Samsung’s LED Component Test Lab Approved by UL for UL Total Certification Program

Samsung Electronics, a world leader in advanced component solutions, announced on May 26, 2016 that its test lab for LED packages and modules has been qualified by UL (Underwriters Laboratories), a widely-recognized global safety science organization, to operate the UL Total Certification Program (TCP), one of the highest levels of testing and qualification under the UL Data Acceptance Program (DAP).

UL’s standards and certification are universally recognized as important indicators of product safety and reliability. To better handle increasing requests for testing and certification, UL has been running DAP, which allows approved manufacturers to test products using their own labs, equipment and engineers, and then submit the test data to UL for review. Samsung’s test lab for LED packages and modules is now recognized for the UL TCP. Within UL-specified parameters, Samsung can manage the full TCP process from examining a product’s structure, to selecting and conducting appropriate UL testing, and obtaining UL certification.

As a UL-approved TCP lab, beginning from May 2016, Samsung will be performing tests to measure the safety of its LED components under varying environmental settings including electrical, temperature and humidity variation.

“Being selected to operate under UL’s Total Certification Program underscores the excellence of Samsung’s LED product quality and the thoroughness of our verification processes,” said SungKwan Lim, vice president of the LED

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Performance in the lighting industry is and will be an increasingly important factor in product differentiation in the market. As already well known, LED technology can have positive or negative effects on daily life - by effecting things such as visual comfort and circadian rhythm - depending on the quality of the light to which a user is exposed.

In an effort to offer additional guidance, UL recently launched a service for verifying the optical flicker of an LED light. Given the fact that flicker free is technically impossible with today’s technology, the UL Verified Mark allows a manufacturer the chance to indicate the flicker percentage of its LED lighting products with the support of UL, a respected third party. This information provides users/specifiers with the opportunity to select and use products that are least likely to visually or biologically disturb their daily life while allowing manufacturers to stand out from the competition.

Get in touch with us today to learn more about this exciting new service.

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**Lighting Program Updates**

- **ENERGY STAR® Luminaires V2.0** took effect June 1, 2016. Any products not updated to V2.0 were removed from the list. If a product was removed from the list and updated test information can be provided, it is not too late to get the product re-certified.

- **ENERGY STAR® Lamps V2.0** will take effect January 1, 2017. There is still time to update any products that are certified to Lamps V1.1 if necessary, but any major changes that could result in additional lifetime testing need to be started soon to meet the early interim 3,000 hour requirement and avoid a lapse in certification.

- The DesignLights Consortium™ (DLC) released their Technical Requirements V4.0 on June 1, 2016. This includes significantly increased efficacy requirements for all products at both the standard and premium levels. Products can still be certified to V3.0/3.1 until August 31, 2016, but all products must meet the V4.0 requirements by April 1, 2017 or be removed from the active qualified products list. DLC will outreach to manufacturers regarding products not meeting the requirements in the fall and will identify products meeting the V4.0 requirements in January 2017. Additionally, DLC released a proposal to allow 4-pin Type-A PL LED replacement lamps for CFLs on June 16, 2016. This proposal would allow lamps to use the existing ballast and will also allow equivalency claims based on luminaire level performance.

- The U.S. Department of Energy (DOE) closed a rulemaking on June 9, 2016 by finalizing the LED Lamps Test Procedure. Most of the test method is consistent with standard practice and generally references IES LM-79-08, with some notable exceptions including that goniophotometers cannot be used and a few other DOE specific conditions. The most significant development in the rulemaking is a requirement for lifetime testing, referencing IES LM-84-14 and TM-28-14 for the test method and projection method respectively. A link to the final rule can be found online and an article describing the rulemaking will be released soon.

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**A Letter From Roberto Inclinati**

Performance in the lighting industry is and will be an increasingly important factor in product differentiation in the market. As already well known, LED technology can have positive or negative effects on daily life - by effecting things such as visual comfort and circadian rhythm - depending on the quality of the light to which a user is exposed. In an effort to offer additional guidance, UL recently launched a service for verifying the optical flicker of an LED light. Given the fact that flicker free is technically impossible with today’s technology, the UL Verified Mark allows a manufacturer the chance to indicate the flicker percentage of its LED lighting products with the support of UL, a respected third party. This information provides users/specifiers with the opportunity to select and use products that are least likely to visually or biologically disturb their daily life while allowing manufacturers to stand out from the competition.

Get in touch with us today to learn more about this exciting new service.

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Roberto Inclinati
Business Development Manager for Luminaires

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**SPECIAL GUEST**

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(cover story continued)

**Samsung’s LED Component Test Lab Approved by UL for UL Total Certification Program**

Quality team, Samsung Electronics. “By fully embracing the UL TCP, we will be able to speed up the UL testing and certification process for our LED products and strengthen the foundation for our LED business around the world.”

“We are confident that UL TCP will support Samsung’s LED business with more flexibility for timely UL certifications,” said Todd Denison, vice president and general manager of UL’s Appliances, HVAC and Lighting division. “UL will continue to work closely with manufacturers to support improvements in the overall safety of LED components.”

