Horticultural Lighting:

Second Draft Guide and Key Questions

The DLC would like your input!

If you have ideas, comments, or suggestions for how to address these issues (or any others), please send a DLC Comment Form with supporting technical justification to info@designlights.org. These key questions apply to the **Second Draft Technical Requirements for LED-Based Horticultural Lighting** released for stakeholder input on August 1, 2018.

Key Question: Major Changes from Draft 1

The DLC has made several key changes to the basic structure and scope of the proposed requirements since the Draft 1 release. To ensure these changes are not missed, here is a summary. Comments on these changes are solicited.

- **Output:**
  All products will be evaluated against a single set of requirements, regardless of output, due to the widely varying applications and form factors in this early stage of market development. The DLC will monitor the composition and performance of products on the QPL and may introduce category distinctions in future revisions as manufacturing and usage trends become more clearly understood.

- **Ultraviolet Light:**
  The DLC understands that ultraviolet (UV) light holds promise for photomorphological and other uses. In its conversations with testing facilities, the DLC learned that the industry's existing infrastructure for testing whole-fixture output, whether via spherical integration or moving-mirror methods, is not yet ready for economical, high-confidence, and repeatable UV measurements. Since these requirements are based on whole-fixture testing, they will not reference product performance in UV wavelengths. The DLC is engaged with standards bodies and testing facilities to monitor and encourage this infrastructural development, and will consider adding references to UV-A and UV-B wavelengths (defined in ANSI/ASABE S640) as technical capacity and industry consensus develops.

- **Far Red Light:**
  The DLC understands that usage of light in the 700-800nm band ("far red") shows promise as an aid to photosynthetic and photomorphological effects in horticulture. As such, it will require the measurement of product output in this

band and publish it on its QPL to aid end users in product selection. However, given the decades-long prevalence of PPF (400-700nm) as a key design criterion in this application, and the need to establish useful baseline comparisons to incumbent light sources, the DLC will only count PPF output towards a fixture's efficacy threshold. As academic research and industry consensus develops, the DLC will remain engaged on the status of far red light and will always be open to considering new data for future revisions.

Key Question: Photosynthetic Photon Intensity Distribution (PPID)

Photosynthetic Photon Intensity Distribution (PPID) contains spatial distribution information describing a fixture's output in the 400-700nm range. It is the horticultural lighting equivalent to the lumen-weighted distribution description contained within what is commonly referred to as an ".ies file", defined via IES LM-63. Given the sensitivity of plant growth to differences in light intensity at the canopy (Photosynthetic Photon Flux Density or PPFD), it is important to designers and end users to understand the distribution and evenness of light in a facility's lighting design.

The DLC is proposing to require PPID data (and publish it on its QPL) with product applications, both for its own understanding of market trends (to inform potential future sub-categories of products) and for the education of designers and end users. A potential risk of the introduction of LEDs to the horticultural market is the application of LED-based products to HPS-based layouts in a "one for one" pattern, without understanding product differences in output and distribution. By publishing this data, the DLC hopes to encourage careful project design and the adoption of best practices.

Many options are available for presenting PPID data to end users. The DLC seeks comment on the various methods described below.

- The core documents, either PPF-filtered LM-63 or the pending draft TM-33, are hosted on the DLC's QPL, and downloadable by end users.
- The documents themselves are not hosted on the DLC's QPL, but images of sufficient size (300 x 300 pixels) summarizing their key characteristics (namely, polar plots of horizontal and vertical intensities) are downloadable by end users for qualitative comparison.
- No documents are hosted on the DLC's QPL, but a link is provided pointing to a manufacturer's website where users can find them. This link must be maintained to keep the associated product eligible.

Key Question: What is the best way to communicate these data to designers and end users?

Key Question: SQD

The Spectral Quantum Distribution (SQD) contains information on the spectral composition of fixture output, in µmol/s, by wavelength, for a user-defined range of wavelengths. Because the DLC is proposing to set its thresholds in the 400-700nm range, while reporting on flux in the 700-800nm ("far red") range, it is proposing to set the required SQD range to 400-800nm.

The DLC is proposing to require this data (and publish it on its QPL) with product applications, both for its own understanding of market trends (to inform potential future sub-categories of products) and for the education of designers and end users. Crop- and application-specific needs may drive users to a particular spectral composition, and by publishing this data, the DLC hopes to encourage careful project design and the adoption of best practices.

Many options are available for presenting SQD data to end users. The DLC seeks comment on the various methods described below.

- The core documents, either TM-27 or the pending draft TM-33, are hosted on the DLC's QPL, and downloadable by end users.
- The documents themselves are not hosted on the DLC's QPL, but images of sufficient size (300 x 300 pixels) summarizing their key characteristics (namely, SQD plots of the 400-800nm range) are downloadable by end users for qualitative comparison.
- No documents are hosted on the DLC's QPL, but a link is provided pointing to a manufacturer's website where users can find them. This link must be maintained to keep the associated product eligible.

