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## DRAFT Testing and Reporting Requirements for Horticultural Lighting

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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.

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### Definitions

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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.

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### Eligibility

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- 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.



- 27 • Fixtures or fixture-like devices that employ complex active cooling systems,  
28 including circulating-liquid cooling methods and external forced-air systems,  
29 are not eligible. Products that incorporate internal active cooling systems that  
30 can be measured via standardized fixture test procedures, such as on-board  
31 fans, are eligible.
- 32 • Fixtures that otherwise fall outside the scope of *ANSI/ASABE X642:*  
33 *Recommended Methods for Measurement and Testing of LED Products for*  
34 *Plant Growth and Development* are not eligible.

## 35 **Testing Methods and Requirements**

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

### 38 **Output:**

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

### 48 **Intended Use:**

49 The DLC will report the manufacturer’s distinction on whether a product is intended  
50 for “supplemental” lighting, or “sole-source” lighting. Supplemental devices are  
51 intended for use in greenhouses or other structures with ceilings and walls that  
52 allow the transmittance of light, and are used to supplement natural sunlight. Sole-  
53 source devices are intended for use in warehouses or other structures that prevent  
54 sunlight from reaching the plant, and are therefore providing all light needed for  
55 plant growth. Product listings will be allowed to indicate both uses if manufacturers  
56 market their products for both situations. Warranty terms will be examined to  
57 ensure that representative daily hours of usage for each intended use will be  
58 allowed (a minimum of 12 hours daily for supplemental, and 18 hours daily for  
59 sole-source).

60 The DLC Technical Requirements for Horticultural Lighting are as follows. Details of  
 61 each metric follow below the table.

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

Parameter/Attribute/Metric	Requirement	Requirement Type	Method of Measurement/Evaluation
Photosynthetic Photon Flux (PPF), ( $\mu\text{mol/s}$ )	High-Output Devices: $\geq 300 \mu\text{mol/s}$	Reported, Category Differentiator	X642, Section 4.2 (LM-79-08) 400nm-700nm range
	Low-Output Devices: $< 300 \mu\text{mol/s}$		
Photon Flux (PF), ( $\mu\text{mol/s}$ )	n/a	Reported	X642, Section 4.2 (LM-79-08) 280nm-800nm range
Spectral Quantum Distribution ( $\mu\text{mol/s/nm}$ )	n/a	Reported	X642, Section 4.2 (TM-27-14 or TM-33) 280nm-800nm range
Photosynthetic Photon Intensity Distribution ( $\mu\text{mol/s/sr}$ )	n/a	Reported	X642, Section 4.3 (TM-33 or adapted LM-63) 400nm-700nm range
Photosynthetic Photon Efficacy (PPE), ( $\mu\text{mol/J}$ )	High-Output Devices: $\geq 2.1 \mu\text{mol/J}$	Required/Threshold	X642, Section 4.2 (LM-79-08) 400nm-700nm range
	Low-Output Devices: $\geq 2.1 \mu\text{mol/J}$		
Flux Maintenance, PPF	$Q_{90} \geq 36,000\text{h}$	Required/Threshold	X642, Section 5.1 and 5.2 (LM-80 / TM-21 testing) 400nm-700nm range
Flux Maintenance, PF	Report time to $Q_{90}$	Reported	X642, Section 5.1 and 5.2 (LM-80 / TM-21 testing) 280nm-800nm range
Driver Lifetime	$\geq 50,000$ hours	Required/Threshold	Driver Technical Specification Sheet and ISTMT
Fan MTBF	$\geq 50,000$ hours	Required/Threshold	Fan Technical Specification Sheet
Warranty	5 years	Required/Threshold	Legal Warranty Terms & Conditions

Parameter/Attribute/Metric	Requirement	Requirement Type	Method of Measurement/Evaluation
Power Factor	≥0.9	Required/Threshold	LM-79/ASABE X642
Total Harmonic Distortion	≤20%	Required/Threshold	LM-79/ASABE X642
Safety Certification	Appropriate Horticultural Lighting designation by OSHA NRTL or SCC-recognized body	Required/Threshold	Per safety certification body (see below)

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64 **Output Characteristics:**

