures and becomes both more stable and more affordable, there will be several significant positive impacts benefiting advertisers, consumers, and operators alike.

Advertisers will benefit from greater lighting uptime, higher quality of light uniformity and better color quality. Consumers will benefit from clearer and easier to read advertising. Communities will benefit from less light trespass and a reduced load on the power grid. And as an industry, we will benefit from lower energy costs, reduced maintenance and safety expenses, reduced lighting credits, improved customer service, and higher perceived value.

It is the hope of the OAAA that the following important considerations and guidelines prove valuable to operators as they consider utilizing LED lighting to help best realize the benefits enumerated above.

The OAAA reserves the right to revise this document at reasonable intervals, and at its sole discretion, to incorporate changes brought about by improvements in technology, or changing industry norms and best practices.

Basic Lighting Guidance

The amount of light sufficient to provide proper illumination to an outdoor display will vary widely based on several factors, such as image size, viewing distance and viewing interval (time), reflected light, background brightness, and nearby competing light sources. However, although there is no universal solution, a good basic illumination guideline which can be modified as needed to address specific requirements, will satisfy the vast majority of needs.

It is important to understand three sets of values that affect this equation:

Total Average Illumination:	The average of all illumination readings taken on a target.
Min-to-Max Illumination:	The ratio of the largest to smallest readings taken on a target.
Uniformity of Illumination:	The min-to-max ratio of readings taken in adjacent areas of a target.

Total average illumination is the most important value when competition with adjacent or competing light sources is a consideration, and more total illumination may be required. Assuming the correct basic fixture design, this additional illumination can be achieved by incorporating additional fixtures rather than a fixture redesign.

The Min-to-Max and Uniformity values should be maintained regardless, as these values govern the ability of the eye to discern inaccuracies in the lighting design, which manifest as hot spots, banding or striations.

In particular, Uniformity of Illumination is a critical measurement which defines illumination differences in adjacent measurement panels. Excessive differences in adjacent measurements are highly visible to the eye.

Specifically, the following values should be considered as good starting points when evaluating LED lighting products:

Total Average Illumination:	200-400 lux.
Minimum-to-Maximum Illumination:	3:1 (i.e., 150 lux minimum, 450 lux maximum)
Uniformity of Illumination:	2:1 (i.e., 150 lux with an adjacent measurement of 300 lux)

If these values are met, the result will be a smooth, even plane of lighting across the face of the display, sufficient to satisfactorily illuminate the display under normal conditions, and with no hot spots, shadows, flares, striations, banding or gradients visible to the naked eye at typical viewing distances during a typical viewing interval.

Generally speaking, excess light is not encouraged, as it is produced at the expense of energy consumption, and also drives up the cost of the finished product, so thresholds of 200 lux minimum and 600 lux maximum should not be exceeded.

The minimum number of fixtures necessary to adequately light a display should be used to limit capital outlay, although installation costs, and costs of re-wiring to accommodate a reduced number of fixtures relative to the existing configuration should be considered when calculating ROI (see the attached payback/ROI calculator).

Generally accepted norms for fixture quantity, wattage and mounting configuration for different size displays are noted below:

Display Size	Fixture Quantity	Wattage target	Distance from Face	Distance below face
Poster (small)	One	75-125W	60”-66”	6”-8”
10-6 x 36 (med)	Two or three	75-150W each	72”	36”
14 x 48 (large)	Two, three or four	150-170W each	72”	36”

Warranty (fixture and driver)

Minimum of 5 years.

Specific Componentry and Construction Guidelines

Optics

This category is shown first because it is the most important. Superior optical design drives every aspect of fixture design. A superior optic, satisfying the criteria outlined in the Basic Lighting Guidance, has several functions:

- Provides a uniform plane of illumination, free of shadows, hot spots, flares or other errors.
- Limits stray light. This is crucial in mitigating future Dark Skies initiatives.
- Directs the output of every LED onto the target, so that every possible watt is used for illumination.
- Reduces the number of LEDs, requiring less wattage compared to less sophisticated designs.
- Reduced wattage and fewer LED’s require a smaller heat sink capacity thus allowing a smaller form factor.
- A smaller form factor results in easier sealing of case against water and dust.
- A smaller form factor also results in lower fixture costs, better ROI, and a cleaner design aesthetic.

- Advanced optics allow for a vertical or near vertical orientation of the LED plane, eliminating snow buildup.
- Demonstrates the technical ability and commitment of the vendor.

It is important to understand that given the nature of the displays in our industry, we are best served by highly customized optics and not standard or slightly-modified floodlight optics. The applications are not the same.

The optical design shall be such, that in the event of LED failure, only the overall illumination level of the display is reduced, not specific areas within the display. Each optic should direct the output of each individual LED onto the entire display (holistic approach), rather than individual LEDs being aimed or directed at individual sections of the display (zoned approach). Failure of up to 15% of the LEDs in a fixture shall not result in a readily apparent reduction in display illumination.

