DRAFT Testing and Reporting Requirements for Horticultural Lighting

Horticultural lighting products must comply with the provisions of this document to be eligible for listing on the DLC Solid-State Horticultural Lighting Qualified Products List (Horticultural QPL). Products eligible for DLC qualification must be complete LED light fixtures. That is, they must be electromagnetic radiation-generating devices analogous to luminaires as defined by ANSI/IES RP-16 sections 6.8.5 and 10.3.1. Only products designed and intended to operate with standard AC line-voltage are eligible, but the DLC intends to issue regular updates to these requirements, and does not exclude the possibility of including DC and PoE-based systems in future revisions.

Definitions

Unless otherwise noted, DLC policy nomenclature is intended to directly reference the definitions from the American Society of Agricultural and Biological Engineers (ASABE) ANSI/ASABE S640: Quantities and Units of Electromagnetic Radiation for Plants (Photosynthetic Organisms), and, where applicable, the Illuminating Engineering Society (IES) ANSI/IES RP-16: Nomenclature and Definitions for Illuminating Engineering, with key deviations or interpretations noted.

Eligibility

The following are eligibility rules for horticultural lighting products:

- Products that are lamps (RP-16 sections 6.8.5.3, and 6.8.5.4), light engines (RP-16 section 6.8.5.5), or identified as retrofit kits intended to replace the light sources or other structures within an existing fixture, are not eligible.
- Fixtures that incorporate light sources other than LED, whether as sole-source or as LED-hybrid fixtures, are not eligible.
• Fixtures or fixture-like devices that employ complex active cooling systems, including circulating-liquid cooling methods and external forced-air systems, are not eligible. Products that incorporate internal active cooling systems that can be measured via standardized fixture test procedures, such as on-board fans, are eligible.

• Fixtures that otherwise fall outside the scope of ANSI/ASABE X642: Recommended Methods for Measurement and Testing of LED Products for Plant Growth and Development are not eligible.

### Testing Methods and Requirements

The structure for the DLC Technical Requirements and subsequent QPL will be divided as follows:

#### Output:

The DLC requirements are divided between “high-output” and “low-output” devices. High-output devices are intended to be energy efficient alternatives to or replacements for high-wattage HID fixtures in top-grow geometries. Such fixtures are generally mounted farther away from the plant canopy than low-output devices. Low-output devices are intended to be energy efficient replacements for lower-wattage non-LED technology, including fluorescent lighting. Such fixtures are generally mounted closer to the plant canopy than high-output devices, and may be used either in a single-layer top-lighting geometry or as multi-layer intra-canopy lighting.

#### Intended Use:

The DLC will report the manufacturer’s distinction on whether a product is intended for “supplemental” lighting, or “sole-source” lighting. Supplemental devices are intended for use in greenhouses or other structures with ceilings and walls that allow the transmittance of light, and are used to supplement natural sunlight. Sole-source devices are intended for use in warehouses or other structures that prevent sunlight from reaching the plant, and are therefore providing all light needed for plant growth. Product listings will be allowed to indicate both uses if manufacturers market their products for both situations. Warranty terms will be examined to ensure that representative daily hours of usage for each intended use will be allowed (a minimum of 12 hours daily for supplemental, and 18 hours daily for sole-source).
The DLC Technical Requirements for Horticultural Lighting are as follows. Details of each metric follow below the table.