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

- 67 • **Photosynthetic Photon Flux (PPF), (μmol/s)**  
 68 This is the total output of the product, over the specific range of wavelengths  
 69 defined by ANSI/ASABE S640 for PPF (400-700nm). This metric is an  
 70 integrated value for the entire device, and contains no granular spectral or  
 71 directional information.
- 72 • **Photon Flux (PF), (μmol/s)**  
 73 This is the total PF output of the product, over the entire range of  
 74 wavelengths defined by ANSI/ASABE S640 (280-800nm). This metric is an  
 75 integrated value for the entire device, and contains no granular spectral or  
 76 directional information. This metric is a reported field only.
- 77 • **Spectral Quantum Distribution (SQD), (μmol/s/nm)**  
 78 This is the distribution of photon flux per photon wavelength, over the entire  
 79 range of wavelengths defined by ANSI/ASABE S640 (280-800nm). This  
 80 distribution is measured and reported as integrated in all directions from the  
 81 device, and contains no granular directional information itself. This will be  
 82 required in TM-27 or pending TM-33 format, per ASABE X642, at a resolution  
 83 of no coarser than 5nm.
- 84 • **Photosynthetic Photon Intensity Distribution (PPID), (μmol/s/sr)**  
 85 This is the distribution of PPF intensity per unit solid angle leaving the device.  
 86 This distribution is measured and reported as integrated for all wavelengths  
 87 across the 400-700nm range leaving the device, and contains no granular  
 88 spectral distribution information itself. This will be required in TM-33 format,  
 89 at a resolution of no less than prescribed in ANSI/IES LM-79.

90 **Efficacy:**

91 The DLC requires testing and reporting of Photosynthetic Photon Efficacy (PPE),  
92 which is the output of the fixture over the specific range of wavelengths defined by  
93 ANSI/ASABE S640 for PPF (400-700nm), divided by all electrical input watts to the  
94 device, including any other ancillary loads (controllers, sensors, cooling fans, etc.).

- 95 • Products with a PPF of  $\geq 300 \mu\text{mol/s}$  of ("high-output products") will be  
96 required to have a PPE of  $\geq 2.1 \mu\text{mol/J}$ .
- 97 • Products with a PPF of  $< 300 \mu\text{mol/s}$  of PPF ("low-output products") will be  
98 required to have a PPE of  $\geq 2.1 \mu\text{mol/J}$ .

99 **Long Term Performance:**

100 The DLC requires the following performance items to characterize the long-term  
101 performance and reliability of the device:

- 102 • **Flux Maintenance, PPF and PF**  
103 This is a characterization of the ability of the device to maintain its output  
104 within the PPF range over time.
  - 105 ○ The DLC will require LED device-level testing and projections in  
106 accordance with the LM-80 and TM-21 industry standards sufficient for  
107 a  $Q_{90}$  of  $\geq 36,000$  hours within the PPF range (400-700nm).
  - 108 ○ The DLC will require testing and projections to report  $Q_{90}$  for the full PF  
109 range of 280-800nm, but will not make determinations or  
110 qualifications based on this data.
  - 111 ○ To support PPF and PF maintenance projections, LM-80 information  
112 must be provided for both the 400-700nm range and the 280-800nm  
113 range.
  - 114 ○ Additionally, *In-Situ Temperature Measurement Testing* (ISTMT) must  
115 be conducted and provided for the hottest LED in the fixture, and LED-  
116 device level drive current must be reported.
  - 117 ○ For fixtures utilizing multiple types of LEDs (for example, a fixture that  
118 includes a blue, a phosphor-converted white, and a red LED):
    - 119 ▪ LM-80 reports must be provided for each type of LED device  
120 present in the luminaire.
    - 121 ▪ ISTMT testing must be provided on the hottest of each of the  
122 LED types. (For example, the hottest blue, white, and red LED in  
123 the fixture, respectively.)
    - 124 ▪ Maximum drive current must be reported for each of the LED  
125 types.

- 126                   ▪ Completed TM-21 calculators must be provided for each LED  
127                   type, corresponding to the LM-80 and ISTMT for that LED type.
- 128                   ▪ For PPF maintenance (400-700nm), each LED type present in  
129                   the fixture must independently meet the  $Q_{90} \geq 36,000$  hour  
130                   requirement. As this is a normalized and relative maintenance  
131                   requirement, it is required that all LED types meet this  
132                   maintenance threshold, irrespective to the portion of output  
133                   they produce within the PAR range.
- 134                   ▪ For the broader PF maintenance (280-800nm), the DLC will  
135                   report the  $Q_{90}$  projection for each LED type present in the fixture  
136                   on the QPL. There will be no threshold performance requirement  
137                   across this broader range.