By managing its own UL-approved test lab, Samsung can reduce the testing period for its LED components by about 50-75 percent, which will contribute to Samsung’s ability to rapidly supply UL-certified LED components to customers.

As a part of the criteria for its TCP qualification, Samsung satisfied quality management system requirements, stipulated by ISO 17025. The ISO 17025 standard is used by testing and calibration laboratories for accreditation that allows them to be widely recognized as technically competent. To maintain its top-notch product examination system, Samsung will maintain a close relationship with UL through a variety of testing validation processes including regular assessment of the Samsung LED test lab as required by the TCP program.

To further underscore its testing proficiency, a few years ago Samsung’s LED test lab was qualified as an international test lab from the Korea Laboratory Accreditation Scheme (KOLAS), a governmental accreditation organization that evaluates quality and technical capabilities of testing and inspection laboratories. The Samsung lab also has been recognized by the VDE Institute, the testing and certification branch of VDE Association for Electrical, Electronic & Information Technologies, one of the largest technical and scientific associations in Europe. Through its conducting of world-renowned test lab processes and procedures, Samsung will continue to enhance the quality of its LED products, while further demonstrating its competence in meeting challenging customer needs.

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**Retail Roundup**

**Did you know…?**

Nearly 60% of consumers associate the UL brand with safety, and more than 40% associate the brand with performance, authenticity and quality.

Do more with the mark that you have earned! With a new team in place we’re looking to work with you on ways you can leverage the UL mark in retail, ecommerce and packaging. UL’s retail services team is engaged with global retailers and manufacturers, changing the way you can promote and share the quality and performance of your product.

Contact our team today for a review of how we can assist with your needs.

Melissa.williams@ul.com,
Director of Retail Services.
Grow Your Knowledge: Horticultural Lighting

By Austin A. Gelder / Lighting Performance Technical Advisor

Introduction

Horticultural lighting has existed for many years as a supplement to, or replacement for sunlight as the catalyst for plant growth. While many light sources have been used, professional, large-scale operations tend toward high intensity discharge (HID) lamps for most supplemental and replacement lighting for plant growth. The success of HID lighting has been such that there are specific chemistries of high pressure sodium and metal halide lamps designed with grow lighting in mind. Since the commercialization of LEDs in lighting, there have been attempts at making LED plant growth lighting using the direct colors and relative adjustability of LED spectrums to try and optimize the light to the plant’s absorption. Significant steps in the efficiency of LED systems have increased the viability of LEDs as an alternative light source to HID lamps for output, and the widespread adoption of LEDs in general lighting has been driving improvements in drivers and cost reductions.

Horticultural industries may enjoy some potential benefits from LED characteristics, such as the ability to develop a spectral power that is tuned to the specific crop grown and adjusted over the plants’ lifecycle and the potential to have greater influence over the quality of the finished product by adjusting the light. Coupled with the ability to direct the LEDs and the long lifespan of the products, the potential for greenhouses is significant.

However, these benefits can only be realized with an understanding of the fixture’s performance, as not every LED fixture can provide the equivalent light output and intensity of the incumbent technologies, and plant lighting has special testing considerations.

This article will explore the differences between the measurement of lighting for vision and what is needed for plants.

Differences Between Horticultural and Traditional Light

Most people are familiar with the concept of light output and intensity, but what we are familiar with as humans is largely from the perspective of photopic vision. This is based on the average human eye response (known as the photopic curve) with metrics such as lumens and lux weighted according to this curve. The photometric curve peaks in the yellow-green region and drops off towards both the blue and red ends of the spectrum; however, this response curve is not applicable to plants, as they do not have eyes.

Rather than reference the photopic response curve, horticultural lighting references the photosynthetic response region (typically referred to as Photosynthetically Active Radiation, or PAR) as a more appropriate reference. Also referenced by some is the McCree Curve, which was developed based on CO2 assimilation per mole of photons between 400nm and 700nm wavelengths. This widely referenced curve has peaks in the blue and red range.

This curve, however, is an average curve, and the many different plant species will vary in their absorption. Additionally, while photosynthesis is certainly an important aspect of horticultural lighting, it is not the only process in plants that relies on a spectrum of light. Additional responses from photoreceptors can impact plant growth characteristics, and some of these have reactions beyond the photosynthetically active range of wavelengths, into the UV and far-red regions. As plants have different responses and additional mechanisms which influence plant growth, using a single curve and weighting the light according to a curve does not make sense.
Grow Your Knowledge: Horticultural Lighting

Evolution of Horticultural Lighting

Artificial lighting has been used to supplement the growth of plants since electric lighting was first developed. Early studies focused on carbon-arc lamps, but incandescent lamps filled the role over time. While these products were effective, they were less efficient and heavily weighted in the red and far red spectrum, which caused elongated stem growth. When discharge lamps came into commercial use, they were used to different effect, and the industry generally settled around high pressure sodium and metal halide lamps for supplemental lighting. Fluorescent lamps have also been used in some situations for a wider spectrum of light due to their use of phosphors, which can tailor the spectrum more towards plant growth.