**Table 1: DLC Horticultural Lighting Technical Requirements**

<table>
<thead>
<tr>
<th>Parameter/Attribute/Metric</th>
<th>Requirement</th>
<th>Requirement Type</th>
<th>Method of Measurement/Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photosynthetic Photon Flux (PPF), (µmol/s)</td>
<td>High-Output Devices: ≥300 µmol/s</td>
<td>Reported, Category Differentiator</td>
<td>X642, Section 4.2 (LM-79-08) 400nm-700nm range</td>
</tr>
<tr>
<td></td>
<td>Low-Output Devices: &lt;300 µmol/s</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Photon Flux (PF), (µmol/s)</td>
<td>n/a</td>
<td>Reported</td>
<td>X642, Section 4.2 (LM-79-08) 280nm-800nm range</td>
</tr>
<tr>
<td>Spectral Quantum Distribution (µmol/s/nm)</td>
<td>n/a</td>
<td>Reported</td>
<td>X642, Section 4.2 (TM-27-14 or TM-33) 280nm-800nm range</td>
</tr>
<tr>
<td>Photosynthetic Photon Intensity Distribution (µmol/s/sr)</td>
<td>n/a</td>
<td>Reported</td>
<td>X642, Section 4.3 (TM-33 or adapted LM-63) 400nm-700nm range</td>
</tr>
<tr>
<td>Photosynthetic Photon Efficacy (PPE), (µmol/J)</td>
<td>High-Output Devices: ≥2.1 µmol/J</td>
<td>Required/Threshold</td>
<td>X642, Section 4.2 (LM-79-08) 400nm-700nm range</td>
</tr>
<tr>
<td></td>
<td>Low-Output Devices: ≥2.1 µmol/J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flux Maintenance, PPF</td>
<td>Q₉₀ ≥36,000h</td>
<td>Required/Threshold</td>
<td>X642, Section 5.1 and 5.2 (LM-80 / TM-21 testing) 400nm-700nm range</td>
</tr>
<tr>
<td>Flux Maintenance, PF</td>
<td>Report time to Q₉₀</td>
<td>Reported</td>
<td>X642, Section 5.1 and 5.2 (LM-80 / TM-21 testing) 280nm-800nm range</td>
</tr>
<tr>
<td>Driver Lifetime</td>
<td>≥50,000 hours</td>
<td>Required/Threshold</td>
<td>Driver Technical Specification Sheet and ISTMT</td>
</tr>
<tr>
<td>Fan MTBF</td>
<td>≥50,000 hours</td>
<td>Required/Threshold</td>
<td>Fan Technical Specification Sheet</td>
</tr>
<tr>
<td>Warranty</td>
<td>5 years</td>
<td>Required/Threshold</td>
<td>Legal Warranty Terms &amp; Conditions</td>
</tr>
</tbody>
</table>
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</tr>
</thead>
<tbody>
<tr>
<td>Power Factor</td>
<td>≥0.9</td>
<td>Required/Threshold</td>
</tr>
<tr>
<td>Total Harmonic Distortion</td>
<td>≤20%</td>
<td>Required/Threshold</td>
</tr>
<tr>
<td>Safety Certification</td>
<td>Appropriate Horticultural Lighting designation by OSHA NRTL or SCC-recognized body</td>
<td>Required/Threshold</td>
</tr>
</tbody>
</table>

### Output Characteristics:

The DLC requires testing and reporting of the following characteristics of the output of horticultural lighting devices:

- **Photosynthetic Photon Flux (PPF), (µmol/s)**
  This is the total output of the product, over the specific range of wavelengths defined by ANSI/ASABE S640 for PPF (400-700nm). This metric is an integrated value for the entire device, and contains no granular spectral or directional information.

- **Photon Flux (PF), (µmol/s)**
  This is the total PF output of the product, over the entire range of wavelengths defined by ANSI/ASABE S640 (280-800nm). This metric is an integrated value for the entire device, and contains no granular spectral or directional information. This metric is a reported field only.

- **Spectral Quantum Distribution (SQD), (µmol/s/nm)**
  This is the distribution of photon flux per photon wavelength, over the entire range of wavelengths defined by ANSI/ASABE S640 (280-800nm). This distribution is measured and reported as integrated in all directions from the device, and contains no granular directional information itself. This will be required in TM-27 or pending TM-33 format, per ASABE X642, at a resolution of no coarser than 5nm.

- **Photosynthetic Photon Intensity Distribution (PPID), (µmol/s/sr)**
  This is the distribution of PPF intensity per unit solid angle leaving the device. This distribution is measured and reported as integrated for all wavelengths across the 400-700nm range leaving the device, and contains no granular spectral distribution information itself. This will be required in TM-33 format, at a resolution of no less than prescribed in ANSI/IES LM-79.
Efficacy:
The DLC requires testing and reporting of Photosynthetic Photon Efficacy (PPE), which is the output of the fixture over the specific range of wavelengths defined by ANSI/ASABE S640 for PPF (400-700nm), divided by all electrical input watts to the device, including any other ancillary loads (controllers, sensors, cooling fans, etc.).

