



Testing and Reporting Requirements for LED-based Horticultural Lighting

Version 2.1 – Draft 2

Proposed Effective Date: July 1, 2021

Text in yellow boxes indicates proposed changes from Version 2.0 that are open for comment.

Horticultural lighting products using LEDs 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”, “Hort QPL”). Products eligible for DLC qualification must be complete LED light fixtures or lamps. That is, they must be electromagnetic radiation-generating devices analogous to luminaires (or fixtures) or LED Lamps (Integrated and Non-Integrated) as defined by ANSI/IES LS-1 sections 6.8.5 and 10.3.1 or 6.8.5.3 and 6.8.5.4, respectively.

Definitions

Unless otherwise noted, DLC policy nomenclature directly references 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 LS-1-20, Lighting Science: Nomenclature and Definitions for Illuminating Engineering*, with key deviations or interpretations noted. Each mention of the term “LED device” in this document is meant to reference LED packages, modules, or arrays.

Eligibility

Products designed and intended to operate with standard North American nominal AC line voltages (typically 120V – 480V) or with DC voltages below 600V are eligible for DLC qualification. The following are further eligibility rules for horticultural lighting equipment:

- Products that are light engines (analogous to LS-1 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 for qualification at this time.



27 • Fixtures that incorporate light sources other than LED, whether as sole-source or as LED-hybrid
28 fixtures, are not eligible for qualification at this time.

29 • Manufacturers must list full and complete model numbers that clearly demonstrate all qualified
30 product options offered.

31 ○ “Full and complete model numbers” means model numbers that include all
32 performance-affecting and non-performance-affecting variations offered, and which do
33 not omit any option that is available to customers in the market. In general, options that
34 do not affect the performance of the product can be submitted as a single model
35 number, and the multiple options can be denoted by bracketing them in the model
36 number.

37 For example, a product that has multiple exterior paint color options or mounting
38 options that do not affect performance may include all color and mounting options in
39 brackets (e.g. "[WH, BLK, SLV, GRY]") within a single model number. Low and high
40 voltage options may be submitted as a single model number (e.g. "ABC 300 [120V-277V,
41 347V-480V] WH") with the worst-case performance reported. Multiple driver variations
42 may be included in single product applications, as noted above, and listed in a single
43 model number as long as they perform nominally the same. If the drivers perform
44 nominally differently – that is, they are not presented to customers as having the same
45 performance other than voltage input and result in different ordering codes – then the
46 unique drivers must be listed in separate model numbers. Options that affect the flux
47 output, presence or lack of dimming capabilities, or spectral tuning options cannot be
48 bracketed and submitted as a single model number.

49 ○ DLC reviewers may check web listings and other marketing materials and reserve the
50 right to request additional information to demonstrate the full and complete model
51 number. A lack of clarity in model numbers will result in delayed application processing;
52 misrepresentation of model numbers in the application process discovered outside the
53 application process will generally be considered a violation of the DLC program and
54 trademark rules.

55 ○ Each model number can only represent the fixture under a single brand. If the fixture
56 can be sold under multiple brands, model numbers must be listed separately for each
57 brand.

58 Testing Methods and Requirements

59 The DLC Technical Requirements for LED-based Horticultural Lighting are as follows. Details explaining
60 each item follow **Table 1**.

61 Table 1: DLC Horticultural Lighting Technical Requirements

Parameter/Attribute/Metric	Requirement	Requirement Type	Method of Measurement/Evaluation
Photosynthetic Photon Flux (Φ_p or PPF) ($\mu\text{mol} \times \text{s}^{-1}$)	n/a	Reported	(ANSI/IES LM-79) 400-700nm range, with 400-500nm, 500-600nm, and 600-700nm bins reported alongside the total
Far-Red Photon Flux ($\Phi_{p,fr}$ or PPF _{FR}) ($\mu\text{mol} \times \text{s}^{-1}$)	n/a	Reported	(ANSI/IES LM-79) 700-800nm range
Photon Flux (PF _{PBAR}) ($\mu\text{mol} \times \text{s}^{-1}$)	n/a	Reported (Optional)	(ANSI/IES LM-79) 280-800nm range
Spectral Quantum Distribution (SQD) ($\mu\text{mol} \times \text{s}^{-1} \times \text{nm}^{-1}$)	n/a	Reported	(ANSI/IES LM-79) (ANSI/IES TM-33-18) 400-800nm range
Photosynthetic Photon Intensity Distribution (I _p or PPID) ($\mu\text{mol} \times \text{s}^{-1} \times \text{sr}^{-1}$)	n/a	Reported	(ANSI/IES LM-79) (ANSI/IES TM-33-18) 400-700nm range
Photosynthetic Photon Efficacy (K _p or PPE) ($\mu\text{mol} \times \text{J}^{-1}$)	$\geq 1.90 \mu\text{mol} \times \text{J}^{-1}$	Required/Threshold	(ANSI/IES LM-79) 400-700nm range
Photon Efficacy (PE _{PBAR}) ($\mu\text{mol} \times \text{J}^{-1}$)	n/a	Reported (Optional)	(ANSI/IES LM-79) 280-800nm range
Photon Flux Maintenance, Photosynthetic (PFM _p)	Q ₉₀ $\geq 36,000$ hours	Required/Threshold	(ANSI/IES LM-80 / IES TM-21 or IES LM-84 / IES TM-28) 400-700nm range, fixture technical specification sheet, and <i>In-Situ Temperature Measurement Test</i> (ISTMT)

Parameter/Attribute/Metric	Requirement	Requirement Type	Method of Measurement/Evaluation
Photon Flux Maintenance, Far-Red (PFM_{FR})	Report time to Q ₉₀	Reported	(ANSI/IES LM-80 / IES TM-21 or IES LM-84 / IES TM-28) 700-800nm range
Driver Lifetime	≥50,000 hours	Required/Threshold	Driver technical specification sheet, fixture technical specification sheet, and <i>In-Situ Temperature Measurement Test</i> (ISTMT)
Fan Lifetime	≥50,000 hours	Required/Threshold	Fan technical specification sheet, fixture technical specification sheet
Warranty	5 years	Required/Threshold	Legal warranty terms & conditions
Power Factor (PF)	≥0.9	Required/Threshold	Benchtop electrical testing or ANSI/IES LM-79
Total Harmonic Distortion, Current (THDi)	≤20%	Required/Threshold	Benchtop electrical testing or ANSI/IES LM-79
Safety Certification	Horticultural Lighting designation by OSHA NRTL or SCC-recognized body	Required/Threshold	ANSI/UL 8800 (ANSI/CAN/UL 8800)

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63 **Output Characteristics:**

64 The DLC requires testing and reporting of the following characteristics for the output of horticultural
65 lighting devices.

- 66 • **Photosynthetic Photon Flux (Φ_p or PPF), (μmol × s⁻¹)**
67 This is the total output of the product over the specific range of wavelengths defined by
68 ANSI/ASABE S640 for PPF (400-700nm). This metric is an integrated value for the entire fixture
69 and contains no spectral or directional information.
70 The DLC Horticultural QPL reports on both the total and ~100nm-wide “bins” of flux within this
71 range to allow end users to understand the fixture’s relative proportions. Test information must
72 provide output in these ranges specifically, in addition to the total 400-700nm output.