138       • **Warranty**

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

145       • **Driver ISTMT**

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

154       • **Fans**

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

159   **Electrical Performance/Power Quality:**

160   The DLC requires the testing and reporting of the following to characterize the  
161   electrical performance of the device:

- 162 • **Power Factor**
- 163 Products must have a measured power factor of  $\geq 0.90$  at any rated input
- 164 voltage.
- 165 • **Total Harmonic Distortion**
- 166 Products must have a measured THDi of  $\leq 20\%$  at any rated input voltage.

167 **Safety:**

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

- 178 • **UL**
- 179 UL has defined a preliminary Outline of Investigation (OOI), currently
- 180 identified as UL 8800, for the review and certification of horticultural lighting
- 181 products. Device manufacturers who use UL for safety certification purposes
- 182 will be expected to be listed on the UL Certification Directory under the
- 183 designation IFAU.
- 184 • **ETL/Intertek**
- 185 ETL has defined an internal set of guidelines for the purposes of certifying
- 186 horticultural fixtures. Although there is not a reference number for ETL's
- 187 guidelines, they generally harmonize with UL 8800, with minor additions.
- 188 Device manufacturers who use ETL for safety certification purposes will be
- 189 expected to be listed on the ETL Certification Directory, specifically as
- 190 Horticultural Fixtures.
- 191 • **Other safety organizations**
- 192 The DLC will work with other safety organizations to understand their rules
- 193 for horticultural products as necessary.



## 194 **Supporting Documentation**

### 195 **Test Reports:**

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

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

### 217 **Additional Application Details**

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

- 220 • A completed application form
- 221 • Specification sheets (or “cut sheets”) for the product
- 222 • Marketing brochures used to describe and sell the product
- 223 • Specification sheets for all drivers and fans employed in the product
- 224 • A self-certification statement, in the form of a digital signature made during  
225 the application process



- 226 • Safety certificates of compliance as issued by the relevant safety body,  
227 attested to by the self-certification statement above
- 228 • A completed TM-21 calculator must be provided for each LED device present  
229 in the fixture, with the applicable LM-80 and ISTMT information for that LED  
230 device

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

## 234 **Special Considerations for Spectrally Tunable** 235 **Devices**

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

- 239 • Products will be tested in full-output (“all channels on”) conditions. Test  
240 reports must specifically state that the product is operated in this mode  
241 during the testing, with a description of the control narrative to ensure that  
242 all photon emission is at its highest designed level.
- 243 • In addition to the “all on” condition, products will repeat a portion of the  
244 overall testing for each control channel, in which the channel under test will  
245 be set to the maximum designed output, while all other channels will be set  
246 to their minimum designed output for this state.
  - 247 ○ The output of the specific channel testing will be displayed in a SQD  
248 chart, with the per-channel test outcomes overlaid on the full-output  
249 chart. Additionally, the test report will present the name, PPF (400-  
250 700nm), and PF (280-800nm) for each of the single-channel scenarios,  
251 along with that of the “all on” condition. These data will support  
252 uniform presentation of information about the product’s spectral tuning  
253 range, aiding product selection and user acceptance.
- 254 • Products will provide user-facing documentation narrating the control  
255 protocol and input parameters employed in controlling the output.
- 256 • For PPF and PF maintenance evaluation:
  - 257 ○ Provisions for products utilizing multiple types of LEDs (above) must  
258 be followed.

- 259                   ○ ISTMT testing must be provided on the hottest of each of the LED  
260 types. This testing must be conducted in the hottest operating mode of  
261 the fixture, corresponding to the “all on” condition (i.e. full-output).

## 262 **Listing on the QPL**

263 Information noted in the requirements and testing above will be noted on the QPL.

264 For SQD and PPF Intensity Distributions, the QPL may allow users of the QPL to  
265 link, download, or view the data array directly for use in calculating specific metrics  
266 or modeling their intended lighting layout.

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