- Products with a PPF of ≥300 µmol/s of (“high-output products”) will be required to have a PPE of ≥ 2.1 µmol/J.
- Products with a PPF of <300 µmol/s of PPF (“low-output products”) will be required to have a PPE of ≥ 2.1 µmol/J.

Long Term Performance:
The DLC requires the following performance items to characterize the long-term performance and reliability of the device:

- **Flux Maintenance, PPF and PF**
  This is a characterization of the ability of the device to maintain its output within the PPF range over time.
  - The DLC will require LED device-level testing and projections in accordance with the LM-80 and TM-21 industry standards sufficient for a Q$_{90}$ of ≥36,000 hours within the PPF range (400-700nm).
  - The DLC will require testing and projections to report Q$_{90}$ for the full PF range of 280-800nm, but will not make determinations or qualifications based on this data.
  - To support PPF and PF maintenance projections, LM-80 information must be provided for both the 400-700nm range and the 280-800nm range.
  - Additionally, **In-Situ Temperature Measurement Testing (ISTMT)** must be conducted and provided for the hottest LED in the fixture, and LED-device level drive current must be reported.
  - For fixtures utilizing multiple types of LEDs (for example, a fixture that includes a blue, a phosphor-converted white, and a red LED):
    - LM-80 reports must be provided for each type of LED device present in the luminaire.
    - ISTMT testing must be provided on the hottest of each of the LED types. (For example, the hottest blue, white, and red LED in the fixture, respectively.)
    - Maximum drive current must be reported for each of the LED types.
• Completed TM-21 calculators must be provided for each LED type, corresponding to the LM-80 and ISTMT for that LED type.

• For PPF maintenance (400-700nm), each LED type present in the fixture must independently meet the $Q_{90} \geq 36,000$ hour requirement. As this is a normalized and relative maintenance requirement, it is required that all LED types meet this maintenance threshold, irrespective to the portion of output they produce within the PAR range.

• For the broader PF maintenance (280-800nm), the DLC will report the $Q_{90}$ projection for each LED type present in the fixture on the QPL. There will be no threshold performance requirement across this broader range.

• **Warranty**
  Products must have a manufacturer-provided warranty of at least 5 years. The warranty terms and conditions must be provided as part of the submittal for qualification. Terms and conditions must not exclude key components such as the LED, driver, cooling fans (if present) or optics, and must not exclude usage of no less than 12 hours per day for supplemental lighting products, or 18 hours per day for sole-source products.

• **Driver ISTMT**
  Applicants must supply a technical specification sheet for the driver they use in their product, showing the lifetime of the driver based on operating temperature and the temperature measurement point (TMP) for monitoring the operating temperature of the driver during operation. In-situ temperature measurement testing must be conducted and a report must be provided with the application showing an operating temperature consistent with the driver spec sheet information and demonstrating that the driver will have a lifetime of at least 50,000 hours.

• **Fans**
  Products that employ cooling fans must provide a technical specification sheet for each fan type employed in the product. The fan specification sheet will specifically state the MTBF of the fan, which must be at least 50,000 hours.

**Electrical Performance/Power Quality:**

The DLC requires the testing and reporting of the following to characterize the electrical performance of the device:
• **Power Factor**  
  Products must have a measured power factor of ≥0.90 at any rated input voltage.

• **Total Harmonic Distortion**  
  Products must have a measured THDi of ≤20% at any rated input voltage.

**Safety:**  
The DLC requires products to be appropriately safety certified by a relevant safety certification body in the United States or Canada. Specifically, products must be certified by an OSHA NRTL or SCC-recognized body to a set of safety requirements and standards deemed applicable to horticultural lighting products by that safety organization. As an industry consensus safety standard for horticultural lighting products does not currently exist, the DLC will remain in contact with relevant safety organizations to understand how they are certifying these products and to ensure that certifications are in accordance with those bodies’ relevant practices. For illustrative purposes, practices of relevant safety organizations are described below:

• **UL**  
  UL has defined a preliminary Outline of Investigation (OOI), currently identified as UL 8800, for the review and certification of horticultural lighting products. Device manufacturers who use UL for safety certification purposes will be expected to be listed on the UL Certification Directory under the designation IFAU.