The problem with the incumbent technology is that it is relatively static. The spectrum cannot be changed as plant growth needs change without actively changing out a lamp, which introduces additional labor. High pressure sodium lamps are cost effective, efficient, and long lasting, but provide a limited spectrum for growth, mainly in the orange and red region. Metal halide lamps, which can provide strong blues (a spectrum that tends to encourage leaf growth), experience rapid lumen depreciation due to darkening of the arc tube and contain very high pressures which often require the use of a lensed fixture. There have been attempts to combine the two into a single lamp, but these lamps end up having a lumen maintenance imbalance, with the blues of the metal halide depreciating more quickly than the high pressure sodium components. Finally, these sources become inefficient as they require reflectors and can deteriorate over time.

The commercialization of LEDs, specifically since LED lights became available in high power packages, has generated interest in the horticultural community due to their long life and multiple color options and this interest has increased as the technology has become more efficient. Using a combination of direct color and/or phosphor-converted white LEDs in a single fixture has the capability of tuning the spectrum to one that is optimal for the specific species of plant being grown. This rapid improvement in LEDs has many considering the switch from other technologies, but the difficulty is determining which fixture is best.

Metrics

The sheer number of metrics that can be associated with visible light can get confusing, and with horticultural lighting this is no different. To reiterate an earlier point, lumens (and lux, candela, etc.) are all adjusted for the human eye response and, as such, are not an appropriate reference and should not be considered when evaluating a fixture for horticultural applications. The primary metrics for horticultural use are focused on the quantities of photons produced (typically measured in micromoles, or 6.022x1017 photons per micromole) as these are what get absorbed by the plant. Though others can be explored, the most common metrics are listed below:

Photosynthetic Photon Flux (PPF) - This metric is the unweighted photon flow in micromoles per second, but not necessarily in any one direction. This would be somewhat analogous to lumens, as it is an overall quantity.

Photosynthetic Photon Flux Density (PPFD) - A density based metric that focuses on how many moles hit one square meter per second. This would be similar to a lux, where it is the quantity hitting a specific area.

Daily Light Integral (DLI) - This metric involves the number of moles of photons that hit a surface over a 24 hour period.

Additional metrics and definitions are being worked on by organizations such as the American Society of Agricultural and Biological Engineers (ASABE), as are the test methods which are used to acquire these measurements. One such potential metric expands the wavelength range beyond photosynthetically active radiation and could include the ranges in UV, far-red and infrared to which plants are also sensitive.

Measurement Considerations

Part of the challenge of measuring the light output of horticultural luminaires has been the lack of available metrics and test methods. This lacking does not necessarily prevent measurement, but it does make a true comparison between two different products tested in different laboratories difficult.
The standard test methods for photometrically oriented luminaires have been used by some, but these methods typically have conditions that are not necessarily applicable to horticultural fixtures. For example, many horticultural luminaires will be exposed to higher temperatures and humidity levels, and the fixture’s performance at 25°C may not be representative of the fixture’s performance when installed in appropriate environments. As the methods can vary, the test report provided may not be able to provide the appropriate amount of information on the light coming out of fixtures for horticultural use.

The ASABE is making efforts to improve these deficiencies by using existing methodologies as much as possible and taking lessons in measurement already learned from photometric measurement. Where applicable, the intent is to reference setup, conditions, and methods in IES test methods such as LM-79 and others; however, these methods cannot be referenced directly as many are focused on photometric references, and the test conditions are not necessarily appropriate as noted above.

Application Considerations

One does not simply install any fixture in a greenhouse and call it a day. Lighting for horticultural applications will have different considerations for operating conditions than most other applications. The specific conditions may vary by application but they all focus around the following conditions and ingredients that help plants grow:

- Irrigation and Humidity
- Temperature
- Chemical Exposure
- Spectral Power Distribution
- Controllability

Irrigation and Humidity

The most obvious and potentially damaging environmental condition that horticultural lighting is exposed to is water. Any type of lighting will have this concern, as electricity and water require some consideration, but this condition is typically magnified in a horticultural environment.

Efficient lighting solutions such as HID or LED have some manner of ballast or driver to convert the incoming AC line voltage into something useful for the light source as well as a method of directing the generated light. For HID, this could be a magnetic or electronic ballast for starting the lamps and maintaining the proper electrical conditions and reflectors for distributing the intense light over an area. For LEDs, this driver can be simple or complex and may have a reflector or a diffuser. Regardless of source type, degradation in either the electrical controls or optical controls will reduce the light output (to zero if the light becomes inoperable) and effectively reduce the yield and/or quality of the product.

Depending on the location of the fixture and the irrigation method in the facility, different levels of protection may be necessary. For drip irrigation or hydroponics, for example, the concern may be focused on keeping the high humidity from damaging internal components rather than guarding against direct spray. For other applications, rain like spray or even more forceful sprays may be a concern with the fixture, either from the irrigation system or from errant sprays due to manual watering.

Ingress protection is a necessary rating for most of these fixtures and should be considered when designing or selecting lighting options. Additional considerations such as ballast potting, conformal coatings, and gasketing for humidity protection may also be beneficial.