- 73 • **Far-Red Photon Flux ($\Phi_{p,fr}$ or PF_{FR}), ($\mu\text{mol} \times \text{s}^{-1}$)**

74 This is the output of the product over the “far-red” band defined by ANSI/ASABE S640 (700-

75 800nm). This metric is an integrated value for the entire fixture and contains no spectral or

76 directional information. This metric is reported only and does not have a qualifying threshold.

77 The DLC Horticultural QPL reports on the total flux of this 100nm-wide band separately for end

78 users’ informational needs.
- 79 • **Photon Flux (PF_{PBAR}), ($\mu\text{mol} \times \text{s}^{-1}$)**

80 This is the output of the product over a plant’s “photobiologically active radiation” (PBAR)

81 wavelength range (280-800nm). This metric is an integrated value for the entire fixture and

82 contains no spectral or directional information. This metric is optionally reported only and does

83 not have a qualifying threshold.

84 The DLC Horticultural QPL reports on the total flux of this PBAR band specifically for end users’

85 informational needs. PF_{PBAR} is intended to convey UV, PAR, and FR radiation, which are often

86 associated with photomorphological effects in plants. PF_{PBAR} is not an ASABE S640 defined term

87 and is not required for DLC qualification, though it can be reported and listed if desired by

88 applicants.
- 89 • **Photon Efficacy (PE_{PBAR}), ($\mu\text{mol} \times \text{J}^{-1}$)**

90 This is the output of the product over a plant’s “photobiologically active radiation” (PBAR) band

91 (280-800nm) divided by the total electrical input watts to the fixture, including any other

92 ancillary loads (controllers, sensors, cooling fans, etc.) used within the lighting system. This

93 metric is an integrated value for the entire fixture and contains no spectral or directional

94 information. This metric is optionally reported only and does not have a qualifying threshold.

95 The DLC Horticultural QPL reports on the total flux of this PBAR band specifically for end users’

96 informational needs. PE_{PBAR} is intended to convey luminaire efficacy in converting electrical

97 energy into UV, PAR, and FR radiation, which are often associated with photomorphological

98 effects in plants. PE_{PBAR} is not an ASABE S640 defined term and is not required for DLC

99 qualification, though it can be listed if desired by applicants.
- 100 • **Spectral Quantum Distribution (SQD), ($\mu\text{mol} \times \text{s}^{-1} \times \text{nm}^{-1}$)**

101 This is the distribution of photon flux per photon wavelength over the photosynthetic and far-

102 red range of wavelengths defined by ANSI/ASABE S640 (400-800nm). The DLC will also accept

103 the distribution of photon flux per photon wavelengths over the PBAR range (280-800nm).

104 When reporting either of the optional PBAR metrics (i.e. PF_{PBAR} and PE_{PBAR}), distribution of

105 photon flux over the PBAR range is required. This distribution is measured and reported as

106 integrated in all directions from the fixture and contains no granular directional information

107 itself. This distribution must be measured and reported from an appropriately accredited

108 facility.

109 An image of this distribution must be submitted within the application in a .jpg graphical file

110 format, at a size of 300x300 pixels or larger. This image will be accessible to users on the QPL.

111 The DLC intends to utilize the required .xml file per ANSI/IES TM-33-18 to generate these images

112 in the future.

113 Please refer to the [TM-33-18 Reporting and Photometric/Spectral Reporting Alternatives](#) section
114 for additional information.

115 • **Photosynthetic Photon Intensity Distribution (I_p or PPID), ($\mu\text{mol} \times \text{s}^{-1} \times \text{sr}^{-1}$)**

116 This is the distribution of photosynthetic photon intensity per unit solid angle leaving the fixture.
117 This distribution is measured and reported as integrated for all wavelengths across the 400-
118 700nm range leaving the fixture and contains no spectral distribution information itself. This
119 distribution must be measured and reported from an appropriately accredited facility.

120 An image of this distribution is to be submitted within the application in a .jpg graphical file
121 format, at a size of 300x300 pixels or larger. This image will be accessible to users on the QPL.
122 The DLC intends to utilize the required .xml file per ANSI/IES TM-33-18 to generate these images
123 in the future.

124 Please refer to the [TM-33-18 Reporting and Photometric/Spectral Reporting Alternatives](#) section
125 for additional information.

126 *Note: The DLC will no longer accept distribution data that are developed through in-house*
127 *assessments. Products that were qualified prior to the V2.0 effective date must provide TM-33-*
128 *18 documents by December 31, 2021 to requalify to the V2.0 Technical Requirements, or the*
129 *products will be delisted.*

130 **Efficacy:**

131 The DLC requires testing and reporting of Photosynthetic Photon Efficacy (PPE), which is the output of
132 the fixture over the specific range of wavelengths defined by ANSI/ASABE S640 for PPF (400-700nm),
133 divided by the total electrical input watts to the fixture, including any other ancillary loads (controllers,
134 sensors, cooling fans, etc.) used within the lighting system.

135 All products are required to have a PPE of $\geq 1.90 \mu\text{mol} \times \text{J}^{-1}$. In both submitted applications and under
136 surveillance testing, the DLC allows an absolute tolerance of -5% to this threshold value. The result of
137 this is the DLC's acceptance of any test report showing an efficacy of $1.81 \mu\text{mol} \times \text{J}^{-1}$ or higher, and the
138 disqualification of any product, either during submission or surveillance testing, with a test report
139 showing an efficacy less than $1.81 \mu\text{mol} \times \text{J}^{-1}$, at any point in the product's specified operating voltage
140 range. All evaluations and listings of this measurement will be rounded to the nearest hundredth.

141 If a product contains multiple drivers:

- 142 • All driver specification sheets must be provided.
- 143 • For each unique driver used, manufacturers must provide electrical testing to document which
144 driver variation results in the overall minimum K_p (PPE) or worst-case driver efficiency, as well as
145 which variation results in the overall worst-case power quality (THDi and PF).
 - 146 ○ This testing must include the input current and wattage; the output voltage, current,
147 and wattage; and the THDi and PF for each driver, at each nominal input voltage.
 - 148 ○ In-house (i.e. non-accredited lab) benchtop electrical testing is sufficient for
149 demonstrating the driver variation that yields the overall minimum K_p (PPE) and

- 150 minimum power quality at the applicable loading conditions and at the applicable input
151 voltages.
- 152 ○ From this electrical characterization testing, the product and conditions representing
153 worst-case efficacy must undergo formal whole-fixture LM-79 testing by an accredited
154 testing lab.
 - 155 ○ For questions about testing requirements for family grouping applications, please refer
156 to the [Family Grouping Application Requirements for LED-based Horticultural Lighting](#)
157 [policy](#).
 - 158 ● Drivers that result in explicitly different nominal fixture performance (for example, if a driver
159 change results in different flux output by the product, determined at the DLC's discretion) are
160 not permissible variations within a single model number and are required to submit a family
161 grouping application for QPL listing. If alternate driver variations result in different input
162 wattage, worst-case will be published on the QPL.
 - 163 ○ Please refer to the [Family Grouping Application Requirements for LED-based](#)
164 [Horticultural Lighting policy](#) for specific testing and reporting requirements for product
165 families.