LED failures in zoned designs without sufficient coverage overlap will result in corresponding areas of reduced illumination within the display, which will be apparent to the public and to the advertiser. In a zoned rather than holistic optical design scenario, the photometric evaluation shall, in addition to showing the buyer the full-power performance of the fixture, also show projections of billboard target illumination in various partial LED failure modes, so that full lighting coverage can be demonstrated even in the event of partial failure.

The nature of the custom optic shall be such that extensions (cutouts) are fully illuminated, with no apparent visible color difference between the extension and the main body of the display. Additionally, sufficient light shall be directed onto the skirt (apron) of the display such that the display is appropriately framed, and the operators' brand is visible and identifiable. Downlight and glare to oncoming traffic shall be minimized to the extent possible.

It cannot be stressed strongly enough that advanced optical design is an absolutely critical element in choosing a lighting fixture. Not only is this a technical and practical necessity upon which the overall fixture design is dependent, but the ability to understand the requirement and produce the optic demonstrates both technical expertise on the part of the vendor, and the willingness of the vendor to make the quite significant commitments necessary to satisfy the requirements specific to our industry. This commitment is a necessary factor as we choose long-term suppliers to our industry.

LED Light Engine

The light engine should be chip-on-board or laminated circuit board construction, with either an engineered optic or engineered reflector.

LEDs should only be should be sourced from the best and most reputable suppliers (E.G., Cree, Nichia, Philips, etc.).

LEDs should not be driven in excess of 70% of the manufacturer's maximum continuous rated amperage for that chip.

Heat Sink and Thermal Management

Although LEDs generate very little heat compared to other light sources, heat produced at the semiconductor level must be dissipated for the LED to reach its design lifespan. Thus, thermal management is a critical element in fixture design, and an inferior or underperforming heat sink design will dramatically shorten the life of the light engine.

The circuit board containing the LEDs shall be thermally coupled to the heat sink either by means of heat-conductive compound or adhesive (acceptable) or by precise machining of the heat sink in the circuit board mounting area such that there are no voids between the heat sink and the circuit board (preferred).

The heat sink capacity shall be sufficient to maintain a junction temperature below the maximum operating temperature specified by the chip manufacturer, when used within the ambient temperature range specified in the mechanical specifications. The performance of the heat sink in operating conditions shall be confirmed by the manufacturer through an independent third party engineering analysis of the completed fixture.

Enclosure (fixture body)

The enclosure should be as compact as possible so as to minimize product cost, installation cost, and to allow for the greatest margin for error in misalignment during the course of service.

If an enclosure is used, it should be gasketed such that no water vapor can be drawn into case in the process of temperature cycling during operation (preferred). If an enclosure is vented to the atmosphere to prevent condensation, provisions should be made to protect all circuitry from damage over time caused by atmospheric moisture, regardless of the presence of condensing moisture. An IP-67 rating against dust and water is the preferred standard.

Gaskets shall be pre-formed pure silicone rubber or formed-in-place curable silicone. If a pre-formed silicone gasket is used, uniform clamping pressure to guarantee a continuous and uninterrupted seal shall be by means of a solid and substantial 1-piece flange, which shall be of a material, construction and thickness sufficient to prevent deformation in the flange that might result in clamping pressure voids or less than uniform clamping pressure. If a formed in place gasket is used, this shall be applied by means of automated robotic tooling.

All electrical connections penetrating the enclosure wall shall be watertight and weatherproof. External wiring shall be minimized, and in any event, shall be armored to prevent abrasion or physical damage.

The preferred mounting method is by means of a non-adjustable bracket so that the fixture is uniformly and consistently oriented to the face of the display. However, all specifics of mounting geometry and adjustability of the mounting bracket are at the discretion of the operator and consistent with their specific needs and best practices.

Either square or round mounting arms are acceptable, but given the nature of the optics, which if properly designed will direct the light very precisely, a square mounting arm is highly recommended, to limit misalignment of the fixture over time. In all cases, the mounting bracket shall be of welded or machined construction suitable for lengthy and rigorous service consistent with typical conditions in our industry.

All hardware and fasteners shall be 18-8 stainless steel at a minimum.

Lab Tests and Certifications

Certain industry standard tests and certifications should be provided by any reputable lighting manufacturer seeking to supply LED lighting fixtures to our industry. Chief among these are the LM-79, LM-80, DLC, and UL or ETL certifications. These certifications should be conducted independently by labs with no affiliation to the lighting manufacturer.

LM-79 testing involves an evaluation of the completed lighting fixture to determine its lumen output, electrical power consumption, heat dissipation, efficiency in lumens per watt, color temperature and CRI rating, and also the angular distribution of light. This test is used to create IES files describing the photometrics of a particular fixture, and will provide an accurate general picture of how that fixture will perform.

In a zoned rather than holistic optical design scenario, the LM-79 photometric evaluation shall, in addition to showing the full power performance of the fixture, also show projections of billboard target illumination in a partial LED failure mode, so that full lighting coverage can be guaranteed even in the event of partial failure of up to 15%.

LM-80 testing involves tests performed on the LED chips themselves to determine lumen output, lumens per watt, drive current requirements and output at these values, short-term (6000 hr) lumen maintenance, and an extrapolated expectation of overall life based on the TM-21 national standard. Any reputable chip manufacturer should already have LM-80 testing completed for any LED being considered for use in our industry.