Temperature

Plants grow better when it is warm. That is fairly common knowledge, but the temperatures at which plants are grown – temperatures that can ranges as high as 30-40°C (86-104°F) – are often higher than the temperatures at which many luminaires are tested. While HID products are relatively insensitive to higher heat, their ballasts must still stay below their maximum temperature in order to achieve the expected lifetime. LED products typically lose intensity and efficiency as their temperature increases, so testing in an environment that is 10-15°C (18-27°F) below where it will be operated could result in overstating the amount of light that will be available to the plants.
For indoor applications, the proper ventilation of excess heat is also a significant consideration. Warmth is good for plants, but excess temperatures can be a problem as well. While lighting has become much more efficient over the years, there is no perfectly efficient lighting system. Any electrical power that is not converted into light and absorbed by the plants has to be converted into something (see the first law of thermodynamics) and that something is heat. In an indoor, warehouse-type growing situation where active ventilation is required, the heat generated by lights can become problematic and costly to remove. Using the least amount of electrical power for the amount of light needed by the plants is a wise strategy for managing energy consumption and the building costs used to control the air temperature.

**Chemical Exposure**

Plants need nutrients to grow properly and, when in an environment that has some exposure to the outdoors, pest control may be a necessity. The specific chemicals vary by crop, and unfortunately there is not a standardized set of chemical tests to consider when designing or selecting horticultural lighting fixtures.

**Spectral Power Distribution**

Selecting the best spectral power distribution is not a simple matter. When light affects the growth characteristics of a plant, it is known as phototropism. At its most basic, phototropism can cause a plant to grow towards or away from a light source, but additional growth changes are possible. The same is also true with spectrum. As noted earlier, a spectrum heavier in reds tends to make plants grow longer stems, and a spectrum heavier in blues encourages leaf growth. While these colors may seem obvious given the McCree Curve, other studies have shown that supplementing these colors with green light (up to a certain point) will enhance growth for some species, further supporting the need for multiple spectrums of light for optimal plant growth.

It stands to reason that to get the best out of a crop of plants, there may be a specific light formula that is appropriate, and that light formula may change over time depending on what the desired growth of the plant is and what stage of the plant lifecycle it is in. With HID lamps, changing the spectrum is possible with certain ballasts by swapping out a metal halide lamp for a high pressure sodium lamp, or vice versa. This is limited, however, to the spectrums that can be made with these technologies. With fluorescent lamps, switching to different phosphor combination lamps can achieve this as well, but with similar limitations to the number of available options. Multi-source LEDs have the potential to offer a wider range of tenability by using multiple direct color LEDs (potentially including UV and IR) and/or including some phosphor-converted white LEDs for a wider spectrum of light. The ‘right’ recipe of light for a plant will depend on the specific species, and this information can be closely guarded as a competitive advantage.

**Controllability**

The ability to alter the lighting according to changes in weather can be a factor for plants grown in greenhouses with supplemental lighting. Plants have their own desired daily light integrals, and it may be beneficial or desirable to not only supplement after sundown, but to allow for ad-hoc supplementation when the weather has been cloudy and less solar radiation is hitting the plants. HID sources can be dimmed to a degree, but they not as efficient when dimmed and have a reduced lifetime when they are turned on or off frequently. Alternatively, LED sources are typically dimmable with the proper driver and can be tied into a sensor similar to those used for indoor daylight harvesting applications, allowing for the proper light level to be maintained in the greenhouse without excess energy use.

**Summary**

Horticultural lighting is not new, but the options to choose from are wider than ever, and the interest in growing a wide variety of crops indoors has put additional focus on lighting options. Intended use, environmental conditions, targeted crops, plant lifecycles and desired flexibility can all be considerations when selecting and designing horticultural lighting fixtures for plant growth. These considerations are particularly important for fixtures that are intended for longterm use, as research may lead to more light recipes and insight into how lighting impacts the quality and quantity of plants that are grown with artificial light.
2016 Webinar Wednesdays: Lighting Performance and Energy Efficiency Regulations

UL is pleased to announce our 2016 calendar of webcasts for the lighting industry. Each one-hour webcast will offer insight and updates to the current North America building and energy efficiency codes at both state and federal levels.

Stay up to date on the ever-changing regulations that impact just about anyone involved in the lighting industry. Our Instructor for this Series is Austin Gelder:

Austin is a Technical Advisor for Lighting Performance with UL, supporting lighting photometric and compliance testing. Prior to joining UL, Austin spent several years in the lighting industry in the areas of LED product development, technical consulting, and lighting testing and measurement. He has worked with the U.S. Environmental Protection Agency (EPA) to lead the development of the ENERGY STAR® Luminaires and Lamps specifications, with Natural Resources Canada to perform a lighting market analysis, and with a LED lamp manufacturer in Atlanta, GA, working as a Technical Manager and Product Manager. Additionally, Austin became Lighting Certified through the NCQLP in 2013, participates in the Illumination Engineering Society’s (IES) Testing Procedures Committees, and is involved with the American Society for Agricultural and Biological Engineers’ (ASABE) efforts to develop metrics and test methods for horticultural lighting.

We hope you will join us for these informative learning sessions.

Click here to learn more about our webcast series.