166 Long-Term Performance:

167 The DLC requires the following performance data to characterize the long-term performance of the
168 fixture:

- 169 ● **Flux Maintenance, Φ_p (PPF) and $\Phi_{p,fr}$ (PF_{FR})**

170 This is a characterization of the ability of the device to maintain its output within the given
171 parameters over time. Given that device output of interest is measured in quanta of photons,
172 and not in lumens, the DLC will use the general engineering term for quanta, "Q", instead of the
173 more-familiar "L" prefix used within general illumination applications.

 - 174 ○ The DLC requires either LED device-level or whole-fixture testing and projections in
175 accordance with the (LM-80 and TM-21) or (LM-84 and TM-28) industry standards
176 sufficient for a Q₉₀ of ≥36,000 hours within the Φ_p (PPF) range (400-700nm).
 - 177 ■ The "Q" in the Q₉₀ value is based strictly on the value shown in cell I42 of the
178 ENERGY STAR [TM-21 calculator](#) or cell I45 of the ENERGY STAR [TM-28 calculator](#).
 - 179 ○ All TM-21 or TM-28 projections must be made at the maximum ambient temperature on
180 the fixture's specification sheet. See [In-Situ Temperature Measurement Testing \(ISTMT\)](#)
181 information below for additional details.
 - 182 ○ The DLC requires testing and projections to report Q₉₀ for the $\Phi_{p,fr}$ (PF_{FR}) range of 700-
183 800nm, but does not make determinations or qualifications based on this data. Please
184 see a description of PFM_{FR}-specific testing requirements in the "[For fixtures using](#)
185 [multiple types of LEDs](#)" section below.
 - 186 ○ To support PFM_P and PFM_{FR} projections, LM-80/LM-84 information must be provided for
187 both the 400-700nm and the 700-800nm range.

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- All new product submissions using the LM-80/TM-21 approach are required to provide LM-80 data in appropriate (PPF, PF_{FR}) units, measured as such at all time points in the LM-80 procedure. The DLC reserves the right to request additional information for all reports referring to “photon flux” that are ambiguous (based on product SQD) about the division of said flux between the PPF and PF_{FR} categories to determine approval.
 - Products qualified with non-PPF units that were converted into PPF units during the provisional period (i.e. prior to V1.2) will be required to provide LM-80 data in appropriate units to requalify under the V2.0 Technical Requirements.
 - Provisionally qualified products will be allowed to update their listings to remove any caveats by submitting actual data by December 2021. The DLC will process these update applications through the month of December, 2021.
 - Products may not be qualified and listed on the QPL without long-term performance data for flux degradation. Products that use LEDs for which no LM-80 data is available are required to undergo LM-84 testing for TM-28 projections.
 - *In-Situ Temperature Measurement Testing (ISTMT):*
 - ISTMTs must be conducted and provided for the hottest LED in the fixture, and LED-device level drive current must be reported.
 - ISTMTs must be conducted and reported in the same manner as thermal testing for safety certification. Specifically, applicants must report the operating temperature of the LED at the fixture’s highest rated ambient temperature within the ISTMT report. This must be done in accordance with acceptable procedures from safety certification standards for measuring and projecting operating temperatures. For example, if a fixture is rated for operation at 40°C ambient, ISTMTs are not accepted if they only show the temperature of the LED when measured during a 25°C ambient condition. In this example, appropriate steps must be taken to characterize the LED operating temperature when the fixture is in a 40°C ambient environment, as defined by the thermal portions of the relevant safety standards.
 - For fixtures using multiple types of LEDs:
 - LM-80 reports (if being used instead of whole-fixture LM-84 data) must be provided for each type of LED device present in the fixture.
 - For DLC evaluations, LED “type” is differentiated by the nominal output of the LED device or the manufacturer of that LED device. For example, a fixture incorporating four different LEDs, with nominal emissions of 440nm, 660nm, 730nm, and a 5000K “white”, is required to provide four LM-80s and associated information for TM-21 projections, corresponding to each of these nominal designations. Some limited

229 cross-applicability of LM-80 data is allowed within phosphor-converted
230 white LEDs of the same series; see [LM-80 applicability](#) information
231 below.

- 232 ▪ ISTMT testing must be provided on the hottest of each LED type (for example,
233 the hottest blue, white, and red LED in the fixture, respectively).
- 234 ▪ Maximum LED drive current must be reported for each LED type.
- 235 ▪ For PFM_P (400-700nm), each LED type present in the fixture that has at least
236 25% of its per-device flux in the PPF range must independently meet the Q₉₀ ≥
237 36,000 hours requirement, as shown by a TM-21 calculation. The DLC does not
238 require device-level SQD data from applicants and will typically accept the
239 applicant’s descriptions of a device’s relative PPF while reserving the right to
240 request explanation.
- 241 ▪ The DLC requires calculated PFM_{FR} for all fixtures with a PF_{FR} output that is equal
242 to or greater than 5% of the fixture’s flux from 400-800nm. For PFM_{FR} (700-
243 800nm), each LED type present in the fixture that has at least 25% of its per-
244 device flux in the PF_{FR} range must report its Q₉₀ duration in hours. The DLC does
245 not require device-level SQD data from applicants and will typically accept the
246 applicant’s descriptions of a device’s relative PF_{FR}, while reserving the right to
247 require explanation. There is no threshold performance requirement across this
248 far-red range; it is a reported value only.

249 ○ LM-80 applicability:

- 250 ▪ For phosphor-converted “white” LEDs within the ANSI nominal chromaticity
251 range, the DLC follows the [ENERGY STAR Requirements for the Use of LM-80](#)
252 [Data](#) published September 2017. Consistent with the ENERGY STAR
253 requirements, for narrow-band emitters, the DLC generally requires an LM-80
254 for each distinct nominal product offered by an LED device manufacturer.
255 Devices of the same type but with different optical codes for beam spread are
256 allowed to cross-apply LM-80 testing. This also applies to products that are in
257 the same series with differences in nomenclature due to marketing changes
258 (see series provisions of ENERGY STAR requirements document). The DLC
259 reserves the right to require additional information to approve all claims of LM-
260 80 applicability.

261 ● **Warranty**

262 Products must have a manufacturer-provided product warranty of at least five years. The
263 warranty terms and conditions must be provided as part of the submittal for qualification. The
264 warranty must cover the complete luminaire and must clearly explain the terms and conditions
265 associated with the warranty. Note that “luminaire” includes light source, housing, heat sink,
266 power supplies, and other electrical components, optics, and any other components such as
267 cooling fans or controls (if present).

268 Warranty terms and conditions can vary widely from manufacturer to manufacturer. The DLC
269 explicitly defines a warranty period of five years and does not have specific requirements for

270 warranty claim terms (e.g. labor, recommissioning, etc.) other than those listed above. The DLC
271 does not verify or validate a manufacturer’s terms, conditions, or process for customer warranty
272 claims. The DLC does not monitor field failure rates of qualified products or warranty policy
273 redemption or history among manufacturers. Industry stakeholders are urged to review
274 warranty terms and conditions as part of the purchasing decision process.