> **Key Question:** What is the best way to communicate these data to designers and end users?

Key Question: Major and Minor Revision Cycle

The DLC understands that its stakeholders have complex, multi-year roadmaps of their own. From utilities to manufacturers to designers, predictability and certainty in the larger industry landscape helps guide decision-making. To that end, the DLC is proposing to establish a 24-month major revision cycle, and 12-month minor revision cycle for its horticultural requirements. This major revision cycle would be primarily marked by a new minimum PPFE threshold, defined by the fifteenth percentile efficacy among listed products on the first day of the eighteenth month of the current revision's cycle.

The DLC is further proposing to unify all product qualifications to last for the length of the in-effect revision cycle, plus a six-month grace period after the beginning of the next

revision cycle. To review the structure of this proposed revision update and qualification duration, please see the companion document, "Horticultural Lighting Requirements Revision Schedule" posted as a companion to this draft Requirements document.

Key Questions: Does the 24-month major revision cycle give enough certainty to stakeholders for their own planning purposes? Does the fifteenth percentile indexing plan strike the right balance between advancing energy efficiency and allowing ex-PAR experimentation? Does this "batch" qualification and delisting approach produce certainty for QPL users? Are there alternate, "non-batch" approaches or methods to setting higher efficacy levels the DLC should consider instead?

Key Question: Labeling

The DLC is interested in making it as easy as possible to quickly understand key facts about a fixture's performance. One example could be to encourage or require the usage of a standardized label on each fixture's spec sheet. One potential design is described in "Proposed Product Label for Electric Lamps Used in the Plant Sciences", by Arend-Jan Both, Bruce Bugbee, Chieri Kubota, Roberto G. Lopez, Cary Mitchell, Erik S. Runkle and Claude Wallace, published in HortTechnology, August 2017 vol. 27 no. 4 544-549.

The DLC is interested in encouraging (or requiring) labeling efforts like these, but wishes to understand any potential complications for stakeholders. For example, the label in question contains variables that are not defined or mentioned in the DLC's Requirements, like Correlated Color Temperature and Color Rendering Index, among others.

Key Questions: Should DLC encourage or require applicants' spec sheets to carry this label to qualify for its QPL? What are the implications of non-verified or non-defined (in DLC's Requirements) variables being present on this label?

Key Questions: Spec Sheets and QPL Data

In the general illumination program, the DLC has seen confusion in the market and is concerned about marketing materials being significantly different than data and performance represented by manufacturers during the qualification process, and therefore listed on the QPL. To avoid similar circumstances in horticultural lighting, the DLC is considering several explicit rules regarding the presentation of data in customer-facing marketing materials.

- First, the DLC is considering requiring any performance claims made on marketing materials to be consistent with data presented during the qualification process.

This would prohibit, for example, a manufacturer from claiming a specific PPF or PPFE on spec sheets or cut sheets when data clearly show a different value.

- Second, similar to SQD and PPID data, the DLC is considering making the submitted spec sheets for each product viewable and accessible to users of the QPL.
- Finally, as products are known and understood to upgrade over time, the DLC is considering more expansive, explicit rules for what types of changes will trigger a required update of listing information, including updates or modifications to spec sheets.

> **Key Questions:** The DLC seeks feedback on the above from all stakeholders and potential users of the QPL. Would working to ensure that marketing claims of performance be consistent with the QPL listings be a value to your use on the QPL as a resource? What would appropriate tolerances be between tested information and marketing claims?

Key Question: Supplemental Educational Material

The DLC views its Requirements and QPL as pieces of a larger effort that will lead to greater agricultural outcomes with reduced resource inputs. The DLC specifically wishes to forestall any unwarranted reliance on assumptions of "one-for-one" product suitability when replacing legacy technologies, since a poorly designed facility may lead to negative grower outcomes, slowing the pace of energy-saving LED adoption. As such, it plans to publish supplemental material to help designers and end users make the most of the coming market transformation. The DLC seeks comment on the type, number, and depth of coverage of these supplemental materials:

- Ultraviolet light: While the DLC is waiting for whole-fixture test methods to mature before reporting or requiring data on UV output, it does not wish to discourage the usage of application-specific measurements of UV output (spectroradiometer readings in typical application geometries, for example) from products. Even though they are problematic for high-volume, fixture-based efforts like the DLC's QPL, they may hold value for well-informed and careful users. The DLC is considering a one-page illustrated guide to this approach to help avoid any unwarranted fear, uncertainty, or doubt.
- Application design: The DLC's standards are fixture based, while a successful grower will have an optimized facility design that considers a lighting layout as one of many crucial factors. The DLC is considering a two-page illustrated guide to describe the necessary "integrated systems" approach, while pointing readers to external sources of authoritative, vendor-neutral advice they can reference.

Key Questions: Are these supplemental materials useful to designers and end users? Are there any topics not covered that should be included? To which external entities should these materials direct readers?