• **ETL/Intertek**  
  ETL has defined an internal set of guidelines for the purposes of certifying horticultural fixtures. Although there is not a reference number for ETL’s guidelines, they generally harmonize with UL 8800, with minor additions. Device manufacturers who use ETL for safety certification purposes will be expected to be listed on the ETL Certification Directory, specifically as Horticultural Fixtures.

• **Other safety organizations**  
  The DLC will work with other safety organizations to understand their rules for horticultural products as necessary.
Supporting Documentation

Test Reports:

The DLC requires that all testing be conducted at appropriately accredited laboratories. Specifically:

- Testing to ASABE X642-defined requirements must be conducted at laboratories that are accredited to ISO 17025 and the appropriate reference test standard by accreditation bodies that are signatories to the ILAC-MRA.
  - Labs conducting testing to X642 Sections 4.1, 4.2, and 4.3 must also be acceptable via the DLC requirements for LM-79 labs in the SSL QPL program.
  - Labs conducting testing to X642 Sections 5.1 and 5.3, and conducting projections via 5.2 and 5.4, must also be acceptable via the DLC requirements for LM-80/LM-84 labs.
- Labs conducting In-Situ Temperature Measurement Testing (ISTMT) must meet at least one of the following, consistent with requirements for SSL for general illumination:
  - Approved by OSHA as Nationally Recognized Testing Laboratories (NRTLs).
  - Approved through an OSHA NRTL data acceptance program or OSHA Satellite Notification and Acceptance Program (SNAP).
  - Accredited for ANSI/UL 1598 or CSA C22.2 No. 250.0-08, including Sections 19.7, 19.10-16, by an accreditation organization that is an ILAC-MRA Signatory.

Additional Application Details

In addition to the test data noted in the sections above, the DLC will require for all submissions:

- A completed application form
- Specification sheets (or “cut sheets”) for the product
- Marketing brochures used to describe and sell the product
- Specification sheets for all drivers and fans employed in the product
- A self-certification statement, in the form of a digital signature made during the application process
• Safety certificates of compliance as issued by the relevant safety body, attested to by the self-certification statement above

• A completed TM-21 calculator must be provided for each LED device present in the fixture, with the applicable LM-80 and ISTMT information for that LED device

The DLC will only accept applications for products with their own testing. Grouping or "family" approaches will be considered if market conditions warrant as the sector matures.

**Special Considerations for Spectrally Tunable Devices**

Spectrally tunable products (those with varying output channels beyond simple, single-axis dimming of the whole product) will be eligible with the following conditions:

- Products will be tested in full-output ("all channels on") conditions. Test reports must specifically state that the product is operated in this mode during the testing, with a description of the control narrative to ensure that all photon emission is at its highest designed level.

- In addition to the "all on" condition, products will repeat a portion of the overall testing for each control channel, in which the channel under test will be set to the maximum designed output, while all other channels will be set to their minimum designed output for this state.
  - The output of the specific channel testing will be displayed in a SQD chart, with the per-channel test outcomes overlaid on the full-output chart. Additionally, the test report will present the name, PPF (400-700nm), and PF (280-800nm) for each of the single-channel scenarios, along with that of the "all on" condition. These data will support uniform presentation of information about the product's spectral tuning range, aiding product selection and user acceptance.

- Products will provide user-facing documentation narrating the control protocol and input parameters employed in controlling the output.

- For PPF and PF maintenance evaluation:
  - Provisions for products utilizing multiple types of LEDs (above) must be followed.
o ISTMT testing must be provided on the hottest of each of the LED types. This testing must be conducted in the hottest operating mode of the fixture, corresponding to the “all on” condition (i.e. full-output).

Listing on the QPL

Information noted in the requirements and testing above will be noted on the QPL. For SQD and PPF Intensity Distributions, the QPL may allow users of the QPL to link, download, or view the data array directly for use in calculating specific metrics or modeling their intended lighting layout.