- 275 • **Driver ISTMT**

276 Applicants must supply a technical specification sheet for the driver(s) they use in their product,
277 showing the lifetime of the driver based on operating temperature and the temperature
278 measurement point (TMP) for monitoring the operating temperature of the driver. In-situ
279 temperature measurement testing must be conducted, and a report must be provided with the
280 application showing an operating temperature consistent with the driver specification sheet
281 information and demonstrating that the driver will have a lifetime of at least 50,000 hours when
282 operating at or above the highest rated ambient temperature on the fixture’s specification
283 sheet.

284 As noted in the [ISTMT](#) description within the flux maintenance section, driver ISTMTs must be
285 conducted and reported in the same manner as thermal testing for safety certification.
286 Specifically, applicants must report the operating temperature of the driver at the fixture’s
287 highest rated ambient temperature within the ISTMT report. This must be done in accordance
288 with acceptable procedures from safety certification standards for measuring and projecting
289 operating temperatures. For example, if a fixture is rated for operation at 40°C ambient, ISTMTs
290 are not accepted if they only show the temperature of the driver when measured during a 25°C
291 ambient condition. In this example, appropriate steps must be taken to report the driver
292 operating temperature when the fixture is operating in a 40°C ambient environment, as defined
293 by the thermal portions of the relevant safety standards.

- 294 ○ For products that may use multiple drivers, specification sheets for each driver must be
295 provided with the details above. Testing must be conducted on each driver at its
296 appropriate worst-case input voltage. If a product uses multiple drivers from the same
297 manufacturer product line or series, then the single worst-case thermal ambient
298 environment of the product line or series requires a driver ISTMT. The DLC will operate
299 with the expectation that the operating condition at the highest wattage in the driver
300 manufacturer’s product line or series is the worst-case thermal ambient environment,
301 but the DLC may ask the manufacturer to provide detailed evidence to document the
302 worst-case driver thermals.

- 303 • **Fans**

304 Products that employ on-board cooling fans must provide a technical specification sheet for
305 each fan type employed in the product, family group, or spectral sub-group, as applicable. The
306 fan specification sheet must state the lifetime of the fan and a reference operating temperature
307 rating for that lifetime claim. The lifetime must be at least 50,000 hours, at an operating
308 temperature at or above the fixture’s highest rated ambient temperature.

309 If the product is available with multiple fan models:

- 310 ○ If fan model variations result in substantively different component temperature or
311 wattage consumption by the fixture (determined at the DLC's discretion), a family
312 grouping application is required with model numbers to represent the different fan
313 variations. DLC reviewers will examine fan model power levels and flow rate to
314 determine this distinction. Products that offer fan variations without substantively
315 different component temperature or wattage consumption by the fixture are allowed to
316 qualify using bracketed variations within a single model number.
- 317 ○ Multiple fan variations require a similar testing and reporting plan to multiple driver
318 variations, as noted in the efficacy section.

319 **Electrical Performance/Power Quality:**

320 The DLC requires testing and reporting of the following items to characterize the electrical performance
321 of the fixture:

- 322 • **Power Factor**
323 Products must have a measured power factor of ≥ 0.90 at any rated input voltage at full output
324 or non-dimmed state.
- 325 • **Total Harmonic Distortion, current (THDi)**
326 Products must have a measured THDi of $\leq 20\%$ at any rated input voltage at full output or non-
327 dimmed state.

328 For products with driver variations, including input voltage variations, electrical testing of each product
329 must be performed, sufficient to characterize the power quality of each driver, at its applicable nominal
330 input voltages and maximum designed output power. Testing to demonstrate that products are
331 compliant with the power factor and total harmonic distortion requirements may be done on an in-
332 house or benchtop setup for practical simplicity, and results must be documented and included in the
333 application materials. Please see the efficacy section regarding the use of this electrical testing for
334 worst-case efficacy driver variation determination. Please refer to the [Family Grouping Testing](#)
335 [Requirements for LED-based Horticultural Lighting policy](#) for specific testing and reporting requirements
336 for product families.

337 **Safety:**

338 Products must be certified by an OSHA NRTL or SCC-recognized body to ANSI/UL 8800 (ANSI/CAN/UL
339 8800) which is applicable for *horticultural lighting products* by that safety organization.

340 For illustrative and reference purposes, practices of acceptable safety organizations are described
341 below:

- 342 • **UL**
343 Fixture manufacturers who use UL for safety certification purposes are required to be listed on
344 the UL Certification Directory under the designation IFAU.

- 345 • **ETL/Intertek**
346 Fixture manufacturers who use ETL for safety certification are required to be listed on the ETL
347 Certification Directory, specifically as Horticultural Fixtures.
- 348 • **CSA Group**
349 Fixture manufacturers who use CSA for safety certification are required to be listed under CSA
350 Group's Classes defined for horticultural lighting equipment in Canada and the US.
- 351 • **TÜV SÜD**
352 Fixture manufacturers who use TÜV SÜD for safety certification are required to be listed on the
353 TÜV SÜD Certification Directory, specifically as a light fixture for use on horticulture purposes.
- 354 • **SGS**
355 Fixture manufacturers who use SGS for safety certification are required to be listed on the SGS
356 Certification Directory, specifically as horticultural lighting equipment.
- 357 • **Other safety organizations**
358 To be added to the DLC's approved list of safety organizations who certify horticultural lighting
359 equipment per ANSI/CAN/UL 8800 requirements, please contact horticulture@designlights.org.

360 **Special Considerations**

361 **Special Considerations for Spectrally-Tunable Products**

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

- 364 • The threshold-qualifying state to be tested must be the manufacturer-designed state with the
365 highest power consumption ("maximum power"). This may or may not be the same as an "all
366 channels on" condition, since fixtures may not be designed to use all their channels
367 simultaneously. Test reports must specifically indicate that the product is operated in this
368 "maximum power" condition during the testing, with a description of the control narrative to
369 ensure that the power state is at its maximum designed level.
- 370 • In addition to the "maximum power" condition, applicants must perform PPF testing for each
371 control channel, in which the channel under test must be set to the maximum designed output,
372 while all other channels must be set to their minimum designed output for this state. The test
373 report must present an identifying name of this channel and setting, the PPF (400-700nm total
374 and 400-500nm, 500-600nm, and 600-700nm "bins" PPF) and PF_{FR} (700-800nm) for each of the
375 single-channel scenarios, and a description of the control narrative to achieve each setting. For
376 each channel tested, a corresponding graphic for the SQD produced in that setting must be
377 provided in the application. Refer to the SQD section for reporting requirements.
 - 378 ○ The flux output of each specific channel testing is displayed on the DLC Horticultural
379 QPL, with the per-channel test outcomes and identifying information for each setting.
380 These data are intended to support standardized communication of information about
381 the product's spectral tuning range, aiding product selection and user acceptance.

- 382 • Applicants must provide user-facing documentation narrating the control protocol and input
383 parameters employed in controlling the output.
- 384 • For PFM_P and PFM_{FR} evaluation:
 - 385 ○ Provisions for products utilizing multiple types of LEDs must be followed as described in
386 the [For fixtures using multiple types of LEDs](#) section.
 - 387 ○ ISTMT testing must be provided on the hottest of each of the LED types. For each
388 unique LED type, ISTMT testing must occur at the operating mode that produces the
389 highest operating temperature in the fixture, for this LED type.
 - 390 ○ The DLC asks any applicants considering LM-84-based maintenance testing on a
391 spectrally-tunable fixture to contact horticulture@designlights.org to discuss their
392 proposed testing plan.