Allentown Lumen Insights Live – Event Recap

On Tuesday June 7th, UL held an event called “Lumen Insights Live” at our Lighting Center of Excellence in Allentown, PA. The event consisted of presentations on Energy Efficiency programs as well as a tour of the laboratory.

Guest speaker Terry McGowan from the American Lighting Association discussed new trends in the Lighting industry. Daniel Rogers of ICF International discussed recent ENERGY STAR® updates on lamps 2.0 and luminaires 2.0. UL’s Austin Gelder covered DesignLights Consortium™ as well as Title 20 and 24 of The California Energy Commission. Stephen Italo presented on current safety topics within UL.

We are very proud of the efforts put forth by all of our staff to make this event successful and thankful for everyone that attended.
Color Property and Quality Metrics
By Austin A. Gelder / Lighting Performance Technical Advisor

Introduction

How many times have there been discussions about how an installed light should be ‘warmer,’ or is ‘the wrong white,’ or does not look as expected in some other way, leading to lost or gray hairs among lighting practitioners? Quantifying and describing intangible attributes is challenging and makes the lighting industry complicated and confusing most of the time. Few topics generate the same passion and disagreement as light quality and color, particularly when new metrics and requirements materialize.

Legislative actions by the California Energy Commission (CEC) and the release of IES TM-30-15 generated renewed industry interest in color quality metrics, causing many in the industry to seek a better understanding of how color is described. Subsequent discussions cover everything from the level of accuracy of rendered colors as compared to the preference of how colors are rendered and the shortcomings of using the Color Rendering Index (CRI) to alternative metrics and the MacAdam Ellipse. To understand these discussions and how different metrics could impact the industry, the existing and referenced metrics need to be understood.

Chromaticity

Chromaticity is a description of the color appearance of a light source and is generally represented as two points on a plane known as a color space.

Black Body Curve

A black body is a theoretical material that absorbs all electromagnetic radiation that hits it, making it an ideal emitter. The black body curve is a representation of the electromagnetic radiation that would be emitted by a black body if it were heated to a specific Kelvin temperature. While there are no perfect black body radiators, tungsten filaments act in a manner that is close to perfect until the point where they melt, which makes this curve relevant to real life. As an example, the appearance of a theoretical black body heated to 2700K would be a warm white chromaticity closer to the yellow-orange end of the spectrum, while a blackbody curve heated to 5000K would be a cool white chromaticity closer to the blue end of the spectrum. The curve generated by the chromaticity of these theoretical spectrums is the basis for the correlated color temperature that the lighting industry uses to describe the appearance of a white light.

Correlated Color Temperature

Correlated color temperature (commonly abbreviated as CCT) is the temperature to which a black body would have to be heated in order to have the same appearance of light. Similar to how heated objects behave, white light will have a ‘warmer’ appearance at low CCTs with more red and orange components in the spectrum. As the CCT gets higher, the spectrum contains comparatively more violet, blue and green components and has a ‘cooler’ appearance. For reference, most incandescent lamps are around 2600K to 2700K, halogen lamps with hotter running filaments run between 2900K and 3000K, and most ‘cool white’ fluorescent lamps have a color appearance of 4000K to 4100K. Due to Multiple chromaticity coordinate pairs, higher CCTs can have the same correlated color temperature, but each individual chromaticity coordinate can only have one correlated color temperature. However, CCT becomes meaningless when the light colors have a significant hue.

MacAdam Ellipse

In specifications and requirements, there are references to chromaticity and MacAdam Ellipses, or quadrangles. The MacAdam Ellipse is named for, D.L. MacAdam, a physicist who was researching the ‘just noticeable difference’ in colors between two lights and discovered that it was 3 standard deviations, or steps, around a point on the blackbody curve. This area on the color space around the target CCT point on the black body curve was generally elliptical and, thus, the MacAdam Ellipse got its name. While MacAdam was referring to 3 steps, production limitations and the realities of noticing a color difference in real life compared to laboratory situations resulted in differences other than 3 steps being used. LED production has typically been sorted into ‘bins,’ and binning techniques favor quadrangles rather than ellipses. Consistency varies with products, but for some examples linear fluorescent was closer to 4 or 5 steps, while CFL and LED products were generally closer to 7 steps. LED tolerances have become tighter over time and some products are much more consistent.

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Standards Corner

Standards information: ulstandards.ul.com/standards

Sign up for “What’s New” at: ulstandards.ul.com/access-standards/whats-new by selecting “Join Email List” on the What’s New site to receive email notifications twice a month that list the various UL, UL Environment, and ULC Standards documents published during that timeframe.

UL 153 - Portable Luminaires
• A new proposal was issued for preliminary review on May 5, 2016. The proposal relates to adding requirements for the use of split SPT-2 cords. A summary of related topics can be found here: http://www.comm-2000.com/ProductDetail.aspx?UniqueKey=31067

UL 1598 - Luminaires (Tri-National Standard)
• The next revision cycle has started and will be a 2-year cycle. Proposals received by the SDOs were issued for preliminary review on August 28, 2015. Comments closed on October 12, 2015. A summary of related topics can be found here: http://www.comm-2000.com/ProductDetail.aspx?UniqueKey=30005.