Designlight Consortium (DLC) is a lighting and utility industry group that performs independent tests to confirm claims made by lighting manufacturers. Billboard lighting would be qualified as a “Pole Mounted Luminaire”. Inclusion in the DLC “Qualified Products List” is almost always a requirement by any utility as owners seek to recover the cost of LED fixtures through various utility incentives and rebates. In essence, if a fixture does not have DLC approval, one will not qualify for a rebate or incentive.

UL and ETL ratings are not always an absolute requirement since fixtures intended for use in our industry generally are not used indoors. However, this requirement is almost always at the discretion of local permitting authorities, and since there is no uniform standard at the local level, conformance with ETL at a minimum, and UL if at all possible, is highly recommended.

Field Testing

As lighting fixtures are being evaluated by individual operators within the industry, certain basic guidelines should be followed and certain basic questions asked:

Ask for all the lab certifications, and evaluate conformance with the electrical and mechanical standards referenced at the end of this document.

Ask for the photometric chart, and also ask if the readings have been confirmed on an actual billboard target. A supplier should be able to provide actual measured readings taken from an actual billboard.

If actual readings from a billboard target are not available, they should be provided. The nominal standard is a photometer reading every (1) one square foot over the surface of a billboard. A better standard is a reading every 6", resulting in 4X as many datapoints. Although this is clearly more work for the vendor, the results will paint a much clearer picture of the lights' measured output relative to the lab projections.

Prior to viewing the fixture on the street, a white board test should be performed to identify any banding, striations, shadows, hot spots, etc. These inaccuracies will be much more apparent on a full-size white board than on a street location with copy. If at all possible, this test should be done in a controlled warehouse environment so that any competing light sources can be eliminated.

Digital photos of every stage of the testing should be taken for future reference. As mounting configurations are finalized, additional photos should be taken from a fixed center location on a tripod, approximately 50' from the face of the billboard so as to minimize the effect of any wide-angle lens distortion. Successive exposures should be made from full exposure to -2 stops, in 1/3 stop increments (see "exposure compensation" in the camera's instruction manual). Since the stopped-down lens effectively makes the digital sensor less sensitive to light, these successive underexposures will progressively show the actual pattern of light produced by the fixture, and this is a quite accurate method of confirming lab results and the effectiveness of changes in the fixtures' mounting geometry to the actual lighting pattern.

Once all due diligence is complete, commence actual field tests. Nothing beats the trained eye.

Summary

Industry-specific LED lighting has the ability to dramatically improve the viewing experience for advertisers and consumers, and to also provide manifest advantages to operators. Conformance with basic guidelines will guarantee that owners and operators in the outdoor industry receive full value for the considerable investment involved.

To recap the primary considerations when researching and evaluating LED lighting, the following are musts:

- Conformance with the Basic Lighting Guideline
- Superior optical design
- Minimum number of fixtures per structure
- Minimum power consumption
- Premium quality components
- Proper heat management
- Compact form factor
- Robust design and weather sealing
- Sufficient lab and field testing

- Competitive price
- Good warranty
- Committed and capable vendor

Engineering Criteria

Basic Lighting Design, Applicable Standards, Electrical

Lumen Depreciation Standard:	IESNA TM21 methodology based on IESNA LM80 results
Lumen Depreciation Factor:	>90% at 50,000 hours of operation at 25C ambient
Minimum Output:	75 lumens per watt (DLC performance metric)
Color Rendering Index (CRI):	Minimum of 65, as measured using IES LM-79 procedures
Color Temperature:	4500K +/- 500K (i.e., 4000-5000K)
Total Harmonic Distortion:	<20%
Power Factor:	>90%
Standard for THD/PF:	ANSI C82.77.2002
AC Surge Protection (lightning):	ANSI/IEEE C62.41 compliant
Capacity, surge protection:	10kV, 5kA (120/240V systems) 6kV/3kA (347/480V systems)
Electrostatic discharge:	IEC 61000-4-2001 Level 4
Inrush current:	NEMA A410:2004, and UL 991:2004
FCC compliance:	Title 47, CFR Part 15, Class A
DC Operation (solar):	Optional (nominal 24VDC)
Ingress rating (dust and water):	(Driver) IP-67 minimum

Basic Lighting Design, Applicable Standards, Mechanical

Vibration:	ANSI C136.31-2001
Operating temperature:	-40C to 50C as per UL/CUL 1598 or CSA-C22.2 No. 250
Ingress rating (dust and water):	IP-66 minimum, but IP-67 preferred due to long life of LEDs
Housing (case), materials:	ANSI H35, ROHS-compliant Aluminum alloy (A360 or A356)
Coating, housing:	Powder coat, rated for 1000 hour salt fog test as per ASTM 117 and D1654
Humidity protection:	IEC 60068-2-3 1987
Lens material:	Tempered glass or optical acrylic
Weight, per fixture:	<36 lbs.
Mounting:	Receiver for 1.5” square tubing (round mounting arm not recommended)
Defrost:	Optional