393 PROPOSED Special Considerations for DC-Powered Fixtures

394 Eligibility Information

395 Horticultural lighting fixtures powered by direct current (DC) are eligible for listing on the Horticultural
396 QPL. DC-powered fixtures include two types:

- 397 • **Modular fixtures where one or several AC-to-DC power source(s) supply(s) power to multiple**
398 **fixtures.** The power source(s) may have a minimum as well as a maximum number of fixtures
399 that they may serve. The AC-to-DC power source(s) may be attached to one of the fixtures or
400 may be located remotely from the fixtures. The power source(s) must be marketed by the
401 fixture manufacturer as the intended power source(s) for that specific fixture model or family.
- 402 • **Fixtures that operate on DC power, where an AC-to-DC power source is not marketed by the**
403 **fixture manufacturer as the intended power source.** These fixtures may be wired to an AC-to-
404 DC power source outside the fixture or in a separate room, or may be part of a DC-only
405 horticultural facility.

406 Technical Requirements Information

407 All V2 Horticultural Lighting Technical Requirements described in **Table 1** must be met in addition to the
408 following requirements, with exceptions as noted.

409 The following requirements apply to applications for DC-powered fixtures, in place of the equivalent AC
410 testing and reporting:

- 412 • **DC-Powered “All-on” Photon Flux Test Report:** Applicants must provide an LM-79 report in PDF
413 format from an accredited third-party test lab with all required photon flux and power values for
414 verification, including DC voltage, current, and power. For dimmable or tunable products, this is
415 the test report of the product at its maximum (non-dimmed) power state.
- 416 • **Tested Power Source Report:** If power sources are marketed with the DC-powered fixture,
417 applicants must provide a table of the following performance values for all drivers offered for

418 sale with the DC fixture. These values may come from benchtop testing (measurements
419 performed by a manufacturer that are not from a certified testing lab). All values must be
420 provided at the minimum and maximum AC input voltages for each driver, as well as at each DC
421 output voltage utilized by the DC-modular fixture (if multiple). A power source specification
422 sheet or other documentation from the power source manufacturer with numerical values listed
423 for each load point may satisfy this requirement, in place of testing.

- 424 ○ Performance values must be provided at each of three load points as determined by the
425 fixture manufacturer (or two load points for power sources that are specified as not
426 allowing loading below 50%):

- 427 ▪ Maximum rated power load
- 428 ▪ 50% of maximum load
- 429 ▪ 20% of maximum load, or the minimum loading specified on the fixture
430 specification sheet if that loading is between 20% and 50%.
- 431 ▪ If the fixture specification sheet specifies minimum loading above 50%,
432 performance values must be provided at full power and at that minimum
433 loading percentage. For example, the minimum load may be specified by
434 minimum requirements such as:
 - 435 – One fixture on a given power source: “30% load for a 100W power
436 source that may power one to three 30W fixtures,”
 - 437 – A minimum number of fixtures per power source specified on the
438 fixture specification sheet: “60% load for a 100W power source that
439 may power either two or three 30W fixtures,” or
 - 440 – A loading requirement for a given power source listed on the fixture
441 specification sheet: “Required operating range of 15-90W output at
442 100W input power.”

- 443 ○ Performance values to be reported in the benchtop test report:

- 444 ▪ Input power demand, shown to the nearest hundredth of a watt
- 445 ▪ DC output power demand, shown to the nearest hundredth of a watt
- 446 ▪ Electrical efficiency (driver output power demand divided by driver power
447 demand), shown as a percentage to two decimal places
- 448 ▪ Power factor, shown to three decimal places
- 449 ▪ Total harmonic distortion of the current waveform as a percentage, shown with
450 one decimal place

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- The following example shows this table for a single power supply:

Manufacturer Name		Model Number		AC Input Voltage Range (V)		DC Output Voltage Range (V)	
ABC Corp.		ABC123		120-277		48	
Input Voltage (V)	Output Power Range (W)	Loading Percentage (%)	Tested Input Power (W)	Tested Output Power (W)	Tested Efficiency (%)	Power Factor	Total Harmonic Distortion (current) (%)
120	300-3000	100	3115.2	3000.0	96.30	0.932	5.0
		50	1610.1	1500.1	93.17	0.928	4.1
		20	677.6	600.0	88.55	0.914	4.0
		Mfgr Minimum	N/A	N/A	N/A	N/A	N/A
277	300-3000	100	3098	3000.0	96.84	0.932	5.6
		50	1600.8	1500.1	93.71	0.927	5.7
		20	665.1	600.0	90.21	0.911	5.9
		Mfgr Minimum	N/A	N/A	N/A	N/A	N/A

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- Fixtures that are not offered for sale with any AC-to-DC power source are not required to provide a tested driver report. These products will be listed with an assumed AC-to-DC conversion efficiency—see below.

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- Consistent with the Horticultural Technical Requirements, Driver ISTMT Reports are required for all horticultural products sold with AC-to-DC or DC-to-DC power sources.

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- Fixtures that are not offered for sale with an AC-to-DC power source are not required to provide a Driver ISTMT Report.

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- Manufacturers shall provide information or specifications for DC cabling on the fixture specification sheets or supplemental marketing documentation. Guidance for maintaining cabling losses to less than 2% for a fully loaded power supply shall be detailed.

462 QPL Listing Information for DC-powered fixtures

463 DC-powered fixtures will be listed on the Horticultural Lighting QPL with the following differences from
464 AC-powered fixtures:

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- New fields will be reported:

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- **“System Type”** will be distinguished between AC and DC products.
- **“DC Input Voltage”** and **“DC Input Current”**, from DC-powered LM-79 for both DC-powered fixture types.
- **“DC Input Power”** and **“DC Photosynthetic Photon Efficacy: 400-700 nm, μmol/J (DC PPE)”** will display the values from the all-on DC photon flux report.

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- Optional new field **“DC PE_{PBAR}”** will be reported if PE_{PBAR} is reported.

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- New fields will display **“AC De-rated Input Power”** and **“AC De-rated PPE”** only for DC-powered fixtures.

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- Additionally, DC-powered fixtures marketed with any AC-to-DC power source will reflect the power efficiency of the AC-to-DC conversion at the load

513 **fully-loaded power supply.”** Is this cabling example useful in a listing for QPL users? Is there a
514 better listing field to demonstrate to QPL users the differences among fixtures in possible
515 cabling, DC voltage, DC current, and parallel or series wiring? Should there be any requirements
516 for cabling examples in product literature?

517 3. In response to industry outreach, the DLC has proposed that cabling information be reported to
518 maintain cabling to less than 2%. Does this reflect industry best practices? If not, to what
519 percentage should cabling losses be maintained?

520 4. Is the proposed method for listing de-rated values for fixtures not offered for sale with any
521 power source appropriate?

522 5. Is it beneficial to list de-rated AC values for Input Power and PPE, in addition to DC values? Are
523 AC values for a worst-case configuration useful in evaluating proposed horticultural lighting
524 systems? Or are system evaluators, such as custom incentive program engineers, more likely to
525 use manufacturer-provided information to calculate power and PPE at the actual load
526 conditions, driver configuration, and input voltage of the system under consideration?