UL 1598C - Light Emitting Diode (LED) Retrofit Luminaire Conversion Kits
• The proposal related to fuse requirements for tubular fluorescent to LED conversion retrofit kits went out for preliminary review on February 6, 2015.

UL 1993 - Self-Ballasted Lamps and Lamp Adapters (Tri-National Standard)
• The next revision cycle has started. UL is the Publication Coordinator. The ballot process for multiple proposals was completed in September of 2015. A summary of related topics can be found here: http://www.comm-2000.com/ProductDetail.aspx?UniqueKey=29887.

UL 1574 - Track Lighting Systems
• A proposal to reaffirm ANSI approval was issued for ballot on April 8, 2016 and due on May 23, 2016. Consensus was achieved and the updated ANSI information will be published in the near future.

UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products
• A new proposal went out for preliminary review on February 19, 2016. The proposal relates to RTI requirements for thermosetting potting compounds. Link to the summary of topics: http://www.comm-2000.com/ProductDetail.aspx?UniqueKey=30669. This proposal has since been withdrawn by the proposal submitter.
• A new proposal went out for preliminary review on April 26, 2016. The proposal relates to revising potting compound requirements. Link to the summary of topics: http://www.comm-2000.com/ProductDetail.aspx?UniqueKey=31025

UL 496 – Lampholders (Bi-National Standard)
• The next revision cycle has started. A Call for Proposals was sent out on May 9, 2014. UL (the Publication Coordinator) sent the proposals received to the Technical Harmonization Committee for review. Multiple proposals went out for preliminary review on October 3, 2014. The proposals related to: (1) Proposed Addition of Requirements for Lampholder Fittings with Integral USB Connectors, (2) Proposed Addition of Requirements for Minimum Lead Wire Gauge Size for GU24 Outlet-Box Lampholders, and (3) Proposed Addition of Requirements to Clarify the Creepage Distances and Clearances Measurements. The comments received in response to the preliminary review were sent to the Technical Harmonization Committee (THC) for review and input. A proposed new edition, which incorporates the proposals that were sent out for preliminary review in October 2014, was issued for ballot on May 23, 2016 with a due date of July 7, 2016. Link to summary of topics: http://www.comm-2000.com/ProductDetail.aspx?UniqueKey=31132.

UL 482 – Portable Sun/Heat Lamps
• FDA proposal to amend performance standard for sunlamp products and ultraviolet (UV) lamps intended for use in these products (which may be viewed at https://federalregister.gov/a/2015-32023) would reference IEC 60335-2-27, Household and similar electrical appliances – Safety Part 2-27: Particular requirements for appliances for skin exposure to ultraviolet and infrared radiation, rather than UL 482. The FDA is seeking comments on the proposed rule by March 21, 2016.

UL 48 – Electric Signs
• A new proposal was issued for preliminary review on May 24, 2016. The proposals relate to: 1) New Requirements for Shipment of Sign Sections; 2) Standard Reference for LED Components and LED Retrofit Kits; and 3) Revision title of Section 4.4.10.2. Link to summary of topics: http://www.comm-2000.com/ProductDetail.aspx?UniqueKey=31138.

UL 879A – LED Sign and Sign Retrofit Kits
• A new proposal was issued for ballot after discussions during the March 10, 2016 STP 48/879A Meeting on May 27, 2016 with a due date of June 27, 2016. The proposals relate to: 1) Deletion of Supplement SA; and 2) Markings for Kit Installation Instructions. Link to summary of topics: http://www.comm-2000.com/ProductDetail.aspx?UniqueKey=31154.
The negative of this system is if two products are on opposite ‘sides’ of an ellipse, even a small eclipse, the difference can be quite noticeable. Even with a 3 step ellipse, products on extremes could be six standard deviations apart. Most specifications still reference 7 step ellipses or quadrangles, but the CEC has been tightening their requirements and requiring closer to a 4 step ellipse.

**Color Rendering Index**

The Color Rendering Index (from CIE 13.3 1995) is one of the older metrics and the one most frequently referenced for programs and regulations. It uses the accuracy of rendering a number of test color samples against how they would be rendered by an ideal source. This is calculated by computer off of the spectral power distribution of the light source.

There are 14 color samples in the Color Rendering Index. The first 8 color samples are a range of relatively unsaturated pastel type colors, the next 4 are strongly saturated colors, the last two - samples 13 and 14 - are a light yellow pink and olive green, respectively. The spectral power distribution is compared to the color characteristics of each sample and a score is generated. The score is negatively affected by undersaturation and oversaturation, with scores ranging from below zero (negative numbers) to a maximum positive value of 100.

The overall rendering score, Ra (which is typically referred to as a product’s CRI), only uses the rendering of the first 8 color samples. The additional chips are considered supplemental and are not included. As the calculation of Ra is only comprised of unsaturated colors, a reasonably good CRI can be obtained without being able to effectively render deeply saturated colors. For example, the most commonly found deficiency in phosphor based products is a deep red, which is a color that would be represented by sample number 9. A low R9 score can result in objects with red undertones (such as human skin, stone or wood products) looking washed out or having an unnatural tone.