527 6. Are the performance data values required for the power source table available from power
528 source manufacturers?

529 7. The proposed requirements would offer no information on power source efficiency below 20%
530 load condition. Is it important to capture power source efficiency below 20% loading, and if so
531 where does this load condition exist in horticultural lighting applications? What minimum
532 loading percentage would reflect this real-world use for AC-de-rated reporting?

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PROPOSED Special Considerations for Externally Supplied Actively Cooled Fixtures

Eligibility Information

- LED horticultural fixtures that employ externally supplied circulating liquid are eligible with the following conditions described below. LED horticultural fixtures that employ externally supplied ducted forced air are not eligible at this time. For simplicity, Version 2.1 may refer to eligible externally supplied actively cooled fixtures as 'actively cooled'.
- The DLC defines externally supplied circulating liquid cooled horticultural fixtures to be products in which liquid, often water or a water/glycol solution, flows through input and output ports of each fixture in the system, being channeled through a cooling plate or other heat exchanger within the fixture.

Technical Requirements Information

- All V2 Horticultural Lighting Technical Requirements described in **Table 1** must be met in addition to the following requirements and clarifications:
 - Manufacturers must specify information regarding allowable operating conditions that affect product performance, including:
 - **Solution type/concentration:**
 - Restrictions or limitations to allowable solution type/concentration shall be described in marketing material/specification sheets and reported on the Hort QPL.
 - **Inlet fluid temperature range:**
 - Minimum and maximum allowable operating inlet fluid temperatures shall be stated in marketing material/specification sheets and reported on the Hort QPL.
 - An image describing the graphical relationship between PPE and inlet fluid temperature covering the complete allowable inlet fluid temperature range shall be provided and reported on the Hort QPL.
 - Flow rate must be held constant across the temperature range and reported on the provided graph.
 - At a minimum, this image shall relate inlet fluid temperature (x-axis) to fixture PPE (y-axis) and must be submitted within the application in a .jpg graphical file format, at a size of 500x500 pixels or larger. This image will be posted on the Hort QPL.
 - All inlet fluid temperature values shall be reported in degrees Celsius.
 - **Self-Protect Cut-Off Functionality:**

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- This is the maximum inlet fluid temperature reached before actively cooled luminaires turn off to protect themselves from failure, in the event that the external cooling system fails.
- Self-protect cutoff temperature must be stated in manufacturer provided marketing material/specification sheet and shall be reported on the Hort QPL.
- LM-79 testing must employ water as the cooling liquid at an appropriate flow rate to maintain the targeted *median inlet fluid temperature* (i.e. middle allowable operating inlet fluid temperature) as defined by the luminaire manufacturer. Average and highest inlet fluid temperature measured during LM-79 testing (measured at fixture-level stabilization per LM-79) shall be provided and reported on the Hort QPL.
- ISTMT testing must employ water as the cooling liquid at an appropriate flow rate to maintain the targeted *worst-case inlet fluid temperature* (i.e. hottest allowable operating inlet fluid temperature) as defined by the luminaire manufacturer. Average and highest inlet fluid temperature measured during ISTMT testing (at stabilization) shall be provided and reported on the Hort QPL.
 - ISTMT reports must report temperature(s) at the fixture’s highest rated ambient temperature, when the highest-rated ambient temperature is greater than the ISTMT ambient temperature.
- All inlet fluid temperatures must be maintained within a tolerance of +/- 2.5 degrees to the target temperature during LM-79 and ISTMT testing.
- Flow rate in terms of gallons per minute (GPM) must be measured during LM-79 testing, with the average and highest flow rate measurements being provided and reported on the Hort QPL.
- Outlet fluid temperature must be measured during LM-79 testing, with the average and highest outlet fluid temperature reported on the Hort QPL.
- To support the qualification of *externally* supplied circulating liquid cooled horticultural fixtures, the DLC will accept LM-79 gonioradiometric testing with methods or equipment from Type C gonimeters and other gonioradiometer types.
 - All *externally* supplied circulating liquid cooled horticultural fixtures seeking qualification by the DLC must test the fixture per ANSI/IES LM-79, including requirements specific to, but not limited to, stabilization and optical measurements, while employing active cooling.

605 QPL Listing Information

606 In addition to the existing fields, *externally* supplied actively cooled fixtures will have the following
607 information listed on the QPL:

- 608 • **“System Type”**
 - 609 ○ *Externally* supplied circulating liquid cooled horticultural fixtures will be distinguished as
610 an AC or DC product, as appropriate, and active cooling presence will be designated as
611 such on the Hort QPL (e.g. as a filterable field)
- 612 • **“Tested Inlet Fluid Temperature” and “Tested Flow Rate”**
 - 613 ○ Maximum measured inlet fluid temperatures and flow rates per ISTMT and LM-79
614 testing
- 615 ○ Average measured inlet fluid temperatures and flow rates per ISTMT and LM-79 testing
- 616 • Additional reporting fields, relating to the allowable operating conditions for the system
617 including:
 - 618 ○ **“Solution Concentration Restrictions”**
619 ○ **“Minimum Allowable Inlet Fluid Temperature” and “Maximum Allowable Inlet Fluid**
- 620
- Temperature”**
- 621 ○
- “Self-Protect Cut-Off Temperature”**
- 622 ○
- PPE vs. Allowable Inlet Fluid Temperature image**

623 Key Questions for V2.1 Draft 2, Externally Supplied Actively Cooled Fixtures

- 624 1. The DLC has proposed that *externally* supplied circulating liquid horticultural fixtures maintain
625 with +/-2.5 degrees C tolerance of the targeted (median or worst-case) inlet fluid temperature.
626 Do LM-79 accredited NRTLs have any concerns with maintaining inlet fluid temperatures within
627 +/-2.5 degrees C? If so, what tolerance would better align with industry best practices?
- 628 2. The DLC has proposed to collect and report an image that displays luminaire-level PPE as a
629 function of inlet fluid temperature to inform our stakeholders about the potential impact the
630 external cooling system design can have on luminaire-level efficacy. Is an image the preferred
631 way for reporting this information on the Hort QPL? If not, what format would be more useful to
632 QPL users?
- 633 3. To support testing of actively cooled products while employing the cooling system, the DLC has
634 proposed to allow LM-79 testing with other than Type C gonioradiometers, which is in conflict
635 with LM-79 requirements which require Type C gonioradiometers . What concerns, if any, are
636 there for NRTLs testing to LM-79 requirements with non-Type C gonioradiometers for actively
637 cooled products?
- 638 4. What, if any, additional considerations should be made for listing eligibility of *externally*
639 supplied circulating liquid cooled horticultural fixtures?

PROPOSED Special Considerations for LED Replacement Lamps

Eligibility Information: Linear Replacement Lamps

LED replacements for linear fluorescent lamps are eligible with the following conditions:

- The DLC defines all tube-style LED products that use lamp holders (i.e. sockets or tombstones) in the luminaire to mechanically and/or electrically connect to the fixture housing and electric supply to fall under these testing requirements. Products that do not employ lamp holders are not eligible as lamps under this policy.
- The following linear lamp types (i.e. T8, T5, or T5HO) and specific lengths are eligible for listing. Marketing material shall indicate that they are intended to replace fluorescent lamps of the same type and length. Products of different lengths, bases, or marketed as intended to replace other types of fluorescent lamps are not eligible. Products intended to operate on magnetic ballasts or those with different base types are not eligible.
 - **T8 Two-Foot Linear Replacement Lamps**
 - LED lamps intended to replace T8 fluorescent lamps. These LED lamps shall be 24 inches long and employ a G13 base.
 - **T8 Four-Foot Linear Replacement Lamps**
 - LED lamps intended to replace T8 fluorescent lamps. These LED lamps shall be 48 inches long and employ a G13 base.
 - **T8 Eight-Foot Linear Replacement Lamps**
 - LED lamps intended to replace T8 fluorescent lamps. These LED lamps shall be 96 inches long and employ a FA8 base.
 - **T5 Four-Foot Linear Replacement Lamps**
 - LED lamps intended to replace T5 fluorescent lamps. These LED lamps shall be 46 inches long and employ a G5 base.
 - **T5HO Four-Foot Linear Replacement Lamps**
 - LED lamps intended to replace T5HO (High Output) fluorescent lamps. These LED lamps shall be 46 inches long and employ a G5 base.
- The following UL Types A, B, Dual Mode (AB) and C are eligible for listing.
 - **Replacement Lamps (UL Type A):**
 - Products in this primary use designation employ lamp holders to connect to the fixture being retrofitted and are designed to be "plug and play" replacements for fluorescent lamps. That is, products in this category operate utilizing an existing fluorescent ballast, and do not require mechanical or electrical changes to the fixture.
 - **Internal Driver/Line Voltage Lamp-Style Retrofit Kits (UL Type B):**

- 675 ▪ Products in this category employ lamp holders to connect to the fixture being
676 retrofitted, but do not operate utilizing the existing fluorescent ballast. These
677 products require rewiring of the existing fixture to bypass the ballast and send
678 line voltage directly to the lamp holders.
- 679 ○ **Dual Mode Internal Driver (UL Type A and Type B):**
- 680 ▪ Products in this category operate utilizing the existing fluorescent ballast and
681 also have the ability to operate utilizing line voltage if the fixture is rewired to
682 bypass the ballast. These products connect to the fixture using standard pin-
683 base connections to the lamp holders.
- 684 ○ **External Driver Lamp-Style Retrofit Kits (UL Type C):**
- 685 ▪ Products in this category employ lamp holders to connect to the fixture being
686 retrofitted, do not operate utilizing the existing fluorescent ballast, and require
687 rewiring of the existing fixture to replace the ballast with an external driver (e.g.
688 the driver is internal to the fixture but external to the lamp). The lamp holders
689 are then wired to receive only the low-voltage electricity that is supplied by that
690 driver.
- 691 ▪ For Type-C lamp systems with non-identical lamps, *Special Considerations for*
692 *Linear Replacement Type-C Lamp Systems with Non-Identical Lamps* as written
693 in the [SSL Testing and Reporting Requirements for Linear Replacement Lamps](#)
694 apply.
- 695 ● The DLC defines bare lamp as the performance characteristics of a replacement lamp, including
696 the effects of an external ballast (for Type A and Dual Mode lamps) or driver (for Type C lamps),
697 if applicable, when operated outside of a luminaire or retrofit kit.

698 **Technical Requirements Information: Linear Replacement Lamps**

- 699 ● Linear replacement lamps seeking horticultural lighting qualification must test the bare lamp
700 according to LM-79 to meet all V2 Horticultural Lighting Technical Requirements as described in
701 **Table 1**, except for Driver Lifetime:
 - 702 ○ Instead of Driver Lifetime:
 - 703 ▪ Lamps must perform In-Situ Temperature Measurement Test (ISTMT) and
704 report at the product’s highest rated ambient temperature using a location on
705 the lamp housing, designated by its manufacturer, which will have the highest
706 temperature of any point on the lamp during normal operation.
 - 707 ▪ Applicants must supply a technical specification sheet for their product,
708 showing the lifetime based on the given location’s operating temperature and
709 an image/diagram showing the temperature measurement point (TMP) for
710 monitoring the operating temperature.
 - 711 ▪ In-situ temperature measurement testing must be conducted, and a report
712 must be provided with the application showing an operating temperature

713 consistent with the specification sheet information and demonstrating that the
714 lamp will have a lifetime of at least 50,000 hours when operating at or above
715 the highest rated ambient temperature on the lamp’s specification sheet.

716 Eligibility Information: Screw-Base Replacements for HID Lamps

717 LED replacements for mogul-base high intensity discharge (HID) lamps are eligible with the following
718 conditions:

- 719 • The DLC accepts Horticultural QPL applications for mogul (E39 and E40) screw-base replacement
720 lamps. UL Type B products, which require removal of the existing ballast from the circuit and the
721 lamp holder to be wired with line voltage, are eligible.
 - 722 ○ Other base types and UL Types are not eligible at this time.
 - 723 ○ Lamps with [Field-adjustable light distribution](#) are not eligible at this time.

724 Technical Requirements Information: Screw-Base Replacements for HID Lamps

- 725 • Screw-base replacements for HID lamps seeking horticultural lighting qualification must test the
726 bare lamp according to LM-79 to meet all V2 Horticultural Lighting Technical Requirements as
727 described in **Table 1**, except for Driver Lifetime, as with Linear Replacement Lamps (see above).
- 728 • Screw-base replacements for HID lamps can be generally omni-directional (the DLC defines
729 omni-directional as a product that emits radiation in all directions except in the base direction)
730 or directional. Manufacturers must self-designate the lamp type using the “Lamp Category”
731 field.
 - 732 ○ Screw-base replacements for HID lamps must report beam angle and field angle during
733 the application process. This information will be displayed on the QPL.
- 734 • Screw-base replacements for HID lamps must report intended mounting position. PPID polar
735 plots must include tested mounting position.

736 QPL Listing Information: All Replacement Lamps

737 In addition to existing fields, replacement lamps will have the following information listed on the
738 Horticultural Lighting QPL:

- 739 • **“Lamp Category”**
 - 740 ○ Options include: Linear Replacement Lamp; Screw-Base Replacements for HID Lamps -
741 Omni-Directional; or Screw-Base Replacements for HID Lamps - Directional
- 742 • **“Base Type”**
 - 743 ○ Options include: G13, G5, FA8, E39, E40
- 744 • **“Product Size Information”**
 - 745 ○ Linear replacement lamps must include the nominal length in inches

- 746 ○ Screw-base replacements for HID lamps must include product dimensions as Maximum
- 747 Overall Length (including base) x width/diameter x height
- 748 ● “UL Type”
- 749 ○ Options for Linear Replacement Lamps include: UL Type A, UL Type B, Dual Mode (UL
- 750 Type AB), UL Type C
- 751 ○ Options for Screw-base replacements for HID lamps include: UL Type B
- 752 ● “Beam Angle”
- 753 ● “Field Angle” (Screw-Base Replacements for HID Lamps only)
- 754 ● “Intended Mounting” (Screw-Base Replacements for HID Lamps only)
- 755 ○ Options include: horizontal, vertical, or universal