However, the logical conclusion that a source with high color rendering will be preferred over a source with lower color rendering does not always hold true. Color preference does not necessarily follow CRI and some studies have shown preference to have certain colors (such as reds) slightly oversaturated, a characteristic that is penalized in the CRI calculations. Additionally, comparing the CRI of light sources with a significantly different CCT will not be useful.

Despite these shortcomings, CRI is still well recognized and reasonably understood as a good metric for color quality. It is referenced by regulations from the U.S. Department of Energy, the CEC, and voluntary programs such as the U.S. Environmental Protection Agency’s ENERGY STAR program and the DesignLights Consortium. CRI also has the advantage of being a single number metric and thus easier to remember. Finally, the incorporation of the metric into existing laws and programs means the industry is unlikely to abandon CRI anytime soon.

**Gamut Area Index**

Rather than focusing on fidelity in reference to any light source, the Gamut Area Index (GAI) typically scores the same color samples as CRI (1-8) and then maps these scores on the 1995 CIE color space. Generally speaking, the larger/higher the gamut area score, the more saturated color objects will appear. However, this metric is not terribly useful on its own, and is most commonly used in conjunction with the CRI metric. A GAI can be over 100, which will result in a lower CRI as the colors will appear oversaturated. A high CRI and high GAI are considered good indicators of color quality but, as with any metric, this is not perfect. The GAI has not been widely adopted in the North American Market and, with the CRI being only moderately understood by consumers as is, adopting an additional metric may not be beneficial.

**Class A Light Sources**

Around 2013, the Lighting Research Center proposed a unified, easy to understand metric. This metric was developed by combining existing metrics with a “line of minimum tint” in the chromaticity determined from their experiments which showed that, depending on the CCT, the appearance of no tint could be above or below the black body curve. This line is below the black body curve for CCTs under...
4000K and above the curve for higher CCTs. The requirements for the chromaticity are small, defined quadrangles the nominal CCTs. The other part of the metric is saturation and color rendering, and the requirement for this is for the light source to have a CRI of greater than 80 and a GAI between 80 and 100.

IES TM-30-15: Technical Memorandum for Evaluating Light

IES TM-30-15 was published in 2015, and its introduction generated significant interest in color metrics. This technical memorandum takes the approach that some other methods have attempted by stating that no one metric is appropriate, and two metrics would make for a better system. The IES also released a calculation software tool that uses the spectral power distribution to generate the metrics.

Similar to the CRI system, multiple color samples are used for evaluation, but rather than 8 samples, 99 samples are used to evaluate color between the test source and the referenced illuminant. All of the samples are based on real objects and purposefully include saturated colors. In addition to the number of samples, referenced illuminants are changed to be the blackbody radiator under 4500K, more continuous as a blend between a blackbody source and the CIE daylight illuminant from 4500 to 5500K, and the CIE daylight illuminant above 5500K. In the CRI system, a hard shift at 5000K made for a discontinuity.

TM-30-15: Fidelity Measure

Similar to CRI, there is a metric that addresses color fidelity, or how accurately colors illuminated by a light source are rendered. The metric that TM-30-15 uses for this is the Fidelity Measure, which is represented as Rf. While the scale of Rf will be similar to the CRI scale (up to 100 for the rendering to be equal to the referenced illuminant), the significant differences in color samples will likely result in different scores.

There may be instances where light sources that were designed specifically for the CRI system, or were designed to maximize the efficacy at a given CRI, may have scores lowered with the inclusion of the saturated color samples of the Rf metric. Similarly, there may be products with lower CRI scores that, when the wider array of color samples are factored in, will have a much higher Rf score. As these differences can be significant, simply moving an existing requirement from CRI to Rf is not a recommended practice. Until industry, specifiers and legislators have been able to assess the changes and evaluate products with different Rf values, requirements based on this metric may not achieve the desired results. In fact, both the National Electrical Manufacturers Association (NEMA) and the Illuminating Engineering Society (IES) itself recommend against including mandatory color rendering measures in regulations until there is a consensus regarding the appropriate metric and values.

TM-30-15: Gamut Index

The second factor of the TM-30-15 metric is the Gamut Index, or Rg. The Gamut Index uses the same set of color samples as the Rf metric and an average area on the color space of the tested illuminant in comparison to that of the referenced illuminant. However, this metric can be above or below 100, which starts causing confusion. At 100, the sample does not increase or decrease the saturation of colors compared to the referenced illuminant. Above 100, the tested source will oversaturate some colors and below 100 will undersaturate some colors. A visual comparison known as a color vector graphic can be used to illustrate differences if desired, showing what areas of the color space are over and under-saturated.

Saturation does not exist in a vacuum, however, and over- or under-saturation will have limitations on what the maximum Rf of a light source can be. If a source does not saturate at a level equivalent to that of the reference source, it cannot have a perfect score.

TM-30-15: Limitations

Like all systems, TM-30-15 has limitations in how it can be used.

Rf and Rg are average values based on a tested sample. Two samples with the same scores may not render every object or color region the same.
The specific areas of interest, if applicable, may have more information looking at the color vector graphic.

Comparing the Rf and Rg scores of light sources with different CCTs is not appropriate because the reference sources can be different. For example, a 3000K source with an Rf and Rg of 80 will show colors very differently than a 5000K source with an Rf and Rg of 80. This is no different than the existing CRI metric, but is worth noting.

Preference is also not included in the metric. As noted in “Class A Sources,” the perceived ‘no tint’ chromaticities do not necessarily line up with the theoretical chromaticities, and along these lines there are some studies that show preferences for chromaticities below the black body curve. There is also research showing that oversaturation can be preferred, or at least not disliked, depending on where the oversaturation is occurring. Once again similar to the current CRI system, preference and fidelity do not necessarily follow the same path.

Finally, while not a problem with the metric per se, theoretical maximum luminous efficacies will be lower for good to high Rf and Rg levels as compared to CRI. This is related to the wider range of samples that includes saturated colors and requires there to be light output at the very low and very high wavelength ranges of the visible spectrum. As these ranges have a comparatively low photometric response, including energy in these spectrums as opposed to more photopically efficient spectrums will lower the theoretical efficacies. This, too, is similar to what happens at higher CRIs, where including more saturated colors (particularly reds) is necessary and makes the product less efficient.

Summary
Color metrics continue to confound, and efforts to improve upon them while having a system that is simple enough for non-lighting practitioners to understand and use will continue to develop. IES’s TM-30-15 is the latest attempt to improve upon the incumbent CRI system and, to that effort, it does address some of the shortcomings, particularly when considering the rendering of saturated sources. The system is not perfect, but that statement would apply to any specification, method, or metric to date. Whether or not the TM-30-15 metrics of Rf and Rg will be adopted in the long run is unknown, but unlike previous attempts to improve upon CRI, some agencies, programs, and specifiers are asking or allowing for the data to be reported. The U.S. Environmental Protection Agency’s ENERGY STAR program requires the TM-30-15 metrics to be reported by certification bodies, and both the U.S. Department of Energy (DOE) LED Lighting Facts and the DesignLights Consortium allow TM-30-15 as an optional field that can be reported and listed with products. This early interest from market influencers shows potential for the new metrics, but CRI will be difficult to supplant as the standard bearer because it is still referenced in several laws from the U.S. DOE and the CEC has requirements for a high CRI and R9 in their building and appliance energy efficiency codes.

Free Recorded UL Webinar — Understanding the UL Class P LED Driver Program

The Class P LED Driver Program was introduced at the beginning of 2016 and is intended to help manufacturers benefit from greater supply chain flexibility and reduced certification expenses.

This free webinar will touch on the following topics:

- The evolution of LED drivers
- Requirements for LED drivers intended to be marked “Class P”
- Requirements for luminaires that use Class P LED drivers

Click here to view the free recording.
China CCC Update – Luminaire (LITE) Standard Update

Helena Y. Wolf / NA Region International Certification Director

There has been a standard update regarding the safety requirements for the CCC Mark for Luminaire Products. According to the Standardization Administration (SAC) of the P.R. China’s announcement, the standard “GB7000.1-2015 (Luminaires – Part 1: General requirements and tests al requirements, IDT IEC60598-1:2014)” has been issued and will become effective on January 1, 2017. This new standard will replace the current version, GB7000.1-2007.

Product Scope of Impact

This standard upgrade will apply to ALL types of Luminaire products subject to the CCC scope. Please refer to the following for specific product categories covered by this standard update:

<table>
<thead>
<tr>
<th>Product category</th>
<th>Group No. in CCC scope*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Luminaires</td>
<td>1001</td>
</tr>
</tbody>
</table>

* The Group Number is identical to the four digits in the middle of the CCC certificate number. For example, for the certificate with Certification Number 2007011001247494, “1001” is the Group Number.

Based on CNCA's Announcement “Circular No. 4, 2012, the relative requirement on the standard update for CCC Approvals,” all the CCC designated certification organizations like CQC will have the right to determine their own version of Implementation Timeline and Guidelines on Documentation and Sample Requirement for Standard Update. So far, CQC has not yet issued such a communication. However, UL will continue to track the development and provide updates as necessary.

How UL Can Help

UL's Global Market Access team can help you achieve compliance by identifying applicable requirements for your specific product or technology feature to comply with current regulations in safety, EMC, wireless and energy efficiency.

For more information, visit our Global Market Access website or contact our experts at gma@ul.com.

These updates are for informational purposes only and are not intended to convey legal or other professional advice.
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9/20/2016 Northbrook, IL

**Designing LED Luminaires for Compliance to UL1598 and UL8750**  
9/1/2016 Fremont, CA  
9/13/2016 Toronto, ON - UL

**UL Hazardous Locations Luminaire and Luminaire Fittings Certification to UL 844**  
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- **Energy Efficiency Program Updates and UL Verification Services**
- **Free Recorded Webinar: UL Cybersecurity Assurance Program – evaluating network-connectable products and systems per common security requirements**
- **Introduction to Zhaga**
- **LED Sign Construction Essentials**
- **LM-79 Performance Testing of Lamps and Luminaries (On-Demand)**