756 Key Questions for V2.1 Draft 2, LED Replacement Lamps

- 757 1. In stakeholder comments on Draft 1, the DLC heard that lamps cannot meet the driver lifetime
- 758 requirements in Table 1 because circuitry for most lamps is often integrated into the electronics
- 759 of the lamp, therefore there is not a single element to make the claim nor perform the
- 760 testing/documentation. As such, in Draft 2 lamps are exempt from meeting the driver lifetime
- 761 requirements but must still have a product lifetime of at least 50,000 hours and perform ISTMT
- 762 at a manufacturer designated location. **Is this lifetime requirement reasonable? If not, please**
- 763 **provide justification to support your rationale.**
- 764 2. In stakeholder comments on Draft 1, the DLC heard that lamps may have difficulty meeting the
- 765 Photon Flux Maintenance requirement of $Q90 \geq 36,000$ hours and/or the warranty requirement
- 766 of 5 years. **If these requirements are not reasonable for lamps, please provide a**
- 767 **recommendation of reasonable requirements and justification to support your rationale.**
- 768

769 **Tolerances**

770 The DLC accepts measurement tolerances to most metrics listed in the Technical Requirements. Please
771 refer to **Table 2** below for additional tolerance information.

772 **Table 2: DLC Horticultural Lighting Technical Requirements Tolerances**

Parameter/Attribute/Metric	V2.0 Tolerances
Photosynthetic Photon Efficacy	-5%
Power Factor	-3 percentage points
Total Harmonic Distortion	+5 percentage points
ISTMT Temperature Measurements	1.1°C or 0.4%, whichever is greater
LM-80 Drive Current	-5%

773
774 Tolerances are intended to account for all testing variation, rounding, and significant digits. The
775 requirement values and tolerances will be interpreted by DLC review staff as exact requirements. While
776 test labs will be expected to follow the requirements of their accreditation and relevant test standards,
777 DLC staff will not employ additional “rounding” to interpret values below the absolute thresholds as
778 passing. For example, if a horticultural lighting product is required to have a PPE of 1.9 with an efficacy
779 tolerance of -5%, any value for efficacy less than 1.81 will be interpreted as a failing value. It is the
780 applicant’s responsibility to check all data presented in an application before submission to ensure
781 compliance with the DLC requirements.

782 **Supporting Documentation**

783 **Test Reports**

784 The DLC requires that all testing be conducted at appropriately accredited laboratories except where
785 noted otherwise. Specifically:

- 786 • Testing of flux, intensity, and electrical characteristics must be conducted at laboratories that
787 are accredited to ISO 17025 and the appropriate reference test standard by accreditation bodies
788 that are signatories to the ILAC-MRA.

- 789 ○ Labs conducting whole-fixture performance testing must also follow the [DLC](#)
790 [requirements for LM-79 labs](#).
- 791 ● Labs conducting testing of device-level and/or fixture-level photon flux maintenance must also
792 follow the [DLC requirements for LM-80/LM-84 labs](#).
- 793 ● Labs conducting *In-Situ Temperature Measurement Testing* (ISTMT) must meet at least one of
794 the following:
- 795 ○ Approved by OSHA as Nationally Recognized Testing Laboratories (NRTLs)
- 796 ○ Approved through an OSHA NRTL data acceptance program or OSHA Satellite
797 Notification and Acceptance Program (SNAP)
- 798 ○ Accredited for ANSI/UL 1598 or CSA C22.2 No. 250.0-08, including Sections 19.7, 19.10-
799 16, by an accreditation organization that is an ILAC-MRA Signatory

800 **TM-33-18 Reporting and Photometric/Spectral Reporting Alternatives**

801 The DLC requires all applicants to submit accompanying .xml files per ANSI/IES TM-33-18 for each parent
802 or single product to represent the spatial and spectral distribution of the tested fixture.

- 803 ● The .xml file must be based on measured data from an accredited lab, accompanying the LM-79
804 testing requirements for spectral and spatial measurements.
- 805 ● The .xml file must include the spectral power distribution data, with an interval resolution of
806 5nm or smaller over the photosynthetic and far-red range of wavelengths defined by
807 ANSI/ASABE S640 (400-800nm). The DLC also requires the distribution of photon flux per photon
808 wavelengths over the PBAR range (280-800nm) in the case that applicants provide PF_{PBAR} and
809 PE_{PBAR} data. Spectral data in 1nm intervals are acceptable. The spectral measurement
810 represents the integrated flux in all directions from the fixture, without directional spectral
811 information. Per TM-33-18, the data is reported in W/nm, not spectral quantum distributions.
812 All DLC developed and interim manufacturer submitted SQD images will report in $\mu\text{mol} \times \text{s}^{-1} \times$
813 nm^{-1} .
- 814 ● The .xml file must also include the Photosynthetic Photon Intensity Distribution (PPID), reported
815 in $\mu\text{mol} \times \text{s}^{-1} \times \text{sr}^{-1}$, over the photosynthetic wavelengths defined by ANSI/ASABE S640 (400-
816 700nm). PPID is the distribution of photosynthetic photon intensity per unit solid angle leaving
817 the fixture. Each measurement is integrated across the 400-700nm range leaving the fixture and
818 contains no granular spectral distribution information (i.e. color over angle).

819 To facilitate time for accredited labs to develop or purchase TM-33-18 reporting software, the DLC
820 offers a 9-month grace period for applicants to provide .xml files compliant with TM-33 reporting for
821 parent products. If TM-33-18 reports are not available, applicants must submit LM-63 and TM-27 (i.e.
822 .ies and .spx files, respectively) for parent products or single products.

- 823 ● For manufacturers choosing to submit .ies and .spx files instead of .xml files in the interim
824 period, they must resubmit data compliant with TM-33-18 reporting requirements by December
825 31, 2021, or the products will be delisted.

- 826 • The .ies files must contain [_OTHER] keywords to describe the units of intensity values and a
827 conversion factor relating photosynthetic photon intensity to luminous intensity (conversion
828 factor = PPF/lumens).

829 **Additional Application Details**

830 In addition to the test data noted in the sections above, the DLC requires the following for all
831 submissions:

- 832 • A completed web-based application form
- 833 • Specification sheets (or “cut sheets”) for the product that include maximum ambient
834 temperature
- 835 • Specification sheets for all drivers and fans employed in the product, including lifetime-at-
836 temperature information
- 837 • Safety certificates of compliance as issued by the relevant safety body, attested to by the DLC
838 self-certification statement
- 839 • If demonstrating flux maintenance at the device-level, a completed TM-21 calculator must be
840 provided for each LED device present in the fixture, with the applicable LM-80 and ISTMT
841 information for that LED device. If demonstrating flux maintenance at the fixture-level, a
842 completed TM-28 calculator must be provided for the fixture, with the applicable LM-84
843 information accompanying it.

844 The DLC will only accept applications for products with testing on the product submitted, with only
845 limited variations permitted as detailed in the sections above. Given the multiple options within product
846 families, the DLC offers the [Family Grouping Application Requirements for LED-based Horticultural
847 Lighting policy](#), which describes a method to determine “worst-case” product family members.